Western Journal of Emergency Medicine

VOLUME 21, NUMBER 3, May 2020

PAGES 470-727

WestJEM

Volume 21, Number 3, May 2020 Open Access at *West*JEM.com ISSN 1936-900X

Western Journal of Emergency Medicine:

Integrating Emergency Care with Population Health

Indexed in MEDLINE

Contents continued on page iii

CALIFORNIA ACEP
AMERICAN COLLEGE OF EMERGENCY PHYSICIANS

ACOEP
The American College of Osteopathic Emergency Physicians

UC Irvine Health

CALAAEM
CALIFORNIA CHAPTER DIVISION OF THE AMERICAN ACADEMY OF EMERGENCY MEDICINE

A Peer-Reviewed, International Professional Journal

ACOEP stands with all emergency physicians and providers on the front line. We thank you for your tireless work and effort.

ACOEP
The American College of Osteopathic Emergency Physicians

www.acoep.org

Western Journal of *Emergency Medicine*:

Integrating Emergency Care with Population Health

Indexed in **MEDLINE, PubMed, and Clarivate Web of Science, Science Citation Index Expanded**

Official Journal of the California Chapter of the American College of Emergency Physicians, the America College of Osteopathic Emergency Physicians, and the California Chapter of the American Academy of Emergency Medicine

Available in MEDLINE, PubMed, PubMed Central, CINAHL, SCOPUS, Google Scholar, eScholarship, Melvyl, DOAJ, EBSCO, EMBASE, Medscape, HINARI, and MDLinx Emergency Med. Members of OASPA.
Editorial and Publishing Office: *West*JEM/Depatment of Emergency Medicine, UC Irvine Health, 333 City Blvd, West, Rt 128-01, Orange, CA 92868, USA
Office: 1-714-456-6389; Email: Editor@westjem.org

Western Journal of *Emergency Medicine*:

Integrating Emergency Care with Population Health

Indexed in **MEDLINE, PubMed, and Clarivate Web of Science, Science Citation Index Expanded**

Official Journal of the California Chapter of the American College of Emergency Physicians, the America College of Osteopathic Emergency Physicians, and the California Chapter of the American Academy of Emergency Medicine

Available in MEDLINE, PubMed, PubMed Central, Europe PubMed Central, PubMed Central Canada, CINAHL, SCOPUS, Google Scholar, eScholarship, Melvyl, DOAJ, EBSCO, EMBASE, Medscape, HINARI, and MDLinx Emergency Med. Members of OASPA.

Editorial and Publishing Office: *West*JEM/Depatment of Emergency Medicine, UC Irvine Health, 333 City Blvd, West, Rt 128-01, Orange, CA 92866, USA
Office: 1-714-456-6389; Email: Editor@westjem.org

Western Journal of *Emergency Medicine*:

Integrating Emergency Care with Population Health

Indexed in **MEDLINE, PubMed, and Clarivate Web of Science, Science Citation Index Expanded**

JOURNAL FOCUS

Emergency medicine is a specialty which closely reflects societal challenges and consequences of public policy decisions. The emergency department specifically deals with social injustice, health and economic disparities, violence, substance abuse, and disaster preparedness and response. This journal focuses on how emergency care affects the health of the community and population, and conversely, how these societal challenges affect the composition of the patient population who seek care in the emergency department. The development of better systems to provide emergency care, including technology solutions, is critical to enhancing population health.

Table of Contents

Policies for peer review, author instructions, conflicts of interest and human and animal subjects protections can be found online at www.westjem.com.

Western Journal **of** *Emergency Medicine*:
Integrating Emergency Care with Population Health
Indexed in **MEDLINE, PubMed, and Clarivate Web of Science, Science Citation Index Expanded**

Table of Contents *continued*

Western Journal of *Emergency Medicine*:
Integrating Emergency Care with Population Health
Indexed in **MEDLINE, PubMed, and Clarivate Web of Science, Science Citation Index Expanded**

Table of Contents *continued*

VITAL STATISTICS

Western Journal of Emergency Medicine (*West*JEM): Integrating Emergency Care with Population Health (*West*JEM) is the premier open-access Medline-indexed EM journal in the world. As the official journal of the California Chapter of the American College of Emergency Physicians (ACEP), American College of Osteopathic Emergency Physicians (ACOEP), and the California chapter division of the American Academy of Emergency Medicine (AAEM), the journal focuses on how emergency care affects health and health disparities in communities and populations. Additionally, *West*JEM focuses on how social conditions impact the composition of patients seeking care in emergency departments worldwide. *West*JEM is distributed electronically to 19,000 emergency medicine scholars and 2,800 in print. This includes 83 academic department of emergency medicine subscribers and 8 AAEM State Chapters.

Western Journal of *Emergency Medicine*:

Integrating Emergency Care with Population Health

Indexed in **MEDLINE, PubMed, and Clarivate Web of Science, Science Citation Index Expanded**

COUNCIL OF RESIDENCY DIRECTORS IN EMERGENCY MEDICINE

CALL FOR PAPERS

For The *Western Journal* of Emergency Medicine Special Issue in Educational Research and Practice

For more information go to:

http://westjem.com/cdem-cord-submission-guidelines

Submit your articles to WESTJEM.com today

All submissions due by 06/15/19

CALL FOR SECTION EDITORS

- Behavioral Health
- Cardiac Care
- Ultrasound
- Clinical Practice
- Pediatric Emergencies
- Public Health
- Trauma Care
- International Medicine
- ED Administration

Send your CV and letter of interest to editor@westjem.org

Learn more at www.westjem.org

WestJEM Integrating Emergency Care with Population Health

CPCEM Clinical Practice & Cases

Call for Reviewers!

Please send your CV and letter of interest to
editor@westjem.org

The Appropriate Use of Testing for COVID-19

Tony Zitek, MD

Kendall Regional Medical Center, Department of Emergency Medicine, Miami, Florida
Nova Southeastern University, Dr. Kiran C. Patel College of Allopathic Medicine, Davie, Florida

Section Editor: Christopher Tainter, MD
Submission history: Submitted March 23, 2020; Revision received April 5, 2020; Accepted April 9, 2020
Electronically published April 13, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.4.47370

Many public officials are calling for increased testing for the 2019 novel coronavirus disease (COVID-19), and some governments have taken extraordinary measures to increase the availability of testing. However, little has been published about the sensitivity and specificity of the reverse transcriptase-polymerase chain reaction (RT-PCR) nasopharyngeal swabs that are commonly used for testing. This narrative review evaluates the literature regarding the accuracy of these tests, and makes recommendations based on this literature. In brief, a negative RT-PCR nasopharyngeal swab test is insufficient to rule out COVID-19. Thus, over-reliance on the results of the test may be dangerous, and the push for widespread testing may be overstated. [West J Emerg Med. 2020;21(3)470–472.]

Disclaimer: Due to the rapidly evolving nature of this outbreak, and in the interests of rapid dissemination of reliable, actionable information, this paper went through expedited peer review. Additionally, information should be considered current only at the time of publication and may evolve as the science develops.

INTRODUCTION

A novel coronavirus disease (COVID-19), caused by SARS-CoV-2, has rapidly spread throughout many countries including the United States since its discovery in December 2019.[1] Many locations in the US are looking to rapidly expand their testing capabilities for this virus as they believe this could provide an important means to battle the COVID-19 pandemic.[2-6] However, the benefit of widespread testing depends on the accuracy of the test, and how the results of the test will affect treatment. For mild cases of COVID-19 (which are the primary target of the outpatient testing facilities), no specific medications are indicated, so in most cases, the results of the test would not change treatment. With regard to the accuracy of the test, the most commonly used test for detecting SARS-CoV-2 is a nasopharyngeal swab that uses a reverse transcriptase-polymerase chain reaction (RT-PCR) to identify viral RNA. Data from in vitro analyses suggest that the RT-PCR test is highly specific for SARS-CoV-2, as it is not positive when exposed to the nucleic acid of other common viruses.[7] Similarly, the in vitro sensitivity of RT-PCR tests is high, but in clinical settings the sensitivity of the nasopharyngeal RT-PCR swab tests for diagnosing COVID-19 is questionable. This article will review the clinical data regarding the accuracy of the COVID-19 RT-PCR test.

SUMMARY OF THE LITERATURE REGARDING COVID-19 TESTING

At this time, no peer-reviewed publications have reported a sensitivity and specificity of RT-PCR tests for COVID-19. One non-peer reviewed publication reports that, based on 87 Chinese patients who were ultimately diagnosed with COVID-19, pharyngeal RT-PCR tests have a sensitivity and specificity of 78.2% and 98.8%, respectively.[8] The sensitivity was 62.5% for "mild" cases.[8] While no other publications currently provide estimates of the sensitivity and specificity, several peer-reviewed publications have provided evidence of a substantial false negative rate with RT-PCR swab tests as described below.

First, a study by Wang et al took various types of specimens from 205 patients with confirmed COVID-19 and tested them with RT-PCR. Of 398 pharyngeal swabs, they found only 126 (32%) were positive. They took just eight nasal swabs, and found five (63%) were positive.[9] (As a side note, the US Centers for Disease Control and Prevention has reported that nasopharyngeal swabs seem to be more sensitive than oropharyngeal swabs, and thus recommends nasopharyngeal testing over oropharyngeal testing.[10]) Wang et al also analyzed specimens from bronchoalveolar lavage (BAL) fluid and sputum and found these were positive in 93% and 72% of cases, respectively.[9]

Along the same lines, Winichakoon et al published a letter to the editor in which they described a case of a COVID-19 patient who had a nasopharygeal/oropharyngeal RT-PCR swab that was negative for COVID-19, but RT-PCR of BAL fluid was positive.[11] Additionally, 19 cases of patients with suspected COVID-19 were reviewed in another small study. Oropharyngeal RT-PCR swab tests were performed in all 19 patients, but were positive in just nine (47.4%).[12]

Next, in a case series described by Xie et al, five patients from the Hunan province of China had ground-glass opacities on chest computed tomography (CT) that were suggestive of COVID-19, but initial pharyngeal RT-PCR tests were negative. Repeat RT-PCR swabs ended up being positive.[13] Similarly, Fang et al analyzed 51 patients who were ultimately confirmed to have COVID-19 who had both a chest CT and RT-PCR testing by either throat swab (45 patients) or sputum (six patients) upon admission to the hospital. Of those 51 patients, the chest CTs had characteristic findings of COVID-19 in 50 (98%). Comparatively, the initial RT-PCR test was positive in 36 of 51 (71%).[14]

Other studies have also demonstrated that initial RT-PCR tests may be negative and then become positive with repeated tests. For example, Wu et al studied the clinical course of 80 patients from the Jiangsu Province who were ultimately diagnosed with COVID-19. Nine of those 80 patients (11.3%) had two negative RT-PCR nasal or oral swabs before their third swabs came back positive.[15] Additionally, Young et al reported the results from daily nasopharyngeal RT-PCR testing that were taken from 18 patients from Singapore who were hospitalized for COVID-19. Interestingly, some patients had positive tests, and then negative tests, and then positive tests again, all within the same hospitalization.[16]

DISCUSSION

The sensitivity and specificity of nasopharyngeal swabs using RT-PCR for the diagnosis of COVID-19 cannot be precisely determined with the published data to this point. However, the available in vitro data along with minimal clinical data suggest that the test has very high specificity. On the other hand, the sensitivity is moderate (perhaps between 63-78%). Among the various ways of performing RT-PCR, pharyngeal swabs seem to have lowest sensitivity; nasal swabs may be a bit more sensitive than pharyngeal swabs. RT-PCR analysis of BAL fluid seems to be the most accurate means of virologic confirmation, but BAL fluid can only reasonably be collected on the sickest cohort of patients. For patients with moderate to severe COVID-19 symptoms, identifying characteristic findings on CT imaging of the chest may be more sensitive than RT-PCR testing.

Given these findings, when a patient has a high pretest probability for COVID-19, a negative test does not rule out the disease. Consequently, policies that assume a high accuracy of RT-PCR testing are perilous. For example, employers should not use a negative test result to decide when someone should return to work. Meanwhile, the perceived need for increased testing propagated by the popular media[17] may lead some patients to visit the ED solely for an unnecessary test, which could put those individuals at increased risk for COVID-19 if they do not already have it. As there is no treatment needed for mild cases of COVID-19, patients with mild symptoms need not go to the emergency department or get testing; instead, they should self-quarantine.

Increased testing could be beneficial in areas of the world where there are very few cases of COVID-19. Aggressive early testing could allow for early identification of cases to allow for early targeted isolation and social distancing measures. However, in cities where COVID-19 is already widespread, the testing of large numbers of individuals with mild illness will have minimal effect on treatment but will require massive resources. There is epidemiological benefit to testing, but in cities already being devastated by COVID-19, the numbers of hospitalizations and mortalities associated with it can be used as indicators of disease impact. Reduced testing of patients with mild disease could save testing materials so that sicker patients and healthcare professionals will have access to testing. Additionally, a large amount of personal protective equipment could be saved by not attempting to test the many thousands and perhaps what will be millions of mild COVID-19 cases.

CONCLUSION

While the exact sensitivity and specificity of RT-PCR tests for COVID-19 are not known, it appears that a positive test is highly suggestive of true COVID-19, but a negative test does not rule out the disease. Patients and providers in epidemic areas should assume they have the disease if they have the signs and symptoms of the disease even if their test was negative. The push for increased testing in areas that already have widespread COVID-19 may be overstated, as the benefits of large-scale use of a moderate sensitivity test are minimal.

Address for Correspondence: Tony Zitek, MD, Kendall Regional Medical Center, Department of Emergency Medicine, 11750 SW 40th St., Miami, FL 33175. Email: zitek10@gmail.com.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Pneumonia of unknown cause — China. World Health Organization. Available at: https://www.who.int/csr/don/05-january-2020-pneumonia-of-unkown-cause-china/en/. Accessed April 5, 2020.
2. ABC 17 New Team. SUNDAY UPDATES: Number of Cole County COVID-19 cases rises to 4. Available at: https://abc17news.com/news/coronavirus/2020/03/22/sunday-updates-number-of-cole-county-covid-19-cases-rises-to-4/. Accessed March 22, 2020.
3. Mumphrey N. Orleans, Jefferson Parish testing sites expand to anyone showing symptoms of COVID-19. Available at: https://www.fox8live.com/2020/03/21/orleans-jefferson-parish-testing-sites-expand-anyone-showing-symptoms-covid-/. Accessed March 22, 2020.
4. Burbank D. Gov. Burgum announced new executive order to allow expanded COVID-19 testing. Available at: https://www.kfyrtv.com/content/news/Confirmed-North-Dakota-COVID-19-cases-increase-to-568997761.html. Accessed March 22, 2020.
5. Federal drive-thru COVID-19 site to expand testing criteria. Available at: https://www.coj.net/welcome/news/federal-drive-thru-covid-19-site-to-expand-testing. Accessed March 22, 2020.
6. Flechas J. COVID-19 testing site to open at Marlins Park as tests and supplies arrive in Miami. Available at: https://www.miamiherald.com/news/coronavirus/article241394686.html. Accessed March 22, 2020.
7. Corman VM, Landt O, Kaiser M, et al. Detection of 2019 novel coronavirus (2019-nCoV) by real-time RT-PCR. *Euro Surveill*. 2020;25(3): 2000045.
8. Ren X, Liu Y, Chen H, et al. Application and optimization of RT-PCR in diagnosis of SARS-CoV-2 infection. *medRxiv*. 2020. Available at: https://www.medrxiv.org/content/10.1101/2020.02.25.20027755v2 Accessed March 22, 2020.
9. Wang W, Xu Y, Gao R, et al. Detection of SARS-CoV-2 in different types of clinical specimens. *JAMA*. 2020. In press.
10. Interim Guidelines for Collecting, Handling, and Testing Clinical Specimens from Persons for Coronavirus Disease 2019 (COVID-19). Available at: https://www.cdc.gov/coronavirus/2019-nCoV/lab/guidelines-clinical-specimens.html. Accessed March 22, 2020.
11. Winichakoon P, Chaiwarith R, Liwsrisakun C, et al. Negative nasopharyngeal and oropharyngeal swab does not rule out COVID-19. *J Clin Microbiol*. 2020. In press.
12. Xie C, Jiang L, Huang G, et al. Comparison of different samples for 2019 novel coronavirus detection by nucleic acid amplification tests. *Int J Infect Dis*. 2020;93:264-7.
13. Xie X, Zhong Z, Zhao W, et al. Chest CT for typical 2019-nCoV pneumonia: relationship to negative RT-PCR testing. *Radiology.* 2020;200343. In press.
14. Fang Y, Zhang H, Xie J, et al. Sensitivity of chest CT for COVID-19: comparison to RT-PCR. *Radiology*. 2020;200432. In Press.
15. Wu J, Liu J, Zhao X, et al. Clinical characteristics of imported cases of COVID-19 in Jiangsu Province: a multicenter descriptive study. *Clin Infect Dis*. 2020. In Press.
16. Young BE, Ong SWX, Kalimuddin S, et al. Epidemiologic features and clinical course of patients infected with SARS-CoV-2 in Singapore. *JAMA*. 2020. In Press.
17. Siegler K. Many who need testing for COVID-19 fail to get access. Available at: https://www.npr.org/2020/04/03/826044608/many-who-need-testing-for-covid-19-fail-to-get-access. Accessed April 5, 2020.

Paradigm Shift for COVID-19 Response: Identifying High-risk Individuals and Treating Inflammation

Paul Kivela, MD, MBA The University of Alabama at Birmingham, Department of Emergency Medicine, Birmingham, Alabama

Section Editor: Mark I. Langdorf, MD, MHPE
Submission history: Submitted March 17, 2020; Revision received March 28, 2020; Accepted March 28, 2020
Electronically published April 13, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.3.47520
[West J Emerg Med. 2020;21(3)473-476.]

Disclaimer: Due to the rapidly evolving nature of this outbreak, and in the interests of rapid dissemination of reliable, actionable information, this paper went through expedited peer review. Additionally, information should be considered current only at the time of publication and may evolve as the science develops.

As an emergency and wellness physician, scientist, father, and 55-year-old man, I have a keen interest in the coronavirus and the resulting COVID-19/severe acute respiratory syndrome (SARS) CoV2 illness. Based on all I have heard from the scientific community, a review of the literature, and a review of historical facts related to other epidemics, I believe we are missing some key points, particularly with regard to how we are approaching prevention of morbidity and mortality. My opinion is the virus is not killing people, but rather the immune response to the virus. Perhaps we need to shift our thinking from screening and treating signs and symptoms to add risk stratifying, measuring, and treating inflammation. I think this approach needs to be seriously vetted. It might be used to screen not just our patients, but also our physicians and nurses to determine who should be seeing patients frontline vs remotely, which patients should be admitted, and which should be sent home.

In the 1918 influenza pandemic, roughly 25% of the world's population was infected and it caused between 50 million and 100 million deaths.[1] If we want to have a different outcome, we have to do something different. I agree that social distancing and quarantine are both key measures to flatten the curve (Figure 1) and slow transmission so that resources are not as overwhelmed. However, we must also consider novel approaches to treat patients who have been infected or may get infected while we wait for a vaccine.

To manage these patients appropriately we must examine the cause of the morbidity and mortality associated with COVID-19. Historically, we know viral infections mostly affect young children and the elderly. This is primarily due to these populations being very susceptible to dehydration. However, this novel virus largely spares the young and preys primarily on those over 40.

This graph in Figure 2 shows the age of those discharged vs died from the first 150 cases in Wuhan, China.[2] From the initial Chinese data, there were no deaths under age 40 with the first 150 patients. The Chinese Center for Disease

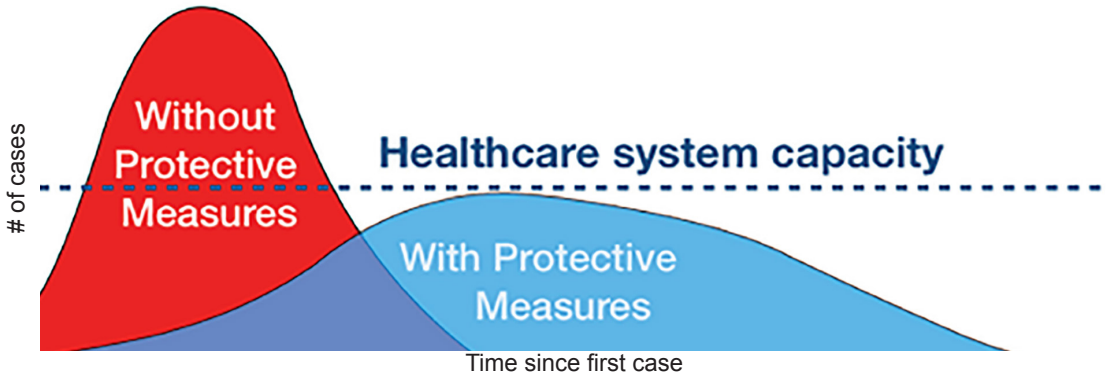


Figure 1. Using protective measures such as social distancing slows virus transmission and eases pressure on hospitals and providers. Adapted from the CDC/The Economist. Available at: https://www.nytimes.com/article/flatten-curve-coronavirus.html.

Control data show the mortality rate logarithmically increased as patients reach 40 years of age[3] (Table 1). Preliminary US and Italian data are similar with even more emphasis on older patients.[4]

Symptoms for younger people are generally mild and many are even asymptomatic. Figure 3 illustrates that the cause of death is from organ failure, usually the lungs or heart.[2] Therefore, we must look beyond complications of dehydration as a key factor and look at the body's immune response to this novel virus instead.

The immune response to this virus seems to be largely consistent with cytokine release syndrome (CRS/cytokine storm). CRS/cytokine storm is a severe systemic inflammatory response that can arise from multiple conditions including infectious and non-infectious diseases, including graft vs host disease, Ebola virus disease, smallpox, and even infusion reactions from certain medications. It is postulated that CRS/cytokine storm was the primary cause of mortality in the 1918 influenza pandemic, SARS, H5N1, and hantavirus outbreaks.

Signs and symptoms of CRS/cytokine storm are the same symptoms that critical COVID-19 patients are presenting with including fever, rapid respirations and heartrate, cough, shortness of breath, fatigue, loss of appetite, muscle and joint pain, nausea, vomiting, diarrhea, low blood pressure, seizures, headache, confusion, and delirium. We must go beyond treating this illness with supportive measures and also treat the inflammatory response to the virus. We have to shift our thinking as many physicians and healthcare workers are not familiar with CRS/cytokine storm.

What we know about seriously ill COVID-19 patients is that they develop a lymphopenia (low T-cell count) and bilateral pulmonary infiltrates, which is likely acute respiratory distress syndrome (ARDS/respiratory failure) and/or heart failure. Many critical patients have elevated cardiac enzymes, inflammatory markers (C-reactive protein [CRP]), and an elevated interleukin-6 (IL-6) level (Figure 4).[2] Testing patients for the virus is probably not enough. Furthermore, we should also consider using other screening tools that measure inflammation such as CRP, IL-6, and ferritin levels[5] so that we can identify those patients who are at higher risk of decompensating.

CRS/cytokine storm occurs when white blood cells are activated and release inflammatory signals (cytokines) that further activate more white blood cells. One of the key cytokines is IL-6, which is also involved in rheumatoid arthritis and several cancers. Traditionally, care for CRS has been supportive, addressing the symptoms of fever, oxygen,

Table 1. COVID-19 mortality rate by age.

Age Group	Mortality rate
80+ years old	14.8%
70-79 years old	8.0%
60-69 years old	3.6%
50-59 years old	1.3%
40-49 years old	0.4%
30-39 years old	0.2%
20-29 years old	0.2%
10-19 years old	0.2%
0-9 years old	None

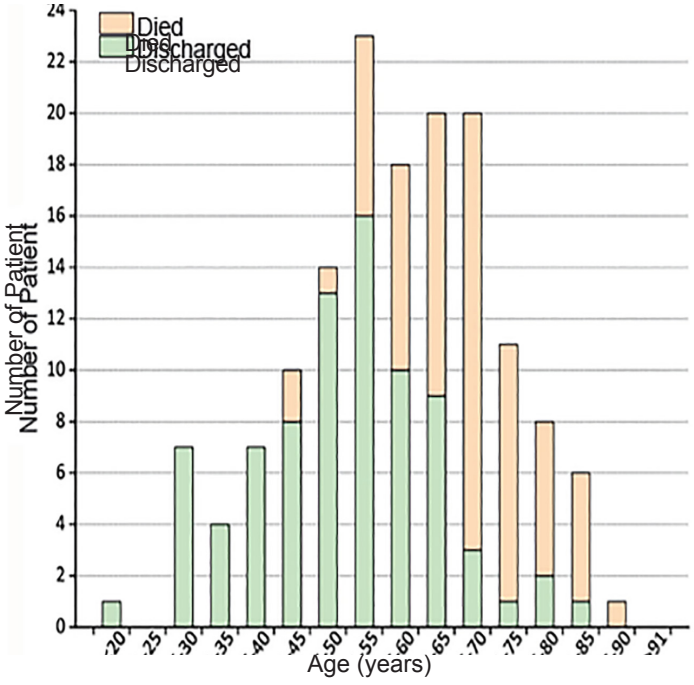
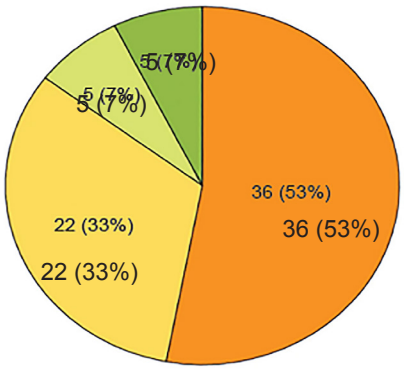


Figure 2. Age of discharged patients vs those who died among the first 150 cases of COVID-19 in China.[2]



Respiratory Failure
Respiratory Failure with Myocardial Damage/Heart Failure
Myocardial Damage/Heart Failure
Unknown

Figure 3. In COVID-19 patients the cause of death is primarily from organ failure, usually the lungs or heart.[2]

fluids, and medications to raise blood pressure. Traditionally, we have used nonsteroidal anti-inflammatory drugs and corticosteroids to treat severe CRS in people with ARDS; however, they have not been shown to have any significant effect on outcomes. Some human immunodeficiency virus medications may be promising but similarly have not yet been proven to be effective.

Biologics are likely the most useful medications in our arsenal to treat CRS/cytokine storm, as they have been shown to improve the immune response by decreasing IL-6. There are two biologic medications approved by the US Food and Drug Administration for anti-IL-6 therapy that may be useful for treating critical COVID-19 patients. Those medications include tocilizumab (Actemra), an antibody directed against the IL-6 receptor, and siltuximab (Sylvant), which is an anti-IL-6 chimeric monoclonal antibody. ACE inhibitors and ARB (angiotensin II receptor blockers) have also been shown to decrease IL-6 levels.[6]

Recent reports indicate that the US is studying azithromycin[7] and hydroxychloroquine.[8] Both of these medications have been found to decrease IL-6 levels. Some of these medications are being investigated and used in China,[9] but as a healthcare worker in the US I have not heard that of many who are considering using medications.

We should also take notice that this virus is disproportionately affecting older men and post-menopausal women. It is interesting that testosterone levels decrease after age 30 in men (and after menopause for women). Patients with low testosterone have elevated IL-6 levels, higher incidences of diabetes, high rates of obesity, and higher overall mortality. The *Journal of the American Geriatric Society* found that "older age, adiposity, slower walking speed, higher disease burden and white blood cell count were associated with increased risk of IL-6 elevation over a three-year period."[10] A study published in the journal *Clinical Endocrinology and Metabolism* concluded that "testosterone replacement shifts the cytokine balance to a state of reduced inflammation" and decreases IL-6.[11]

There is a long list of other substances and behaviors that can also potentially decrease IL-6 including the following[12]: Vitamin D3,[13] zinc,[14] magnesium,[15], probiotics,[16] aspirin,[17] fish oil/DHA,[18] and resveratrol,[19] to name a few. Conversely, diabetes, high blood sugar, high glycemic load foods, starchy foods, and potentially coffee can actually increase IL-6 levels.

So what can we do? I recommend that the public continue to adhere to recommendations set forth by government health officials, but go one step further and take steps to decrease inflammation by limiting sugary and fatty foods, exercising daily (preferably outdoors) and consider taking appropriate supplements to decrease IL-6 levels, and consider testosterone therapy especially in those individuals with low hormone levels.

I also recommend that physicians and healthcare providers continue to use supportive measures, but also consider screening by measuring inflammatory markers, risk-

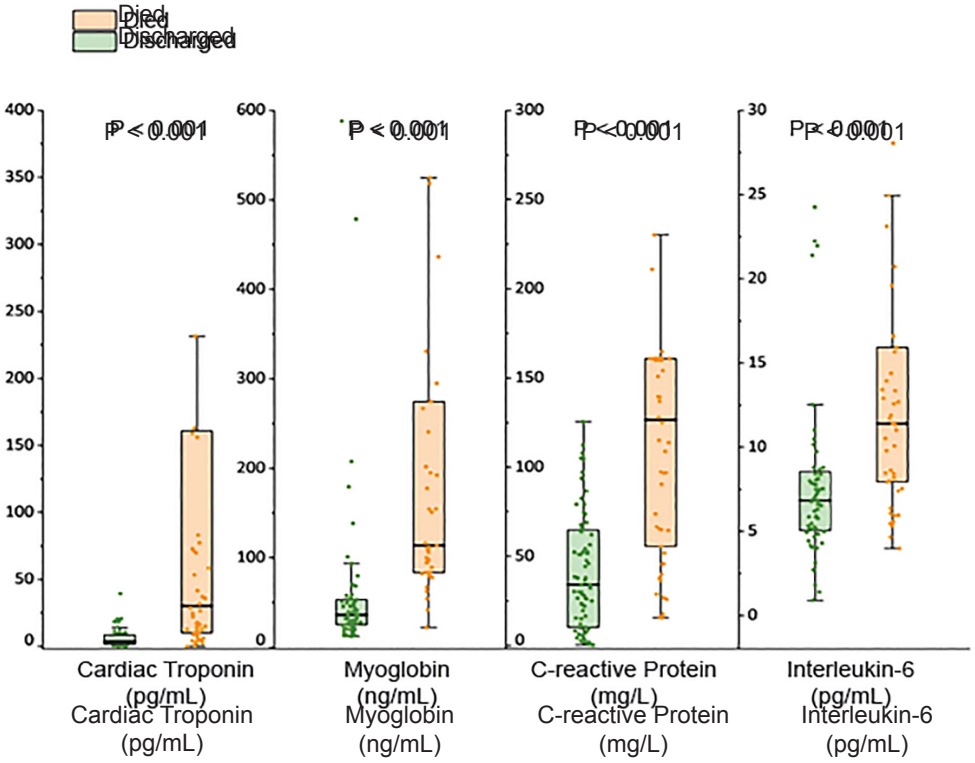


Figure 4. Inflammatory markers are indicative of higher mortality.[2]

categorizing individuals, treating the immune response to this virus, and studying anti-inflammatory therapies. We can also possibly use inflammatory markers to help risk-stratify which providers should be working on the frontline and which should work remotely. We cannot sit by idly waiting for a vaccine and simply use supportive measures as we get overwhelmed with patients. We must be brave and consider novel approaches to identify, triage, and manage patients affected by this novel virus.

Address for Correspondence: Paul Kivela, MD, MBA, The University of Alabama at Birmingham, Department of Emergency Medicine, 1922 7th Ave S, KB 321, Birmingham, AL 35233. Email: pkivela@uabmc.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. Paul Kivela, MD, MBA is a Clinical Professor at the University of Alabama at Birmingham. He is a Past President of California and National ACEP. He owns a concierge medical practice focused on optimizing health. The practice uses many modalities to reduce inflammation, including low glycemic diet, exercise, weight loss, vitamin supplementation, and bio-identical hormone replacement. He has no financial interest in any pharmacy or supplement company, receives no honoraria, educational grants, speaking fees, consultancies, and does not provide expert testimony or engage in patent-licensing arrangements. He has no financial interest (personal or professional) in the subject matter or materials discussed in this manuscript.

REFERENCES

1. 1918 Pandemic (H1N1 virus). Available at: https://www.cdc.gov/flu/pandemic-resources/1918-pandemic-h1n1.html. Accessed March 15, 2020.
2. Ruan Q, Yang K, Wang W, et al. Clinical predictors of mortality due to COVID-19 based on an analysis of data of 150 patients from Wuhan, China. *Intensive Care Med.* 2020. In press.
3. The Novel Coronavirus Pneumonia Emergency Response Epidemiology Team. The epidemiological characteristics of an outbreak of 2019 novel coronavirus disease (COVID-19) in China. *Zhonghua Liu Xing Bing Xue Za Zhi.* 2020;41(2):145-51.
4. Does the coronavirus think I'm old? Available at: https://nymag.com/intelligencer/2020/03/coronavirus-and-its-high-mortality-rate-among-older-patients.html. Accessed March 15, 2020.
5. Kell DB, Pretorius E. Serum ferritin is an important inflammatory disease marker, as it is mainly a leakage product from damaged cells. *Metallomics*. 2014;6(4):748-73.
6. Gamboa JL, Pretorius M, Todd-Tzanetos DR, et al. Comparative effects of angiotensin-converting enzyme inhibition and angiotensin-receptor blockade on inflammation during hemodialysis. *J Am Soc Nephrol.* 2012;23(2):334–42.
7. Bouwman JJ, Visseren FL, Bouter PK, Diepersloot RJ. Azithromycin inhibits interleukin-6 but not fibrinogen production in hepatocytes infected with cytomegalovirus and chlamydia pneumonia. *J Lab Clin Med*. 2004;144(1):18-26.
8. Willis R, Seif AM, McGwin G Jr, et al. Effect of hydroxychloroquine treatment on pro-inflammatory cytokines and disease activity in SLE patients: data from LUMINA (LXXV), a multiethnic US cohort. *Lupus*. 2012;21(8):830-5.
9. China backs use of Roche's Actemra for coronavirus. Available at: http://www.pmlive.com/pharma_news/china_backs_use_of_roches_actemra_for_coronavirus_1328014. Accessed March 5, 2020.
10. Zhu S, Patel KV, Bandinelli S, et al. Predictors of interleukin-6 elevation in older adults. *J Am Geriatr Soc*. 2009;57(9):1672-7.
11. Malkin CJ, Pugh PJ, Jones RD, et al. The effect of testosterone replacement on endogenous inflammatory cytokines and lipid profiles in hypogonadal men. *J Clin Endocrinol Metab*. 2004;89(7):3313-8.
12. Inhibiting interleukin-6 (IL-6): the key to health. Available at: https://selfhack.com/blog/interleukin-6/. Accessed March 17, 2020.
13. De Haes P, Garmyn M, Degreef H, et al. 1,25-dihydroxyvitamin D3 inhibits ultraviolet B-induced apoptosis, jun kinase activation, and interleukin-6 production in primary human keratinocytes. *J Cell Biochem*. 2003;89(4):663-73.
14. Hatakeyama D, Kozawa O, Otsuka T, et al. Zinc suppresses IL-6 synthesis by prostaglandin F2α in osteoblasts: Inhibition of phospholipase C and phospholipase D. *J Cell Biochem*. 2002;85(3):621-8.
15. Kim DJ, Xun P, Liu K, et al. Magnesium intake in relation to systemic inflammation, insulin resistance, and the incidence of diabetes. *Diabetes Care*. 2010;33(12):2604-10.
16. Rajkumar H, Kumar M, Das N, et al. Effect of probiotic lactobacillus salivarius UBL S22 and prebiotic fructo-oligosaccharide on serum lipids, inflammatory markers, insulin sensitivity, and gut bacteria in healthy young volunteers: a randomized controlled single-blind pilot study. *J Cardiovasc Pharmacol Ther*. 2015;20(3):289–98.
17. Kim SR, Bae MK, Kim JY, et al. Aspirin induces apoptosis through the blockade of IL-6-STAT3 signaling pathway in human glioblastoma A172 cells. *Biochem Biophys Res Commun*. 2009;387(2):342-7.
18. Vedin I, Cederholm T, Freund Levi Y, et al. Effects of docosahexaenoic acid–rich n−3 fatty acid supplementation on cytokine release from blood mononuclear leukocytes: the OmegAD study. *Am J Clin Nutr.* 2008;87(6):1616-22.
19. Kloesch B, Dietersdorfer E, Broell J, et al. The polyphenols curcumin and resveratrol effectively block IL-1β and PMA-induced IL-6, IL-8 and VEGF-A expression in human rheumatoid synovial fibroblasts. *Ann Rheum Dis.* 2012;71(S1):A90-A91.

Healthcare Ethics During a Pandemic

Kenneth V. Iserson, MD, MBA University of Arizona, Department of Emergency Medicine, Tucson, Arizona

Section Editor: Mark I. Langdorf, MD, MHPE
Submission history: Submitted April 3, 2020; Accepted April 3, 2020
Electronically published April 13, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.4.47549

As clinicians and support personnel struggle with their responsibilities to treat during the current COVID-19 pandemic, several ethical issues have emerged. Will healthcare workers and support staff fulfill their duty to treat in the face of high risks? Will institutional and government leaders at all levels do the right things to help alleviate healthcare workers risks and fears? Will physicians be willing to make hard, resource-allocation decisions if they cannot first husband or improvise alternatives?

With our healthcare facilities and governments unprepared for this inevitable disaster, front-line doctors, advanced providers, nurses, EMS, and support personnel struggle with acute shortages of equipment—both to treat patients and protect themselves. With their personal and possibly their family's lives and health at risk, they must weigh the option of continuing to work or retreat to safety. This decision, made daily, is based on professional and personal values, how they perceive existing risks—including available protective measures, and their perception of the level and transparency of information they receive. Often, while clinicians get this information, support personnel do not, leading to absenteeism and deteriorating healthcare services. Leadership can use good risk communication (complete, widely transmitted, and transparent) to align healthcare workers' risk perceptions with reality. They also can address the common problems healthcare workers must overcome to continue working (ie, risk mitigation techniques). Physicians, if they cannot sufficiently husband or improvise lifesaving resources, will have to face difficult triage decisions. Ideally, they will use a predetermined plan, probably based on the principles of Utilitarianism (maximizing the greatest good) and derived from professional and community input. Unfortunately, none of these plans is optimal. [West J Emerg Med. 2020;21(3)477–483.]

Disclaimer: Due to the rapidly evolving nature of this outbreak, and in the interests of rapid dissemination of reliable, actionable information, this paper went through expedited peer review. Additionally, information should be considered current only at the time of publication and may evolve as the science develops.

INTRODUCTION

Disasters recur on a regular basis. In any disaster, and especially in those caused by disease, the public expects healthcare professionals to be on the front lines. Indeed, most healthcare professionals expect that of themselves and their colleagues. In most disasters, and certainly during the current COVID-19 pandemic, frontline healthcare professionals face two key ethical issues: (1) whether to respond despite the risks involved; and (2) how to distribute scarce, lifesaving medical resources. In this paper, I discuss how healthcare professionals weigh risk factors related to their response and the actions the healthcare community can take, including proper communication and mitigating responder concerns, to maximize and maintain our caregiver workforce. I then very briefly discuss the ethics of scarce resources and suggest options, such as recalling retired clinicians to service, improvisation, and husbanding available resources to mitigate rationing.

ETHICAL ASPECTS OF THE CURRENT PANDEMIC

As COVID-19 devastates the world, bringing another feared and inevitable highly infectious pandemic to the current generation of healthcare professionals, we face a slew of ethical dilemmas. Some of our colleagues around the globe reportedly have already had to make resource-allocation decisions about which patients to treat. Others have had to struggle to provide lesser degrees of ("degraded") care. We have little direct control over these situations. Most of the world failed to recognize the

existential threat of this new coronavirus early enough to fully prepare institutional, local, regional, national, and international mobilization and response. Political expediency, hubris, scientifically ignorant leaders, and incomplete information led to this inadequate advance planning by minimizing the threat when it appeared, further delaying vital public health action.

At this point, the most vital ethical decision in our war against an unseen enemy is the one over which each of us has direct control: Will we stay to help in the fight?

Most disaster plans depend on physicians, nurses, support staff, and prehospital personnel to maintain healthcare's frontlines during crises. Yet planners cannot automatically assume that all healthcare workers will respond. Will our hospitals and clinics have enough physicians, advanced practitioners, nurses, technicians, maintenance, and administrative staff to keep the doors open, the computers running, the linens clean, the lights on, and the facilities safe? Will our 9-1-1 systems still be able to dispatch medics, firefighters, and police? That depends on the iterative, possibly hourly or daily, decisions that each affected individual repeatedly makes.

Such decisions are not purely ethical, but rather are complex determinations based on religious and personal values, family and community responsibilities, health and financial stability, and risk assessment. In 2001, for example, the AMA Code of Ethics was modified from "solemnly commit[ing] ourselves to apply our knowledge and skills when needed, though doing so may put us at risk"[1] to "physicians should balance immediate benefits to individual patients with ability to care for patients in the future."[2] The American College of Emergency Physicians, meanwhile, stated in its 2017 Code of Ethics for Emergency Physicians: ''Courage is the ability to carry out one's obligations despite personal risk or danger. Emergency physicians exhibit courage when they assume personal risk to provide steadfast care for all emergency patients, including those who are agitated, violent, infectious, and the like."[3]

Despite these professional ethical codes, nothing—either morally or legally—compels a response to risk-prone situations. Other than military personnel, no one is required to respond to potentially life-threatening emergencies. Professional oaths and codes may serve to guide practitioners, but they are not absolutes. The factors that guide people to respond are very personal; healthcare workers' individual behavior and that of our organizational, professional and political leadership can modify those factors to increase the number that are willing to respond.[4]

VALUES

The moral backbone of medical professionals—a duty to put the needs of patients first—may be tested as they determine whether to stay and carry out their professional roles or to step back and decrease their own personal risks. Whether providers will stay depends on their *own risk assessment and value system*. The "duty to treat" when one's health, life, or personal well-being is threatened is not absolute. In a risk-prone situation, each of us will prioritize our personal and professional values, those traits in ourselves that we consider to be our fundamental driving forces. "Most clinicians first assess the risks to our own and to our family's life, health, and safety. We may then factor in, to varying degrees, our religious beliefs and personal motivations, all colored by elements of our personality. Next, we may consider professional factors, including the precepts in our healthcare profession's oaths and codes, as well as other ethical and religious dicta to which we subscribe. Most clinicians will focus on their concrete professional responsibilities."[5] These professional factors include:

- Supporting/assuming the same risk as colleagues
- Collegial pressure/consequences of not helping
- Augmenting community welfare
- Fulfilling public expectation and trust
- Using societally underwritten special training and professional status
- Fulfilling implied consent to help those in need (social contract)

Emergency physicians may also feel that in these situations they are compelled to use their special knowledge about triage, allocation of scarce resources (eg, vaccines, prophylactic or treatment medications, or intensive care unit [ICU] ventilators), public health mandates (eg, isolation or quarantine, or mandatory vaccination), and the use of altered standards of care.[4,6]

RISK ASSESSMENT AND MITIGATION

Risk Assessment

When preparing for a disaster, planners should consider not how they expect people to respond, but rather why they are likely to respond.[7] The risks to physicians and other healthcare providers' *will vary* by the nature of the causative agent, the provider's activities and underlying health, and the protections offered and used. People decide which risks to accept or to avoid based on their own perceptions of the source and quality of the information they receive.[8,9] Quick, emotional impressions often precede and guide ''rational'' risk appraisals.[10] Provider and population *perception of their risk from COVID-19 will probably not be congruent with reality*. In part, this will be due to the discordant messages from many senior politicians and other officials, but also will be influenced by the real-time updates in scientific knowledge about the disease, its transmission, and possible protective measures.

Risk Communication and Mitigation

In crises, individuals must balance good information from valid media, government, and other sources to help identify the actual risks to themselves and their loved ones. Providing the best current information about the risks as well as the

opportunities to assist during a crisis will help healthcare professionals make defensible decisions in disaster settings.[5] Transparent and consistent information generates the trust necessary for both caregivers and the population to develop a reasonable risk assessment during conditions of uncertainty.[11] Issuing incomplete or conflicting information, as was done during the first months of the COVID-19 outbreak, caused many providers to make decisions to respond based on heated emotions and inaccurate risk perceptions. People have been shown to naturally exaggerate the risk of phenomena that are unknown or "dreaded," such as those with delayed, irreversible or manmade effects; those that have new, unknown, or unobservable risks; those that are global; and those that are "hyped" by the media.[5]

Historical precedent and the nature of the medical profession demonstrate that *we will have enough physicians and, probably, nurses* to treat patients. Other professional and non-professional staff needed to keep healthcare institutions operating may not be as willing to risk themselves. Recent history suggests that we probably will not have enough support personnel because, although they may be at as much or more risk than healthcare professionals, their personal safety is often considered as an afterthought by administrators. "An important lesson from the SARS outbreak is that, whereas most clinicians will ''stay and fight,'' vital support personnel, including those in materials and supply, logistics, cleaning, information technology communications, maintenance, and refuse removal, may feel no commitment to assist; moreover, they may feel undervalued, unprotected from risks, and ignored when they are omitted from vital communications."[12]

If all the staff necessary to run medical facilities fail to receive timely, relevant and believable information, they may not respond, and the quality of available healthcare will deteriorate. Widely distributing accurate risk assessments and descriptions of protective measures for staff will encourage the maximal number of clinicians and other necessary personnel to respond to the situation. Therefore, disaster planners and managers should do everything possible to communicate the risks clearly to *all* members of the healthcare system and to provide them with as much support and security as possible.

Risk communication (Figure 1) is "the exchange of real-time information, advice and opinions between experts and people facing threats to their health, economic or social well-being." [13] Its purpose "is to enable people at risk to

1. **Be First:** Quickly sharing information about a disease outbreak can help stop the spread of disease, and prevent and reduce illness and even death. People often remember the first information they receive should come from health experts.
   - Even if the cause of the outbreak or specific disease is unknown, share facts that are available. This can help you stay ahead of possible rumors.
   - Share information about the signs and symptoms of disease, who is at risk, treatment and care options, and when to seek medical care.
2. **Be Right:** Accuracy establishes credibility. Information should include what is known, what is not known, and what is being done to fill in the information gaps.
   - Public health messages and medical guidance must complement each other. For example, public health officials should not widely encourage people to go to the doctors if doctors are turning people away and running out of medicine for critically ill people.
   - Always fact check with subject-matter experts. One incorrect message can cause harmful behaviors and may result in people losing trust in future messages.
3. **Be Credible:** Honesty, timeliness, and scientific evidence encourage the public to trust your information and guidance. Acknowledge when you do not have enough information to answer a question and then work with the appropriate experts to get an answer.
   - Do not make promises about anything that is not yet certain, such as distribution of vaccines or mediciations without confirmed availability.
   - Clinicians should be present at press or community events to answer medical questions.
4. **Express Empathy:** Disease outbreaks can cause fear and disrupt daily lives. Lesser-known or emerging diseases casue more uncertainty and anxiety. Acknowledging what people are feeling and their challenges shows that you are considering their perspectives when you give recommendations.
   - For example, during a telebriefing for the coronavirus disease 2019 response: *"Being quarantined can be disruptive, frustrating, and feel scary. Especially when the reason for quarantine is exposure to a new disease for which there may be limited information."*
5. **Promote Action:** In an infectious disease outbreak, public understanding of and action on disease prevention is key to stopping the spread.
   - Keep action messages simple, short, and easy to remember, like "cover your cough."
   - Promote action messages in different ways to make sure they reach those with disabilities, limited English proficiency, and varying access to information.
6. **Show Respect:** Respectful communication is particularly important when people feel vulnerable. Respectful communication promotes cooperation and rapport. Actively listen to the issues and solutions brought up by local communities and local leadership.
   - Acknowledge different cultural beliefs and practices about diseases, and work with communities to adapt behaviors and promote understanding.
   - Do not dismiss fears or concerns. Give people a chance to talk and ask questions.

Figure 1. Crisis emergency risk communication in an infectious disease outbreak.[16]

make informed decisions to protect themselves and their loved ones."[13] Risk communication can help keep healthcare and other vital workers at their posts. But it must be done by appropriate people, educated in risk-communication techniques, in a trustworthy manner (honestly, frequently, open/available), and through easily accessible means, which includes role-modeling by those in charge.[14]

In addition to providing information, research shows that to attain the maximal response during risk-prone and other disasters, planners must do everything practicable to mitigate perceived risks and to address other concerns that may prevent staff from being either able or willing to work in a disaster (Table 1). To address one concern, on March 20, 2020, the American Academy of Emergency Medicine issued a position statement saying, in part, that they believe "a physician, nurse, PA, first responder or other healthcare professional has the right to be removed from the schedule of work requiring direct contact with patients potentially infected with COVID-19 for issues of personal health, such as being on immunosuppressive therapy or other similar concerns, without the risk of termination of employment."[15]

Rarely discussed, but a key part of maintaining our workforce, is to support the psychosocial needs of the healthcare team. According to medical anthropologist Monica Schoch-Spana, "Pandemics aren't just physical. They bring with them an almost shadow pandemic of psychological and societal injuries as well."[17] Psychosocial support for healthcare workers in the current war against COVID-19 will be akin to post-traumatic stress disorder treatment for soldiers manning the front lines for extended periods. People respond to the

Table 1. Disaster responders' concerns and planners' potential mitigating actions.[5,18-25]

Responders' Concerns	Mitigating Actions
Risk to/safety of responder	• Actions to help protect responder: priority for vaccinations, priority for prophylactic/treatment medications, appropriate/sufficient PPE, and prespecified responder decontamination procedures • Clear, continuous, consistent, honest, and transparent communication to all responders • Continuously available (and updatated as necessary) disaster plan • Knowledgeable individuals available to answer any workplace safety questions
Risk to/safety of responder's family and loved ones	• Actions to help protect family: priority for vaccinations, priority for prophylactic/treatment medications, decontaminating responder, and providing PPE at home • Clear, proactive, consistent, honest, transparent, and ongoing communication from employer to responder's family • Continuously available (and updated as necessary) disaster plan • Knowledgeable individuals available to answer any questions about responder and family safety
Child and elder care	• Provide paid sitters or care at health care facility • Arrange, in advance, for local governments to keep schools open, whenever possible
Risk to/safety of responder's pets	• Provide or pay for pet care
Trust/confidence in health care organization/leadership	• Have and communicate to all employees an all-hazard disaster plan, including risk-reduction measures, that is easily accessible, practiced, and modified as necessary based on circumstances • Maintain clear, continuous, consistent, honest, and transparent communication to all responders about current disaster knowledge and plan • Overtly and continuously demonstrate duty to protect and support responders
Inadequate disaster-related Human Resource policies[30]	• Provide life/disability insurance and liability/legal protection for duration of disaster response • Responders may leave work as necessary • Flexible work hours • Clear return-to-work policies • Provide responders with communication (if possible) to their families
Adequate reimbursement for time and activities	• Guaranteed appropriate pay/comp time/bonus pay for level of their activities
Safe, guaranteed transportation	• Private vans or rooms and board at health care facility • Arrange, in advance, for local governments to keep mass transit systems running, whenever possible
Mandatory quarantine	• Clear, consistent, and reasonable quarntine policy
Personal illness/PTSD	• Guaranteed treatment for disaster-acquired medical/psychiatric problems
Job requirements	• Effort to make all responders feel they are valued part of the disaster response • Clear description of any modified job expectations/requirements during disaster

PPE, personal protective equippment; *PTSD,* postraumatic stress disorder.
Reprinted, with permission, from the *Journal of Environmental and Occupational Medicine*.[7]

risks differently, so experienced professionals will need to intervene before tragic, adverse events occur.

SCARCE RESOURCES AND SOME SOLUTIONS

In the current pandemic, some key resources are and will increasingly become scarce. Physicians will need to consider how to distribute available resources and obtain or improvise others. The most ethical course of action is to do everything possible to delay having to ration. Vital materials already in short supply include viral test kits and their associated equipment and reagents, personal protective equipment (PPE), ventilators, and hospital – especially ICU – beds. While China rapidly erected new, prefabricated hospitals to treat patients and many countries around the world are establishing alternative care sites, the United States has been slow to act.

Often not considered, healthcare workers, especially those with expertise treating the critically ill, will inevitably become a scarce resource. However, as the situation changes, most healthcare workers will constantly reassess their decisions about responding. As increasing numbers of personnel get sidelined due to actual or suspected disease, exhaustion, or fear for themselves or their families. Some active and retired personnel who initially stayed out of the fight or were sidelined due to illness or other circumstances may reassess their decision and join the battle. Employing senior medical students and extending advance practitioners' scope of practice has been suggested as one way to ameliorate this problem.

In England and Wales, the National Health Service has asked about 65,000 retired doctors and nurses to return to work. In Scotland, they are recalling those who retired within the past three years. If these clinicians have been away from practice for more than a short time, they will receive brief refresher training.[26] The Institute of Medicine, among others, have described how to best manage resource scarcity in a widespread disaster (Table 2). Many of these strategies are discussed in more detail elsewhere.[27]

ETHICS OF SCARCE RESOURCE ALLOCATION

During or after attempts at conservation, reutilization, adaption, and substitution are performed maximally, rationing will need to be implemented.[31] The ethical principle that guides rationing is distributive justice, which requires that scarce resources be distributed fairly, providing them to those most in need. Specifically, it requires impartial and neutral decision makers to consistently apply rationing decisions across people and time (treating like cases alike).[32] This is based on Utilitarian principles, including conservation of resources, fiduciary responsibility (stewardship), multiplier effect (does the person have a job that will save other lives?), immediate usefulness, medical success, and caretaker role.[33,34] Most ethicists agree, however, that such distribution should be equitable, although in some circumstances other distribution methods, such as first come, first served; equal distribution; and even, no distribution may be more rational. Even with agreement about equitable distribution, scarcity often requires clinicians to prioritize which patients receive the resources.[33,34]

As the COVID-19 pandemic extends its devastation, physicians around the world are already facing the daunting task of rationing lifesaving resources. This is upending their traditional method of treating the sickest first in emergency departments or "first come first served" in the ICUs.[31] In Italy, physicians have reported limiting ventilators to those less than 60 years old, and China and Spain have implemented medical resource rationing. The US government and many states that have developed rationing plans have yet to explicitly implement them.[35] Many of these plans may be outdated, and none have been tested to determine whether they will save lives. In fact, a Canadian study of H1N1 patients found that 70% of patients that a rationing plan would have removed from ventilators survived with continued ventilation.[36]

Dr. Laura Evans, an intensivist at the University of Washington, is working with her state to devise a triage plan that would be doing "the most good for the most people and be fair and equitable and transparent in the process." Yet the Washington State Health Department recently issued a statement that "triage teams under crisis conditions should consider transferring patients out of the hospital or to palliative care if the patient's baseline functioning was marked by 'loss of reserves in energy, physical ability, cognition and general health.'"[36]

Rationing plans must conform to general ethical principles and to existing community moral standards. Community input into these plans is vital for maintaining the public's trust in

Table 2. Strategies for Scarce Resource Situations.[27-30]

- **Prepare**—e.g., anticipate challenges, develop plans, stockpile materials. Identify leaders who can source or develop alternative supplies and equipment. Identify and train risk communicators. Plan to mitigate personnel difficulties in responding.
- **Conserve**—implement conservation strategies for supplies in shortage or anticipated shortage to ensure the minimum impact/compromise possible (e.g., determining "at-risk" groups with priority for therapies in shortage and overall strategies to conserve use of oxygen delivery devices [i.e., ventilators] or PPE.
- **Substitute**—provide an equivalent or near-equivalent medication or delivery device.
- **Adapt**—use of equipment for alternative purposes (e.g., anesthesia machine as ventilator)
- **Re-use**—plan to re-use a wide variety of materials after appropriate disinfection or sterilization (e.g., may include oxygen delivery devices).
- **Re-allocate**—if no alternatives exist, remove a resource from one area/patient and allocate to another who has a higher likelihood of benefit (i.e., greater chance of surviving or more post-disease years to live).

PPE, personal protective equipment.

clinicians, the institutions, and the organizations involved in disaster relief and resource allocation. A major ethical dilemma is that current rationing criteria may skew away from normally disadvantaged populations. In the past, allocation plans were developed by the healthcare community. In the current crisis, some planning groups have tried to address this by asking disparate communities throughout their region to offer input into the plans.[36]

In all circumstances, rationing scarce medical resources is difficult and stressful. Such distribution, rather than being based on politics, money or power, must be based on an equitable (fair), openly available, pre-existing plan. It may be beneficial to have emergency physicians and intensivists take the lead (under set protocols) in making these decisions, since they have had more experience than others in doing this on a regular basis. Ideally, they will have support from their institutions' bioethics consultants, social workers, and chaplains.

Rationing will not end when medications to treat COVID-19 are eventually identified or vaccines are produced for prevention. In the first weeks or months there will be limited amounts available, with massive public anguish over how they are being distributed. Those involved in developing and implementing healthcare resource distribution will need to think ahead and include this eventuality in their plans. Lastly, resource allocation is not the only option. Disasters are the exact situations where clinicians and administrators need to "think outside the box" by expanding clinical roles and responsibilities, relaxing restrictive regulations, improvising medical equipment, and devising other solutions to scarcity.[27] Until the pandemic ends, we will need to encourage our healthcare workforce to stay at their posts and to use their fortitude and intellect as they face the multiple challenges involved with their jobs.

CONCLUSION

- Physicians and other healthcare providers' individual risks will vary by the nature of the causative agent, the provider's activities and underlying health, and the protections offered and used.
- Provider and population perception of risk will probably not be congruent with reality.
- History and the nature of the healthcare professions demonstrate that we will have enough professional personnel to treat patients.
- History suggests that we will not have the necessary support personnel—unless we respect their jobs and their risks and communicate with them in an open and honest manner.
- The distribution of scarce, lifesaving resources will first require searching for alternatives and then making triage decisions based on careful planning with, if possible, widespread input.

Address for Correspondence: Kenneth V. Iserson, MD, MBA, Department of Emergency Medicine, The University of Arizona, 4930 N Calle Faja, Tucson, AZ 85718. Email: kvi@email.arizona.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. American Medical Association. Declaration of professional responsibility. Adopted by the AMA House of Delegates, December 2001. Available at: https://www.cms.org/uploads/Declaration-of-Professional-Responsibility. Accessed March 21, 2020.
2. American Medical Association. AMA Code of Medical Ethics' opinion on physician duty to treat. Opinion 9.067 – Physician obligation in disaster preparedness and response. *Virtual Mentor*. 2010;12(6):459.
3. American College of Emergency Physicians (ACEP). 2017 Code of Ethics for Emergency Physicians. Available at: www.acep.org/globalassets/new-pdfs/policy-statements/code-of-ethics-for-emergency-physicians.pdf. Accessed March 21, 2020.
4. Iserson KV. Must I respond if my health is at risk? *J Emerg Med*. 2018 Aug 1;55(2):288-93.
5. Iserson KV, Heine CE, Larkin GL, et al. Fight or flight: the ethics of emergency physician disaster response. *Ann Emerg Med*. 2008;51(4):345–53.
6. Taylor HA, Rutkow L, Barnett DJ. Willingness of the local health department workforce to respond to infectious disease events: empirical, ethical, and legal considerations. *Biosecur Bioterror*. 2014;12(4):178–84.
7. Dynes RR, Quarantelli EL. The role of local civil defense in disaster planning. Columbus, OH: Disaster Research Center, Ohio State University; 1977. Cited in: Gershon RR, Magda LA, Qureshi KA, et al. Factors associated with the ability and willingness of essential workers to report to duty during a pandemic. *J Occup Environ Med*. 2010;52(10):995–1003.
8. Kasperson JX, Kasperson RE, Pidgeon NF, Slovic P. The social amplification of risk—assessing 15 years of research and theory. In: Slovic P (ed.) *The Feeling of Risk: A New Perspective on Risk Perception*. Cambridge, UK: Cambridge University Press; 2010:317–44.
9. Kasperson RE, Renn O, Slovic P, et al. The social amplification of risk: a conceptual framework. *Risk Anal*. 1988;8(2):177–87.
10. Zajonc RB. Feeling and thinking: preferences need no inferences. *Am Psychol*. 1980;35(2):151–75.

11. Zinn JO. Heading into the unknown: everyday strategies for managing risk and uncertainty. *Health Risk Soc*. 2008;10(5):439–50.
12. S.H. Gray, Professional experiences—personal dangers. Lecture given at the Departments of Emergency Medicine and Critical Care, St. Michael's Hospital, IICE 2005; Montreal, Quebec, Canada; 2005.
13. World Health Organization. General information on risk communication. Available at: https://www.who.int/risk-communication/background/en/. Accessed March 21, 2020.
14. The Most Difficult Healthcare Decisions: Part 3 (B). Available at: https://www.youtube.com/watch?v=RamrF1HUXyw. Accessed March 20, 2020.
15. American Academy of Emergency Physicians. AAEM Position Statement on Protections for Emergency Medicine Physicians during Covid-19. Available at: www.aaem.org/resources/statements/position/protections-for-eps-during-covid-19. Accessed 20 March 2020.
16. Centers for Disease Control and Prevention. CERC in an Infectious Disease Outbreak Available at: https://emergency.cdc.gov/cerc/resources/pdf/315829-A_FS_CERC_Infectious_Disease.pdf. Accessed March 21, 2020.
17. Wan W, Achenbach J, Johnson CY, Guarino B. Coronavirus will radically alter the U.S. *The Washington Post*. Available at: www.washingtonpost.com/health/2020/03/19/coronavirus-projections-us/. Accessed March 21, 2020.
18. Gershon RR, Magda LA, Qureshi KA, et al. Factors associated with the ability and willingness of essential workers to report to duty during a pandemic. *J Occup Environ Med*. 2010;52(10):995–1003.
19. Garrett AL, Park YS, Redlener I. Mitigating absenteeism in hospital workers during a pandemic. *Disaster Med Public Health Prep*. 2009; 3(Suppl 2):S141–7.
20. Devnani M. Factors associated with the willingness of healthcare personnel to work during an influenza public health emergency: an integrative review. *Prehosp Disaster Med.* 2012;27(6):551–66.
21. Gee S, Skovdal M. The role of risk perception in willingness to respond to the 2014–2016 West African Ebola outbreak: a qualitative study of international healthcare workers. *Glob Health Res Policy*. 2017;2:21.
22. Damery S,Wilson S, Draper H, et al. Will the NHS continue to function in an influenza pandemic? A survey of healthcare workers in the West Midlands, UK. *BMC Public Health*. 2009;9:142.
23. Ranse J, Arbon P, Cusack L, et al. Understanding the willingness of Australian emergency nurses to respond to a healthcare disaster. *Prehosp Disaster Med.* 2011;26(suppl 1):s151.
24. Klein I, Balicer R, Aharonson-Daniel L, Jaffe E. Emergency medical services workers' willingness to work during pandemic influenza. *Prehosp Disaster Med*. 2011;26(suppl 1):s138.
25. U.S. Office of Personnel Management. Pandemic information. Available at. https://archive.opm.gov/pandemic/index.aspx. Accessed March 21, 2020.
26. BBC News. Coronavirus: Tens of thousands of retired medics asked to return to NHS. Available at: www.bbc.com/news/uk-51969104. Accessed March 21, 2020.
27. Iserson KV. (2016). *Improvised Medicine: Providing Care in Extreme Environments, 2nd ed.* McGraw-Hill Publishing, New York, NY.
28. Hick JL, Barbera JA, Kelen GD. Refining surge capacity: Conventional, contingency, and crisis capacity. *Disaster Medicine and Public Health Preparedness* 2009;3(Suppl 1):S59–S67. https://doi.org/10.1097/DMP.0b013e31819f1ae2.
29. Institute of Medicine. Crisis standards of care: A systems framework for catastrophic disaster response: Volume 1: Introduction and CSC framework. Washington, DC: The National Academies Press, 2012.
30. Hick JL, Hanfling D, Wynia MK, Pavia At. Duty to Plan: Health Care, Crisis Standards of Care, and Novel Coronavirus SARS-CoV-2. National Academy of Medicine Perspectives. Available at: https://nam.edu/duty-to-plan-health-care-crisis-standards-of-care-and-novel-coronavirus-sars-cov-2/. Accessed March 21, 2020.
31. Centers for Disease Control and Prevention. Ethical considerations for decision making regarding allocation of mechanical ventilators during a severe influenza pandemic or other public health emergency. Available at: www.cdc.gov/about/advisory/pdf/VentDocument_Release.pdf. Accessed March 22, 2020.
32. Kinlaw K, Levine R. Ethical Guidelines in Pandemic Influenza, 2007. Available at www.cdc.gov/od/science/integrity/phethics/docs/panflu_ethic_guidelines.pdf. Accessed March 22, 2020.
33. Iserson KV, Moskop JC. Triage in medicine—Part I: concept, history, and types. *Ann Emerg Med.* 2007;49(3):275-81.
34. Moskop JC, Iserson KV. Triage in medicine—Part II: underlying values and principles. *Ann Emerg Med.* 2007;49(3):282-7.
35. Takenaga L, Wolfe J, Wright-Piersanti T. Coronavirus briefing: What happened today. *New York Times*. Available at: https://www.nytimes.com/2020/03/20/us/coronavirus-today.html. Accessed March 20, 2020.
36. Fink S. The hardest questions doctors may face: Who will be saved? Who won't? *New York Times*. Available at: https://www.nytimes.com/2020/03/21/us/coronavirus-medical-rationing.html. Accessed March 22, 2020.

Alternative Care Sites: An Option in Disasters

Kenneth V. Iserson, MD, MBA University of Arizona, Department of Emergency Medicine, Tucson, Arizona

Section Editor: Mark I. Langdorf, MD, MHPE
Submission history: Submitted March 23, 2020; Accepted April 3, 2020
Electronically published April 13, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.4.47552

During the current COVID-19 pandemic, the limited surge capacity of the healthcare system is being quickly overwhelmed. Similar scenarios play out when an institution's systems fail, or when local or regional disasters occur. In these situations, it becomes necessary to use one or more alternative care sites (ACS). Situated in a variety of non-healthcare structures, ACS may be used for ambulatory, acute, subacute, or chronic care. Developing alternative care facilities is the disaster-planning step that moves communities from talking to doing. This commitment pays real dividends if a disaster of any magnitude strikes. This paper discusses the basic criteria for selecting, establishing and ultimately closing an ACS, difficulties of administration, staffing, security, and providing basic supplies and equipment. [West J Emerg Med. 2020;21(3)484–489.]

Disclaimer: Due to the rapidly evolving nature of this outbreak, and in the interests of rapid dissemination of reliable, actionable information, this paper went through expedited peer review. Additionally, information should be considered current only at the time of publication and may evolve as the science develops.

Introduction: Why Have an Alternative Care Site?

During the current COVID-19 pandemic, the limited surge capacity of the healthcare system is being quickly overwhelmed. Similar scenarios play out when an institution's systems fail—or when local or regional disasters occur. In these situations, it becomes necessary to use one or more alternative care sites (ACS). Situated in a variety of non-healthcare structures, ACS may be used for ambulatory, acute, subacute, or chronic care. Developing alternative care facilities is the disaster-planning step that moves communities from talking to doing. This commitment pays real dividends when a disaster of any magnitude strikes.

Any available site may initially be used to provide healthcare after a disaster. After a massive earthquake in Turkey in 1999, for example, makeshift medical centers were set up on street corners and in ruined buildings.[1] Five months after Hurricane Katrina, when the media spotlight had dimmed, the New Orleans Convention Center still housed a makeshift medical center. The "emergency rooms" consisted of six military-surplus tents in which about 5000 patients, many of them uninsured poor, were treated each month.[2]

After 9/11, Canadian emergency medicine resident physicians used a New York City high school as a medical facility. They later wrote:

> *When we arrived at Stuyvesant High School, we found that there was limited electrical power because many local power grids were knocked out . . . Thus, many of the more intricate procedures, such as suturing, needed to be performed under the illumination of hand-held flashlights. The layout of the triage was very simple. In the main foyer of the school were approximately 8 stretchers clustered together in a makeshift patient care area. Surrounding the cots were dozens of large boxes of unorganized medical equipment, many unopened. The injured arrived either by ambulance or were ambulatory, and promptly triaged. Each stretcher, when possible, was staffed with two nurses, an attending physician, a resident and a medical student. As there were few survivors of the direct disaster, all patients we assessed were emergency response personnel and volunteer rescue workers.*[3]

As the current pandemic enveloped the world, China rapidly built new hospitals, and military units and civilians deployed tent facilities. In the US, states are considering using hotels, ice rinks, stadiums, nursing homes, ships, and recently closed hospitals as alternative care facilities, while the federal government promises that large temporary hospitals will soon be available in the most-affected areas.[4] Having to do this during a crisis demonstrates our dismal preparation for what is a rare, but predictable, event.

Issues in Establishing an ACS

Several inter-related issues must be resolved when establishing a viable ACS. These include the following:

- Who will decide to open the facility? Under whose authority will the site be established and run? This should normally be decided at a regional level.
- Who will direct the facility's operations?
- What types of patients will the facility house and treat? Will the ACS be used to decompress hospitals or nursing homes, or to provide primary care? What patient acuity will it accept? Will it accept oxygen-dependent patients?
- Which available facility will be used for this type of medical care? What will be the selection criteria? How will approval for use be gained? What will be the infrastructure dependencies? Or will the site be a previously designated portable/temporary shelter?
- Who will staff the ACS, including medical support and volunteer staff?
- What durable and disposable supplies and equipment will be available? In what quantities?
- What operational support (meals, sanitation needs, and infrastructure) will be required?
- What policies and what patient documentation will be used?
- Who will decide to close the ACS? What criteria will be used?

Implementation Difficulties

Planning for ACS is difficult, and takes personnel time, financial resources, and political capital. For these reasons, most regions have abandoned any real ACS planning. Rather, they use a conceptual model, such as "we can use the stadium," without any further thought. Only when a disaster strikes do they find that the "planning" was woefully inadequate. As a demonstration of how poorly prepared we are, the American Medical Association sent a letter to Congressional leadership on March 19, 2020, demanding funding for frontline treatment: "Providing the funding for the capacity to care for mildly or moderately sick Covid-19 patients in an alternative care site when they cannot appropriately care for themselves at home, such as outpatient facilities or large structures in the community that are in close proximity to a hospital, will provide additional capacity for sicker Covid-19 patients that need more intensive care. This is a crucial step in ensuring we have as much inpatient capacity as possible to respond to the sickest Covid-19 patients."[5]

In addition to a lack of finances and leadership, another major stumbling block is that, to be effective, multiple groups that traditionally have not done so, must work together.

Who Controls, Opens, and Closes the Site?

The single most important issue for the successful establishment of an ACS is determining its ownership, command, and control. These are political issues that should be decided at a local or regional (as opposed to institutional) level. Decisions must be made about the individual(s) who can decide whether, when, and where an ACS should be opened, as well as about who has the authority to operate the site.[6,7]

Deciding to open an ACS is bound up with bureaucratic and financial implications. While an individual hospital can make the decision alone, the decision will usually be regional, with support from many sources, especially the government

If a hospital decides to open an ACS as part of its emergency operations plan, they assume an enormous burden that few except the largest institutions can manage. This includes the need to find an acceptable facility; to staff and equip it; to establish policies and manage it; to coordinate operations with emergency medical services, the Red Cross, and other community emergency assets; and, lastly, to finance it. While there may be many fewer bureaucratic obstacles to "going it alone," the sheer magnitude of such an operation presents formidable barriers.

In some cases, where the need is obvious and no leadership has either prepared for or is willing to support establishing an ACS, individual clinicians and support staff may need to open an ACS on their own. That was the case in St. Bernard Parish (county) after Hurricane Katrina, when three family practitioners opened the only medical facility in two parishes in what had been the lobby of the ExxonMobil refinery, located on the highest point in the parish. Using equipment and supplies salvaged from the flood water (with the help of the St. Bernard Paris Sheriff's Office), they provided care for a week after the storm. They recruited nurses who were willing to stay and help, as well as two family practice residents from a nearby state (one was a relative). Eventually, a disaster medical assistance team (DMAT; AZ-1, from Arizona) assumed responsibility for that ACS.

An exit strategy and exit criteria should be built into the initial plan. The decision to close an ACS is much easier if pre-set and widely understood guidelines control the process. However, ACS closure can be overtaken by events, such as when multiple ACS facilities (opened after Katrina) had to be abandoned when Hurricane Rita threatened the area.

How Will the ACS be Used?

Most of the decisions about an ACS (staffing, equipment, supplies, and type of structure) flow from the way it will be used. Therefore, that is the first major decision. Possible uses include the following: [6, 7]

- Facility in which to quarantine or isolate patients
- Facility to house low-acuity patients from hospitals and nursing homes
- Ambulatory care/vaccination clinic
- Primary triage point to decide where and how patients can best be treated
- Acute care inpatient facility

- Place to provide palliative care for hospitalized patients
- Facility to house patients discharged from hospitals so that they can be released earlier than usual
- Combination of many or all the above functions

Note that many alternative care facilities have multiple functions. Some develop as the situation progresses, although these should not exceed the facility's structural, staffing, or logistical capabilities.

Which Type of Facility to Use?

Selecting facilities to serve as an ACS is an imprecise science and varies with the event. Most commonly used are facilities of opportunity, or "buildings of convenience," which are non-medical structures that can be adapted into an ACS.[6, 7] The building selection process works best if there is first a clear idea of the role planned for the ACS. Buildings typically used as an ACS are listed in Table 1. An often-forgotten fact is that if an ACS can accommodate patients from nursing home/long-term care facilities, those beds can be converted for acute care use (often with an existing oxygen supply).

If there are options when selecting an ACS, especially if it selected in advance of a disaster, some basic questions must be answered to get the best possible facility. Of course, even the best facility will still need much improvisation to make it functional. (Table 2).

Structural Issues: Selection Criteria

Rate possible alternative care facilities using pre-set criteria (Table 3). Give each criterion a rating (1 to 5) based on how close it comes to the same criterion in a hospital. Sites with the highest total ranking should be the first choice for an ACS. The lack or inadequacy of some criteria may eliminate the structure from consideration, such as the inability to secure the structure or to fulfill most of the criteria listed under "Utilities."

An example of a rating procedure for each criterion is as follows: 5 = equal to or same as hospital; 4 = similar to that of a hospital, but with some limitations (ie, quantity/condition); 3 = similar to that of a hospital, but with major limitations (ie, quantity/condition); 2 = not similar to that of a hospital and would require minimal modifications to make the facility useable; 1 = not similar to that of a hospital and would require major modifications to make the facility useable; 0 = does not exist in this facility or is not applicable to this event.

Before use begins, facilities' internal space should be laid out in an organized fashion. A grid system allows clinicians to make "rounds" and know exactly where to find a patient (eg, bed A4). Public health issues are critical (eg, safe food and water supply, sanitation, latrine resources).[6,7]

Staffing and Security

Once a suitable facility is identified, staffing and emergency privileging of healthcare professionals become issues. Staff may be volunteers, off-duty providers from the primary facility, retired clinicians, military personnel, or designated members of disaster response teams (eg, DMAT). Table 4 lists the ideal staffing for each 12-hour shift in a 50-bed inpatient ACS.

Staff members face several issues, including that of arranging for provisions to house and feed the patients. If volunteers are used (as they should be), they should have their own coordinator who understands that some volunteers may not want to do certain tasks (eg, colostomy care, diaper changes). Establish who is going to do what. Note that placing an ACS near a college or university enlarges the potential workforce (eg, sports teams, fraternities, religious groups) to help carry patients, set up equipment, and so forth.[6,7]

In chaotic situations, security becomes an extremely important concern, especially since local law enforcement will be stretched thin. Establish a system to identify staff members, patients, and their families. "Planners must develop robust security plans. It is helpful if security personnel have previous experience in dealing with patients, especially those with behavior disorders. The best potential source of security staff would be off-duty hospital security personnel, but these individuals may not be available. Other potential sources would include on- or off-duty police officers, activated members of the National Guard, or volunteers."[6] "Security makes patients and staff members feel safe and keeps out troublemakers. Having uniformed people on site (even Reserve Officer Training Corps [ROTC] cadets) makes a real difference."[6]

Many of these positions are interchangeable. For the ACS to function optimally, everyone must be willing to do any job for which they are qualified.

Table 1. Buildings/structures typically used as alternative care sites during disasters.[6,7]

Adult detention facility	Aircraft hanger	Church
Community/recreation center	Convalescent care facility	Fairground
Government building	Hotel/motel	Meeting hall
Military facility	National Guard armory	Same-day surgical center/clinic
School	Shuttered hospital	Sports facility/stadium
Trailer/tent (military or other)		

Table 2. Questions to ask when selecting an alternative healthcare site.[8]

- Will the structure accommodate the expected number of patients and staff, and the planned activities?
- Is the structure located in a relatively safe area (culturally and geographically)? Is it structurally sound?
- Is it easily accessible by ambulance, foot, and automobile/public transportation?
- Is there adequate electrical power (plus back-up power or the capacity to tie in to large portable generators)?
- Is there adequate potable water, ventilation, refrigeration, and lighting? Are the ventilation and lighting systems on the back-up generator? Are there also other back-up electrical outlets for critical equipment, such as ventilators?
- Are there kitchen facilities adequate for the number of people expected (patients, staff, visitors)?
- Is the entire patient care area wheelchair/stretcher accessible? If elevators are needed, are they on the back-up power system?
- Will there be separate space for other necessary functions, such as staff sleeping/rest areas, communications center, command center, waiting area, security office, pharmacy, equipment supply and storage areas, chapel/family counseling area, and a morgue?
- Can the building be secured? Can you control patient and staff traffic?
- Are there phone and computer access lines? Will cellular phones and radios (two-way, ambulance, public sector, and ham) work within the building without interference?
- Can lights be dimmed in sleeping and patient care areas?
- Are the doors > 33 inches wide to permit ambulance stretchers to move through them?
- Are there areas to load and unload patients and supplies? Ideally, these will accommodate forklifts.
- Is there parking for patients, staff, and visitors?
- Are toilet and shower facilities adequate for the anticipated number of patients, staff, and visitors? (*)
- Does the facility have oxygen or will it be readily available? (*)
- Is the facility easy to clean for patient use?

(*) Important and often overlooked in planning alternative care sites.

Table 3. Criteria to consider in alternative care site selection.

Infrastructure	
Door sizes and stairways adequate for gurneys	Floors
Parking for staff and visitors	Roof
Ventilation	Walls
Toilet facilities/showers (number of)	Loading dock
Total space and layout	
Auxiliary spaces (pharmacy, counselors, chapel)	Staff areas
Lab specimen handling area	Equipment/supply storage area
Mortuary holding area	Family area
Patient decontamination areas	Food supply and prep area
Pharmacy area	Patient care/ward areas
Utilities	
Electrical power (Backup present? Adequate for anticipated equipment?)	Air conditioning (Sufficient for the number of people?)
Lighting	Heating
Refrigeration	Water (Hot?)
Communications	
Communication (number of phones, local/long distance, intercom)	Wired for information technology and Internet access
Two-way radio capability to main facility	Other services
Other factors	
Ability to lock down facility	Laundry
Oxygen delivery capability	Biohazard and other waste disposal
Ownership/other uses during disaster	Proximity to hospitals
Accessibility/proximity to public transportation	Liability insurance coverage

Table 4. Idealized staffing for a 50-bed alternative care site per 12-hour shift.[6,7]

Physician, 1	Physician Extender (Physician Assistant/Nurse Practitioner), 1	Registered Nurse or Licensed Practical Nurse, 6
Health Technician, 4	Unit Secretary, 2	Respiratory Therapist, 1
Case Manager, 1	Social Worker, 1	Medical Assistant/Phlebotomist, 1
Food Service, 2	Chaplain/Pastoral, 1	Day Care/Pet Care, 1
Volunteer, 4	Engineering/Maintenance, 0.25	Biomedical Engineer, 0.25
Security, 2	Housekeeper, 2	Lab, 1
Patient Transporter, 2		

Supplies and Equipment

Supplies and equipment for an ACS will vary with its mission and range from extremely primitive to similar to those found in the basic hospital (not including the operating rooms or radiology). Conversely, the lack of specific items, such as oxygen, may limit an ACS's role. Oxygen and pharmaceuticals are often difficult to obtain during a disaster.

Oxygen

While generally taken for granted in modern (developed-world) hospitals, oxygen is an expensive, difficult-to-acquire commodity. Table 5 lists the costs, power requirements, and flow rates for some typical portable oxygen delivery systems. In the least-developed countries, the solution is often to use oxygen concentrators, although facility-size units are not commonly available unless purchased in advance. The most common solution is to not accept oxygen-dependent patients in an ACS. Obtaining oxygen from industrial sources may also solve the problem in resource-poor situations. Because industrial-grade oxygen is purer than medical grade, biomedical engineers may be needed to help adapt the connections to medical equipment.[10] Reducing oxygen use in patients who may not really need it may also be necessary.

Pharmaceuticals

The nature of the ACS responsibilities (acute and chronic care) and the patient population will determine what pharmaceuticals are needed. In St. Bernard Parish after Hurricane Katrina, for example, the ACS pharmacy (containing items that Sheriff's officers scrounged from the non-flooded shelves in local pharmacies) was used primarily to supply chronic medications to members of the military and rescue teams. Many medications, despite pharmaceutical company claims and clinician habits, have adequate substitutes that are often readily available. When such needs arise, pharmacists should automatically suggest them for use.[12] Most ACS will also need to stock medications to provide acute respiratory therapy, acute hemodynamic support, pain control, anxiolytics, antibiotic coverage, and behavioral health maintenance.[6,7]

Alternative Care Site Tools

In March 2020, the US Department of Health and Human Services Office of the Assistant Secretary for Preparedness and Response issued the *Federal Healthcare Resilience Task Force Alternate Care Site (ACS) Toolkit* 2020. It contains a detailed description of the staffing and, most importantly, a checklist to assure that the site is appropriate as an ACS.[13] Their Healthcare Emergency Preparedness Information Gateway has collected a wide variety of free monographs and teaching tools about ACS (Topic Collection: Alternate Care Sites (including shelter medical care).[14] The best of these is the California Department of Public Health Government-Authorized Alternate Care Site Training Guide.[7] In 2009, the Agency for Healthcare Research and Quqlity published three free downloadable resources to help identify and run alternative care sites. One is a monograph, *Disaster Alternate Care Facilities: Selection and Operation,* and two are interactive tools, *Disaster Alternate Care Facility Selection Tool*, and the *Alternate Care Facility Patient Selection Tool*[6]).

Table 5. Oxygen equipment typically available.[11]

Oxygen generation systems	Oxygen flow rate (L/min)	Power required (kW)	Cost of unit $1000	Oxygen purity (%)
Expeditionary deployable oxygen concentration system	120	8	131	93 ± 3
Portable therapeutic oxygen concentration system	45	7	40	93+
Portable oxygen generation system	33	12	35	93–95
Patient ventilation oxygen concentration system	20	4.3	35	93 ± 3
Home oxygen compressor	3	0.2	2.5	93 ± 3

Address for Correspondence: Kenneth V. Iserson, MD, MBA, Department of Emergency Medicine, The University of Arizona, 4930 N Calle Faja, Tucson, AZ 85718. Email: kvi@email.arizona.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Erri Emergency Services Report. *Emergencynet News Service*, Wednesday, August 18, 1999. Vol. 3, 229-09:00cdt; Turkey. Death toll from earthquake now exceeds 3,500.
2. Callebs, S. CNN. "You are taking your life in your hands." Available at: https://www.cnn.com/CNN/Programs/anderson.cooper.360/blog/2006/02/you-are-taking-your-life-in-your-hands.html. Accessed March 22, 2020.
3. Carvalho AM, Delvin ME, Rosenczweig C, et al. Helping at ground zero: the experience of four Canadian emergency medicine residents and an emergency department nurse. *CJEM*. 2002;4(2):115-8.
4. Kim SR, Rubin O, Pezenik S. States look to closed hospitals and college dorms to meet coronavirus demands: "Alternative care facilities" are popping up across the country. Available at: https://abcnews.go.com/Politics/states-closed-hospitals-college-dorms-meet-coronavirus-demands/story?id=69683447. Accessed March 21, 2020.
5. Pollack RJ, Madara JL, Cole L. American Medical Association letter to congressional leadership. March 19, 2020. Available at: https://searchlf.ama-assn.org/undefined/documentDownload?uri=%2Funstructured%2Fbinary%2Fletter%2FLETTERS%2FMarch-19-2020-AHA%2520AMA-ANA%2520Letter-wo.pdf. Accessed March 21, 2020.
6. Cantrill S, Bonnett C, Pons P. Alternative care sites. In: Phillips SJ, Knebel A (eds.). *Providing Mass Medical Care with Scarce Resources: A Community Planning Guide*. Rockville, MD: Agency for Healthcare Research and Quality, 2006:74-101.
7. California Department of Public Health. Government-Authorized Alternate Care Site Training Guide. Available at: www.cidrap.umn.edu/practice/standards-and-guidelines-healthcare-surge-during-emergencies. Accessed March 21, 2020.
8. Iserson KV. Making do when the ED is down. *Emergency Physician International*. Available at: https://issuu.com/epi-mag/docs/issue_8 Accessed March 20, 2020.
9. AHRQ. Disaster Alternate Care Facilities: Report and Interactive Tools. Available at: www.ahrq.gov/research/shuttered/acfselection/index.html Accessed March 22, 2020.
10. Iserson KV. *Improvised Medicine: Providing Care in Extreme Environments.* 2nd ed. McGraw-Hill Publishing, New York, NY. 2016:142-3.
11. Berry DK, Shackelford LS, Hewitt II CA. Appendix A: Oxygen supply options. In: Phillips SJ, Knebel A (eds.). *Providing Mass Medical Care with Scarce Resources. A Community Planning Guide*. Rockville, MD: Agency for Healthcare Research and Quality, 2006.
12. Iserson KV. *Improvised Medicine: Providing Care in Extreme Environments.* 2nd ed. McGraw-Hill Publishing, New York, NY. 2016:186-93.
13. HHS Office of the Assistant Secretary for Preparedness and Response (*ASPR). Federal Healthcare Resilience Task Force Alternate Care Site (ACS) Toolkit*. Available at: https://files.asprtracie.hhs.gov/documents/acs-toolkit-ed1-20200330-1022.pdf. Accessed April 2, 2020.
14. U.S. Department of Health and Human Services. Topic Collection: Alternate Care Sites (including shelter medical care). Available at: https://asprtracie.hhs.gov/technical-resources/48/alternate-care-sites-including-shelter-medical-care/47. Accessed March 22, 2020.

Augmenting the Disaster Healthcare Workforce

Kenneth V. Iserson, MD, MBA University of Arizona, Department of Emergency Medicine, Tucson, Arizona

Section Editor: Mark I. Langdorf, MD, MHPE
Submission history: Submitted April 3, 2020; Accepted April 3, 2020
Electronically published April 13, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.4.47553

In disasters such as the COVID-19 pandemic, we need to use all available resources to bolster our healthcare workforce. Many factors go into this process, including selecting the groups of professionals we will need, streamlining their licensing and credentialing processes, identifying appropriate roles for them, and supporting their health and well-being. The questions we must answer are these: How many staff will we need? How do we provide them with emergency licenses and credentials to practice? What interstate licensing compacts and registration systems exist to facilitate the process? What caveats are there to using retired healthcare professionals and healthcare students? How can we best avoid attrition among and increase the numbers of international medical graduates? Which non-clinical volunteers can we use and in what capacities? The answers to these questions will change as the crisis develops, although the earlier we address them, the smoother will be the process of using augmentees for the healthcare system. [West J Emerg Med. 2020;21(3)490–496.]

Disclaimer: Due to the rapidly evolving nature of this outbreak, and in the interests of rapid dissemination of reliable, actionable information, this paper went through expedited peer review. Additionally, information should be considered current only at the time of publication and may evolve as the science develops.

INTRODUCTION.

How many staff will we need?

At the onset of a disaster, or when many unknowns exist, it is not clear how many healthcare staff will be needed. Healthcare administrators and emergency management must attempt to calculate needs based on projected illnesses and existing capacities. Based on a 40% prevalence of COVID-19 in the United States during the pandemic, 100 million people infected, about 21 million will be hospitalized, with about 4.5 million of them needing intensive care. While healthcare systems across the country have varying abilities to accommodate this patient load, a six-month epidemic will result in filling 275% of the potentially available capacity of inpatient beds and >500% of the intensive care unit (ICU) bed capacity. If the course is flattened to 12 months, the need for hospital beds would be 137% and the ICU beds 254% of capacity.[1] Either situation will require a significant increase in our physician, nurse, and associated workforce.

Increased bed capacity will also necessitate additional doctors and nurses. As of late March, New York was increasing existing hospitals' bed capacity by at least 50%, doubling the number of ICU beds, and waiting for the US Army to convert four sites into temporary hospitals for people needing less intensive care or who are recovering.[2] Washington State has received 1000 hospital beds from the military, and California, anticipating a need for more than 19,000 new beds, is opening multiple temporary hospitals, including reopening some that had closed. Florida is similarly opening multiple hospitals with thousands of beds.[2]

In disaster situations, although most healthcare professionals will want to respond, whether they actually do so, and then continue to do so, depends on the risk they perceive to themselves and their families, the measures being taken to keep them safe, the value they see in their work, the completeness and transparency of the information they are given about the developing situation, and their personal (professional, religious, and other) values.[3,4]

Once healthcare professionals decide to stay, their numbers will inevitably decrease due to the vast influx of patients and the expanded roles they must perform, leading to burnout, as well as to illness-related attrition, especially in epidemics. For example, 14% of Spain's first 40,000 confirmed coronavirus cases were medical professionals.

Catalonia's Igualada Hospital put 30% of its staff in home isolation. Similar scenarios have occurred across Europe.[5] The above examples demonstrate that additional physicians, nurses, and support staff will be needed. Most will be volunteers. Such volunteers can augment regular staff if careful thought is given to the vetting process, the roles they are assigned, and the support they will receive.

Which healthcare professionals are needed?

A wide variety of healthcare professionals can help augment normal staff (Table 1). Many of them will be asked to expand their scope of practice. As the American College of Chest Physicians wrote, "During a disaster, all work usually performed may not be 'essential' but all health-care workers are essential. The goal . . . is to match the caregiver competencies with patient needs. To that end . . . the scope of practice and experience of various caregivers, should be used to assign caregivers to the patients."[6]

Primary clinicians who may have normally worked in a variety of specialties can be assigned to positions in which they will be useful. All physicians, advanced nurse practitioners, and physician assistants can help in their areas of expertise or in fast-track and primary care, permitting the full-time staff to treat the sickest patients. Surgeons of all types, podiatrists, and some dentists (eg, oral surgeons) can assist in the emergency department (ED), clinics, and the operating room. Volunteer healthcare professionals can also staff alternative care sites. These extensions of clinicians' scopes of practice are informal; they are based on supervisors' knowledge of an individual's capabilities and on extenuating circumstances. When a practitioner is inexperienced, he or she is supervised by a current staff member.

In the areas hardest hit by the pandemic, nurses, especially those with ED and critical care experience, are in short supply.[7] While experienced nurses may be asked to diagnose and prescribe treatments during disasters, some states have curtailed some advanced practice nurses' work. Although these nurses routinely assume primary care responsibilities, 12 states are still restricting them to practice only with a supervising physician.[8] Pennsylvania, in contrast, has changed its rules to allow family care nurse practitioners (and retail pharmacists) to care for COVID-19 patients, if needed.[9]

Certified but unlicensed paramedics and emergency medical technicians can perform a variety of healthcare services, depending on their training and experience. Using alternative care practitioners may be beneficial for some populations; each facility must decide for itself which category to use.

EMERGENCY LICENSING AND CREDENTIALING OF HEALTHCARE PROFESSIONALS

There are two issues to confront when using healthcare professionals to augment the system: state licensing, and institution-specific credentials to perform diagnostic and therapeutic procedures. If healthcare professionals volunteer within a state in which they are licensed, hospitals need only credential them to perform clinical duties. This process becomes a bit more flexible than normal during disasters. Permitting out-of-state healthcare professionals to work requires not only verifying their *licenses*, but also getting the state to grant specific permission; many states are now doing so under the Uniform Emergency Volunteer Health Practitioner Act (UEVHPA) or a separate emergency exception.

As of 2020, 18 states and the District of Columbia have enacted UEVHPA, which allows them to recognize out-of-

Table 1. Post-disaster healthcare volunteer categories.

Healthcare professionals (licensed)		
Physician	Dentist/Oral surgeon	Veterinarian
Nurse (RN, LPN, LVN, etc.)	Physician assistant	Pharmacist
Podiatrist	Behavioral health professionals (marriage and family therapists, medical and public health social workers, mental health and substance abuse social workers, psychologists, and mental health counselors)	Advanced practice nurses (nurse practitioners, nurse anesthetists, certified nurse midwives, and clinical nurse specialists)
Healthcare professionals (may be certified; no licensing requirement)		
Medical technologist and laboratory staff	Morgue assistant	Dental assistant
Diagnostic medical sonographer	Paramedic	Pharmacy technician
Medical records librarian	Biomedical engineer	Nursing assistant, tech
Chaplain	Respiratory therapist	Phlebotomist
Alternative medical practitioners (may be licensed in some jurisdictions)	Radiologic technologists and technicians	Athletic Trainer

RN, registered nurse; *LVN*, licensed vocational nurse; *LPN*, licensed practical nurse.

state licenses for a variety of health practitioners during a state of declared emergency. Other states, such as New York, Florida, South Carolina, Georgia, and Texas, have separately loosened licensure requirements for physicians, nurses, advanced nurse practitioners, or pharmacists. Current state-specific information about licensure requirements during the COVID-19 epidemic is available through the National Conference of State Legislatures (www.ncsl.org/research/labor-and-employment/covid-19-occupational-licensing-in-public-emergencies.aspx).[10] To make it easier for hospitals and healthcare agencies to verify physicians and physician assistants' licensing information, the Federation of State Medical Boards (FSMB) is offering them free access to its Physician Data Center (PDC), which contains licensure and disciplinary information for the more than one million physicians and physician assistants in the United States (US).[11]

Once individual licenses are verified, institutions must then ascertain which *credentials* to allow based on an individual's skills and proficiency. The PDC helps hospitals to quickly verify physicians and physician assistants' medical schools, training, any disciplinary actions, and specialty certifications.[12] With this information, the Joint Commission permits hospitals to provide emergency credentialing/disaster privileges on an individual basis. For physicians, the process involves, at a minimum, presentation of a medical license and photo identification, and, usually, personal and malpractice coverage information.[13] If the process is already contained in their medical staff bylaws, hospitals can then grant temporary privileges "to fulfill an important patient care, treatment, and service need," such as that "the patient care volume exceeds the level that can be handled by currently privileged practitioners and additional practitioners are needed to handle the volume."[14] The hospital CEO normally grants the privileges after receiving the medical staff president's recommendation.[14]

ORGANIZED TEAMS

In the US, organized medical teams include the Disaster Medical Assistance Teams (DMAT) and the Public Health Service Commissioned Corps. In major disasters (eg, Hurricane Katrina, COVID-19), the military may also assist. The benefits of organized groups are that they are usually self-sufficient, have experience in disaster situations, and have the necessary personnel, including credentialed healthcare professionals. Health professionals on these teams may, by federal law, practice in any state where they have been deployed during disasters. They have also been pre-credentialed for specific diagnostic and therapeutic procedures. Unfortunately, one cannot rely on these organized disaster teams to respond immediately, especially if they must mobilize and travel considerable distances. Bureaucratic red tape often prevents them from arriving for a considerable time after a state requests them. In some cases, it has taken at least 10 days until they were on site and operational.

INTERSTATE LICENSING COMPACTS

Several programs exist within the US to license and evaluate healthcare professionals' general credentials so that they can work in other locations, either within their state or in other states during disasters. These are the Emergency Management Assistance Compact (EMAC), the Nurse Licensure Compact (NLC), and the Recognition of EMS Personnel Licensure Interstate CompAct (REPLICA).

The EMAC is an interstate mutual aid agreement to train for and to respond to emergency events, including natural and man-made disasters. Under EMAC, once a governor declares a disaster, the state can request assistance through the EMAC Operating System. A management team is sent to help the requesting state's emergency operations center evaluate and obtain the appropriate resources. When EMAC has been activated, the receiving state recognizes responders' licenses, certificates, and permits, "subject to such limitations and conditions as the governor of the requesting state may prescribe."[15] EMAC was ratified by the US Congress in 1996[16] and has been adopted by all states, the District of Columbia, the US Virgin Islands, Puerto Rico, and Guam. The requesting state is responsible for reimbursing the assisting state for any expenses incurred. EMAC also addresses liability and compensation (sometimes through the Federal Emergency Management Agency).[17-19]

The NLC is an agreement between 34 states allowing nurses residing in and having a license in an NLC state to practice in other states that are part of the agreement. In 2018, the Enhanced Nursing Licensure Compact (eNLC) was implemented, requiring applicants to undergo state and federal, fingerprint-based, criminal background checks. Nurses working under the NLC must practice in accordance with the laws of the state where the patient is located and are subject to that state's jurisdiction, licensing board, courts, and laws.[15] Unfortunately, four of the states hardest hit thus far[20] by COVID-19 (Washington, New York, Illinois, and California) are not signatories to this compact.[21]

REPLICA allows EMS personnel to work across state boundaries in the performance of their assigned EMS duties. It functions in both routine and disaster settings and has been approved by 27 states.[22] REPLICA grants legal recognition to EMS personnel licensed in any other member state. Under the agreement, EMS personnel must complete an FBI biometric criminal background check when applying for a new EMS license and states must share licensing and disciplinary actions with the other participating states.[23]

A legal framework for the International Emergency Management Assistance Compact (IEMAC) already exists in Connecticut statutes. It describes a mutual aid system among six New England states and five Canadian provinces. However, no other jurisdiction has approved or implemented it. Its structure would provide licensure reciprocity for health professionals and other disaster workers aiding a government-initiated emergency response.[15,24]

EMERGENCY SYSTEM FOR ADVANCE REGISTRATION OF VOLUNTEER HEALTH PROFESSIONALS CREDENTIALING SYSTEM (ESAR-VHP)

The ESAR-VHP is a federal program that established state registries for licensed and credentialed volunteer health professionals. Each state has its own registry process, generally requiring registrants to submit extensive documentation in advance of a crisis. Once a state's governor declares an emergency and mobilizes the state emergency management office, hospitals and other healthcare facilities can use ESAR-VHP to obtain previously verified information about volunteers' licenses, credentials, and accreditations, as well as training skills, competencies, and employment.[25] Table 1 lists the healthcare professionals that states most commonly register.

The ESAR-VHP assigns volunteers into one of four credential levels, based on the verified documents they provide.

- Level 1: Clinically active in a hospital, either as an employee or by having hospital privileges.
- Level 2: Clinically active in a wide variety of settings (eg, clinics, nursing homes, and shelters).
- Level 3: Meets the basic qualifications necessary to practice.
- Level 4: Those with healthcare experience or education that would be useful when assisting clinicians and providing basic healthcare not controlled by the scope of practice laws (eg, health professions students or retired health professionals who no longer hold a license).[26]

Many ESAR-VHP registrants participate through the Medical Reserve Corps (MRC), a national network of 175,000 volunteers in about 850 locally organized and activated units. Despite its name, MRC volunteers include not only medical and public health professionals, but also community members without healthcare backgrounds.[27] As of late March 2020, approximately 100 MRC units were supporting COVID-19 response activities, especially assisting with call center operations (eg, fielding inquiries from the general public and local medical providers), community education, patient case and contact investigations, and patient monitoring. Some have been asked to support patient testing efforts and surge staffing needs (eg, hospitals, alternate care sites, and EMS).[25]

RETIREES, STUDENT VOLUNTEERS AND INTERNATIONAL MEDICAL GRADUATES

Many volunteers in a disaster setting will be retired clinicians or healthcare students. Both can be problematic for different reasons. International medical graduates (IMG) present a host of benefits and problems.

Retirees

In mid-March, Spain began the emergency recruitment of 50,000 healthcare workers, ranging from medical students to retired doctors.[28] In what the United Kingdom's medical director called "outbreaks of altruism," thousands of retired physicians and nurses are returning to work in the National Health Service (NHS) at the government's request.[29]

According to data from the Federation of State Medical Boards, most US states "are loosening their licensing rules to give those with clinical skill the ability to pitch in, such as allowing out-of-state physicians to practice right away, asking retired physicians to volunteer, and more."[30] In late March, New York's Health Commissioner said the state would welcome retirees and those with expired licenses to return to clinical medicine.[2] Pennsylvania is permitting physicians who retired within the past five years to reactivate their medical licenses at no cost. It also waived licensing requirements for both in-state and out-of-state healthcare providers to treat patients via telemedicine.[9] As it begins to augment overwhelmed civilian medical systems, the US Army has solicited its retired doctors, nurses, and medics who have served in critical care or EMS positions to return to work if they are not already employed in the civilian sector.[31]

New York State officials have said that they will recertify individuals for immediate deployment.[2] Those returning to work in the NHS after >3 years' retirement, however, will take a short refresher course. This highlights one problem with this group of (usually) older individuals. Their knowledge of current practice may be outdated. In some cases, such as in the COVID-19 pandemic, they also may be at much higher risk of dying, although once an immunoglobulin G test is readily available, those found to have had the disease may be immune.[32] Many of them also may have other health-related problems.[30] This requires individual screening by a knowledgeable professional. In addition, they will need malpractice insurance, which they undoubtedly lack. On the other hand, they will bring a lifetime of knowledge and experience, and often amazing skill in those procedures with which they are familiar.

Students

Healthcare student volunteers pose the opposite problem. Their health and cognitive abilities are rarely an issue. Yet, depending on their level of training, they may have insufficient experience to be useful in many critical areas. More importantly, it raises the ethical issue of whether society should potentially sacrifice many next-generation practitioners to function in a potentially minor role. While in the UK more than 24,000 final-year student nurses and doctors are starting to work in the NHS,[29] US healthcare students have mostly been pulled off clinical rotations.[33] New York University Medical School offered its senior medical students who meet all graduation and screening requirements the voluntary opportunity to graduate three months early so they can help relieve the strain on frontline clinicians. The plan is to have them immediately begin working as paid interns in their hospital's internal medicine and emergency departments, although they do not have to continue in those specialties.[34] Medical schools across the country

have followed their lead. Many health professions students are assisting their colleagues in non-clinical ways, including staffing community and clinic information lines, helping to procure additional personal protective equipment, babysitting, grocery shopping, and doing other necessary chores for hospital workers, and volunteering on time-sensitive COVID-19 laboratory projects.[30,35]

International Medical Graduates

So far, this group of generally well-trained additional physicians has received little attention. IMGs include those in training whose visas will soon expire, those accepted into US residency programs for July 1 but who cannot gain entry to the US; and those still unlicensed due to the requirement that they need to repeat a residency in the US. Dr. Irwin Redlener, director of the National Center for Disaster Preparedness at Columbia University, advocates revisiting the rules about internationally trained physicians who are living in the US. He believes that we should eliminate "for now—the regulation that you have to repeat your residency in order to practice in the US. These people are ready to go, and my experience with them is they're very talented, very well trained and coming from all different countries. That's a pool we should tap."[30]

To address the dilemma of IMG physicians who may soon be compelled to leave the workforce against their will or who were supposed to begin residencies, the American Medical Association "urged immigration authorities to extend visas for foreign national physicians lawfully practicing in the US and for the Departments of State and Homeland Security to expedite visa processing to ensure that non-US citizen IMGs can enter the country to begin their residency training programs on July 1."[36] As of early April, the government has not taken any action to retain or acquire these physicians.

NON-CLINICAL VOLUNTEERS

Many vital jobs in healthcare can be accomplished by those with no significant or non-healthcare experience (Table 2). In Britain, more than 500,000 volunteers are helping the NHS in non-clinical roles, primarily delivering food and medicines, driving patients to appointments, and phoning people with underlying health conditions who are isolating themselves from the virus by staying at home.[29] The local and national Red Cross can supply a general workforce, but normally does not provide professional health care.

SUPPORTING THE AUGMENTEES

Disaster work is stressful. Supervisors must carefully manage augmentees who may not be familiar with the facility, its procedures, and personnel, even if they are healthcare professionals. That includes carefully planning the group's work schedules, housing, meals, and security. Burnout is common among disaster workers. Often this is due to workers' unwillingness to step aside to let others assume their tasks at the end of a shift. Augmentees housed in the patient treatment facility may be unable to rest adequately, especially when sleeping and resting areas are not sufficiently isolated from patient care areas. Food keeps the army of disaster healthcare workers on its feet and helps maintain esprit de corps. With limited outside sources of prepared food coupled with long work hours, facilities should expect to feed staff 24 hours a day.[37]

The most important principle is to make safety the first consideration—in all situations. A necessary part of the overall security system is to supply some type of identification—preferably in a format that cannot be easily copied—to those volunteers who have authorization to enter the healthcare facility. For example, some nurses in New York City hospitals are benefiting from newly instated protections, including "nurses now being driven to and from work in private cars whose drivers are certified healthy, sealed lunches being delivered to their hospitals, childcare, and grocery deliveries to their families at home."[7] New York nurse Katherine Ramos, currently working at an ED and caring for two ill family members, said grocery delivery "made a major difference in her ability to continue to care for others and help flatten the curve. 'They have not just been keeping me safe, but they've been keeping the rest of the populations safe, which is huge,' Ramos said. 'I don't want to be the one spreading anything to anybody.'"[7]

Personal welfare is often disregarded in times of crisis. Experienced disaster team members suggest that encouraging augmentees to care for themselves will allow them to function

Table 2. Non-clinical volunteer positions.

Possessing vital skills		
Communication	Facility maintenance/construction	Transportation
Food services	Local access/political connections	Translation
Security	Waste disposal	Engineering
Computer operations/maintenance		
Other volunteers		
Runner	Transporter	Assistants to skilled personnel
Patients' families, who routinely provide nontechnical bedside nursing care in many countries and cultures, especially on pediatric units; this care should be encouraged and expanded with non-COVID-19 patients when nursing care is limited.		

better and longer. Specifically, ask them to rest whenever possible, hydrate frequently, eat often but generally avoid simple sugars and caffeine, and get exercise.[38]

CONCLUSION

In disasters such as the COVID-19 pandemic, we need to use all available resources to bolster our healthcare workforce. Many factors go into this process, including selecting the groups of professionals we will need, streamlining their licensing and credentialing processes, identifying appropriate roles for them, and supporting their health and well-being.

Address for Correspondence: Kenneth V. Iserson, MD, MBA, Department of Emergency Medicine, The University of Arizona, 4930 N Calle Faja, Tucson, AZ 85718. Email: kvi@email.arizona.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Tsai TC, Jacobson BH, Jha AK. American hospital capacity and projected need for COVID-19 patient care. Health Affairs blog. Available at: www.healthaffairs.org/do/10.1377/hblog20200317.457910/full/. Accessed March 26, 2020.
2. Evans M, Armour S. Hospital capacity crosses tipping point in U.S. coronavirus hot spots. Wall Street Journal. Available at: www.wsj.com/articles/hospital-capacity-crosses-tipping-point-in-u-s-coronavirus-hot-spots-11585215006?mod=djemHL_t. Accessed March 26, 2020.
3. Iserson KV, Heine CE, Larkin GL, et al. Fight or flight: the ethics of emergency physician disaster response. *Ann Emerg Med*. 2008;51(4):345–53
4. Iserson KV. Healthcare ethics during a pandemic. *West J Emerg Med*. 2020. (In press).
5. Minder R, Peltier E. Virus knocks thousands of health workers out of action in Europe. *New York Times*. Available at: www.nytimes.com/2020/03/24/world/europe/coronavirus-europe-covid-19.html. Accessed March 26, 2020.
6. Robinson L, Hick JL, Curtis JR, et al. For the American College of Chest Physicians' Task Force for Mass Definitive Care for the Critically Ill During a Disaster: Medical Resources for Surge: Definitive care for the critically ill during a disaster: medical resources for surge capacity. *Chest*. 2008;133(5):32–50.
7. Fitzpatrick S, McFadden C, Whitman J, Monahan K. U.S. hospitals brace for another challenge — an unprecedented shortage of nurses. NBC News. Available at: www.nbcnews.com/health/health-care/u-s-hospitals-brace-another-challenge-unprecedented-shortage-nurses-n1167786. Accessed March 25, 2020.
8. Havlak J. Red tape keeps nurses from volunteering to help coronavirus patients. Carolina J. Available at: www.laurinburgexchange.com/features/health/34879/red-tape-keeps-nurses-from-volunteering-to-help-coronavirus-patients. Accessed March 26, 2020.
9. Leigh H. PA reactivating retired healthcare providers' licenses to treat COVID-19 patients. Available at: www.fox43.com/article/news/health/coronavirus/pa-reactivating-retired-healthcare-providers-licenses-to-treat-covid-19-patients/521-458744d3-3bb1-4540-97e1-98e845d57af8. Accessed March 26, 2020.
10. Hentze I. COVID-19: Occupational licensing during public emergencies. Available at: https://www.ncsl.org/research/labor-and-employment/covid-19-occupational-licensing-in-public-emergencies.aspx. Accessed March 27, 2020.
11. Terry K. Docs can work across state lines in COVID-19 crisis: White House. *Medscape*. Available at: www.medscape.com/viewarticle/927282. Accessed March 25, 2020.
12. Simmons-Duffin S. States get creative to find and deploy more health workers in COVID-19 fight. Available at: www.npr.org/sections/health-shots/2020/03/25/820706226/states-get-creative-to-find-and-deploy-more-health-workers-in-covid-19-fight. Accessed March 26, 2020.
13. Schultz CH, Stratton SJ. Improving hospital surge capacity. A new concept for emergency credentialing of volunteers. *Ann Emerg Med*. 2007;49(5):602–9.
14. The Joint Commission. Critical Access Hospital. Medical Staff MS Chapter, Sections EM.02.02.13; MS.06.01.13. October 03, 2019.
15. Hodge JG, Gable LA, Cálies SH. The legal framework for meeting surge capacity through the use of volunteers. *J Contemporary Law Policy*. 2005;22(1):5–71.
16. Emergency Management Assistance Compact, Pub. L. No. 104-321.
17. Emergency Management Assistance Compact. Model Intrastate Mutual Aid Legislation and Model State-County Mutual Aid Deployment Contract. Available at:www.emacweb.org. Accessed March 27, 2020.
18. Association of State and Territorial Health Officials. Emergency Management Assistance Compact Fact Sheet. Available at: www.astho.org/Programs/Preparedness/Public-Health-Emergency-Law/Emergency-Authority-and-Immunity-Toolkit/Emergency-Management-Assistance-Compact-Fact-Sheet/. Accessed March 27, 2020.
19. National Emergency Management Association. State Emergency Management Director Handbook. Lexington, KY: NEMA, 2019:103-115. Available at: www.in.gov/dhs/files/NEMA-EM-Director-Handbook-2019.pdf. Accessed March 27, 2020.
20. Centers for Disease Control and Prevention. Cases in U.S. Available at: www.cdc.gov/coronavirus/2019-ncov/cases-updates/cases-in-us.html. Accessed March 26, 2020.
21. Nursing Licensure Compact. Available at: www.ncsbn.org/nurse-licensure-compact.htm. Accessed March 25, 2020.
22. National Registry of Emergency Medical Technicians. Recognition of EMS Personnel Licensure Interstate CompAct (REPLICA). Available at: www.nremt.org/rwd/public/document/replica. Accessed March 27, 2020.

23. Interstate Commission for EMS Personnel Practice. The EMS Compact. Available at: www.emscompact.gov/. Accessed March 27, 2020.
24. General Statutes of Connecticut, Chapter517b; Revised to January 1, 2019. International Emergency Management Assistance Compact. Available at: www.cga.ct.gov/current/pub/chap_517b.htm. Accessed March 25, 2020.
25. Personal communication with HHS spokesperson, March 25, 2020.
26. U.S. Department of Health and Human Services. About ESAR-VHP. Available at: www.phe.gov/esarvhp/pages/about.aspx. Accessed March 25, 2020.
27. 42 U.S. Code § 300hh–15. Volunteer Medical Reserve Corps.
28. Minder R, Peltier E. Virus knocks thousands of health workers out of action in Europe. *New York Times*. Available at: www.nytimes.com/2020/03/24/world/europe/coronavirus-europe-covid-19.html. Accessed March 26, 2020.
29. BBC online. Coronavirus: Thousands volunteer to help NHS with vulnerable. Available at: /www.bbc.com/news/uk-52029877. Accessed March 26, 2020.
30. Simmons-Duffin S. States get creative to find and deploy more health workers in COVID-19 fight. Available at: www.npr.org/sections/health-shots/2020/03/25/820706226/states-get-creative-to-find-and-deploy-more-health-workers-in-covid-19-fight. Accessed March 26, 2020.
31. Lamothe D. Army seeks retired medical personnel to rejoin service to combat the coronavirus. *Washington Post*. Available at: www.washingtonpost.com/national-security/2020/03/25/army-seeks-retired-medical-personnel-rejoin-service-combat-coronavirus/. Accessed March 26, 2020.
32. Etherinton D. The FDA just okayed multiple 15-minute blood tests to screen for coronavirus, but there are caveats. Available at: https://techcrunch.com/2020/03/27/the-fda-just-okayed-multiple-15-minute-blood-tests-to-screen-for-coronavirus-but-there-are-caveats/. Accessed March 29, 2020.
33. Farber ON. Medical students can help combat Covid-19. Don't send them home. Available at: www.statnews.com/2020/03/14/medical-students-can-help-combat-covid-19/. Accessed March 26, 2020.
34. Barone V. NYU offers early graduation to senior med students in bid to fight coronavirus. *New York Post*. Available at: nypost.com/2020/03/24/nyu-offers-early-graduation-to-senior-med-students-in-bid-to-fight-coronavirus/ Accessed March 26, 2020.
35. Anon. Columbia Medical students start COVID-19 virtual volunteer group. March 24, 2020. www.cuimc.columbia.edu/news/columbia-medical-students-start-covid-19-virtual-volunteer-group. Accessed March 26, 2020.
36. Robeznieks A. AMA: Fix immigration issues so IMGs can help fight COVID-19. Available at: www.ama-assn.org/delivering-care/public-health/ama-fix-immigration-issues-so-imgs-can-help-fight-covid-19?&utm_source=BulletinHealthCare&utm_medium=email&utm_term=032620&utm_content=MEMBER&utm_campaign=article_alert-morning_rounds_daily&utm_uid=2056837&utm_effort=MRNRD0. Accessed March 26, 2020.
37. Klein KR, Rosenthal MS, Klausner HA. Blackout 2003: preparedness and lessons learned from the perspectives of four hospitals. *Prehospital Disaster Med*. 2005;20(5):343–9.
38. Hinds JE, Gathney JK, Levy MJ. Disaster Issues in Public Health: NDMS Team Operations in Hostile Environments. NDMS Response-Team Training Program. 2003.

Ibuprofen During the COVID-19 Pandemic: Social Media Precautions and Implications

Brandon M. Carius, DSc, MPAS, PA-C* *Brooke Army Medical Center, JBSA Fort Sam Houston, Texas
Steven G. Schauer, DO, MS*†‡ †US Army Institute of Surgical Research, JBSA Fort Sam Houston, Texas
‡Uniformed Services University of the Health Sciences, Bethesda, Maryland

Section Editor: Mark I. Langdorf, MD, MHPE
Submission history: Submitted April 14, 2020; Revision received April 17, 2020; Accepted April 17, 2020
Electronically published April 24, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.4.47686
[West J Emerg Med. 2020;21(3)497–498.]

Disclaimer: Due to the rapidly evolving nature of this outbreak, and in the interests of rapid dissemination of reliable, actionable information, this paper went through expedited peer review. Additionally, information should be considered current only at the time of publication and may evolve as the science develops.

The ongoing spread of COVID-19, also known as the novel coronavirus, has created significant concerns often leading to panic throughout the world as to its virulence and lethality. Regularly published media track newly infected patient rates and deaths further driving public panic, which invariably leads to people seeking information. As the use of social media continues to complement and augment the drive for free, open-access medical education, some have previously highlighted limitations posed by such a largely unregulated online venue.[1] Previously, these opinions targeted much smaller populations, such as the push against electronic cigarettes after vaping-associated pulmonary injury was identified in 2019. With the increasing reach of COVID-19, however, concerns are not isolated to one section of society, but have instead permeated widely.

The potential for danger and patient harm is already evident, even as the United States and the world begin to grapple with large-scale lockdowns and nationwide efforts. The recent cascade of events surrounding the use of ibuprofen to treat fever in COVID-19 patients illustrates the power and deception of social media. On March 14, French Health Minister and physician Olivier Verán tweeted that "taking anti-inflammatory drugs (ibuprofen, cortisone …) could be an aggravating factor of the infection." Within 24 hours, over 43,000 individuals retweeted this advice despite little evidence to support this claim. In this short time, the World Health Organization's (WHO) Christian Lindmeier, when asked about the tweet, quickly agreed that "we recommend using paracetamol, and do not use ibuprofen as a self-medication."[2] Major international news organizations immediately were abuzz with stories regarding the dangers of ibuprofen in COVID-19, "#ibuprofen" trended on social media, with many declaring it should not be used to treat fever at all. Twenty-four hours later, the official push against ibuprofen seemed to suddenly halt, and the WHO declared that it would not recommend against the use of ibuprofen to treat medical conditions, including COVID-19 patients.[3]

All of this concern was driven by a single letter published online in the *Lancet* on March 11 stating that the use of ibuprofen could theoretically increase the expression of angiotension-converting enzyme 2 (ACE2) and facilitate COVID-19 infection.[4] It is important to note that this letter cited no studies to directly link ibuprofen use to ACE2 expression. Yet with a single tweet, we witnessed a major ripple effect against the use of a foundational antipyretic, and within 24 hours a whiplash back. But, there is no way to discern just how far the original statements reached, or whether the subsequent recalls undid the original misinformation entirely. While Dr. Verán's statement was retweeted thousands of times, it remains unclear how far this information penetrated given that recalls rarely carry the impact that original statements do.

Similar social media turbulence has occurred with hydroxychloroquine and chloroquine, treatments for malaria and rheumatological diseases that have shown initial promise in small trials. This led to scarcity concerns that groups would try to purchase large quantities preemptively in case of approval by the US Food and Drug Administration (FDA).[5] Some states then went as far as to restrict prescription practices specifically out of concern for stockpiling these medications.[6] This further demonstrates the effect that social media have on the practice of medicine even in the absence of science supporting these practices. Never have we witnessed such a large-scale concern over a generic medication in the setting of a health crisis.

While news organizations continue to search for up-to-the-minute stories, and seek the most page views with sensational headlines, medical professionals must recognize our role in providing unsensational care. Efforts should be made to funnel questions to official organizations, such as the Centers for Disease Control and Prevention, the FDA, and local healthcare networks. Patients with concerns should seek evaluation and care in the clinical setting, not through social media. The turbulence of declarations and retractions makes the unease of this time all the worse. We must help centralize information by refraining from declarative diatribes and pushing unproven correlations.

Address for Correspondence: Brandon M. Carius, DSc, MPAS, PA-C, Brooke Army Medical Center, 3551 Roger Brooke Drive, JBSA Fort Sam Houston, TX 78234. Email: brandon.m.carius.mil@mail.mil.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. The views expressed herein are those of the authors and do not reflect the official policy or position of Brooke Army Medical Center, the US Army Institute of Surgical Research, the Uniformed Service University of the Health Sciences, the U.S. Army Medical Department, U.S. Army Office of the Surgeon General, the Department of the Army, the Department of the Air Force, the Department of Defense, or the U.S. Government.

REFERENCES

1. Trethewey SP. Medical misinformation on social media: cognitive bias, pseudo-peer review, and the good intentions hypothesis. *Circulation*. 2019;140(14):1131-3.
2. WHO Now Officially Recommends to Avoid Taking Ibuprofen for COVID-19 Symptoms. Available at: https://www.sciencealert.com/who-recommends-to-avoid-taking-ibuprofen-for-covid-19-symptoms. Accessed March 21, 2020.
3. Andersen T. WHO Walks Back Warning About Ibuprofen and Coronavirus, 'Not Aware' of any Negative Effects. *Boston Globe*. Available at: https://www.bostonglobe.com/2020/03/19/metro/is-it-safe-take-ibuprofen-amid-coronavirus-pandemic/. Accessed March 21, 2020.
4. Fang L, Karakiulakis G, Roth M. Are patients with hypertension and diabetes mellitus at increased risk for COVID-19 infection? *Lancet Respir Med*. 2020;8(4). In press.
5. Coronavirus Update: Access to Hydroxychloroquine (Plaquenil) for People with Lupus. Available at: https://www.lupus.org/news/coronavirus-update-access-to-hydroxychloroquine-plaquenil-for-people-with-lupus. Accessed March 21, 2020.
6. Medication limitations. Texas State Board of Pharmacy. Available at: https://www.pharmacy.texas.gov/files_pdf/291.30.pdf. Accessed March 21, 2020.

Humanism in the Age of COVID-19: Renewing Focus on Communication and Compassion

Jonathan D. Sonis, MD, MHCM
Maura Kennedy, MD, MPH
Emily L. Aaronson, MD, MPH
Joshua J. Baugh, MD, MPP
Ali S. Raja, MD, MBA, MPH
Bryan J. Yun, MD, MBA, MPH
Benjamin A. White, MD

Massachusetts General Hospital, Harvard Medical School, Department of Emergency Medicine, Boston, Massachusetts

Section Editor: R. Gentry Wilkerson, MD
Submission history: Submitted April 7, 2020; Revision received April 16, 2020; Accepted April 17, 2020
Electronically published April 24, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.4.47596
[West J Emerg Med. 2020;21(3)499–502.]

Disclaimer: Due to the rapidly evolving nature of this outbreak, and in the interests of rapid dissemination of reliable, actionable information, this paper went through expedited peer review. Additionally, information should be considered current only at the time of publication and may evolve as the science develops.

INTRODUCTION/BACKGROUND

The global novel coronavirus (COVID-19) pandemic continues to worsen and has become one of the largest clinical and operational challenges faced by emergency medicine since its inception as a specialty. As the virus spreads across the United States, our emergency departments (ED) continue to see increased volumes of infected patients, many of whom are not only critically ill, but acutely aware and fearful of their circumstances and potential mortality. Given the significant fear, anxiety, and uncertainty that has accompanied this pandemic, there may be no more important time than now to focus on staff-patient communication and the expression of empathy and compassion.

Unfortunately, while patients and their families often face terrifying and isolating circumstances, many of the techniques ingrained in us as emergency clinicians to comfort patients in times of uncertainty are also challenged by the need for self-preservation from this disease. Infection precautions, while critical to reduce the spread of COVID-19, are by their very nature "isolating," and make placing a hand on a patient's shoulder, sitting at the foot of the bed, or spending a few extra minutes in a patient's room much less likely to occur. In addition, many of the epidemiological techniques and interventions aimed at reducing the spread of disease (eg, social distancing, reduced in-person interactions) can mean both that the arriving patient already feels some degree of isolation and that the clinicians caring for them are primed to continue a more distanced approach.

Further, as we attempt to preserve personal protective equipment (PPE) in the face of a critical nationwide shortage, many EDs have moved to use telephone and video technology to interview, reassess, and educate our patients; and therefore, even the comfort provided by the doctor "walking in" may be lost. This may serve – explicitly or implicitly – to increase a patient's sense of isolation and even stigmatization. And the interpersonal isolation experienced by our patients is even more pronounced outside the walls of the ED. For those well enough to return home and wait, hoping for improvement and not clinical decline, our instructions are clear: stay at home, alone, and isolate yourself from everyone – even your own family.

For all of these reasons, the burden of COVID-19 extends far beyond the physiologic manifestations. While the social and psychological scars that this pandemic will leave on all of us remain to be seen, the decreased compassion and humanism experienced by our patients is unquestionable. Yet, even while avoiding direct physical contact, wearing PPE, limiting in-person communication, and demanding social isolation, opportunity still exists to express the empathy that led us to the practice of medicine far before the age of COVID-19. But, while ED providers and staff are stretched so thin – both professionally and emotionally – is it practical to put another "ask" on our plates?

We argue that emphasizing compassion and humanism in our current circumstances will not be burdensome for our staff, but rather improve our own job and personal satisfaction during this challenging time. As Dr. Thomas Lee, an internist and leader in patient experience advancement, wrote in his 2016 piece, *Physician Burnout and Patient Experience: Flip Sides of the Same Coin*, "the answer to physician burnout is not to reduce aspirations for the care that we deliver to our patients… it is to become more ambitious."[1] Those who feel that they "care for all

patients equally even when it is difficult" may not only be more resistant to burnout, but more resilient when facing stressful situations such as the COVID-19 pandemic.[2] None of this needs to be time- or labor-intensive: the 40 seconds of compassion found by Johns Hopkins researchers to be enough to make a meaningful difference for patients is less time than it takes many of us to log into our medical record software.[3,4]

GERIATRIC-SPECIFIC CHALLENGES

Not only is it widely accepted that geriatric patients bear a higher burden of morbidity and mortality with COVID-19, but older patients also face a greater number of challenges related to communication, compassion, and less-than-ideal care environments because of this pandemic.

While video and telephonic alternatives to bedside evaluation may facilitate communication with patients while maintaining physical separation to limit healthcare worker exposure and preserve PPE, these solutions may not be as effective in older patients, who commonly have hearing and visual impairment, challenges with manual dexterity due to arthritis, and cognitive impairment, all of which impede effective use of such technology. Accordingly, when caring for older adults, the healthcare provider may be faced with choosing between adequate communication and minimizing healthcare provider exposure and PPE usage.

Additionally, many healthcare facilities are enacting strict visitor restrictions to minimize the potential for nosocomial COVID-19 spread. While these decisions may be appropriate from an institutional level, they take a significant emotional toll on patients, family members, and the care providers tasked with communicating these policies. For patients with cognitive impairment, there is also substantial medical risk associated with being separated from family members or caregivers: those with dementia may demonstrate behaviors such as fidgeting, wandering, or increased aggression to communicate pain, hunger, or need for toileting, and without the presence of family at the bedside to aid in interpretation, these needs are at risk of going unmet.[5-8] To alleviate this, some facilities do allow exemptions to current visitor restrictions, including for patients with dementia. For spouses of older patients, this may leave them with an impossible choice – to stay at the bedside to comfort their loved one and facilitate care, or to stay home and reduce their own risk of personal exposure.

Lastly, while pharmacologic treatment of agitation in patients with dementia or delirium is typically reserved for those with severe symptoms given the associated risk of death in older adults, more aggressive management with antipsychotic medications may become commonplace in the setting of COVID-19. The inability of staff to spend time – and valuable PPE – at the bedside to provide redirection, combined with the absence of those family members at the bedside who so often provide comfort and reassurance, may lead to pharmacologic intervention for less severe agitation than under usual conditions.[9]

POTENTIAL INTERVENTIONS

Despite these challenges, emergency clinicians have at their disposal a myriad of techniques that have previously proven effective, and multiple opportunities for patient care optimization exist. In fact, many of the benefits of increased focus on communication, empathy, and compassion may be enhanced during the COVID-19 crisis, underscoring the need to focus effort and, as necessary, resources, on their expansion.

Patient Arrival

While patients arriving to the ED are greeted by necessary, strongly worded signage and physical barriers reminding them of the need to maintain distancing and to immediately make staff aware of infectious symptoms, as well as reminding them of visitor exclusion policies, the communication techniques used by front-end staff to welcome patients are critical. Simple, scripted language for triage staff reminding patients that infection control is being emphasized to maintain their own and the staff's safety, and that despite isolation precautions they will not be forgotten, may allow patients to adjust their expectations compared to usual circumstances, enhancing their satisfaction and reducing frustration throughout their visit.[10,11]

Signage communicating infection control policies is critical, and print must be large enough to be easily deciphered by geriatric patients, and medical interpreters must be readily available to provide information in non-English languages. These steps serve not only to improve understanding and reduce the risk of inadvertent policy lapses, but to improve overall engagement with care and patient experience. Multiple studies suggest that, taken together, these factors also improve patient outcomes.[12-15]

Clinician Evaluation

Even as many EDs have moved rapidly toward using tablet-based video conferencing and other technology-based solutions to reduce time spent by clinicians and staff at the bedside, staff can – and should – still employ empathic communication techniques to comfort patients at times of maximal stress. The importance of each member of the care team introducing themselves, whether evaluating the patient in person or by video, cannot be overstressed. Given the anonymity caused by extensive PPE use, including face shields and masks, preexisting challenges with making ED patients aware of individual care-team roles are exacerbated.[16]

Reminder mnemonics such as ICARE (Introduction and stating role in care, Collaboration with patients, Acknowledgment of emotions and the situation, Reflective listening, and Expectation setting) or AIDET (Acknowledge, Introduce, Duration, Explanation, Thank you) may be particularly useful heuristic tools during the COVID-19 pandemic when capacity is already stretched thin.[17,18] As nursing staff generally spend more time at the bedside than physicians and other providers and are subject to the same – or more significant – limitations in bandwidth, it is vital that they be included in any efforts to improve communication in current circumstances.[19]

Finally, to maximize the positive perceived empathy of the brief period spent at the bedside, sitting (eg, on a stool) as opposed to standing is imperative; this simple act increases patients' perceptions of both the time spent with them by care providers and of clinician compassion.[20,21]

Discharge Planning

While most patients evaluated for COVID-19 in the ED are medically appropriate for discharge home, symptomatic patients may suffer from fear and uncertainty about their expected course of illness. Using uniform written discharge instructions specifically for patients either confirmed to have COVID-19 or awaiting testing results may have many benefits.[22] Not only will reducing variability improve adherence to isolation and other outpatient management recommendations, but providing frontline staff with comprehensive, pre-written instructions reduces the work burden associated with individual patient discharges and allows for the inclusion of extended information surrounding expected disease course, follow-up planning, and support resources for those suffering from the psychological effects of isolation or requiring local resources such as access to food. Again, provision of information in patients' native languages is obligatory to ensure optimal comprehension.[23]

As many patients will be discharged despite ongoing symptoms and – as hospital capacity constraints grow – even potentially with evidence of moderate disease, post-discharge follow-up calls, in which a staff member contacts patients by phone following ED discharge, will continue to serve multiple purposes. First, identification of worsening symptoms such as shortness of breath or weakness may prompt recommendation to return to the ED for reevaluation. Second, engaging patients by phone following discharge serves to remind them of the compassionate care they received in the ED, potentially mitigating the negative psychological effects of ongoing home isolation.[24]

CONCLUSION

The 2020 novel coronavirus pandemic presents an unprecedented challenge to emergency care clinicians and staff as well as to ED patients and their families. Given the significant fear, anxiety, and uncertainty that has accompanied the proliferation of the virus across the world, there is no more important time to focus on best practices surrounding communication, empathy, and compassion. This is particularly critical for geriatric patients who find themselves at highest risk of injury – both physiologic and psychologic – from this crisis. Fortunately, numerous opportunities exist to make small but meaningful practice changes with the potential of dramatically improving our patients' and staff's experience. While the fundamental disruptions to all of our lives brought by COVID-19 are hopefully temporary, the gains we make in maximizing humanism in our care can benefit our patients indefinitely.

Address for Correspondence: Jonathan D. Sonis, MD, MHCM, Massachusetts General Hospital, Founders Building Suite 850, 55 Fruit Street, Boston, MA 02114. Email: jonathan.sonis@mgh.harvard.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Physician burnout and patient experience: flip sides of the same coin. Available at: https://catalyst.nejm.org/doi/full/10.1056/CAT.16.0812. Accessed April 4, 2020.
2. Helping health care workers avoid burnout. Available at: https://hbr.org/2018/10/helping-health-care-workers-avoid-burnout. Accessed April 4, 2020.
3. Trzeciak S, Mazzarelli A, Booker C. (2019). *Compassionomics: The Revolutionary Scientific Evidence That Caring Makes a Difference*. Pensacola, FL: Studer Group Publishing.
4. Fogarty LA, Curbow BA, Wingard JR, McDonnell K, Somerfield MR. Can 40 seconds of compassion reduce patient anxiety? *J Clin Oncol.* 1999;17(1):371-9.
5. Aftab A, Shah AA. Behavioral emergencies: special considerations in the geriatric psychiatric patient. *Psychiatr Clin North Am*. 2017;40(3):449-62.
6. Backhouse T, Camino J, Mioshi E. What do we know about behavioral crises in dementia? a systematic review. *J Alzheimer's Dis*. 2018;62(1):99-113.
7. Weitzel T, Robinson S, Barnes MR, et al. The special needs of the hospitalized patient with dementia. *Medsurg Nurs.* 2011;20(1):13-8.
8. Radue R, Walaszek A, Asthana S. Neuropsychiatric symptoms in dementia. *Handb Clin Neurol.* 2019;167:437-54.
9. British Geriatrics Society. Coronavirus: managing delirium in confirmed and suspected cases. Available at: https://www.bgs.org.uk/resources/coronavirus-managing-delirium-in-confirmed-and-suspected-cases. Accessed April 5, 2020.
10. Shah S, Patel A, Rumoro D, Hohmann S, Fullam F. Managing patient expectations at emergency department triage. *Patient Exp J.* 2015;2(2):31-44.
11. Lateef F. Patient expectations and the paradigm shift of care in emergency medicine. *J Emerg Trauma Shock.* 2011;4(2):163-7.
12. Green AR, Nze C. Language-based inequity in health care: Who is the "poor historian"? *AMA J Ethics.* 2017;19(3):263-71.

13. Ngo-Metzger Q, Sorkin DH, Phillips RS, et al. Providing high-quality care for limited English proficient patients: The importance of language concordance and interpreter use. *J Gen Intern Med.* 2007;22(SUPPL. 2):324-30.
14. Flores G. The impact of medical interpreter services on the quality of health care: a systematic review. *Med Care Res Rev*. 2005;62(3):255-99.
15. Green AR, Ngo-Metzger Q, Legedza ATR, et al. Interpreter services, language concordance, and health care quality: Experiences of Asian Americans with limited english proficiency. *J Gen Intern Med.* 2005;20(11):1050-6.
16. Allen T, Rieck T, Salsbury S. Patient perceptions of an AIDET and hourly rounding program in a community hospital: Results of a qualitative study. *Patient Exp J*. 2016;3(1):42-9.
17. AIDET: a popular way of improving patients' care experience - ACEP Now. Available at: https://www.acepnow.com/article/aidet-a-popular-way-of-improving-patients-care-experience/. Accessed April 5, 2020.
18. Aaronson EL, White BA, Black L, et al. Training to improve communication quality: an efficient interdisciplinary experience for emergency department clinicians. *Am J Med Qual.* 2019;34(3):260-5.
19. Dempsey C, Reilly B, Buhlman N. Improving the patient experience: real-world strategies for engaging nurses. *J Nurs Adm.* 2014;44(3):142-51.
20. Swayden KJ, Anderson KK, Connelly LM, et al. Effect of sitting vs. standing on perception of provider time at bedside: A pilot study. *Patient Educ Couns*. 2012;86(2):166-71.
21. Strasser F, Palmer JL, Willey J, et al. Impact of physician sitting versus standing during inpatient oncology consultations: Patients' preference and perception of compassion and duration. A randomized controlled trial. *J Pain Symptom Manage*. 2005;29(5):489-97.
22. Taylor DMD, Cameron PA. Discharge instructions for emergency department patients: What should we provide? *J Accid Emerg Med.* 2000;17(2):86-90.
23. Crane JA. Patient comprehension of doctor-patient communication on discharge from the emergency department. *J Emerg Med*. 1997;15(1):1-7.
24. Guss DA, Gray S, Castillo EM. The impact of patient telephone call after discharge on likelihood to recommend in an academic emergency department. *J Emerg Med*. 2014;46(4):560-6.

Preliminary Results of Initial Testing for Coronavirus (COVID-19) in the Emergency Department

Vaishal M. Tolia, MD, MPH
Theodore C. Chan, MD
Edward M. Castillo, PhD, MPH

University of California, San Diego, Department of Emergency Medicine, San Diego, California

Section Editor: Mark I. Langdorf, MD, MHPE
Submission history: Submitted March 21, 2020; Revision received March 23, 2020; Accepted March 23, 2020
Electronically published March 27, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.3.47348

Introduction: On March 10, 2020, the World Health Organization declared a global pandemic due to widespread infection of the novel coronavirus 2019 (COVID-19). We report the preliminary results of a targeted program of COVID-19 infection testing in the ED in the first 10 days of its initiation at our institution.

Methods: We conducted a review of prospectively collected data on all ED patients who had targeted testing for acute COVID-19 infection at two EDs during the initial 10 days of testing (March 10-19, 2020). During this initial period with limited resources, testing was targeted toward high-risk patients per Centers for Disease Control and Prevention guidelines. Data collected from patients who were tested included demographics, clinical characteristics, and test qualifying criteria. We present the data overall and by test results with descriptive statistics.

Results: During the 10-day study period, the combined census of the study EDs was 2157 patient encounters. A total of 283 tests were ordered in the ED. The majority of patients were 18-64 years of age, male, non-Hispanic white, had an Emergency Severity Index score of three, did not have a fever, and were discharged from the ED. A total of 29 (10.2%) tested positive. Symptoms-based criteria most associated with COVID-19 were the most common criteria identified for testing (90.6%). All other criteria were reported in 5.51–43.0% of persons being tested. Having contact with a person under investigation was significantly more common in those who tested positive compared to those who tested negative (63% vs 24.5%, respectively). The majority of patients in both results groups had at least two qualifying criteria for testing (75.2%).

Conclusion: In this review of prospectively collected data on all ED patients who had targeted testing for acute COVID-19 infection at two EDs in the first 10 days of testing, we found that 10.2% of those tested were identified as positive. The continued monitoring of testing and results will help providers understand how COVID-19 is progressing in the community. [West J Emerg Med. 2020;21(3)503-506.]

Disclaimer: Due to the rapidly evolving nature of this outbreak, and in the interests of rapid dissemination of reliable, actionable information, this paper went through expedited peer review. Additionally, information should be considered current only at the time of publication and may evolve as the science develops. On February 11, 2020, the World Health Organization renamed the virus COVID-19.

INTRODUCTION

On March 10, 2020, the World Health Organization (WHO) declared a global pandemic due to widespread infection of the novel coronavirus COVID-19 (coronavirus disease 2019) internationally. Due to a number of challenges, including the unpredictable availability of testing materials, testing for the acute infection was sporadic in the early days of the epidemic in the United States. As a result, testing in emergency departments (ED) has been limited and only began to increase following the WHO declaration. We report the preliminary results of a targeted program of COVID-19 infection testing in the ED in the first 10 days of its initiation at our two institutional EDs.

METHODS

We conducted a review of prospectively collected data on all ED patients who had targeted testing for acute COVID-19

infection at two EDs, located at an urban teaching hospital (ED census approximately 50,000/year), and academic quaternary medical center (ED census approximately 35,000/year) in San Diego, California, within the same healthcare system during the initial 10 days of testing (March 10-19, 2020). During this initial period with limited resources, testing was targeted toward high-risk patients with the following known criteria as per Centers for Disease Control and Prevention (CDC) guidelines: patients presenting with symptoms concerning for COVID-19 infection (fever AND cough or shortness of breath); travel within 14 days to countries with high rates of infection (at that time China, Iran, Italy, Japan, and South Korea); or risk factors for infection complications (including age or co-morbid conditions); or the patient was a healthcare worker who could potentially expose others at risk. Test ordering was at the discretion of the attending emergency physician based on these criteria.

We used the ePLex SARS-CoV-2 test, which detects virus particles in clinical samples collected with a nasopharyngeal swab. The test was conducted under the GenMark Diagnostics platform with a US Food and Drug Administration emergency-use authorization, and evaluated in-house at our institution's clinical laboratory. Data collected from patients who were tested included demographics, clinical characteristics, and test qualifying criteria. Demographics included age group (<18, 18-64, and 65+), gender, and race/ethnicity, Clinical characteristics included Emergency Severity Index (ESI) score, fever present on arrival to ED (yes/no), ED disposition, and COVID-19 test results. Test qualifying criteria included symptoms, contact with a person under investigation, a healthcare worker with potential contact of an infected person, recent travel to high-risk areas, and high-risk comorbidities. Patient demographics, clinical characteristics and test qualifying questions are presented overall and by test results with descriptive statistics.

Table 1. Patient demographics and clinical characteristics by test results for patients who were tested for COVID-19 during the first 10 days of testing.

	Positive (n = 29)		Negative (n = 254)		Total (n = 283)	
Characteristics	Number	(%)	Number	(%)	Number	(%)
Age group						
<18	0	(0.0)	2	(0.8)	2	(0.7)
18-64	25	(86.2)	211	(83.1)	236	(83.4)
65+	4	(13.8)	41	(16.1)	45	(15.9)
Gender						
Female	13	(44.8)	120	(47.2)	133	(47.0)
Male	16	(55.2)	134	(52.8)	150	(53.0)
Race/ethnicity						
Hispanic	4	(13.8)	47	(18.5)	51	(18.0)
NH White	20	(69.0)	141	(55.5)	161	(56.9)
NH Black	0	(0.0)	13	(5.1)	13	(4.6)
NH Asian/PI	2	(6.9)	25	(9.8)	27	(9.5)
Other/Mixed/Unknown	3	(10.3)	28	(11.0)	31	(11.0)
Emergency severity index						
Resuscitation	0	(0.0)	1	(0.4)	1	(0.4)
Emergency	3	(10.3)	46	(18.3)	49	(17.5)
Urgent	14	(48.3)	120	(47.8)	134	(47.9)
Less urgent	11	(37.9)	72	(28.7)	83	(29.6)
Non-urgent	1	(3.4)	12	(4.8)	13	(4.6)
Fever present on arrival						
Yes	2	(6.9)	25	(9.9)	27	(9.6)
No	27	(93.1)	227	(90.1)	254	(90.4)
ED Disposition						
Admit/Transfer	6	(20.7)	75	(29.5)	81	(28.6)
Discharged/AMA/Eloped	23	(79.3)	179	(70.5)	202	(71.4)

Note: Missing measures included 2 temperature and 3 Emergency Severity Index values for patients with negative COVID-19 results.
COVID-19, coronavirus 2019; *NH,* non-Hispanic; *PI,* Pacific Islander; *ED,* emergency department; *AMA,* against medical advice.

RESULTS

During the 10-day study period, the combined census of the study EDs was 2157 patient encounters. This was a decrease of about 21.2% from the same time period in 2019. A total of 283 tests were ordered in the ED. Patient demographics and clinical characteristics are presented in Table 1. The majority of patients were 18–64 years of age, male, non-Hispanic white, had an ESI score of three, did not have a fever, and were discharged from the ED. A total of 29 (10.2%) tested COVID-19 positive. Among these, characteristics paralleled the overall distribution of all patients that were tested. The majority (23/29, 79.3%) of COVID-19 positive patients were also discharged, left against medical advice, or eloped, while those who were admitted or transferred (6/29) were split between patients 18-64 years of age and 65 or older (three from each group). There have been no deaths in our cohort of COVID-19 patients.

The test qualifying criteria are reported in Table 2. Symptoms-based criteria most associated with COVID-19 were the most common criteria identified for testing (90.6%). All other criteria were reported in 43.0% or less of patients. Travel was the least common qualifying response (5.5%). We found only small differences in test qualifying criteria by symptoms and being a healthcare worker, between patients testing positive and negative. Having contact with a person under investigation was significantly more common in those testing positive vs negative (63% vs 24.5%, respectively). The majority of patients in both results groups had at least two qualifying criteria for testing (75.2% overall).

DISCUSSION

COVID-19 infection is caused by a novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), a new human pathogen first identified in Wuhan, Hubei Province, China, in December 2019 that has led to worldwide pandemic. COVID-19 is similar to other zoonotic coronaviruses, named for the so-called "spike proteins" that appear like a crown on these enveloped viruses. A number of coronavirus types are "common cold" pathogens, while certain novel strains have led

Table 2. COVID-19 test qualifying question for patients who were tested for COVID-19 during the first 10 days of testing (n = 235/283 tested).

	Positive (n = 27)		Negative (n = 208)		Total (n = 235)	
Qualifying questions	Number	(%)	Number	(%)	Number	(%)
Symptoms						
Yes	25	(92.6)	188	(90.4)	213	(90.6)
No	2	(7.4)	20	(9.6)	22	(9.4)
Contact with person under investigation						
Yes	17	(63.0)	49	(23.6)	66	(28.1)
No	10	(37.0)	159	(76.4)	169	(71.9)
Healthcare worker						
Yes	7	(25.9)	51	(24.5)	58	(24.7)
No	20	(74.1)	157	(75.5)	177	(75.3)
Foreign travel to COVID endemic country						
Yes	3	(11.1)	10	(4.8)	13	(5.5)
No	24	(88.9)	198	(95.2)	222	(94.5)
Comorbidities						
Yes	8	(29.6)	93	(44.7)	101	(43.0)
No	19	(70.4)	115	(55.3)	134	(57.0)
Total number of confirmed qualifying questions						
0	0	(0.0)	3	(1.4)	3	(1.3)
1	4	(14.8)	51	(24.5)	55	(23.4)
2	15	(55.6)	123	(59.1)	138	(58.7)
3	7	(25.9)	30	(14.4)	37	(15.7)
4	0	(0.0)	1	(0.4)	1	(0.4)
5	1	(3.7)	0	(0.0)	235	(0.4)

Note: Questions were asked for 235 (83.0%) of the 283 patients who received COVID-19 testing.
COVID-19, coronavirus 2019.

to outbreaks of respiratory diseases (SARS-CoV-1, Middle East respiratory syndrome (MERS-CoV).

Worldwide, as of March 27, 2020, there have been nearly 586,000 confirmed cases of COVID-19 resulting in 26,865 deaths. In the US there have been over 97,000 cases with over 1,400 deaths.[1] For the majority of infections, COVID-19 results in a mild respiratory illness.[2] However, a significant number result in serious morbidity and death, associated with advanced age and co-morbidities including hypertension, diabetes, and immunosuppression.[3]

The first case of COVID-19 confirmed in the US was reported in January 2020.[4] The early stages of the response to COVID-19 in the US was hampered by multiple challenges and issues, particularly availability of diagnostic testing for the novel coronavirus.[5] As a result, testing has been limited with specific criteria recommended by the CDC including severity of disease, such as requiring hospitalization, recent travel, or risk factors for significant morbidity and mortality.[6] In response, a number of innovative approaches have been piloted to assess patients for the disease.[7]

As of mid-March, the CDC reported 7038 confirmed or presumptive positive coronavirus tests, with a total number of specimens tested by CDC labs of 4484 and US public health laboratories of 33,340.[8,9] In our study, in the initial 10 days of in-house testing for ED patients meeting criteria for diagnostic evaluation, we report a 10.2% incidence rate of 283 tests conducted. The true incidence rate of COVID-19 in the US is unknown and will continue to be unclear until the ability for mass testing becomes available.

LIMITATIONS

First, we report only preliminary data from the ED for an initial brief period (10 days). We believe this is one of the first reports of the results of in-house novel coronavirus testing in the emergency setting. Second, our study was conducted at a single healthcare institution with two EDs in one metropolitan region and thus our results may not reflect the conditions or expected findings in other communities or hospital EDs. Finally, this report is in the early stages of the pandemic in the US and in particular in the very early stages of testing availability in the US. It is likely that with further expansion of testing access and availability, new information and insights into this pandemic and its impact on our healthcare resources and communities will be discovered.

CONCLUSION

In this review of prospectively collected data on all ED patients who had targeted testing for acute COVID-19 infection at two EDs in the first 10 days of testing, we found over 10% of those tested were identified as positive. Nearly all of these patients did not have a fever when they arrived to the ED. However, a history of viral infection symptoms was the most common criteria for testing. The continued monitoring of testing and results will help providers understand how COVID-19 is progressing in the community and identify patient characteristics most suggestive of acute infection. This will help with public health surveillance and ongoing efforts to reduce the transmission of the virus and "flatten the curve."

Address for Correspondence: Edward M. Castillo, MPH, PhD, University of California, San Diego, Department of Emergency Medicine, 200 West Arbor Dr., #8676, San Diego, CA 92103. Email: emcastillo@ucsd.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Mapping 2019-nCoV. Available at: https://systems.jhu.edu/research/public-health/ncov/. Accessed March 20, 2020.
2. Del Rio C, Malani PN. 2019 novel coronavirus – important information for clinicians. *JAMA*. 2020;323(11):1039-40.
3. Severe outcomes among patients with coronavirus disease 2019 (COVID-19) — United States, February 12–March 16, 2020. *Morb Mortal Wkly Rep*. 2020. In Press.
4. Holshue ML, Debolk C, Lindquist S, et al. First case of 2019 novel coronavirus in the United States. *NEJM*. 2020;382(10):929-36.
5. Sharfstein JM, Becker SJ, Mellow MM. Diagnostic testing for the novel coronavirus. *JAMA*. 2020. In Press.
6. Evaluating and testing persons for coronavirus disease 2019 (COVID-19). Available at: https://www.cdc.gov/coronavirus/2019-nCoV/hcp/clinical-criteria.html. Accessed March 18, 2020.
7. Bryson-Cahn C, Duchin J, Makarewicz VA, et al. A novel approach for a novel pathogen: using home assessment team to evaluate patients for 2019 novel coronavirus. *Clin Infect Dis*. 2020. In Press.
8. Cases in U.S. Available at: https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/cases-in-us.html. Accessed March 18, 2020.
9. Testing in U.S. Available at: https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/testing-in-us.html. Accessed March 18, 2020.

Sex- and Gender-specific Observations and Implications for COVID-19

Lauren A. Walter, MD*†
Alyson J. McGregor, MD, MA*†

*University of Alabama at Birmingham, Department of Emergency Medicine, Birmingham, Alabama
†Warren Alpert Medical School of Brown University, Department of Emergency Medicine, Providence, Rhode Island

Section Editor: Mark I. Langdorf, MD, MHPE
Submission history: Submitted April 2, 2020; Accepted April 3, 2020
Electronically published April 10, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.4.47536
[West J Emerg Med. 2020;21(3)507-509.]

Disclaimer: Due to the rapidly evolving nature of this outbreak, and in the interests of rapid dissemination of reliable, actionable information, this paper went through expedited peer review. Additionally, information should be considered current only at the time of publication and may evolve as the science develops. On February 11, 2020, the World Health Organization renamed the virus COVID-19.

This is a critical time for medicine. As we observe the exponential rise in the number of individuals in the United States (US) who are infected with COVID-19, we try to prepare. Those in the front lines are trying to protect themselves and their patients with the daily ration of personal protective equipment and ventilation assistive equipment. Many individuals are racing against time to develop the needed novel treatments and vaccines. Public health officials work with what little information is known in order to make effective recommendations for prevention. However, at this pivotal time in history where every detail obtained by US health officials could be lifesaving, we are leaving out vital information.

Descriptive and observational data from Wuhan, China, note that the majority (51%-66.7%) of affected patients have been male. In addition, male sex was an independent risk factor associated with refractory disease and death (2.8% death rate for men vs 1.7% for female).[1,2] Currently, men represent 58% of COVID-19 infected patients in Italy and 70% of COVID-related deaths.[3] As coronavirus cases and deaths in the US continue to soar, sex-specific, comprehensive data with regard to US patients is not yet available.

Sex- and gender-based medicine (SGBM) incorporates how biological *sex* and the sociocultural aspects of *gender* affect health and illness. It acknowledges the interrelationship between sex and gender on health outcomes and promotes consideration of this variable in both research and clinical practice. SGBM has demonstrated significant evidence-based impact on cardiovascular disease, stroke, sports medicine, and pain management, just to name a few

Sex and gender differences have been observed in infectious diseases previously. On a broad and critical scale, Nasir et al demonstrated that males with all-cause infectious sepsis have a 70% greater mortality than their female counterparts. Likewise, respiratory infection-specific epidemiological data from recent SARS (2003) and MERS (2012) outbreaks demonstrated a significantly higher case fatality rate in males as compared to females, 21.9% vs 13.2%.[4,5]

Sex-specific Factors

Is the biological male more susceptible to an increased severity of infection? Or does the biological woman have natural protection against these viruses? In a 2017 *BMJ* article, Dr. Kyle Sue demonstrated the effect of sex hormones, estrogen and testosterone, on immune system response and engagement, resulting in a less robust immunologic response in males and subsequent increased morbidity and mortality from viral respiratory illnesses.[6] In addition, the X chromosome carries the largest number of immune-related genes in the human genome, perhaps also contributing to female's superior immune response (as well as a female preponderance in autoimmune diseases).[7]

Angiotensin-converting enzyme 2 (ACE2) and its role in viral transmission and associated morbidity has also been a topic of recent COVID-19 associated discussion. ACE2 receptors on pulmonary endothelium serve as a main entry point for coronavirus. Several previous animal models have demonstrated increased ACE2 activity in the male or ovariectomized model, suggesting a sex hormone influence.[8] The gene for the ACE2 receptor is also, interestingly, on the X chromosome.[9]

Gender-specific Factors

Behavioral and cultural variables have also influenced current COVID-19 epidemiology. Smoking in particular has

been implicated as a significant contributor to disease severity, and gender-specific patterns are quite apparent here. The smoking rate in China is much higher in men than in women (288 million men vs 12.6 million women; 2018 data).[10] Likewise, in Italy, men are more likely to smoke than women at any age (1.12x to 1.7x, depending on age cohort; 2018 data).[11] Similar gender-specific trends are also present in the US, where 17.6% of smokers are men as compared to 13.6% of women.[12]

In addition, as the traditional caregivers and coordinators of care for their loved ones, women, particularly working mothers, tend to spend more time than men focused on medical issues related to both their own healthcare and that of their families.[13] In general, men are more likely to engage in health-related risks which, even prior to the COVID-19 pandemic, has been shown to result in higher rates of injury and disease.[14] Suen et al demonstrated in 2019 that being a middle-aged female was a protective factor with regard to hand hygiene knowledge and practice.[15]

Population Health Research Capsule

What do we already know about this issue?
COVID-19 represents an unparalleled public health crisis. Like many other infectious diseases, sex and gender differences in health outcomes have already been globally observed.

What was the research question?
We sought to summarize and explain known COVID-19-related sex and gender differences.

What was the major finding of the study?
Sex and gender differences are having significant impacts on current COVID-19 health outcomes.

How does this improve population health?
This perspective brings attention to the importance of sex and gender, specifically as they impact current clinical management and research during the COVID-19 pandemic.

Implications for COVID-19 Management

As clinical researchers and pharmaceutical companies race to find an effective treatment strategy or vaccine for COVID-19, no sex- or gender-specific recommendations have been released with regard to the care and management of individuals affected by the novel coronavirus. Appreciating the weight of known sex- and gender-specific epidemiologic observations thus far, however, will be an important highlight of the information gathered to date. This, combined with what is already known about sex- and gender-based pulmonary and infectious disease pathology, may lead to important treatment breakthroughs that consider the sex and/or gender of patient in the comprehensive management plan.

In addition, the current pandemic weighs heavily on emotional wellness along with physical health. COVID-19 has also released a contagion of fear, anxiety, and stigma that will have implications for downstream mental health effects including post-traumatic stress disorder (PTSD). In general, the prevalence of PTSD has been shown to be substantially higher in women.[16] This has been re-substantiated in the setting of the COVID-19 outbreak in Wuhan, China, where women scored significantly higher on the PCL-5 (DSM-5 self-report measure for PTSD) than men, including higher rates of re-experiencing and negative alterations in cognition or mood.[17] Early recognition and effective treatment can ameliorate the burden of PTSD on both the individual and society, particularly for women who have been shown to have a modest advantage with regard to treatment response.[18]

Future Considerations

Since 2016, the NIH has required inclusion of sex as a biological variable (SABV) in the study design for funded research.[19] Recognizing the weight these variables play in disease outcome should result in universal adoption of SABV as scientists develop and engage in COVID-19 research. While men appear to be disproportionately affected and at risk for COVID-19 infection and associated morbidity, researchers should avoid the slippery slope of the traditional male-dominant test and analysis approach.

When considering pharmaceutical therapy advances, several previous studies have established that women are much more likely to experience adverse drug reactions (ADR) than men.[20] In fact, historically the majority of drugs recalled from the market were done so due to serious ADRs reported by women, quite often because they were never tested on women during clinical trials. Several sex-specific pharmacokinetic and pharmacodynamic differences have been well documented.[21]

Yes, time is of the essence right now; however, COVID-19 does not get a "pass" in considering sex and gender when gathering data or testing treatments. Sex and gender have already proven to be crucial variables in the short history of COVID-19; they will continue to be factors of marked importance. Making healthcare providers and researchers aware of their impact in real time will be crucial to the integration of susceptibility profiles and improving outcomes during an active public health crisis.

Address for Correspondence: Lauren A. Walter, MD, University of Alabama at Birmingham, Department of Emergency Medicine, OHB 251, 619 19th St S, Birmingham, AL 35249. Email: lwalter@uabmc.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Mo P, Xing Y, Xiao Y, et al. Clinical characteristics of refractory COVID-19 pneumonia in Wuhan, China. *Clin Infect Dis*. 2020. In Press.
2. Chen N, Zhou M, Dong X, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet*. 2020;395(10223):507–13.
3. Remuzzi A, Remuzzi G. COVID-19 and Italy: what next? *Lancet*. 2020;S0140-6736(20)30627-9.
4. Channappanavar R, Fett C, Mack M, et al. Sex-based differences in susceptibility to severe acute respiratory syndrome coronavirus infection. *J Immunol*. 2017;198(10):4046–53.
5. Matsuyama R, Nishiura H, Kutsuna S, et al. Clinical determinants of the severity of Middle East respiratory syndrome (MERS): a systematic review and meta-analysis. *BMC Public Health*. 2016;16(1):1203.
6. Sue K. The science behind "man flu." *BMJ*. 2017;359:j5560.
7. Schurz H, Salie M, Tromp G, et al. The X chromosome and sex-specific effects in infectious disease susceptibility. *Hum Genomics*. 2019;13(1):2.
8. Liu J, Ji H, Zheng W, et al. Sex differences in renal angiotensin converting enzyme 2 (ACE2) activity are 17β-oestradiol-dependent and sex chromosome-independent. *Biol Sex Differ*. 2010;1(1):6.
9. Patel SK, Velkoska E, Freeman M, et al. From gene to protein-experimental and clinical studies of ACE2 in blood pressure control and arterial hypertension. *Front Physiol*. 2014;5:227.
10. Cai H. Sex difference and smoking predisposition in patients with COVID-19. *Lancet Respir Med*. 2020. In Press.
11. Statista Research Department. "Number of Smokers by Age and Gender in Italy 2018." *Statista*. Available at: www.statista.com/statistics/501615/italy-smokers-by-age-and-gender/. Accessed March 27, 2020.
12. National Institute on Drug Abuse. "Are There Gender Differences in Tobacco Smoking?" *NIDA*. Available at: www.drugabuse.gov/publications/research-reports/tobacco-nicotine-e-cigarettes/are-there-gender-differences-in-tobacco-smoking. Accessed March 27, 2020.
13. "A Health Care Consumer Gender Gap." *Managed Care Magazine*. Available at: www.managedcaremag.com/archives/2016/8/health-care-consumer-gender-gap. Accessed March 27, 2019.
14. Harris CR, Jenkins M. Gender differences in risk assessment: Why do women take fewer risks than men? *Judgm Decis Mak*. 2006;1(1):48-63.
15. Suen LKP, So ZYY, Yeung SKW, et al. Epidemiological investigation on hand hygiene knowledge and behaviour: a cross-sectional study on gender disparity. *BMC Public Health*. 2019;19(1):401.
16. K Farhood L, Fares S, Hamady C. PTSD and gender: Could gender differences in war trauma types, symptom clusters and risk factors predict gender differences in PTSD prevalence? *Arch Womens Ment Health*. 2018;21(6):725–33.
17. Liu N, Zhang F, Wei C. Prevalence and predictors of PTSS during COVID-19 Outbreak in China Hardest-hit Areas: Gender differences matter. *Psychiatry Res*. 2020. In Press.
18. Blain LM, Galovksi TE, Robinson T. Gender differences in recovery from posttraumatic stress disorder: a critical review. *Aggress Violent Behav*. 2010;15(6):463-74.
19. "NIH Policy on Sex as a Biological Variable." *National Institutes of Health*, U.S. Department of Health and Human Services. Available at: orwh.od.nih.gov/sex-gender/nih-policy-sex-biological-variable. Accessed March 27th, 2020.
20. Tran C, Knowles SR, Liu BA, et al. Gender differences in adverse drug reactions. *J Clin Pharmacol*. 1998;38(11):1003–9.
21. Franconi F, Campesi I. Pharmacogenomics, pharmacokinetics and pharmacodynamics: interaction with biological differences between men and women. *Br J Pharmacol*. 2014;171(3):580–94.

Brief Summary of Potential SARS-CoV-2 Prophylactic and Treatment Drugs in the Emergency Department

Cortlyn Brown, MD*
Jeanne Noble, MD*
Zlatan Coralic, PharmD†

*University of California San Francisco, Department of Emergency Medicine, San Francisco, California
†University of California San Francisco School of Pharmacy, San Francisco, California

Section Editor: Mark I. Langdorf, MD, MHPE
Submission history: Submitted March 18, 2020; Revision received March 26, 2020; Accepted March 27, 2020
Electronically published March 31, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.3.47328

As of March 30th, 2020 there were 161,807 total cases and 2,953 total deaths of SARS-CoV-2 in the United States, with the number of cases expected to rise. Other than supportive care, there are no SARS-CoV-2 specific treatments available for patients discharged from the emergency department (ED) or those admitted to the hospital. In addition, there are no vaccines available to protect our at-risk healthcare workers. The National Institutes of Health is conducting a Phase 1 clinical trial to evaluate for a potential vaccine and the recipients have started to receive the investigational vaccine.[2] We present a brief overview of the potential prophylactic and treatment agents under investigation, some which could be initiated in the ED if proven effective. [West J Emerg Med. 2020;21(3)510–513.]

Disclaimer: Due to the rapidly evolving nature of this outbreak, and in the interests of rapid dissemination of reliable, actionable information, this paper went through expedited peer review. Additionally, information should be considered current only at the time of publication and may evolve as the science develops.

INTRODUCTION

As of March 30th, 2020 there were 161,807 total cases and 2,953 total deaths of SARS-CoV-2 in the United States,[1] with the number of cases expected to rise. Other than supportive care, there are no SARS-CoV-2 specific treatments available for patients discharged from the emergency department (ED) or those admitted to the hospital. In addition, there are no vaccines available to protect our at-risk healthcare workers. The National Institutes of Health is conducting a Phase 1 clinical trial to evaluate for a potential vaccine.[2] We present a brief overview of the potential prophylactic and treatment agents under investigation, some of which could be initiated in the ED if proven effective.

METHODS

We conducted a literature search on March 17th, 2020 (updated March 30th, 2020) on PubMed and the Cochrane Library. Search terms included "COVID-19/SARS-CoV-2 treatment or prophylaxis or drugs or therapy." Abstracts of relevant papers were reviewed by the authors. Drug information was obtained from Lexicomp Online.[3]

CONVALESCENT SERUM

Human convalescent sera has been used since the early twentieth century and is currently under investigation for prophylaxis and treatment.[4] To obtain the serum, blood is drawn from a subject who has recently recovered from the target disease. After processing, blood that is noted to have high titers of neutralizing antibodies is then administered to high risk individuals such as those with underlying medical conditions, healthcare providers, or those with confirmed exposure.

Convalescent sera has also been used in modern times. It was used during the H1N1 influenza outbreak and found to reduce respiratory viral burden, cytokine response, and mortality in H1N1 infected ICU patients.[5] Convalescent sera has also been used for other coronaviruses. Eighty SARS-CoV positive patients treated with convalescent serum before day 14 of illness had improved prognosis compared to those treated later.[6] There are case reports of convalescent sera administration during the current SARS-CoV-2 outbreak in China, but few details are available.[7] In addition, the drug maker Takeda is working on developing a SARS-CoV-2 immunoglobulin serum.[4]

To enter a cell, coronaviruses depend on the binding of the viral spike proteins to cellular receptors as well as S protein

priming by host cell proteases. Hoffmann *et al* found that SARS-CoV-2 uses the SARS-CoV angiotensin converting enzyme 2 (ACE2) receptor to enter cells and the serine protease TMPRSS2 for S protein priming.[8] Hoffmann *et al* utilized this information and found that convalescent SARS-CoV serum, which is known to have a neutralizing antibody against the viral S protein, decreased SARS-CoV-2 entry into the cell *in vitro*. They also found that rabbit serum raised against the S1 subunit of the SARS-CoV virus inhibited SARS-CoV and SARS-CoV-2 entry into the cell *in vitro*. These data suggest that neutralizing antibody responses raised against SARS-CoV might offer protection against SARS-CoV-2. In addition, given that TMPRSS2 is required for entry, a TMPRSS2 inhibitor, although not convalescent serum, is another possible target.

There are, however, known risks of convalescent sera including possible allergic reaction to other products in the sera and transmission of other diseases. There are also theoretical risks, most notably antibody-dependent enhancement of infection as well as the possibility that antibody exposure may attenuate the immune system leaving individuals vulnerable to subsequent reinfection.[9]

The feasibility of extracting, processing, and providing the serum to ED clinicians for use is a challenge. A commercially available product could be easier to procure and administer. However, at this time there is no formal recommendation or guidelines to initiate this therapy for patients in the ED or those clinicians working directly with COVID-19 patients.

Population Health Research Capsule

What do we already know about this issue?
There are now over 150,000 individuals, worldwide, with COVID-19, the disease caused by the SARS-CoV-2 virus.

What was the research question?
This paper summarizes the literature on potential prophylactic and treatment drugs in consideration for COVID-19.

What was the major finding of the study?
There is limited data supporting all potential COVID-19 treatment and prophylactic drugs but some show promise.

How does this improve population health?
A potential treatment or prophylactic drug for COVID-19 could halt the course of the current pandemic and save lives.

OTHER POSSIBLE PROPHYLACTIC OR TREATMENT AGENTS

SARS-CoV, MERS-CoV, and SARS-CoV-2 are all betacoronaviruses. Although no prophylaxis or treatment exists against SARS-CoV-2, there are several drugs which have been subject to limited trials or are currently under investigation.[10] These drugs include remdesivir, chloroquine, hydroxychloroquine, azithromycin, lopinavir-ritonavir, tocilizumab, sarilumab, and losartan.

Both remdesivir and chloroquine have shown some efficacy against SARS-CoV-2. Remdesivir incorporates into nascent viral RNA chains causing pre-mature termination whereas chloroquine increases the endosomal pH required for viral/cell fusion and interferes with glycosylation of cellular receptors.

Wang *et al* showed that remdesivir and chloroquine had a high selectivity against SARS-CoV-2 and blocked viral infection *in vitro* in African green monkey cells.[11] Remdesivir interfered after the virus had entered the cell, whereas chloroquine interfered at entry and post-entry stages. More importantly, their preliminary data suggest the same effects in human cell lines.

In the U.S., remdesivir is currently only available as an investigational agent or through compassionate use protocols for confirmed SARS-CoV-2 hospitalized patients with invasive mechanical ventilation.[12] At this time, the use of this agent in the ED is unlikely.

Chloroquine and hydroxychloroquine are oral medications that could potentially be used to treat outpatients and those admitted to the hospital. However, as with this author's institution, these agents may be restricted for COVID-19 indications in the ED until further evidence is available with several exceptions including very sick patients that are admitted. As these agents are available in the community, ED clinicians should exercise caution counseling patients inquiring about chloroquine and hydroxychloroquine, especially with the recent report of a fatal chloroquine overdose intended for COVID-19 self-treatment.[13]

There are currently over 10 clinical trials in China evaluating the effect and safety of chloroquine in the treatment of SARS-CoV-2 associated pneumonia. Although preliminary data have not been released, Gao *et al* reported in a news briefing by the State Council of China that chloroquine phosphate had "demonstrated marked efficacy and acceptable safety in treating COVID-19 associated pneumonia in multicenter clinical trials."[14,15]

Hydroxychloroquine is a chloroquine analog with fewer drug-drug interactions. Yao *et al* studied African green monkey cells *in vitro* and found that chloroquine and hydroxychloroquine decreased SARS-CoV-2 viral replication in a concentration-dependent manner but that hydroxychloroquine was more potent.[16] They also evaluated physiologically-based pharmacokinetic models *in vivo*. Based

on these results, they recommend an oral loading dose of 400 mg hydroxychloroquine sulfate twice daily on day one followed by a maintenance dose of 200 mg twice daily for four days.

Jun *et al* conducted a prospective study of 30 SARS-CoV-2 positive patients randomized to either standard treatment or hydroxychloroquine. They found no difference between the two groups with respect to median duration from hospitalization to undetectable serum SARS-CoV-2, median time to body temperature normalization, and development of diarrhea and liver function test abnormalities.[17] Gautret *et al*, however, found that the addition of azithromycin to hydroxychloroquine improved virus elimination.[18] There are current studies investigating the use of hydroxychloroquine chemoprophylaxis for healthcare workers (ClinicalTrials.gov: NCT04318015).

Cao et al conducted a randomized, controlled, open label trial of lopinavir-ritonavir with 199 SARS-CoV-2 hospitalized adult patients with an oxygen saturation less than or equal to 94% on room air or partial pressure of oxygen to fraction of inspired oxygen less than 300 This cohort would then include mild, moderate as well as severely hypoxic patients.[19] They found no difference in 28 day mortality in the lopinavir-ritonavir group compared to the standard-care group (19.2% vs 25.0%; 95% confidence interval [CI] -17.3 to 5.7) or percentages of patients with detectable viral RNA at various time points. They also noted significant gastrointestinal side effects and stopped the lopinavir-ritonavir early in 13 patients (13.8%) because of adverse events. The lack of survival benefit as well as the significant side effects make this drug unlikely to be used in the ED at this point.

There are also ongoing studies with monoclonal antibodies tocilizumab (ClinicalTrials.gov: NCT04317092) and sarilumab (ClinicalTrials.gov: NCT04315298). Both of these agents are interleukin -6 receptor antagonists that could theoretically attenuate cytokine and acute phase reactants.[3] Further, as the SARS-CoV-2 depends on the ACE2 receptor for entry, another multicenter placebo-controlled trial is enrolling patients evaluating losartan (angiotensin 2 receptor blocker) in patients requiring hospitalizations (ClinicalTrials.gov: NCT04312009).

SUMMARY

Convalescent sera has been used in the past as viral prophylaxis and treatment but there is currently a lack of human data on use against SARS-CoV-2. Remdesivir and chloroquine (or hydroxychloroquine) are two medications that have also shown promising results *in vitro* but clinical trial data have yet to be released. Press releases on these medications have discussed promising results. At this time there is no evidence or consensus to initiate these therapies in the ED.

Address for Correspondence: Cortlyn Brown, MD, University of California San Francisco School of Medicine, Department of Emergency Medicie, 1001 Potrero Avenue, San Francisco, CA 94110, Building 5, Room IE22A. Email: Cortlyn.brown@ucsf.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Coronavirus Disease 2019 (COVID-19) in the U.S. Available at: https://www.cdc.gov/coronavirus/2019-ncov/cases-in-us.html. Published March 13, 2020. Accessed March 13, 2020.
2. NIH clinical trial of investigational vaccine for COVID-19 begins. Available at: https://www.nih.gov/news-events/news-releases/nih-clinical-trial-investigational-vaccine-covid-19-begins. Published March 16, 2020. Accessed March 18, 2020.
3. Lexi-Drugs Online. Available at: https://www.wolterskluwercdi.com/lexicomp-online/. Published 2020. Accessed March 23, 2020.
4. Takeda Initiates Development of a Plasma-Derived Therapy for COVID-19. Available at: https://www.takeda.com/newsroom/newsreleases/2020/takeda-initiates-development-of-a-plasma-derived-therapy-for-covid-19/. Published March 4, 2020. Accessed March 14, 2020.
5. Hung IF, To KK, Lee C-K, et al. Convalescent Plasma Treatment Reduced Mortality in Patients With Severe Pandemic Influenza A (H1N1) 2009 Virus Infection. *Clin Infect Dis.* 2011;52(4):447-56.
6. Cheng Y, Wong R, Soo YOY, et al. Use of convalescent plasma therapy in SARS patients in Hong Kong. *Eur J Clin Microbiol Infect Dis.* 2005;24(1):44-6.
7. China puts 245 COVID-19 patients on convalescent plasma therapy. Xinhua. Available at: http://www.xinhuanet.com/english/2020-02/28/c_138828177.htm. Published February 28, 2020. Accessed March 23, 2020.
8. Hoffmann M, Kleine-Weber H, Schroeder S, et al. SARS-CoV-2 Cell Entry Depends on ACE2 and TMPRSS2 and Is Blocked by a Clinically Proven Protease Inhibitor. *Cell.* March 2020. In Press.
9. Casadevall A, Pirofski L. The convalescent sera option for containing COVID-19. *J Clin Invest*. March 2020. In Press.
10. Zumla A, Chan JFW, Azhar EI, et al. Coronaviruses - drug discovery and therapeutic options. *Nat Rev Drug Discov.* 2016;15(5):327-47.
11. Wang M, Cao R, Zhang L, et al. Remdesivir and chloroquine effectively inhibit the recently emerged novel coronavirus (2019-nCoV) in vitro. *Cell Res.* 2020;30(3):269-71.
12. Gilead. Available at: https://rdvcu.gilead.com. Accessed March 18, 2020.

13. Man dies after ingesting chloroquine in an attempt to prevent coronavirus. Available at: https://www.nbcnews.com/health/health-news/man-dies-after-ingesting-chloroquine-attempt-prevent-coronavirus-n1167166. Accessed March 24, 2020.
14. Gao J, Tian Z, Yang X. Breakthrough: Chloroquine phosphate has shown apparent efficacy in treatment of COVID-19 associated pneumonia in clinical studies. *Biosci Trends.* February 2020. In Press.
15. Audio transcript of the news briefing held by the State Council of China on February 17, 2020. The National Health Commission of the People's Republic of China. February 2020. Available at: http://www.nhc.gov.cn/xcs/yqfkdt/202002/f12a62d10c2a4 8c6895cedf2faea6e1f.shtml. Accessed March 24, 2020.
16. Yao X, Ye F, Zhang M, et al. In Vitro Antiviral Activity and Projection of Optimized Dosing Design of Hydroxychloroquine for the Treatment of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). *Clin Infect Dis.* March 2020. In Press.
17. Jun C, Danping L, Ping L, et al. A pilot study of hydroxychloroquine in treatment of patients with common coronavirus disease-19 (COVID-19). *J Zhejiang Univ (Med Sci).* 2020;49.
18. Gautret P, Lagier J-C, Parola P, et al. Hydroxychloroquine and azithromycin as a treatment of COVID-19: results of an open-label non-randomized clinical trial. International Journal of Antimicrobial Agents. March 2020. In Press.
19. Cao B, Wang Y, Wen D, et al. A Trial of Lopinavir–Ritonavir in Adults Hospitalized with Severe Covid-19. *N Engl J Med.* March 2020. In Press.

15 Smartphone Apps for Older Adults to Use While in Isolation During the COVID-19 Pandemic

Swechya Banskota, BS*
Margaret Healy, BS†
Elizabeth M. Goldberg, MD, ScM‡§

*The Warren Alpert Medical School of Brown University, Providence, Rhode Island
†Johnson & Wales University, Providence, Rhode Island
‡The Warren Alpert Medical School of Brown University, Department of Emergency Medicine, Providence, Rhode Island
§Brown University School of Public Health, Department of Health Services, Practice and Policy, Providence, Rhode Island

Section Editor: Ioannis Koutroulis, MD
Submission history: Submitted March 23, 2020; Revision received April 5, 2020; Accepted April 6, 2020
Electronically published April 14, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.4.47372

The maintenance of well-being, healthcare, and social connection is crucial for older adults (OA) and has become a topic of debate as much of the world faces lockdown during the coronavirus disease 2019 (COVID-19) pandemic. OAs have been advised to isolate themselves because they are at higher risk for developing serious complications from severe acute respiratory syndrome coronavirus. Additionally, nursing homes and assisted-living facilities across the country have closed their doors to visitors to protect their residents. Mobile technology such as applications (apps) could provide a valuable tool to help families stay connected, and to help OAs maintain mobility and link them to resources that encourage physical and mental well-being. Apps could address cognitive, visual, and hearing impairments. Our objective was to narratively summarize 15 apps that address physical and cognitive limitations and have the potential to improve OAs' quality of life, especially during social distancing or self-quarantine. [West J Emerg Med. 2020;21(3)514–525.]

Disclaimer: Due to the rapidly evolving nature of this outbreak, and in the interests of rapid dissemination of reliable, actionable information, this paper went through expedited peer review. Additionally, information should be considered current only at the time of publication and may evolve as the science develops.

INTRODUCTION

In January 2020, the first case of coronavirus disease 2019 (COVID-19) was identified in the United States. Shortly thereafter, visitation restrictions and guidance to reduce contact with older adults (OA), ≥ age 65, were put in place at many facilities caring for OAs with the aim to protect them from infection.[1–3] According to the World Health Organization, the case fatality rate for COVID-19 in older adults in China 80 years and older was 21.9% compared to 1.4% for people of all ages with no underlying health conditions.[4] However, as many state and civic leaders are now debating lockdowns many OAs may lack the assistance they need at home or in facilities to meet their daily needs. Self-imposed and/or institution-imposed social distancing could make OAs feel isolated, anxious, and sorrowful over their loss of independence and connections to friends and family.

OAs ≥ age 65 are increasingly using mobile technologies (MT) for healthcare purposes.[5] MTs such as applications (app) could help OAs stay connected to friends and family, remain active, and access resources to address their daily nutritional, physical, and mental health needs. Therefore, MTs and apps can be useful to OAs by limiting their need to leave their residences, and risk exposure to COVID-19 by helping them remain in contact with loved ones, have access to meal delivery services, electronic access to healthcare providers to see to their chronic health conditions, and physical and cognitive impairment aids.

MTs can address loneliness and isolation, which have been associated with higher risks of depression and cardiovascular risk factors in OAs.[6,7] Digital technology can enhance well-being and improve social connectedness by improving social support and engagement in activities.[8,9] Although the positive effect of the use of information and

communication technologies on social connectedness and social support seems to be short term, lasting less than six months,[9] these tools could provide help during the critical first months of the COVID-19 pandemic to protect this population from the risks of loneliness and social isolation. Accessible to those with smartphones and internet connection, various apps may be useful tools for OAs so that they do not have to battle social distancing in isolation.

Nine in ten OAs who own MTs reported they use them to initiate communication through text messages or emails, obtain traffic information and news, and purchase apps.[10] Sixty-nine percent of smartphone-using participants had downloaded or purchased apps before.[10] Only 18% felt confident about data safety, highlighting that privacy and security are major concerns for them.[10-11] Although OAs own MT and use apps, apps designed to enhance physical and mental health are not being used and/or recommended, nor have OAs been well educated in the relative safety and security of these apps.[12] Additionally, previous research has shown that even though OA technology ownership rates are high, with four in ten older adults owning smartphones, the usability rates are low,[5] which implies that OAs may need some guidance in both choosing and using apps that could benefit them. This article is intended to provide guidance to clinicians and family members seeking to help their older patients or loved ones during the COVID-19 pandemic and in other situations where isolation occurs.

Population Health Research Capsule

What do we already know about this issue?
Older adults (OA) need support to address daily needs and maintain their mental and physical health as they practice social isolation during the pandemic.

What was the research question?
Are there smartphone apps that could potentially address OAs' health and daily needs during the COVID-19 pandemic?

What was the major finding of the study?
We found 15 inexpensive and accessible smartphone apps that could support OAs during the pandemic.

How does this improve population health?
These apps enable OAs to stay connected and maintain independence and health while practicing social isolation.

METHODS

In this narrative review of apps for OAs, we aimed to find apps available to OAs on the Apple Store that could potentially facilitate health during times of social distancing and/or self-quarantines. These apps were curated by a research team that included an emergency medicine attending and physician scientist in geriatrics and digital health, a medical student, a graduate student in biotechnology, and others. The apps are categorized by common healthcare needs within the OA population addressed by the following categories: 1) social networking; 2) medical, with subcategories a) telemedicine and b) prescription management; 3) health and fitness; 4) food and drink; and 5) visual and hearing impairment. App categories were determined based on app categories already in place on the Apple Store, with the exception of a category to address the specific needs of OAs with visual and hearing impairment, for which we did a custom search using the terms "blind" and "deaf" Details about the app developer, cost (both to download and for services included in the app), function, ratings and reviews, and user experience (in the form of anecdotes) were searched and summarized. All app rating and review data was last updated to this article on March 18, 2020.

Inclusion and Exclusion Criteria

In the final list of 15 apps, we aimed to include those that are either designed to target the OA population or have features that could benefit OAs during pandemics and outbreaks when social isolation and/or self-quarantine is encouraged. Apps with broad acceptability were given priority. Hence, apps needed a rating of 4.5 or higher and at least 3000 reviews on the Apple Store. Exceptions were given for apps with broad appeal and applicability to the objective, such as FaceTime, Medisafe, and apps that assist people with vision and hearing impairment, as shown in Figure 1. Apps were further screened based on function and then ranking. Users' experiences of the app were given consideration during the selection; hence, recent customer reviews that demonstrated that the app was a valuable product for an OA were selected and summarized as anecdotes. We conducted a literature review using PubMed and Google Scholar on the topic, but as many apps are not rigorously tested for usability and efficacy in the OA population, this selection was mainly based on expert review.

RESULTS

We list several apps that assist OAs with daily needs. These are summarized by cost and intended use in Table 1. User ratings and reviews, in the form of anecdotes, are provided in Table 2.

DISCUSSION

Many apps are available to help OAs navigate isolation during the COVID-19 pandemic. While not all of the apps on our list are marketed specifically to OAs, we include apps with broad acceptability and positive user experience to ensure a list that helps access healthcare, maintain mental and physical

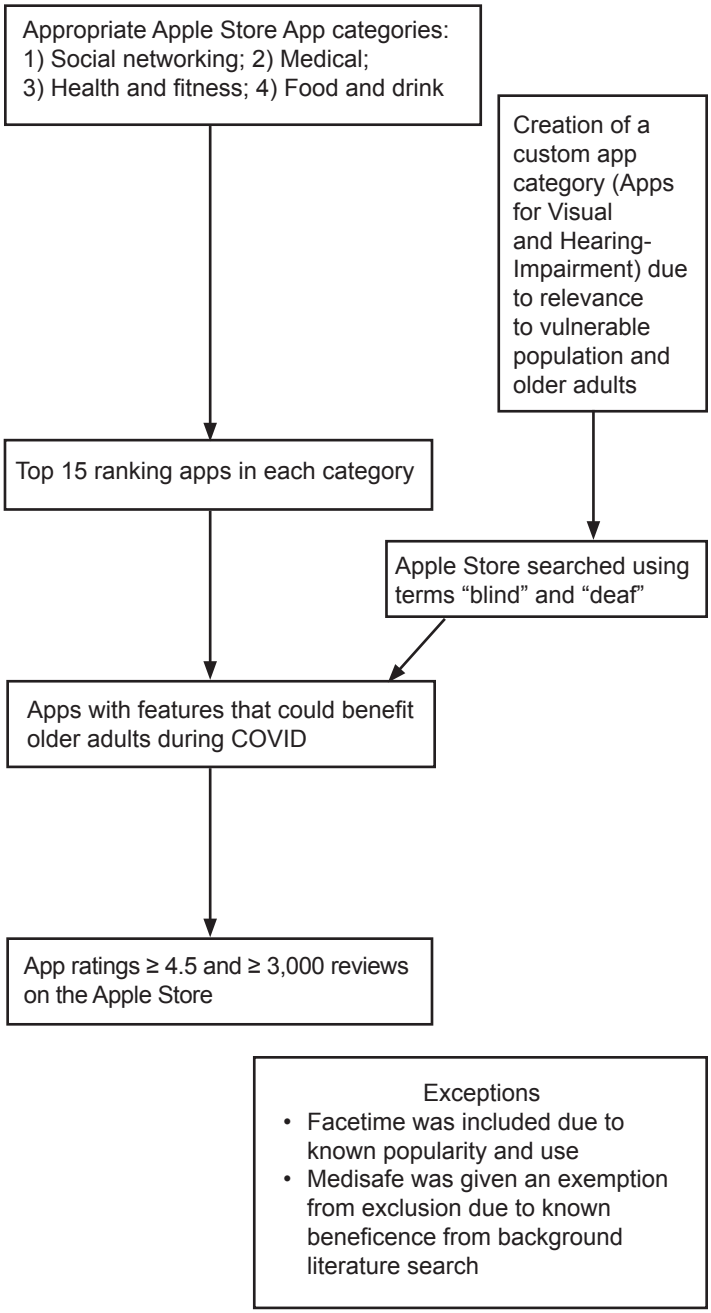


Figure 1. Inclusion and exclusion criteria for 15 smartphone apps for older adults to use during the coronavirus disease 2019 pandemic. *COVID,* coronavirus disease.

health, and meets OAs' various social and functional needs during social distancing during the COVID-19 outbreak. These apps could also provide OAs fearing loss of independence a sense of purpose and control over their life and health.

Social Networking Apps (FaceTime and Skype)

Social isolation and self-quarantine, whether it is self-imposed, legally and/or institutionally mandated, can lead to negative impacts on an OA's mental and physical well-being.[13] The impact of social isolation on health could be as harmful as traditional risk factors such as high blood pressure, smoking, and obesity.[14] Even before COVID-19, 28% (13.8 million) of OAs were living alone.[15] Social isolation has been linked to physical and cognitive conditions including heart disease, high blood pressure, anxiety, depression, Alzheimer's disease, and a weakened immune system.[15] Fortunately, MT could provide a solution to isolation by enhancing the connection with loved ones in a safe and easy way, through apps such as FaceTime and Skype. Although MT cannot replace face-to-face interaction, it can still provide ease for those who feel a loss of connection.

OAs who use video chat apps, including FaceTime and Skype, are estimated to decrease their symptoms of depression by half.[16] In a survey of 1400 OAs, those who use video chats were found to have lowered probability of depression symptoms, whereas depression rates among OAs who use instant messaging and social media networks were similar to OAs who do not use any communication technology.[16] Skype is the oldest video chat app that offers the widest device support, including for Android, iOS, Windows Phone, and Blackberry. It can run on desktop software including Windows PC and Apple's MacBook.[17] Nursing homes and OA living residences frequently use Skype to connect OA residents to their loved ones, even though the app takes some explanation to learn the software so users can fully understand how to use it.[6] Additionally, per recent policy changes by the US Department of Health and Human Services (HHS) Office for Civil Rights (OCR), Medicare beneficiaries may have improved access to their medical providers through FaceTime and Skype by approving reimbursement at the same rate for an in-person as a telemedicine visit.[18]

Food & Drink Apps (DoorDash & Instacart)

Food and drink apps on the Apple Store can be a solution for vulnerable populations as users have access to same-day delivery services such as DoorDash and Instacart, allowing them to remain in their homes and maintain social distance. DoorDash has implemented "No-Contact Delivery Options" as a response to COVID-19. The app allows users to fill out personalized delivery instructions, requesting drivers to leave orders outside to avoid person-to-person contact.[19] Users have the ability to text pictures and/or descriptions to where drivers should place their order, which may be easier for some than typing due to the loss of dexterity with aging. Due to the closure of many restaurants, individuals should verify that a restaurant is open before placing an order. Instacart, a grocery delivery service, has seen a surge in demand for the month of March 2020 due to COVID-19, especially in states with an increased number of cases, and also promises drop-off delivery that minimizes contact.[20] These apps can cater to the OA population by giving them the option to stay home or providing families with the option to order food for their older loved ones rather than deliver it on their own, if they themselves are in quarantine.

Table 1. Cost and function of 15 smartphone apps for older adults to use daily while in isolation during the coronavirus disease 2019 pandemic.

App Name	Developer	Cost	Function
Social Networking Apps			
FaceTime	Roberto Garcia, Apple Engineer	Free app built into Apple products upon purchase	May be used on any Apple products including iPhone, iPad, iPod Touch, and MacBook; enables phone and video call communication, either one-on-one or in groups between Apple product users.
Skype	Skype Technologies	Free to download the app and use features domestically. $2.99 monthly subscription for international use.	May be used on mobile devices and computers; allows for communication between Skype users via one-on-one or group phone or video calls.
Medical Apps: Telemedicine			
Teladoc	Teladoc	Free to download app. Expenses depend on the user's health insurance (accept Medicaid, Medicare, and some commercial insurance). Per the Centers for Medicare & Medicaid Services (CMS) guidance, telehealth is covered at the same rate as in-person visits during the COVID-19 crisis.	Connects patients to a board-certified doctor 24/7 through phone visits. If needed, a prescription can be sent to the patient's pharmacy.
K Health: Primary Care	K Health Inc.	Free to download app. Expenses depend on the user's insurance. Per CMS guidance, telehealth is covered at the same rate as in-person visits during the COVID-19 crisis.	Provides digital primary care for patients and free risk assessments for COVID-19.
Doctor on Demand	Phil McGraw, Jay McGraw, Adam Jackson	Free to download app. App works with or without insurance and is available at reduced rates through many major health plans and large employers. The average cost of a video consultation copay with insurance is $24, and $99 flat rate fee without insurance. Per CMS guidance, telehealth is covered at the same rate as in-person visits during the COVID-19 crisis.	Provides face-to-face digital connection with a doctor, psychiatrist or psychologist through video on people's iPhone or iPad; provides urgent care, behavioral health, preventive health, and chronic care management; provides services in many languages when appointment is scheduled.
Medical Apps: Prescription Management			
GoodRx- Save on Prescriptions	Trevor Bezdec	Free to download, but individuals may opt to purchase GoodRx Gold membership for $5.99/month per individual (and $9.99/month for up to six family members, including pets) for greater discount on prescriptions	An online app that finds prescription discounts and offers medication coupons.
Medisafe Medication Management (Medisafe)	Rotem Shor	Medisafe is free, but Medisafe premium monthly subscription is $4.99/month, and premium yearly subscription is $39.99/year.	Provides personalized medication reminders for each medication; provides vital drug interaction warnings; keeps users connected with caregivers through real-time missed medication alerts.

COVID-19, coronavirus disease 2019.

Table 1. Continued.

App Name	Developer	Cost	Function
Health & Fitness Apps			
Calm	Michael Acton Smith and Alex Tew	Free to download and use limited version of app. Free 7-day trial of the premium version after which access costs $12.99/month, $59.99/year, and $299.99 for a lifetime subscription	App for mindfulness and meditation to lower stress and improve sleep.
Headspace: Meditation & Sleep	Headspace Inc.	Free to download, but costs $12.99 per month for access to the meditation sessions beyond the introductory ones. Alternatively, can cost $95 for an annual subscription.	Relaxation app with guided meditation and mindfulness techniques to lower stress and improve sleep.
Yoga: Down Dog	Yogi Buddhi Co.	Free to download app. Monthly subscription is $7.99/month, but until May 1st, users have access to all features due to COVID-19.	Allows users to practice yoga in their homes with over 60,000 configurations to create a new workout daily. Includes beginner and tailored OA classes.
MyFitnessPal	Under Armour Inc.	Free version available. Premium access costs $49.99 per year.	Online calorie counter and diet plan. Users can log exercise and step count.
Food & Drink Apps			
DoorDash- Food Delivery	DoorDash Inc.	Free to download but delivery and platform service fee and fee for meal; subscription fee of $9.99 a month available to receive unlimited, no-fee deliveries on orders of $15 or more (but subscription is currently only available in some areas).	Food delivery service. Allows users to order food from participating restaurants and cafes.
Instacart	Maplebear Inc.	Free to download, but fee for delivery service (can be paid per delivery basis, but delivery is free with monthly membership of $9.99 or annual membership of $99	Same-day grocery delivery that allows users to request specific items from grocery stores.
Apps for Visual & Hearing-Impairment			
Be My Eyes- Helping the Blind	Hans Jorgen	None	Connects blind and visually impaired people with sighted people who assist them with tasks.
Glide - Live Video Messenger	Glide	Free to download, and free for the first 90 days. A 3-month subscription costs $1.99, and a 1-year subscription costs $6.99.	Allows you to send "lightning-fast" video messages, enabling on-demand communication using sign language and visuals.

OA, older adult.

Medical Apps: Telemedicine Apps (Doctor on Demand, Teladoc, and K Health: Primary Care)

As a COVID-19 response, hospitals and clinics across the country have started to defer elective appointments and surgeries.[21,22] OAs may benefit from this restriction due to reduced exposure to the virus, but many have chronic health conditions that need to be addressed. Telemedicine may provide a temporary solution for these needs. The Centers for Medicare & Medicaid Services' recent expansion of Medicare coverage for telehealth services to its beneficiaries provides an alternative for in-person medical care, and the waiver of Medicare's cost-sharing requirements for COVID-19 will improve access to care.[18,23] CMS requires services provided via telehealth to be used for patients with an established relationship with the provider (but

Table 2. Ratings and user reviews of 15 smartphone apps for older adults to use daily while in isolation during the Coronavirus Disease 2019 (COVID-19) pandemic.

App Name	Ratings	Anecdotes ("Review Title," Year Review Was Posted)
Social Networking Apps		
FaceTime	Not available because it is a free app built into Apple products upon purchase.	Not available because it is a free app built into Apple products upon purchase.
Skype	4.5 stars; 41.5K ratings; #9 Social Networking	"Skype is easy and good to use in terms of functionality and interface. I use Skype phone to call international phones because the rate is very reasonable" ("Good and Easy To Use," 2020).
Medical Apps: Telemedicine		
Teladoc	4.8 stars; 190K ratings; #4 in Medical	"This has become my go to for our family. We never have a long wait, the doctors are knowledgeable and we get our prescriptions right away. This service provides massive value" ("Always Reliable," 2020).
K Health: Primary Care	4.8 stars; 8K ratings; #7 Medical	"All 3 of my kids were diagnosed with the flu. Discovered this app and wow it was a lifesaver. Spoke to the doctor and got my rx without having to leave the house" ("Great for Sick Mom," 2020).
Doctor on Demand	4.9 stars; 48K ratings; #15 Medical	User did not have to leave home to get an antibiotic prescription at a local pharmacy, and reported, "What a fantastic service!" ("Amazing," 2020).
Medical Apps: Prescription Management		
GoodRx- Save on Prescriptions	4.8 stars; 523K ratings; #2 in Medical	A patient was paying $50 dollars for a prescription until they switched to GoodRx. Now they are only paying $15 for the same medication ("Saving $$$," 2020).
Medisafe Medication Management (Medisafe)	4.7 stars; 35K ratings; #113 in Medical	"My wife just came home from hospital with 3 medications from specialists and 1 medication from a primary doctor. I struggled to keep up until I started this app" ("Couldn't do Without this App," 2020).
Health & Fitness Apps		
Calm	4.8 stars; 748K ratings; #2 in Health & Fitness	"I struggle with anxiety anyway, and with a pandemic upon us, I've enjoyed using calm as a tool. I've used it during the day to deepen my meditation and yoga" ("Helpful," 2020).
Headspace: Meditation & Sleep	4.9 stars; 623K ratings; #6 in Health & Fitness	"...Headspace is always my go-to for high quality soothing meditations. It has helped me calm down in the COVID-19 crisis, and Headspace is none other" ("Life-Changing," 2020).
Yoga: Down Dog	4.9 stars; 95K ratings; #7 Health & Fitness	User states "this app helped improve my physical and mental well-being. I was able to start to learn more about yoga, build core strength, and flexibility" ("Great for Beginners," 2020).
MyFitnessPal	4.7 stars; 946K ratings; #10 Health & Fitness	"I've tried many fitness apps in my life and My Fitness Pal has easily surpassed all others. It logs your food and nutritional facts so easily you can scan a barcode and it automatically logs it in your daily nutritional facts" ("Great App," 2020).
Food & Drink Apps		
DoorDash- Food Delivery	4.8 stars; 5.8M ratings; #1 in Food & Drink	"I'm blind and use voiceOver. The app is easy to use and is fully accessible." ("Paul's Review," 2020).
Instacart	4.8 stars; 735K ratings; #2 in Food & Drink	"...As a senior my daughters told me about Instacart. I love it. It's easy for me to select my favorite brands and the delivery people have been so courteous. Long time, life time customer." ("Long Time Customer," 2020)
Apps for Visual & Hearing-Impairment		
Be My Eyes- Helping the Blind	4.7 stars; 4.3K ratings; no ranking	"I got a call to help someone out with their mail. After my call I had a huge smile on my face because it felt so good helping out..." ("Great app," 2020).
Glide- Live Video Messenger	4.5 stars; 17K ratings; no ranking	"I use this app fairly regularly to communicate via ALS. It works great and I love the many features" ("Great for ASL," 2020).

will not conduct audits to ensure this), and that "providers must use an interactive audio and video telecommunications system that permits real-time communication."[18]

Medical apps that provide telehealth could facilitate care "early during the course of an acute problem or chronic disease exacerbation," and provide healthcare access to those patients who have never had a prior correspondence with a provider.[24,25] These resources could be valuable to uninsured and undocumented OAs in the US.[26,27] These platforms may also be viewed as an extra resource that provide patients, especially those living in medically underserved areas, where access to care is limited.

These platforms can connect patients to remote physicians during emergency closures and during times of increased demand for medical services.[28] For example, during Hurricanes Harvey and Irma, Doctor on Demand offered visits for chronic conditions, advice, counseling, and refills, and back and joint concerns.[29] Doctor on Demand, Teladoc, and K Health: Primary Care are options available on the Apple Store that provide access to licensed physicians for non-emergency medical problems and are Health Insurance Portability and Accountability Act of 1996 (HIPAA) compliant.[30–32] Doctor on Demand and Teladoc are considered leaders in telemedicine, and are covered by many insurances including UnitedHealthcare, Aetna, Cigna, and some state Medicaid programs, although coverage may be different, and different insurances have different preferred telehealth destinations.[30,32–35] It is also important to note that many states have made changes to their telemedicine license policies due to COVID-19.[23,36]

The fact that our healthcare system was not equipped to provide telehealth on a mass scale for an outbreak is demonstrated by the waiver of penalties for HIPAA violation for using "everyday communication technologies such as FaceTime and Skype" to provide medical care during the COVID-19 emergency.[18] In contrast, smartphone apps we have listed that provide telehealth services ensure HIPAA-compliant services, which may be preferred by some patients with privacy concerns.

Telemedicine has not always been embraced as a viable solution for patients.[37] Providers in these platforms do not have access to key information from physical examination and diagnostic testing; in addition, they lack access to care coordination and insight gained from longitudinal care.[24,37] However, telemedicine may be the only viable solution during COVID-19, and many experts predict OAs could benefit long term from the improved access to care these platforms provide. Telehealth clinicians have experience working with limited exam and diagnostics tools and should acknowledge when an actual visit is necessary due to the acuity of the condition or the need for an in-person exam or procedure. Patients are generally satisfied with telehealth service use.[38,39] Therefore, access to care during this time may contribute to reduction of anxiety and frustration, in addition to feelings of loneliness, in the OA population.

It is important to note that racial disparity is known to exist in telemedicine access, as well as that the majority of current telemedicine users are younger adults.[25] Therefore, ensuring equity in telemedicine access is important during this crisis, along with special effort in introducing and orienting OAs from under-represented backgrounds.

Medical Apps: Medication-related Apps (Medisafe & GoodRx)

In adults 60 years and older, more than 76% use two or more prescription drugs and 37% used five or more (called polypharmacy).[40] Furthermore, per the Kaiser Family Foundation, "about one-fifth of older adults report[ed] not taking their prescribed medication as prescribed due to cost."[41] GoodRx provides discounts on medication, which could be particularly useful for OAs with a limited budget or high out-of-pocket costs due to being on multiple medications. According to an AARP survey, 32% of midlife adults provided regular financial support for basic necessities to their parents regularly in 2019, and more than a quarter of these adults reported that this caused them financial strain.[42] Hence, GoodRx may be useful for adults financially supporting older parents, and for working Americans laid off due to business shutdowns.[43]

This is also a time when family members and caregivers who typically visit OAs and check on their medications are unable to do so because of social isolation and visitor restrictions at nursing homes and assisted living facilities. Medisafe could help OAs with trouble adhering to a medication regimen due to cognitive impairment or polypharmacy. Self-reported medication nonadherence is common in community-dwelling older adults especially in those with cardiovascular disease.[44] Cardiovascular disease is a known risk factor for mortality among OAs who contract COVID-19.[45]

Medication nonadherence itself can be dangerous, as it contributes to more than 10% of hospital admissions in older adults, and is associated with increased incidence of heart failure.[46,47] Hospital admissions may increase risk of exposure to COVID-19, and heart failure is associated with worse prognosis in OAs with COVID-19.[45] Thus, OAs should be especially careful about medication adherence during this pandemic to protect health. In one study, participants using Medisafe had a small improvement in self-reported medication adherence.[48] Therefore, Medisafe, along with its real-time missed medication alerts and frequent check-ins via phone calls by family members or healthcare providers, may help OAs stay in the path of medication adherence. In 2015, Medisafe announced a partnership with GoodRx to help lower medication costs.[49] Medisafe along with GoodRx could help reduce barriers to medication adherence.

Health and Fitness Apps (Calm, Headspace, Yoga: Down Dog, and MyFitnessPal)

OAs are prone to worrying about their health.[50] Anxiety could be exacerbated during the COVID-19 crisis. Health anxiety has been found to be associated with more "distress, impairment,

disability and health service utilization."[51] This finding underscores the importance of curating apps targeting health applications for OAs mental health. A study shows that OAs are "motivated to use digital technologies to improve their mental health."[52] In a study with participants aged 18-49, frequent use of Headspace for 30 days was associated with improvement in mental health, specifically depressive symptoms and resilience.[53] In another study among college students, students who used Calm for eight weeks reported reduced stress.[54] Although there has been no published research looking at the effectiveness of using applications such ase Calm and Headspace in OAs, these apps could be a useful tool to address anxiety.[55]

Social isolation and quarantine can decrease physical activity and promote sedentary behavior, which is problematic in a population that already spends 60% of awake time engaged in sedentary activities.[56] Sedentary behavior is associated with disability in activities of daily living, development of metabolic syndrome, and an increased risk of all-cause mortality in the elderly.[57] Long duration of sitting is negatively associated with femoral bone mineral density (FBMD) in women, whereas duration of light intensity physical activity is positively associated with FBMD.[58] Physical activity intervention has been proven effective in improving physical activity behavior in healthy OAs, and most sequences of yoga are classified as a light-intensity physical activity.[59,60] Some small studies also suggest that, in OAs, yoga may be superior to conventional physical-activity intervention.[61]

Suggesting healthy OAs to use an app such as Yoga: Down Dog could reduce the ill-effects of sedentary behaviors. Encouraging OA users to set a goal to pursue daily physical activity during social isolation and may serve as behavior intervention.[59] Yoga could protect psychological health in this difficult time, and help with sleep quality.[62,63] In a study in OAs, chair yoga participants had more improvement in anger, anxiety, depression, well-being, general self-efficacy, and self-efficacy for daily living than control and chair exercise participants.[62]

Chronic conditions common in OAs, such as hypertension and diabetes, can be controlled with exercise and good diet.[64] MyFitnessPal, which provides a calorie counter and diet plan, could be a motivator for behavior change. MyFitnessPal is a behavior intervention that could provide benefit of well-being, but it requires self-efficacy.[59,65] Limitations of MyFitnessPal include unreliable estimation of (micro-) nutrients ingestion and ineffectiveness in patients without goals and willingness to self-monitor calories.[66-69] Therefore, although MyFitnessPal may be recommended to promote healthy behavior, OAs should not use MyFitnessPal by itself, and work in conjunction with a dietitian if possible.[70]

Apps for Visual & Hearing-Impairment (Be My Eyes - Helping the Blind, and Glide - Live Video Messenger)

When asked about the vulnerable populations that have an increased risk of being affected by COVID-19, Dr. Lisa Cooper of Johns Hopkins reported that individuals with vision and hearing impairments are also vulnerable.[71] As of 2016, an estimated four million OAs had vision disability.[72] Vision impairments double the risk of falls, which one of four OAs experience, and are associated with morbidity and mortality.[73] OAs with vision impairments who live alone and do not receive any caretaker service have to overcome greater challenges regarding activities of daily living and instrumental activities of daily living, which limits one's quality of life and independence. Be My Eyes, the largest online support for the visually impaired, may be a useful resource to these OAs, especially at this time.[74,75] Per Be My Eyes, over two million volunteers speaking over 180 languages have signed up on the app to assist those with impairments, increasing acceptance, socialization, and independence for this population.[75,76] With the goal to help visually impaired individuals navigate through daily activities, volunteers have the ability to assist OAs who do not have support at home by keeping them safe, enabling users to have a sense of independence and support.[75,76]

An estimated one in three people between the ages 65-74 have difficulty hearing, with half of those older than 74 having difficulty hearing.[77] OAs with hearing impairment have a greater chance of becoming depressed due to feeling frustrated and embarrassed about not understanding what is being said.[77] Howard A. Rosenblum, chief executive officer of the National Association of the Deaf, stated that the US government must make information on COVID-19 accessible in American Sign Language (ASL), including information on how the virus affects education and employment access, among others.[78] Glide - Live Video Messenger enables the ability to communicate to the hearing-impaired population through ASL and/or just videos. This may negate feelings of loneliness and depression during times of social distancing for COVID-19. Additionally, important information pertaining to disease characteristics, local and state business closures, financial updates, and other communications on COVID-19 could be shared to those with hearing impairments effectively and promptly using Glide.

LIMITATIONS

Our summary of the 15 apps, listed in Figure 2, was based on the functionality of apps on the Apple Store primarily using the "Top Charts" list and expert opinion. Rather than creating an exhaustive list, we focused on a brief list of apps that could be recommended to OAs during the COVID-19 pandemic. Apple Store is not accessible in all smartphones, and there is a far greater ownership rate of Android devices compared to iOS. However, except for FaceTime, the other apps on our list can also be found on Google Play Store, the Android app store. It is important to note that because app features may differ slightly on the two operating systems, user experience and ratings for the apps may vary between the two digital-distribution platforms.

Due to the limitations in our methodology, our 15 apps list does not address the barriers faced by older adults with hearing impairments but without experience using sign language. For these older adults, live captioning apps such

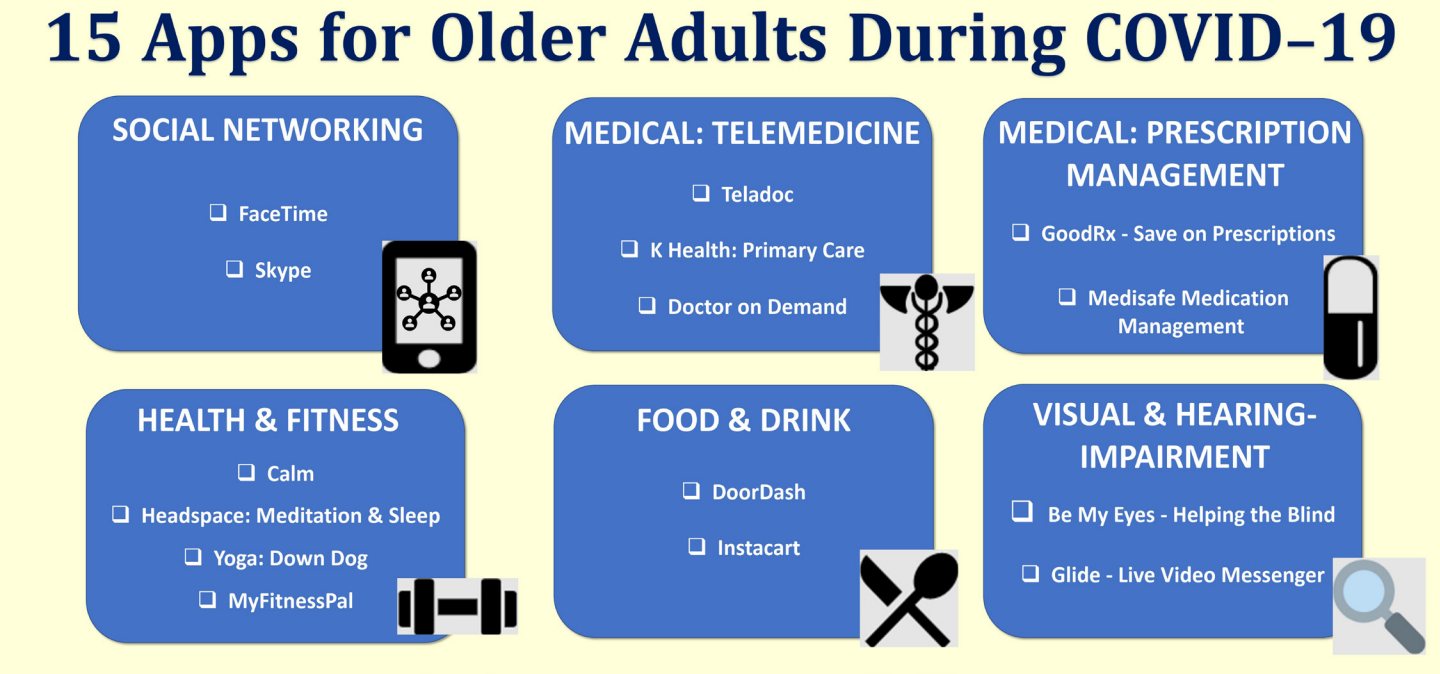


Figure 2. 15 smartphone apps for older adults to use daily while in isolation during the coronavirus disease 2019 pandemic.

as Ava, Otter.ai, and Microsoft Translator may be suggested. These apps can be downloaded on both iOS and Android devices. While Microsoft Translator is a completely free, Ava and Otter.ai is free for occasional use, which limits users to 5 hours/month and 600 minutes/month, respectively. Unlimited access can be purchased with a subscription to premium plans.

It is also critical to acknowledge that while digital health and MT use by OAs is increasing, few apps have been reviewed and tested for usability and efficacy in clinical trials among the OA population. In the future, additional research assessing the usability of these apps in the OA population using the Mobile App Rating Scale, or other usability models such as the technology acceptance model, should be conducted.[79,80] However, many of the apps we have suggested fulfill an unmet need and could help OAs maintain physical and mental health, independence, address disabilities, and some financial security. Most importantly, they encourage and allow for a less imprisoning and isolating experience for OAs during this crisis.

CONCLUSION

Apps are inexpensive and accessible, and research has shown that OAs can use smartphones when provided the necessary training.[81] There is an increase in the use of smartphones in the aging population.[82] Recommending these 15 apps, along with providing some training and guidance, to an OA could help decrease loneliness and maintain and/or improve the health and independence of OAs during the COVID-19 pandemic. While apps cannot substitute for all in-person care, they could supplement or substitute some in-person care.

ACKNOWLEDGMENTS

This publication was made possible by the National Institute on Aging (R03AG056349; K76AG059983), and the Brown Physicians, Inc. Academic Assessment Research Award (PI: Goldberg). The authors would like to thank Armen Deirmenjian and Kunzhao Li for support during the initial process of apps selection.

Address for Correspondence: Elizabeth Goldberg, MD, ScM, 55 Claverick Street, Second floor, Room 203, Providence, RI 02903. Email: elizabeth_goldberg@brown.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Healy J, Richtel M, Baker M. Nursing homes becoming islands of isolation amid 'shocking' mortality rate. *The New York Times*. Available at: https://www.nytimes.com/2020/03/10/us/coronavirus-nursing-homes-washington-seattle.html. Accessed March 19, 2020.
2. Schoch D. Families worried about loved ones in nursing homes amid coronavirus. AARP. Available at: https://www.aarp.org/caregiving/health/info-2020/preventing-coronavirus-in-nursing-homes.html. Accessed March 19, 2020.
3. Preparing for COVID-19:long-term care facilities, nursing homes. CDC. Available at: https://www.cdc.gov/coronavirus/2019-ncov/healthcare-facilities/prevent-spread-in-long-term-care-facilities.html. Accessed March 19, 2020.
4. Coronavirus disease (COVID-19) pandemic. World Health Organization. Available at: https://www.who.int/emergencies/diseases/novel-coronavirus-2019. Accessed March 21, 2020.
5. Quinn CC, Staub S, Barr E, et al. Mobile support for older adults and their caregivers: dyad usability study. *J Med Internet Res*. 2019;21(5):e12276.
6. Williams D, Ahamed SI, Chu W. Designing interpersonal communication software for the abilities of elderly users. In: *Proceedings - IEEE 38th Annual International Computers, Software and Applications Conference Workshops, COMPSACW 2014*. Institute of Electrical and Electronics Engineers Inc.; 2014:282-287.
7. Courtin E, Knapp M. Social isolation, loneliness and health in old age: a scoping review. *Health Soc Care Community*. 2017;25(3):799-812.
8. Barbosa Neves B, Franz R, Judges R, et al. Can digital technology enhance social connectedness among older adults? a feasibility study. *J Appl Gerontol*. 2019;38(1):49-72.
9. Chen YRR, Schulz PJ. The effect of information communication technology interventions on reducing social isolation in the elderly: a systematic review. *J Med Internet Res*. 2016;18(1):e18.
10. Oscar Anderson G. Getting Connected: Older Americans Embrace Technology to Enhance Their Lives. Available at: https://www.aarp.org/research/topics/technology/info-2018/technology-use-attitudes.html. Accessed March 19, 2020.
11. Miller J, Ward C, Lee C, et al. Sharing is caring: the potential of the sharing economy to support aging in place. *Gerontol Geriatr Educ*. January 2018:1-23.
12. Elliott T, Yopes MC. Direct-to-consumer telemedicine. *J Allergy Clin Immunol Pract*. 2019;7(8):2546-2552.
13. Valtorta N, Hanratty B. Loneliness, isolation and the health of older adults: Do we need a new research agenda? *J R Soc Med*. 2012;105(12):518-522.
14. Singh A, Misra N. Loneliness, depression and sociability in old age. *Ind Psychiatry J*. 2009;18(1):51-55.
15. Social isolation, loneliness in older people pose health risks. National Institute on Aging. Available at: https://www.nia.nih.gov/news/social-isolation-loneliness-older-people-pose-health-risks. Accessed March 19, 2020.
16. Teo AR, Markwardt S, Hinton L. Using Skype to beat the blues: longitudinal data from a national representative sample. *Am J Geriatr Psychiatry*. 2019;27(3):254-262.
17. Pegoraro R. FaceTime, Skype, Google? Best app to call grandma. *USA TODAY*. Available at: https://www.usatoday.com/story/tech/columnist/2016/12/11/how-choose-best-video-calling-app/95301370/. Accessed March 19, 2020.
18. Medicare telemedicine health care provider fact sheet | CMS. Available at: https://www.cms.gov/newsroom/fact-sheets/medicare-telemedicine-health-care-provider-fact-sheet. Accessed March 20, 2020.
19. Duffett B. Food delivery companies offer 'social distance' with no-contact delivery options. Eater San Francisco. Available at: https://sf.eater.com/2020/3/12/21175886/postmates-doordash-grubhub-no-contact-covid-19. Accessed March 19, 2020.
20. Barreira A. Instacart, Farmstead see demand surge amid COVID-19. *San Francisco Business Times*. Available at: https://www.bizjournals.com/sanfrancisco/news/2020/03/11/grocery-delivery-companies-see-boom-as-covid-19.html. Accessed March 19, 2020.
21. Health Care Update. University Hospitals. Available at: https://www.uhhospitals.org/healthcare-update. Accessed March 19, 2020.
22. Mayo Clinic appointment guidance during COVID-19 - Mayo Clinic. Available at: https://www.mayoclinic.org/covid-19. Accessed March 19, 2020.
23. Robeznieks A. Key changes made to telehealth guidelines to boost COVID-19 care | American Medical Association. Available at: https://www.ama-assn.org/delivering-care/public-health/key-changes-made-telehealth-guidelines-boost-covid-19-care?&utm_source=BulletinHealthCare&utm_medium=email&utm_term=032020&utm_content=MEMBER&utm_campaign=article_alert-morning_rounds_daily&utm_uid=14. Accessed March 20, 2020.
24. Uscher-Pines L, Mehrotra A. Analysis of teladoc use seems to indicate expanded access to care for patients without prior connection to a provider. *Health Aff (Millwood)*. 2014;33(2):258-264.
25. Diaz VA, Player MS. Direct-to-patient telehealth: opportunities and challenges. *R I Med J (2013)*. 2020;103(1):35-37.
26. The use of telehealth for serving the undocumented | CCHP Website. Center for Connected Health Policy. Available at: https://www.cchpca.org/about/projects/use-telehealth-serving-undocumented. Accessed March 19, 2020.
27. Price M, Williamson D, McCandless R, et al. Hispanic migrant farm workers' attitudes toward mobile phone-based telehealth for management of chronic health conditions. *J Med Internet Res*. 2013;15(4):e76.
28. Uscher-Pines L, Fischer S, Chari R. The promise of direct-to-consumer telehealth for disaster response and recovery. *Prehosp Disaster Med*. 2016;31(4):454-456.
29. Uscher-Pines L, Fischer S, Tong I, et al. Virtual first responders: the role of direct-to-consumer telemedicine in caring for people impacted by natural disasters. *J Gen Intern Med*. 2018;33(8):1242-1244.
30. FAQ – Teladoc. Available at: https://www.teladoc.com/providers/faq/. Accessed March 19, 2020.
31. Privacy Policy | K Health. K Health. Available at: https://www.khealth.ai/privacy-policy-carespree. Accessed March 19, 2020.
32. Doctor on Demand. Telemedicine.arizona.edu. Available at: https://

telemedicine.arizona.edu/servicedirectory/doctor-demand. Accessed March 19, 2020.
33. Lazur B, Bennett A, King V. The Evolving Policy Landscape of Telehealth Services Delivered in the Home and Other Nonclinical Settings - Issue Brief. Available at: www.milbank.org. Accessed March 19, 2020.
34. Pai A. UnitedHealthcare now covers Doctor On Demand, American Well video visits too. *MobiHealthNews*. Available at: https://www.mobihealthnews.com/43052/unitedhealthcare-now-covers-doctor-on-demand-american-well-video-visits-too. Accessed March 19, 2020.
35. Blue Cross And Blue Shield Of Minnesota names Doctor On Demand as preferred telehealth destination. Blue Cross Blue Shield. Available at: https://www.bcbs.com/news/press-releases/blue-cross-and-blue-shield-minnesota-names-doctor-demand-preferred-telehealth. Accessed March 19, 2020.
36. States Waiving Licensure Requirements/Renewals in Response to COVID-19. Available at: https://www.fsmb.org/siteassets/advocacy/pdf/state-emergency-declarations-licensure-requirement-covid-19.pdf. Accessed March 20, 2020.
37. Beck M. Telemedicine spreads rapidly, but some physician groups worry about quality of care. *Wall Street Journal*. https://www.wsj.com/articles/where-does-it-hurt-log-on-the-doctor-is-in-1399589901. Published 2014. Accessed March 19, 2020.
38. Player M, O'Bryan E, Sederstrom E, et al. Electronic visits for common acute conditions: Evaluation of a recently established program. *Health Aff (Millwood)*. 2018;37(12):2024-2030.
39. Polinski JM, Barker T, Gagliano N, et al. Patients' satisfaction with and preference for telehealth visits. *J Gen Intern Med*. 2016;31(3):269-275.
40. Gu Q, Dillon CF, Burt VL. Prescription drug use continues to increase: U.S. prescription drug data for 2007-2008. *NCHS Data Brief*. 2010;(42):1-8.
41. Kirzinger A, Neuman T, Cubanski J, et al. Data note: prescription drugs and older adults | The Henry J. Kaiser Family Foundation. Kaiser Family Foundation. Available at: https://www.kff.org/health-reform/issue-brief/data-note-prescription-drugs-and-older-adults/. Accessed March 19, 2020.
42. Skufca L. A survey of midlife adults providing financial support to family members. AARP. Available at: https://www.aarp.org/research/topics/economics/info-2020/midlife-adults-providing-financial-support-to-family-members.html. Accessed March 19, 2020.
43. Siegel R. Layoffs intensify leading to soaring unemployment claims as coronavirus business closures continue. *The Washington Post*. Available at: https://www.washingtonpost.com/business/2020/03/18/unemployment-insurance-coronavirus/. Accessed March 19, 2020.
44. Marcum ZA, Zheng Y, Perera S, et al. Prevalence and correlates of self-reported medication non-adherence among older adults with coronary heart disease, diabetes mellitus, and/or hypertension. *Res Soc Adm Pharm*. 2013;9(6):817-827.
45. Are you at higher risk for severe illness? | CDC. CDC. Available at: https://www.cdc.gov/coronavirus/2019-ncov/specific-groups/high-risk-complications.html. Accessed March 19, 2020.
46. Schlenk EA, Dunbar-Jacob J, Engberg S. Medication non-adherence among older adults: a review of strategies and interventions for improvement. *J Gerontol Nurs*. 2004;30(7):33-43.
47. Munger MA, Van Tassell BW, LaFleur J. Medication nonadherence: an unrecognized cardiovascular risk factor. *MedGenMed*. 2007;9(3):58.
48. Morawski K, Ghazinouri R, Krumme A, et al. Association of a smartphone application with medication adherence and blood pressure control: The MedISAFE-BP randomized clinical trial. *JAMA Intern Med*. 2018;178(6):802-809.
49. Medisafe partners with GoodRx to help app users lower medication costs - Medisafe. Medisafe. Available at: https://www.medisafe.com/press-release/medisafe-partners-with-goodrx-to-help-app-users-lower-medication-costs/. Accessed March 20, 2020.
50. Hunt S, Wisocki P, Yanko J. Worry and use of coping strategies among older and younger adults. *J Anxiety Disord*. 2003;17(5):547-560.
51. Sunderland M, Newby JM, Andrews G. Health anxiety in Australia: prevalence, comorbidity, disability and service use. *Br J Psychiatry*. 2013;202(1):56-61.
52. Andrews JA, Brown LJ, Hawley MS, et al. Older adults' perspectives on using digital technology to maintain good mental health: interactive group study. *J Med Internet Res*. 2019;21(2):e11694.
53. Flett JAM, Hayne H, Riordan BC, et al. Mobile mindfulness meditation: a randomised controlled trial of the effect of two popular apps on mental health. *Mindfulness*. 2018;10(5):863-876.
54. Huberty J, Green J, Glissmann C, et al. Efficacy of the mindfulness meditation mobile app "calm" to reduce stress among college students: Randomized controlled trial. *JMIR Mhealth Uhealth*. 2019;21(6).
55. Choo C, Kuek J, Burton A. Smartphone applications for mindfulness interventions with suicidality in Asian older adults: a literature review. *Int J Environ Res Public Health*. 2018;15(12):2810.
56. Matthews CE, Chen KY, Freedson PS, et al. Amount of time spent in sedentary behaviors in the United States, 2003-2004 - PubMed. U.S National Library of Medicine.
57. De Rezende LFM, Rey-López JP, Matsudo VKR, et al. Sedentary behavior and health outcomes among older adults: A systematic review. *BMC Public Health*. 2014;14(1):1-9.
58. Chastin SFM, Mandrichenko O, Helbostadt JL, et al. Associations between objectively-measured sedentary behaviour and physical activity with bone mineral density in adults and older adults, the NHANES study. *Bone*. 2014;64:254-262.
59. Chase JAD. Interventions to increase physical activity among older adults: a meta-analysis. *Gerontologist*. 2015;55(4):706-718.
60. Larson-Meyer DE. A systematic review of the energy cost and metabolic intensity of yoga. *Med Sci Sports Exerc*. 2016;48(8):1558-1569.
61. Patel NK, Newstead AH, Ferrer RL. The effects of yoga on physical functioning and health related quality of life in older adults: a systematic review and meta-analysis. *J Altern Complement Med*. 2012;18(10):902-917.
62. Bonura KB, Tenenbaum G. Effects of yoga on psychological health in older adults. *J Phys Act Heal*. 2014;11(7):1334-1341.
63. Alexander GK, Innes KE, Selfe TK, et al. "More than I expected": perceived benefits of yoga practice among older adults at risk for

cardiovascular disease. *Complement Ther Med*. 2013;21(1):14-28.
64. 10 Most Common Chronic Diseases - Healthy Aging Blog | NCOA. NCOA. Available at: https://www.ncoa.org/blog/10-common-chronic-diseases-prevention-tips/. Accessed March 19, 2020.
65. Langer EJ, Rodin J. The effects of choice and enhanced personal responsibility for the aged: a field experiment in an institutional setting. *J Pers Soc Psychol*. 1976;34(2):191-198.
66. Teixeira V, Voci SM, Mendes-Netto RS, et al. The relative validity of a food record using the smartphone application MyFitnessPal. *Nutr Diet*. 2018;75(2):219-225.
67. Fallaize R, Franco RZ, Pasang J, et al. Popular nutrition-related mobile apps: an agreement assessment against a UK reference method. *JMIR Mhealth Uhealth*. 2019;21(2).
68. Patel ML, Hopkins CM, Brooks TL, et al. Comparing self-monitoring strategies for weight loss in a smartphone app: randomized controlled trial. *JMIR Mhealth Uhealth*. 2019;21(2):e12209.
69. Laing BY, Mangione CM, Tseng CH, et al. Effectiveness of a smartphone application for weight loss compared with usual care in overweight primary care patients. *Ann Intern Med*. 2014;161(10 Suppl):S5-S12.
70. Chen J, Berkman W, Bardouh M, et al. The use of a food logging app in the naturalistic setting fails to provide accurate measurements of nutrients and poses usability challenges. *Nutrition*. 2019;57:208-216.
71. Baldwin B. CNNnewsroom interview: Anchor Brooke Baldwin Interviews Johns Hopkins' Dr. Lisa Cooper. 2020.
72. Blindness Statistics | National Federation of the Blind. National Federation of the Blind. Available at: https://www.nfb.org/resources/blindness-statistics. Accessed March 19, 2020.
73. Vision Health & Age| Risk | VHI | CDC. Available at: https://www.cdc.gov/visionhealth/risk/age.htm. Accessed March 19, 2020.
74. Be My Eyes. Be My Eyes. Available at: https://www.socialtech.org.uk/factsheets/social-tech-guide-be-my-eyes-factsheet.pdf. Accessed March 19, 2020.
75. Varnier J. "Be My Eyes" app lets volunteers help bring sight to blind and low-vision people. 3 WTRK. Available at: https://www.wtkr.com/news/be-my-eyes-app-lets-volunteers-help-bring-sight-to-blind-and-low-vision-people. Accessed March 19, 2020.
76. Iati M. Be My Eyes app connects blind people with sighted volunteers. *The Washington Post*. Available at: https://www.washingtonpost.com/lifestyle/2018/12/27/answering-quick-video-call-help-blind-person-is-so-awesome/. Accessed March 20, 2020.
77. Hearing loss: a common problem for older adults. National Institute on Aging. Available at: https://www.nia.nih.gov/health/hearing-loss-common-problem-older-adults. Accessed March 19, 2020.
78. Rosenblum HA. National Association of the Deaf - NAD. National Association of the Deaf. Available at: https://www.nad.org/2020/03/12/coronavirus/. Accessed March 19, 2020.
79. Stoyanov SR, Hides L, Kavanagh DJ, et al. Mobile app rating scale: a new tool for assessing the quality of health mobile apps. *JMIR Mhealth Uhealth*. 2015;3(1):e27.
80. Charness N, Boot WR. Technology, gaming, and social networking. In: *Handbook of the Psychology of Aging: Eighth Edition*. Elsevier Inc.; 2015:389-407.
81. Vaportzis E, Clausen MG, Gow AJ. Older adults experiences of learning to use tablet computers: A mixed methods study. *Front Psychol*. 2018;9:1631.
82. Anderson M, Perrin A. Technology use among seniors | Pew Research Center. Pew Research Center. Available at: https://www.pewresearch.org/internet/2017/05/17/technology-use-among-seniors/. Accessed March 19, 2020.

Assessment of the Angolan (CHERRT) Mobile Laboratory Curriculum for Disaster and Pandemic Response

Michael D. Owens, DO, MPH, CEM* *Naval Medical Center Portsmouth, Portsmouth, Virginia
Michael L. Lloyd, MD* †Integrated Research Facility, National Institute of Allergy and Infectious Diseases,
Tyler M. Brady, MPH† National Institutes of Health, Fort Detrick, Frederick, Maryland
Robin Gross, MS†

Section Editor: Ioannis Koutroulis, MD
Submission history: Submitted March 24, 2020; Revision received April 6, 2020; Accepted April 6, 2020
Electronically published April 13, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.4.47385

Introduction: As of April 5, 2020, the World Health Organization reported over one million confirmed cases and more than 62,000 confirmed coronavirus (COVID-19) deaths affecting 204 countries/ regions. The lack of COVID-19 testing capacity threatens the ability of both the United States (US) and low middle income countries (LMIC) to respond to this growing threat, The purpose of this study was to assess the effectiveness through participant self-assessment of a rapid response team (RRT) mobile laboratory curriculum

Methods: We conducted a pre and post survey for the purpose of a process improvement assessment in Angola, involving 32 individuals. The survey was performed before and after a 14-day training workshop held in Luanda, Angola, in December 2019. A paired t-test was used to identify any significant change on six 7-point Likert scale questions with $\alpha < 0.05$ (95% confidence interval).

Results: All six of the questions – 1) "I feel confident managing a real laboratory sample test for Ebola or other highly contagious sample;" 2) "I feel safe working in the lab environment during a real scenario;" 3) "I feel as if I can appropriately manage a potentially highly contagious laboratory sample;" 4)"I feel that I can interpret a positive or negative sample during a suspected contagious outbreak;" 5) "I understand basic Biobubble/mobile laboratory concepts and procedures;" and 6) "I understand polymerase chain reaction (PCR) principles" – showed statistical significant change pre and post training. Additionally, the final two questions – "I can more effectively perform my role/position because of the training I received during this course;" and "This training was valuable" – received high scores on the Likert scale.

Conclusion: This Angolan RRT mobile laboratory training curriculum provides the nation of Angola with the confidence to rapidly respond and test at the national level a highly infectious contagion in the region and perform on-scene diagnostics. This mobile RRT laboratory provides a mobile and rapid diagnostic resource when epidemic/pandemic resource allocation may need to be prioritized based on confirmed disease prevalence. [West J Emerg Med. 2020;21(3)526–531.]

Disclaimer: Due to the rapidly evolving nature of this outbreak, and in the interests of rapid dissemination of reliable, actionable information, this paper went through expedited peer review. Additionally, information should be considered current only at the time of publication and may evolve as the science develops.

INTRODUCTION

Background

As of April 5, 2020, the World Health Organization (WHO) reported 1,133,758 confirmed cases and 62,784 confirmed coronavirus (COVID-19) deaths affecting 204 countries/regions.[1] It is recognized that the lack of COVID-19 testing capacity

threatens the ability of both the United States (US) and low middle income countries (LMIC) to respond to this growing threat.[2] For comparison, the 2014 Ebola epidemic in Western Africa (Liberia, Sierra Leone, Guinea, and Nigeria) infected tens of thousands of individuals and claimed more than 11,000 lives, with a case fatality rate of approximately 60%.[3,4]

There is growing evidence that this current outbreak is more widespread than reported due to the lack of laboratory capacity and resources.[5] This parallels the experiences identified in "After Action Reports" and lessons learned during the 2014 Western Africa Ebola epidemic. However, COVID-19 is now a pandemic affecting multiple LMICs and the US whose current laboratory capacity is limited. [2]

A mobile laboratory (bioBUBBLE, Inc., Fort Collins, CO) using GeneXpert (Cepheid Inc, Sunnyvale, CA) technology to conduct reverse transcription polymerase chain reaction (RT-PCR) was deployed during the 2014 West Africa Ebola outbreak and again in the 2017 Democratic Republic of Congo (DRC) Ebola outbreak.[6] This field-deployable diagnostic tool provided results in as little as 90 minutes. RT-PCR is a laboratory technique combining reverse transcription of ribonucleic acid to deoxyribonucleic acid (DNA) and the amplification of disease-specific DNA targets using the polymerase chain reaction (PCR). In acute respiratory infections, RT-PCR is used to detect viruses from respiratory secretions. The use of this technology to develop a simple, rapid, and robust detection capability with minimal training and lab experience or infrastructure has been demonstrated during previous international health emergencies such as severe acute respiratory syndrome (SARS).[5]

On March 21, 2020, it was reported that the US Federal Drug Administration approved the first rapid point-of-care COVID-19 test capable of delivering results in under an hour.[7] This test kit involves taking a nasopharyngeal swab and can be done in an office, clinic, or a mobile lab in about 45 minutes. Administering the test does not require any specialty training other than what was provided within the curriculum, and the lab is capable of running 24 hours a day/seven days a week.

This current global outbreak presents challenges to local, regional, and national medical communities to mitigate the current pandemic. A global response involving logistical, epidemiological, public health, and medical interventions may slow and contain the further spread of this contagion. Employing a mobile lab with biocontainment capability and a rapid, automated diagnostic test in regions where on-site diagnostics may be of benefit allows for a focused response and resource distribution by rapidly identifying positive cases.

One of the mitigation and response strategies learned during the 2014 Ebola epidemic includes rapid response teams that are trained, prepared, and mobilized immediately when a suspect case is identified. A strategy of Rapid Isolation and Treatment of Ebola using the Liberia Ministry of Health and Social Welfare (MOHSW), supported by the US Centers for Disease Control and Prevention (CDC), WHO, and other agencies in Liberia began to respond systematically to suspected cases in remote areas in August 2014.[3] This rapid response concept, when instituted in later outbreaks, was one of the factors that helped contain the Ebola virus disease (EVD) outbreak in the DRC in May 2017. Teams that are competently and confidently trained in RT-PCR, personal protective equipment (PPE) protocols, and mobile laboratory capabilities provide a valuable resource by confirming cases quickly and efficiently. Follow-up interventions are then deployed in a manner such that treatment, isolation/quarantine efforts, and other response and mitigation efforts are more effective and focused.

The nation of Angola, due to its proximity to EVD-endemic areas and its own experiences with Marburg and 2017 yellow fever epidemics, created a Community Health Emergency Rapid Response Team (CHERRT) sponsored by the national military and Ministry of Health (MOH). These Angolan RRT members were trained for two weeks in December 2019 by the US Navy and experts from the National Institutes of Health (NIH). The first week of training included tabletop scenarios, individual break-out sessions, didactic lectures, hands-on training with equipment and PPE, and patient scenarios. The second week of training focused on RT-PCR, laboratory techniques, diagnostics, and use of the mobile lab and rapid diagnostic on-site testing. A pre- and post-training survey was completed by the participants, to include self-assessments of their perceived ability to perform RT-PCR diagnostics and work with the mobile lab.

Population Health Research Capsule

What do we already know about this issue?
The African Ebola outbreaks and current COVID-19 pandemic affirm that rapid and accurate diagnostics influence response and outcomes.

What was the research question?
We conducted an assessment of a mobile lab curriculum for disaster and pandemic response based on current models.

What was the major finding of the study?
This curriculum provided the Angola Community Health Emergency Rapid Response Team with the confidence to respond to a disaster/pandemic at the national level.

How does this improve population health?
Rapid and accurate diagnostic confirmation of a Public Health Emergency of International Concern using a mobile lab improves response and mitigates further spread of a contagion.

OBJECTIVES

The purpose of this study was to assess the effectiveness through participant self-assessment of a RRT mobile lab curriculum based on the WHO Ebola Virus Disease Consolidated Preparedness Checklist, Revision 1[8] and the mobile lab training curriculum developed by the NIH. Using a pre-post confidential questionnaire with eight 7-point scale Likert questions and an open-ended comments section, we assessed the impact of the training curriculum on each participant's self-perceived ability to perform his/her duties.

METHODS

Study Design and Setting

This pre-post study was conducted in Luanda, Angola. A conference room providing space for presentations, breakout sessions, and simulation were used during the two weeks of training in the hospital. Three native Portuguese speakers provided direct interpretation when needed during the two weeks of training. All educational materials including presentations were translated by native Portuguese speakers prior to the event. The planning team from the Angolan military and US Navy met prior to the event and used previous curriculums to establish the training topics, activities, and schedule for this specific program.

A survey was provided to the 32 study participants before the initiation of training and immediately upon completion of the training. The pre-event survey included six Likert-scale questions assessing the individuals' perceived ability to work and manage a real sample in a contagious environment and interpret the results. The post-survey questionnaire included these same six questions, two additional Likert-scale questions assessing the overall effectiveness of the training, and a ninth open-ended question requesting comments for needed additional training. The study design used SQIRE 2.0 guidelines for quality improvement reporting.[9] The study received a waiver from the institutional review board.

Selection of Participants

A total of 32 Angolan classroom participants completed the course and the surveys. Chosen by the Forças Armadas Angolanas (FAA) and the Angolan MOH, the participants were a mixture of civilian and military physicians, nurses, social workers, and lab technicians. This program was sponsored by the US Africa Command (US AFRICOM).

Intervention

A pre-course survey was provided to the 32 study participants before the initiation of training and immediately upon completion of the training. The pre-intervention survey included six Likert-scale questions assessing their perceived ability to handle and manage a real sample in a contagious environment, and independently interpret the results. The first week's training (December 2-6, 2019) covered topics and training that the planning teams identified as high-yield prior to the training to include public health, disaster response, donning/doffing of PPE, and patient and Ebola treatment unit protocols. The second week of training (December 9-13, 2019) focused on lab concepts that included the following: basic lab skills; lab safety, setup and use of the mobile lab; and RT-PCR skills. The majority of the participants had little to no prior experience with this equipment prior to the CHERRT training.

The post-intervention questionnaire included the same six pre-intervention questions, two additional Likert-scale questions assessing the overall effectiveness of the training, and a final ninth question requesting comments for needed additional training (Table 1).

Methods of Measurement and Outcome Measures

The primary outcome was the calculated change in the six Likert-scored questions asked before and after the training assessing self-perceived competence and ability to perform their respective duties on the team. These six questions were provided on an anonymous form in Portuguese using a 7-point Likert scale ranging from "1," designated as strongly disagree, to "7," designated as strongly agree. Translators were available in Portuguese to assist with questions on the survey. The participants were instructed to circle one number from one to seven for each of the Likert-scale questions. Each participant was given a unique identifier allowing for anonymity and pairing analysis. The survey abstractors were not blinded to the study hypothesis.

Secondary outcomes included the two additional Likert-scale questions assessing overall effectiveness of the training and a final, open-ended comment section eliciting recommendations for additional training that the respondent felt was needed or desired. The two additional post-intervention questions used the same 7-point Likert scale as the pre-intervention assessment, allowing for consistency.

Primary Data Analysis

The completed survey data was entered into Microsoft Office Excel 2007 (Microsoft Corp, Redmond, WA). We calculated means and standard deviations (SD) for each of the six pre- and post-intervention questions that were repeated on the surveys for comparison, and the two questions that were only asked on the post-intervention questionnaire. The comments elicited from the final question were translated into English by a professional translator identified by the US Armed Forces team. Using the unique identifiers, we compared the six repeated pre- and post-self-assessment questions using a paired t-test. Means, SDs, 95% confidence intervals (CI), and two-tailed p values were calculated for each of the six questions. We also calculated means and SDs for the two unique post-intervention questions regarding participants' assessment of the training program.

A total of 32 pre-intervention and 27 post-intervention questionnaires were completed. Five individuals did not participate during the last day of the program that included ceremonial activities and completion of the survey. These five individuals were considered lost to follow-up. The pre- and post-intervention surveys were paired using the unique identifiers.

RESULTS

All six of the questions – 1) "I feel confident managing a real laboratory sample test for Ebola or other highly contagious sample" (95% CI, -3.53 to -1.65; p=<0.0001); 2) "I feel safe working in the lab environment during a real scenario" (95% CI, -3.64 to -1.59; p=<0.0001); 3) "I feel as if I can appropriately manage a potentially highly contagious laboratory sample" (95% CI, -3.90 to -2.17; p=<0.0001); 4) "I feel that I can interpret a positive or negative sample during a suspected contagious outbreak" (95% CI, -2.12 to -0.40; p=0.006), 5) "I understand basic Biobubble/mobile laboratory concepts and procedures"(95% CI, -4.69 to -0.79; p=<0.0001); and 6) "I understand PCR principles" (95% CI, -3.17 to -1.31; p=<0.0001) – showed statistically significant change pre and post training (Table 1). The course participants scored highly on the final two post-training questions – "I can more effectively perform my role/position because of the training I received during this course" (6.74), and "This training was valuable" (7.00).

The participants were provided a final open-ended question: "What additional training is needed or desired?" Comments from this question included requests for more hands-on time, epidemiology, prehospital and general patient transport, additional disease review, more frequent training for skill and knowledge maintenance, additional statistics on disease impact, and organizational communication.

DISCUSSION

As of March 5, 2020, WHO reported 1,133,758 confirmed cases and 62,784 confirmed coronavirus (COVID-19) deaths affecting 204 countries/regions.[1] Drawing parallels to the West African Ebola outbreak in 2014 that infected over 20,000 individuals resulting in approximately 11,000 deaths,[4,9] the Ebola outbreak provides many lessons for future epidemics/pandemics, such as the current COVID-19 outbreak. These lessons learned include a need for increased surveillance, more effective ecological health interventions, expanded prediction modeling and improved risk communication, as well as improved diagnostic tools, medications and vaccines, and local and global response.[10] Interventions created and employed around the world to respond to highly infectious disease outbreaks include RRTs and a mobile lab for rapid, on-scene diagnostics. The Angolan RRT is trained to respond to an infection of public concern as well as larger concepts of disaster response and management that will help contain the spread of any potentially infectious disease outbreak. The nation of Angola with the assistance of the US Armed Forces identified 32 individuals of various specialties with a focus on lab personnel for this annual CHERRT training.

The WHO EVD Consolidated Preparedness Checklist, Revision 1,[8] identifies 11 key components requiring minimal resources, and was used as a baseline for the training competencies. These competencies were supplemented with protocols, checklists, standard operating procedures (SOP), and instructor experiences. The team's training on these concepts as assessed by the pre- and post-course intervention showed statistically significant changes in all six categories. These scores of self-perceived improved abilities, knowledge, and confidence provide evidence that this type of training improves personnel's perception in the team's ability to respond based on the training experience.

For COVID-19, as of March 2020 the lab capacity in the

Table 1. Pre- and post-course survey questions administered to participants who underwent training in the use of mobile labs and on-site diagnostic testing.

Question	Pre-course mean ± SD (n = 32)	Post-course mean ± SD (n =27)	P-value
1. I feel confident managing a real laboratory sample test for Ebola or other highly contagious sample.	3.56 ± 2.28	6.15 ± 1.32	<0.0001
2. I feel safe working in the lab environment during a real scenario.	3.85 ± 2.56	6.46 ± 1.24	<0.0001
3. I feel as if I can appropriately manage a potentially highly contagious laboratory sample.	3.00 ± 2.14	6.04 ± 1.43	<0.0001
4. I feel that I can interpret a positive or negative sample during a suspected contagious outbreak.	3.15 ± 2.28	4.41 ± 2.42	0.006
5. I understand basic Biobubble/mobile laboratory concepts and procedures.	2.74 ± 2.12	6.48 ± 1.48	<0.0001
6. I understand PCR (polymerase chain reaction) principles.	2.92 ± 2.12	5.16 ± 1.84	<0.0001
7. I can more effectively perform my role/position because of the training I received during this course.		6.74	
8. This training was valuable.		7.00	

SD, standard deviation.
Scores based on 1 to 7 Likert scale. 1 = Strongly Disagree, 4 = Neutral, 7 = Strongly Agree.

US did not meet the need for diagnostics testing even after the entry of commercial lab companies such as Laboratory Corporation of America Holdings and Quest Diagnostic.[11] Improving lab capacity is important in assessing the extent of the outbreak in the US as well as in LMICs on the continent of Africa, which has limited diagnostic resources. The mobile lab is one such resource that is readily deployable, cost effective, and provides a safe containment platform for rapid on-scene diagnostic capabilities. The sampling and testing methods are not dependent on shipping the samples to a reference lab, thus speeding up diagnostic turnaround in LMICs or regions of the world that lack such labs. The current pandemic has identified an additional gap with regard to labs. It seems that even when labs are available, they can be quickly overwhelmed by the increased number of samples. This proposed model could be easily implemented with confidence and minimal training based on accepted protocols and past experience.

Working in highly contagious and volatile environments requires confidence in one's abilities as well as knowledge of the situation and environment (situational awareness). This confidence translates to an awareness of the environment inside a soft-walled lab with biocontainment capability, reducing the risk of cross-contamination of samples and/or spillage. Formal training based on lessons learned, consensus protocols and checklists, and provider experience provide a foundation for adequately trained teams that can effectively intervene and contain a global outbreak.

A long-term follow-up of the participants' abilities, as well as an assessment of each future activation, may further strengthen the perceived benefits of this training curriculum. The pre and post assessments, survey statements, participants' comments, and national/regional priorities provide the material for continued adjustments on curriculum development and implementation.

LIMITATIONS

There are several limitations to this study. First, we often had to use materials translated from English to Portuguese. Native Portuguese speakers from the US Armed Forces were used for translation of instructional materials, surveys, and presentations when needed for clarification. Additionally, some of the participants took part in prior disaster training and/or Ebola workshops three years prior to this intervention. This earlier training was provided by the lead instructor; therefore, some program participants already had some baseline knowledge of the presented material. To that extent, in preparation for the final workshop, the RRT conducted some of its own training prior to the engagement.

The survey focused on the specific training event; however, prior training or lab experience by some individuals could potentially have contributed to the relatively higher scores on the pre-intervention questions that did not achieve significance. The team was hand-picked by the MOH and the military, allowing for potential selection bias for better trained and educated personnel. Additionally, the survey abstractors were not blinded to the study hypothesis. The assessments are based on self-reported competence and ability after the training and simulations and do not reflect actual events. Finally, this study's limitations include those inherent to any pre- and post-intervention survey methodology.

CONCLUSION

This Angolan CHERRT training curriculum based on WHO guidelines, After Action Reports, a NIH standard mobile lab curriculum, and internationally accepted standard operating procedures, provides the nation of Angola with the confidence to rapidly respond at the national level to a highly infectious contagion in the region and perform onsite mobile lab diagnostics. This mobile RRT laboratory provides a potential rapid diagnostic resource when epidemic/pandemic resource allocation may need to be prioritized based on confirmed disease prevalence.

Address for Correspondence: Michael Owens, DO, MPH, CEM, Naval Medical Center Portsmouth, 620 John Paul Jones Circle, Portsmouth, VA 23708. Email: michael.d.owens18.civ@mail.mil.

Conflicts of Interest: By the WestJEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, or the U.S. Government. Dr. Owens and Dr. Lloyd are employees of the U.S. Government. This work was prepared as part of their official duties. Title 17 U.S.C 105 provides that "Copyright protection under this title is not available for any work of the United States Government." Title 17 U.S.C 101 defines a United States Government work as a work prepared by a military service member or employee of the United States Government as part of that person's official duties. There are no other conflicts of interest or sources of funding to declare.

REFERENCES

1. World Health Organization. Coronavirus disease 2019 (COVID-19) Situation Report. World Health Organization. Available at: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports/. Accessed April 5, 2020.
2. Lim D, Ehley B. Exclusive: U.S. coronavirus testing threatened by shortage of critical lab materials. *Politico*. Available at: https://www.politico.com/news/2020/03/10/coronavirus-testing-lab-materials-shortage-125212. Accessed March 19, 2020.
3. Centers for Disease Control and Prevention. Update: Ebola virus disease epidemic – West Africa, February 2015. *MMWR Morb Mortal Wkly Rep*. 2015;64(7)186-7.

4. Jacobson KH, Aguirre AA, Bailey CL, et al. Lessons from the Ebola outbreak: action items for emerging infectious disease preparedness and response. *EcoHealth*. 2016;13:200-12.
5. Corman VM, Landt O, Kaiser M, et al. Detection of 2019 novel coronavirus (2019-nCoV) by real-time RT-PCR. *Euro Surveill*. 2020;25(3):1-8.
6. World Health Organization. New technology allows for rapid diagnosis of Ebola in the Democratic Republic of Congo. World Health Organization. 2017. Available at: Accessed March 20, 2020.
7. Romo V. FDA approves first rapid COVID-19 test. NPR: The Coronavirus crises. Available at: https://www.npr.org/sections/coronavirus-live-updates/2020/03/21/819629909/fda-approves-first-rapid-covid-19-test. Accessed March 22, 2020.
8. World Health Organization. Ebola Virus Disease. Consolidated Preparedness Checklist. Revision 1. January 15, 2015. Available at: https://apps.who.int/iris/bitstream/handle/10665/137096/WHO_EVD_Preparedness_14_eng.pdf?sequence=1. Accessed March 20, 2020.
9. Ogrinc G, Davies L, Goodman D, et al. SQUIRE 2.0 (Standards for Quality Improvement Reporting Excellence): revised publication guidelines from a detailed consensus process. *BMJ Qual Saf.* 2016;25:986-92.
10. World Health Organization. WHO declares an end to the Ebola outbreak in the Democratic Republic of Congo. Available at: http://afro.who.int/news/who-declares-end-ebola-outbreak-democratic-republic-congo. Accessed January 22, 2018:
11. Steenhuysen J, O'Donnedd C. Despite entry of large private labs, coronavirus tests remain scarce in U.S. Health News. Reuters. Available at: https://www.reuters.com/article/us-health-coronavirus-usa-testing/despite-entry-of-large-private-labs-coronavirus-tests-remain-scarce-in-u-s-idUSKBN20Z3XP. Accessed March 20, 2020.

Descriptive Analysis of Extubations Performed in an Emergency Department-based Intensive Care Unit

Nathan L. Haas, MD*†‡°
Patrick Larabell, MD*°
William Schaeffer, DO*
Victoria Hoch, MD*
Miguel Arribas, MD*
Amanda C. Melvin, MS*†
Stephanie L. Laurinec*†
Benjamin S. Bassin, MD*†‡

*University of Michigan, Department of Emergency Medicine, Ann Arbor, Michigan
†University of Michigan, Department of Emergency Medicine, Division of Critical Care, Ann Arbor, Michigan
‡Michigan Center for Integrative Research in Critical Care, University of Michigan, Ann Arbor, Michigan
°Co-first authors

Section Editor: Christopher Tainter, MD
Submission history: Submitted March 29, 2020; Revision received April 18, 2020; Accepted April 20, 2020
Electronically published April 24, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.4.47475

Introduction: Extubation of appropriate patients in the emergency department (ED) may be a strategy to avoid preventable or short-stay intensive care unit (ICU) admissions, and could allow for increased ventilator and ICU bed availability when demand outweighs supply. Extubation is infrequently performed in the ED, and a paucity of outcome data exists. Our objective was to descriptively analyze characteristics and outcomes of patients extubated in an ED-ICU setting.

Methods: We conducted a retrospective observational study at an academic medical center in the United States. Adult ED patients extubated in the ED-ICU from 2015-2019 were retrospectively included and analyzed.

Results: We identified 202 patients extubated in the ED-ICU; 42% were female and median age was 60.86 years. Locations of endotracheal intubation included the ED (68.3%), outside hospital ED (23.8%), and emergency medical services/prehospital (7.9%). Intubations were performed for airway protection (30.2%), esophagogastroduodenoscopy (27.7%), intoxication/ingestion (17.3%), respiratory failure (13.9%), seizure (7.4%), and other (3.5%). The median interval from ED arrival to extubation was 9.0 hours (interquartile range 6.2-13.6). One patient (0.5%) required unplanned re-intubation within 24 hours of extubation. The attending emergency physician (EP) at the time of extubation was not critical care fellowship trained in the majority (55.9%) of cases. Sixty patients (29.7%) were extubated compassionately; 80% of these died in the ED-ICU, 18.3% were admitted to medical-surgical units, and 1.7% were admitted to intensive care. Of the remaining patients extubated in the ED-ICU (n = 142, 70.3%), zero died in the ED-ICU, 61.3% were admitted to medical-surgical units, 9.9% were admitted to intensive care, and 28.2% were discharged home from the ED-ICU.

Conclusion: Select ED patients were safely extubated in an ED-ICU by EPs. Only 7.4% required ICU admission, whereas if ED extubation had not been pursued most or all patients would have required ICU admission. Extubation by EPs of appropriately screened patients may help decrease ICU utilization, including when demand for ventilators or ICU beds is greater than supply. Future research is needed to prospectively study patients appropriate for ED extubation. [West J Emerg Med. 2020;21(3)532–537.]

Disclaimer: Due to the rapidly evolving nature of this outbreak, and in the interests of rapid dissemination of reliable, actionable information, this paper went through expedited peer review. Additionally, information should be considered current only at the time of publication and may evolve as the science develops.

Population Health Research Capsule

What do we already know about this issue?
Extubation of appropriate patients in the emergency department (ED) may be a strategy to avoid preventable or short-stay intensive care unit (ICU) admissions, and could allow for improved ICU utilization.

What was the research question?
What were characteristics and outcomes of patients extubated in an ED-ICU setting?

What was the major finding of the study?
Extubations of 202 ED patients were included; 0.5% required re-intubation within 24 hours, and 7.4% required ICU admission.

How does this improve population health?
Extubation by emergency physicians of appropriately screened patients may help optimize ICU utilization by preventing avoidable ICU admissions.

INTRODUCTION

Endotracheal intubation is commonly performed in the emergency department (ED) and prehospital setting for respiratory failure or airway protection. Extubation is infrequently performed in the ED, possibly due to anticipated duration of underlying process requiring intubation, prompt transfer to the intensive care unit (ICU) when a bed is available, variability in clinician experience, and limited ability to monitor patients post-extubation. Many ICUs are facing increasingly strained capacity, resulting in ED boarding of critically ill patients.[1] Demand for ventilators or ICU beds often outweighs supply, including during a pandemic. However, prolonged boarding of mechanically ventilated patients in the ED has been associated with worse outcomes.[2]

Extubation of appropriate patients in the ED may be a strategy to avoid preventable or short-stay ICU admissions. In addition, decreasing duration of mechanical ventilation likely reduces exposure to the harms associated with mechanical ventilation, which include barotrauma, lung injury, hypotension, gastrointestinal bleeding due to stress ulceration, ventilator-associated pneumonia, deconditioning, diaphragm weakness, and pneumothorax.[3] Limited data regarding extubation of ED patients exists. A retrospective study of 50 trauma patients extubated in the ED suggested that, when appropriately screened for extubation readiness, 0% of patients required unplanned re-intubation, and a small subset was able to be discharged from the ED.[4] Several additional patient populations have been identified as potentially appropriate for ED extubation,[5,6] although published data supporting these practices is lacking.

A novel ED-ICU setting may provide an ideal environment for emergency physicians (EP) to safely extubate appropriate ED patients. The objective of this study was to descriptively analyze characteristics and outcomes of patients extubated in an ED-ICU.

METHODS

Study design and setting

This was a retrospective observational study conducted at a single, large, academic medical center in the United States with approximately 75,000 adult ED visits per year. The institutional review board at the University of Michigan reviewed and approved this study and determined it exempt from ongoing review. This study is presented in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.[7]

The Joyce and Don Massey Family Foundation Emergency Critical Care Center (EC3), an ED-ICU, was created in 2015 to provide comprehensive critical care for ED patients. The EC3 consists of five resuscitation bays and nine ICU-styled patient rooms adjoining the main ED. The EC3 is staffed by a separate team of EPs with or without critical care fellowship training, house staff, physician assistants, and ED nurses (with additional ICU training) who care for patients after initial management by the primary ED team.[8]

Selection of Participants

Adult ED patients extubated in EC3 from February 2015 through November 2019 were included and analyzed via retrospective review of the electronic health record (EHR). An EHR query identified patients with an order for "extubate patient" while in EC3. The authors manually reviewed all charts to ensure appropriateness for inclusion and data extraction. The date range, which determined the study size, was determined by the date EC3 opened (February 2015).

Measurements and Outcomes

Age, gender, location of intubation, hours from ED arrival to extubation, ED disposition, unplanned re-intubation within 24 hours of extubation, and ED length of stay (LOS) (inclusive of time in both the main ED and ED-ICU) were collected from the EHR and analyzed. Individual case review was performed to identify indication for intubation, extubation for palliative purposes, and the attending physician at the time of extubation. The primary outcomes of interest were unplanned re-intubation rate and ED disposition. The study

authors manually extracted data from the EHR, and a separate study author iteratively reviewed a subset of charts for quality assurance and to assure accuracy.

Analysis

We performed a descriptive analysis of all patients meeting inclusion criteria. Separate subgroup analyses compared cohorts grouped by indication for intubation. Statistical analysis was performed using Microsoft Excel (Microsoft Corporation, Redmond, WA) and a TI-30X IIS (Texas Instruments, Dallas, TX) calculator. Analysis was conducted from December 2019 to March 2020.

RESULTS

A total of 202 patients were identified and included for analysis; 85 (42%) were female and median age was 60.86 years (Table 1). Locations of endotracheal intubation included ED (n =138, 68.3%); outside hospital ED (n = 48, 23.8%), and emergency medical services/prehospital (n=16, 7.9%). Intubations were performed for indications of airway protection (n = 61, 30.2%); urgent esophagogastroduodenoscopy (EGD) (n = 56, 27.7%); intoxication/ingestion (n = 35, 17.3%); respiratory failure (n = 28, 13.9%); seizure (n=15, 7.4%); and other (n = 7, 3.5%).

The median interval from ED arrival to extubation was 9.0 hours (IQR 6.2-13.6). The median total ED LOS was 18.37 hours (interquartile range [IQR] 12.56-26.51) inclusive of time in both the ED and the ED-ICU. The median ED-ICU LOS was 14.8 hours (IQR 8.7-23.0). The overall rate of unplanned re-intubation within 24 hours of extubation in the ED-ICU was 0.5%. The attending emergency physician at the time of extubation was not critical care fellowship trained in 113 cases (55.9%).

We performed a subgroup analysis of patients who underwent palliative or compassionate extubation. This was defined as extubation with the expectation of imminent respiratory failure in order to relieve suffering associated with tracheal intubation and mechanical ventilation.[9] Sixty patients underwent compassionate extubation in the ED-ICU, of whom 26 (43.3%) were female and median age was 76.63 years. In this group, the median interval from ED arrival to extubation was 7.0 hours (IQR 4.7-11.2), and the median total ED LOS was 14.0 hours (IQR 10.0-19.5). Forty-eight (80%) died in the ED-ICU, 11 (18.3%) were admitted to medical-surgical units, and one (1.7%) was admitted to intensive care. No patients were re-intubated within 24 hours of extubation. The attending EP was not critical care fellowship trained in 32 cases (53.3%).

Of patients *not* extubated compassionately (n =142), zero died in the ED-ICU. Eighty-seven (61.3%) were admitted to medical-surgical units, 14 (9.9%) were admitted to intensive care, 40 (28.2%) were discharged from the ED-ICU, and one (0.7%) was transferred to another facility. The median time interval from ED arrival to time of extubation was 9.9 hours (IQR 7.0-15.0). The rate of unplanned re-intubation within 24 hours of extubation in the ED-ICU was 0.7%. The attending EP was not critical care fellowship trained in 81 cases (57.0%).

DISCUSSION

This study suggests select ED patients can be safely extubated in an ED-ICU by EPs. This practice appears associated with reduced short-stay ICU admissions. Optimal utilization and allocation of ICU resources, including ventilators, is essential when ICU capacity is under strain and demand outweighs supply. ED extubation of appropriately selected patients in appropriately monitored settings is one strategy to help decrease ICU utilization.

There is a paucity of data regarding extubation of ED patients. To our knowledge, the only existing case series of patients extubated in the ED included only patients intubated in the setting of trauma.[4] In our study, zero of the observed cohort were intubated in the setting of trauma, although several other patient populations were extubated in the ED. These included patients requiring intubation for airway protection in the setting of transient central nervous system depression, need for urgent EGD, acute intoxication, and seizure. These are consistent with groups previously identified as appropriate for ED extubation.[6] As a spectrum of illness severity exists within these populations, it is imperative the underlying process requiring intubation has resolved prior to consideration of extubation. Patients pursuing palliative care may also benefit from ED extubation, and compassionate extubation has the benefit of limiting patient and family suffering and facilitating end-of-life care when appropriate resources exist.

One patient required unplanned re-intubation within 24 hours of extubation during the study period. The patient was initially intubated for airway protection in the setting of agitated delirium requiring sedation to facilitate diagnostics, therapeutics, and patient and staff safety. The patient was extubated in the ED-ICU by an EP with critical care fellowship training, and was re-intubated about nine hours later for acute hypoxic respiratory failure and ongoing agitated delirium requiring sedation for patient and staff safety. He was extubated in the inpatient ICU two days later, and discharged five days later with no appreciable complications of either intubation or mechanical ventilation.

The observed rate of extubation failure was 0.5%. This is lower than previously published rates of 10 - 20% for all ICU patients,[11-13] although these rates were derived from more heterogeneous groups of ICU patients with longer durations of mechanical ventilation and protracted illness. These findings suggest ED extubation is safe in appropriately screened patients at low risk for extubation failure. No established criteria for extubation readiness were used in our patient population, although an extubation readiness protocol and future prospective study of this practice may be beneficial.

Management of rapidly reversible critical illness, including extubation of appropriately screened patients, in an ED-ICU may help alleviate strain facing many inpatient ICUs. Preventing short-stay ICU admissions is one strategy to optimize ICU bed allocation for patients decompensating on wards, ICU-to-

Table 1. Characteristics of patients extubated in emergency department-based intensive care unit, by indication for intubation.

	All extubations, n = 202	Compassionate extubations*, n = 60	All other extubations, n = 142	Intoxication/ ingestion, n = 34	Seizure, n = 15	Esophago-gastroduo-denoscopy, n = 55	Airway protection/ depressed mental status, n = 21	Respiratory failure, n = 14	Other, n= 3
Age, median (years)	60.86	76.63	51.48	36.59	49.7	55.2	62.2	69.1	69.7
Gender, female (%)	42.1	43.3	41.5	35.3	33.3	38.2	42.9	71.4	66.7
Location of intubation (%)									
ED	68.3	55.0	73.9	88.2	46.7	92.7	47.6	35.7	66.7
Prehospital/EMS	7.9	16.7	4.2	8.8	0	1.8	4.8	7.1	0
Outside hospital ED	23.8	28.3	21.8	2.9	53.3	5.5	47.6	57.1	33.3
Hours from ED arrival to extubation, median (IQR)	9.0 (6.2-13.6)	7.0 (4.7-11.2)	9.9 (7.0-15.0)	9.5 (7.1-16.1)	7.1 (5.6-11.7)	10.2 (7.4-13.9)	10.1 (6.7-12.2)	9.3 (6.5-15.6)	20.3 (18.1-27.4)
ED disposition, n (%)									
Admission to intensive care unit	15 (7.4)	1 (1.7)	14 (9.9)	2 (5.9)	0 (0)	4 (7.3)	5 (23.8)	3 (21.4)	0 (0)
Admission to general ward	98 (48.5)	11 (18.3)	87 (61.3)	15 (44.1)	14 (93.3)	34 (61.8)	13 (61.9)	8 (57.1)	3 (100)
Discharge	40 (19.8)	0 (0)	40 (28.2)	17 (50)	1 (6.7)	16 (29.1)	3 (14.3)	3 (21.4)	0 (0)
Deceased	48 (23.8)	48 (80)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Transfer to another facility	1 (0.5)	0 (0)	1 (0.7)	0 (0)	0 (0)	1 (1.8)	0 (0)	0 (0)	0 (0)
Unplanned re-intubation within 24 hours, n (%)	1 (0.5)	0 (0)	1 (0.7)	0 (0)	0 (0)	0 (0)	1 (4.8)	0 (0)	0 (0)
Median ED length of stay, hours	18.37 (12.56-26.51)	14.0 (10.0-19.5)	20.5 (13.8-27.3)	19.8 (12.8-29.0)	23.6 (15.3-26.3)	19.3 (13.4-26.4)	20.2 (16.0-25.2)	26.4 (17.7-29.8)	36.9 (32.7-39.1)

ED, emergency department; *EMS,* emergency medical services; *IQR,* interquartile range.
*Compassionate extubation: performed with expectation patient would not adequately maintain respiratory status, and to limit patient and family suffering.

ICU transfers, and patients with more prolonged critical care needs.[8,14-16] In our study, only 7.4% of the observed patient population required an inpatient ICU admission after receiving care in the ED-ICU, and 43.6% did not require hospitalization. In the absence of ED extubation or an ED-ICU, we hypothesize that the vast majority (perhaps even all) of these patients would have been admitted to an inpatient ICU only to quickly undergo extubation and transfer. EP-performed extubation of appropriately selected patients may help reduce short-stay ICU admissions and optimize inpatient ICU bed utilization.

Endotracheal intubation and mechanical ventilation have been associated with a number of adverse events. These include barotrauma, laryngeal injury, lung injury, hypotension, gastrointestinal bleeding due to stress ulceration, ventilator associated pneumonia, deconditioning, diaphragm weakness, and pneumothorax.[3,17-23] Extubation should be performed as soon as appropriate to mitigate these risks. Physical location should not preclude extubation when indicated and appropriate resources are present, and the ED (or ED-ICU) is often the location where extubation is first appropriate. This study helps demonstrate the safety and feasibility of extubation in this environment.

LIMITATIONS

The retrospective observational nature of this study limits interpretation of results to association rather than causation. This study was conducted at a single, academic medical center in the United States, in a unique setting (ED-ICU) with a low patient-to-nurse ratio of 2:1.[10] For the EP, the evaluation of a patient, decision to extubate, performance of extubation, and monitoring post-extubation presents a task that can require time and effort, while competing demands for time and effort are constantly present. An ED-ICU may help mitigate this challenge. Thus, the generalizability of these results to many EDs may be limited. The sample size in each subgroup is relatively small, due to the relative infrequency of ED extubation. No specific criteria existed for determination of patients' readiness for ED extubation, and patients were determined suitable for extubation at the attending physician's discretion.

Nearly half (44.1%) of extubations were performed by EPs with critical care fellowship training, who may have possessed more familiarity with liberation from mechanical ventilation than non-fellowship trained EPs. Still, the majority of extubations were performed by EPs without critical care fellowship training, suggesting critical care fellowship training is likely not necessary to safely make this decision in many cases. However, we did not compare extubation experience or success between fellowship-trained and non-fellowship trained physicians. A larger proportion of our study subjects had been intubated prior to transfer to our hospital (23.8%), or for time-limited procedures (EGD; 27.7%) than would be typical for a community hospital. Data was manually extracted from the EHR by study authors who were not blinded to the study hypothesis, and was directly input to a spreadsheet, although no formal standardized data sheet was used otherwise.

CONCLUSION

This study demonstrates that select ED patients can be safely extubated in an ED-ICU by EPs. Only 7.4% required ICU admission; whereas if ED extubation had not been not pursued most or all patients would have required ICU admission. Management of rapidly reversible critical illness, including extubation of appropriately screened patients, in an ED-ICU may help optimize ICU utilization by preventing avoidable short-stay ICU admissions, including when demand for ventilators or ICU beds is greater than supply. With increasing ED boarding of critically ill patients, ED extubation may contribute to more effective allocation of inpatient critical care resources. Future research is needed to prospectively study patients appropriate for ED extubation, and to assess the impact of an ED-ICU on additional critically ill patient populations.

ACKNOWLEDGMENTS

The authors would like to acknowledge the Joyce and Don Massey Family Foundation, which provided support for the Joyce and Don Massey Family Foundation Emergency Critical Care Center. No grant or other funding was used for the purposes of this manuscript.

Address for Correspondence: Nathan L. Haas, University of Michigan, Department of Emergency Medicine, Taubman Center B1354, 1500 E Medical Center Drive, SPC 5303, Ann Arbor, MI 48109-5303. Email: haasn@med.umich.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Halpern SD. ICU capacity strain and the quality and allocation of critical care. *Curr Opin Crit Care*. 2011;17(6):648-57.
2. Hung SC, et al. Determining delayed admission to the intensive care unit for mechanically ventilated patients in the emergency department. *Crit Care*. 2014;18(4):485.
3. Zwillich CW, et al. Complications of assisted ventilation: a prospective study of 354 consecutive episodes. *Am J Med.* 1974;57(2):161-70.
4. Weingart SD, et al. Trauma patients can be safely extubated in the emergency department. *J Emerg Med.* 2011;40(2):235-9.
5. Gray SH, Ross JA, Green RS. How to safely extubate a patient in the emergency department: a user's guide to critical care. *CJEM.* 2013;15(5):303-6.

6. Nwakanma CC, Wright BJ. Extubation in the emergency department and resuscitative unit setting. *Emerg Med Clin North Am.* 2019;37(3):557-68.
7. Von Elm E, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *J Clin Epidemiol.* 2008;61(4):344-9.
8. Gunnerson KJ, et al. Association of an emergency department–based intensive care unit with survival and inpatient intensive care unit admissions. *JAMA Netw Open.* 2019;3(7):e197584.
9. Kok VC. Compassionate extubation for a peaceful death in the setting of a community hospital: a case-series study. *Clin Interv Aging.* 2015;10:679-85.
10. Schneider SM, et al. Emergency department crowding: a point in time. *Ann Emerg Med.* 2003;42(2):167-72.
11. Thille AW, Richard JC, Brochard L. The decision to extubate in the intensive care unit. *Am J Respir Crit Care Med.* 2013;187(12):1294-302.
12. Thille AW, et al. Outcomes of extubation failure in medical intensive care unit patients. *Crit Care Med.* 2011;39(12):2612-8.
13. Epstein SK, Ciubotaru RL, Wong JB. Effect of failed extubation on the outcome of mechanical ventilation. *Chest.* 1997;112(1):186-92.
14. Chidi OO, Perman SM, Ginde AA. Characteristics of short-stay critical care admissions from emergency departments in Maryland. *Acad Emerg Med.* 2017;24(10):1204-11.
15. Haas NL, et al. An emergency department–based intensive care unit is associated with decreased hospital and intensive care unit utilization for diabetic ketoacidosis. *J Emerg Med.* 2019. In press.
16. Herring AA, et al. Increasing critical care admissions from US emergency departments, 2001–2009. *Crit Care Med.* 2013;41(5):1197.
17. Gammon RB, Shin MS, Buchalter SE. Pulmonary barotrauma in mechanical ventilation: patterns and risk factors. *Chest*. 1992;102(2):568-72.
18. Colice GL. Resolution of laryngeal injury following translaryngeal intubation. *Am Rev Respir Dis*. 1992;145(2 Pt 1):361-4.
19. Kollef MH. Ventilator-associated complications, including infection-related complications: the way forward. *Crit Care Clin.* 2013;29(1):33-50.
20. Rello J, et al. Incidence, etiology, and outcome of nosocomial pneumonia in mechanically ventilated patients. *Chest*. 1991;100(2):439-44.
21. Jaber S, et al. Rapidly progressive diaphragmatic weakness and injury during mechanical ventilation in humans. *Am J Respir Crit Care Med.* 2011;183(3):364-71.
22. Mutlu GM, Mutlu EA, Factor P. GI complications in patients receiving mechanical ventilation. *Chest*. 2001;119(4):1222-41.
23. Schweickert WD, Hall J. ICU-acquired weakness. *Chest*. 2007;131(5):1541-9.

Addressing Challenges in Obtaining Emergency Medicine Away Rotations and Standardized Letters of Evaluation Due to COVID-19 Pandemic

Linda Katirji, MD* *University of Kentucky, Department of Emergency Medicine, Lexington, Kentucky
Liza Smith, MD† †University of Massachusetts Medical School, Baystate Medical Center, Department of Emergency Medicine, Springfield, Massachusetts
Alexis Pelletier-Bui, MD‡ ‡Cooper Medical School of Rowan University, Department of Emergency Medicine, Camden, New Jersey
Emily Hillman, MD, MHPE§ §University of Missouri—Kansas City School of Medicine, Truman Medical Center, Department of Emergency Medicine, Kansas City, Missouri
Xiao Chi Zhang, MD, MS¶ ¶Thomas Jefferson University, Department of Emergency Medicine, Philadelphia, Pennsylvania
Michael Pasirstein, MD, MPH‖ ‖Drexel University College of Medicine, Department of Emergency Medicine, Philadelphia, Pennsylvania
Mark Olaf, DO# #Geisinger Commonwealth School of Medicine, Department of Emergency Medicine, Scranton, Pennsylvania
Jazmyn Shaw** **University of Mississippi School of Medicine, Univeristy of Mississippi Medical Center, Jackson, Mississippi
Douglas Franzen, MD, MEd†† ††University of Washington, Department of Emergency Medicine, Seattle, Washington
Ronnie Ren, MD†

Section Editor: Mark I. Langdorf, MD, MHPE
Submission history: Submitted March 27, 2020 Accepted March 27, 2020
Electronically published April 2, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.3.47444
[West J Emerg Med. 2020;21(3)538–541.]

Disclaimer: Due to the rapidly evolving nature of this outbreak, and in the interests of rapid dissemination of reliable, actionable information, this paper went through expedited peer review. Additionally, information should be considered current only at the time of publication and may evolve as the science develops.

From the Advising Students Committee in Emergency Medicine

With the unpredictable future of the coronavirus disease 2019 (COVID-19) pandemic, institutions have begun altering the clinical experience for students and instituting travel bans for both their faculty and students.[1] On March 17, 2020, a joint recommendation from the Association of American Medical Colleges and the Liaison Committee on Medical Education was issued, which supported suspending clinical activities for medical students for a two-week minimum.[2] There exists precedence for sudden medical school curricular adaptations in response to emerging diseases and disasters, including alterations in planned didactics, distance learning, and other methods of risk mitigation.[3–5] Numerous institutions have begun canceling clerkship rotations for visiting students, while others are prohibiting their own students from traveling to complete away rotations. While many institutions have initiated video conferencing and virtual simulation in lieu of clinical exposure, there is increasing concern that these students will suffer from limited opportunities to evaluate and treat patients in emergency department settings and to receive real-time assessment of their clinical skills.

The Council of Residency Directors in Emergency Medicine (CORD) Advising Students Committee in Emergency Medicine (ASC-EM) anticipates institutional and regional variability in both the spread and response to COVID-19. Travel restrictions and host institution rotation closures will impact the number of emergency medicine (EM) rotations EM-bound medical students can complete in an unprecedented manner. They may prevent students from completing any away rotations this academic cycle, challenging the students' collective ability to obtain EM Standardized Letters of Evaluation (SLOE) outside of their home institution. For students without a home EM program to rotate in, they may not have the ability to obtain any SLOE at all, which could be devastating to their EM residency application.[6,7]

Historically, SLOEs obtained from home and away EM rotations have served as important tools to determine which candidates to invite for residency interviews.[6-9] Approximately 80% of EM programs will not consider an applicant for an interview unless they have at least one SLOE.[10,11] In the most recent review of the Emergency Medicine Residents' Association (EMRA) Match website, of the 175 out of 258 programs self-reporting a SLOE requirement, only 13 programs (7%) stated they would review an applicant without a SLOE while 79 programs (45%) stated they required two SLOEs before

considering an applicant for interview.[12]

Over the past decade, the group SLOE, written by the EM clerkship and residency education team at a residency program, has become the preferred SLOE for residency EM applications.[6,8,13,14] Program directors have since held single-author SLOEs, SLOEs from EM faculty not affiliated with a residency program, and non-SLOE format letters of recommendation (LoR) in lesser regard.[6,15] In the present COVID-19 pandemic, students without a residency-based home EM rotation will face markedly greater barriers to obtaining these coveted group SLOEs. EM's emphasis on residency group SLOEs over other letter types creates an undue burden on these vulnerable students and makes the application process intrinsically inequitable. This inequity warrants a reevaluation of the current application practice.

In this continuously evolving, exceptionally challenging time, it is important for the educational community to face these challenges in a united front. ASC-EM proposes the following recommendations for all stakeholders, including EM program leadership, medical schools, and EM-bound medical students, to consider for the upcoming EM application cycle.

For Program Directors:

1. Programs should be flexible with their SLOE requirements.
    a. ASC-EM recommends for application cycle 2020-2021 that residency program leadership consider reducing the number of SLOEs needed to review an application to **one SLOE (or fewer)** to account for students who cannot obtain a SLOE at their home institution or from away rotations. We also recommend programs to accept alternative letters of recommendations to act as surrogates for their typical group SLOE requirements as detailed in the paragraphs below.

2. Programs should give weight to alternative LoRs that include the traditional SLOE content.
    a. Examples of alternative LoRs include, but are not limited to, a SLOE from a home EM rotation at an institution without an associated EM residency program ("orphan" SLOEs), EM sub-specialty SLOEs (ultrasound, toxicology, pediatric EM, emergency medical services, or other sub-specialties), and LoRs written by advisors for the instance that a student has been entirely unsuccessful in obtaining an EM rotation. The CORD website contains instructions and a template for writing such SLOEs.[16]
    b. Given the increased emphasis on alternative LoRs, letter writers must be instructed to address relevant clinical and professional competencies typically seen in the "Qualifications for EM" section of SLOEs. A standard template for this can be found on the CORD website.[17]

For Deans and Letter Writers:

3. Writers should use clear language to reflect a student's loss of opportunities.
    a. Medical Student Performance Evaluation (MSPE): Due to the anticipated institutional and regional variability, ASC-EM recommends that institutions include a clear, explicit statement in their MSPE explaining any institutional policy limiting their students' ability to complete EM rotations.
    b. SLOE and alternative LoRs: ASC-EM recommends the inclusion of the following standard verbiage in SLOEs and alternative LoRs to identify students that could not obtain the recommended number of rotations:

    "This student was unable to obtain the expected number of residency SLOE opportunities due to uncontrollable circumstances surrounding the COVID-19 pandemic. These circumstances include [include all that apply] home institution prohibiting school-related travel, cancellation of home EM rotation, cancellation of EM away rotations the student had accepted, and inability to find an EM rotation willing to accept students."

For Medical Students:

4. Students should consider going on fewer away rotations.
    a. We anticipate EM rotations that accept visiting students will become a scarce opportunity that must be shared to maintain a healthy application environment. We ask all stakeholders in the EM application process, including but not limited to faculty advisers, clerkships, and students, to be cognizant of the number of EM rotations each student chooses to complete. Given the possibility of drastically limited EM rotation positions, ASC-EM would like to revise the number of away rotations we have recommended students complete in previous application cycles.
    b. Students who can rotate at their home EM program: In the event that a student is able to both travel to institutions accepting visiting students and secure available clerkship positions, that student should not complete more than one away rotation.
    c. Students without a home EM program: Students should not complete more than two away rotations.

For Institutions and Clerkship Directors Still Accepting Visiting Students:

5. Clerkship directors and medical schools should preferentially consider students without a home EM program for an EM clerkship at their institution.
    a. To yield a more equitable distribution of scarce audition rotation opportunities, host institutions and their clerkship directors should actively seek applicants who are unable to obtain a SLOE from their home institution.
    b. Applicants without a home EM rotation, whether it be due to restrictions on students rotating in their home EM department or lack of a home EM residency program altogether, should communicate that status in their

visiting clerkship application, if possible.

c. CORD ASC-EM maintains a living document of medical schools where students lack access to a home EM program, so-called orphan programs. Application reviewers should use this tool to aid their decision making when determining which students to invite for visiting opportunities. The most up to date document can be found here.

For Stakeholders Involved in the Restriction of Visiting Rotations:

6. The status of EM rotations should be clear and accurate.
   a. The status of visiting EM rotations should be accurately represented on relevant platforms such as Visiting Students Learning Opportunities (VSLO). Institutions should work with their respective application platforms to ensure that students cannot apply to rotations that have been or will be canceled due to the COVID-19 pandemic. We encourage institutions to keep the availability indicator for their rotation on EMRA Match for Clerkships up to date as well as the "Information Students Should Know" section for relevant COVID-19 updates.[12] Students should not be expected to apply to rotations uncertain of whether the rotation is open or canceled.

7. Students should be protected from financial implications of canceled rotations.
   a. Financially, students are the most vulnerable group among all stakeholders. Institutions restricting their students from traveling should help their students recoup the money already spent on setting up visiting rotations. Host institutions canceling their visiting rotations should work with their application platform, such as VSLO, to refund students who have already applied to or accepted a rotation there.

We understand that these proposed changes may be uncomfortable for programs that have relied on SLOEs to be the most important representation of a student's abilities, and for students who are eager to be able to demonstrate their competencies in the audition setting.[6–8] Ultimately, these recommendations are motivated by the need to preserve the health and safety of our EM community and to ensure that students who traditionally are at the greatest disadvantage in navigating the application process are not excluded entirely from consideration.

Although the COVID-19 pandemic was the impetus for these unique recommendations, our response may be applicable to future, unforeseen circumstances that alter the usual application process. Emergency physicians are known to be adaptable to their ever-changing clinical environment, and we are confident that our flexibility will extend to the academic realm as well.

Address for Correspondence: Linda Katirji, MD, University of Kentucky, Department of Emergency Medicine, 800 Rose Street Room M-53, Lexington, Kentucky 40536. Email: linda.katirji@uky.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. CDC. Coronavirus (COVID-19). Available at: https://www.cdc.gov/coronavirus/2019-ncov/index.html. Published 2020. Accessed March 27, 2020.
2. AAMC. Guidance on Medical Students' Clinical Participation: Effective Immediately. Available at: https://www.aamc.org/system/files/2020-03/Guidance on Student Clinical Participation 3.17.20 Final.pdf. Published 2020. Accessed March 27, 2020.
3. Starr I. Influenza in 1918: recollections of the epidemic in Philadelphia. 1976. *Ann Intern Med*. 2006;145(2):138-40.
4. Park SW, Jang HW, Choe YH, et al. Avoiding student infection during a Middle East respiratory syndrome (MERS) outbreak: a single medical school experience. *Korean J Med Educ*. 2016;28(2):209—17.
5. Hansoti B, Douglass K, Tupesis J, et al. Guidelines for safety of trainees rotating abroad: consensus recommendations from the Global Emergency Medicine Academy of the Society for Academic Emergency Medicine, Council of Emergency Medicine Residency Directors, and the Emergency Medicine Residents' Association. *Acad Emerg Med*. 2013;20(4):413-20.
6. Love JN, Smith J, Weizberg M, et al. Council of Emergency Medicine Residency Directors' standardized letter of recommendation: the program director's perspective. *Acad Emerg Med*. 2014;21(6):680-7.
7. National Residency Matching Program. *Results of the 2018 Program Director Survey*. 2018. Available at: www.nrmp.org. Accessed March 27, 2020
8. Love JN, Ronan-Bentle SE, et al. The Standardized Letter of Evaluation for postgraduate training: a concept whose time has come? *Acad Med*. 2016;91(11):1480-2.
9. Griffith M, DeMasi SC, McGrath AJ, et al. Time to reevaluate the away rotation: improving return on investment for students and schools. *Acad Med*. 2019;94(4):496-500.
10. Negaard M, Assimacopoulos E, Harland K, et al. Emergency medicine residency selection criteria: an update and comparison. *AEM Educ Train*. 2018;2(2):146-53.
11. King K, Kass D. What do they want from us? A survey of EM program directors on EM application criteria. *West J Emerg Med*. 2017;18(1):126-8.

12. EMRA Match. EMRA. Available at: https://webapps.emra.org/utils/spa/match#/search/list/. Accessed March 27, 2020.
13. Grall KH, Hiller KM, Stoneking LR. Analysis of the evaluative components on the Standard Letter of Recommendation (SLOR) in emergency redicine. *West J Emerg Med*. 2014;15(4):419-23.
14. Girzadas DVJ, Harwood RC, Dearie J, et al. A comparison of standardized and narrative letters of recommendation. *Acad Emerg Med*. 1998;5(11):1101-4.
15. Jarou Z. *EMRA and CORD Student Advising Guide*. (Hillman E, Kellogg A, Lutfy-Clayton L, Pelletier-Bui A, Shandro J, eds.). Irving, TX: Emergency Medicine Residents' Association; 2019.
16. CORD. The Standardized Letter of Evaluation (SLOE) for Non-EM Residency Faculty. Available at: https://www.cordem.org/resources/residency-management/sloe/sloe---non-em-residency-faculty/. Accessed March 27, 2020
17. CORD. Official CORD Standardized Letter of Evaluation (SLOE). Available at: https://www.cordem.org/globalassets/files/sloe/sloe-2019---non-em-residency-faculty.pdf. Accessed March 27, 2020.

Definitive Airway Management of Patients with a King Laryngeal Tube™ in Place in the COVID-19 Pandemic

Benjamin J. Sandefur, MD*
Brian E. Driver, MD†
Calvin A. Brown III, MD‡
Robert F. Reardon, MD†

*Mayo Clinic College of Medicine and Science, Department of Emergency Medicine, Rochester, Minnesota
†Hennepin County Medical Center, Department of Emergency Medicine, Minneapolis, Minnesota
‡Brigham and Women's Hospital and Harvard Medical School, Department of Emergency Medicine, Boston, Massachusetts

Section Editor: R. Gentry Wilkerson, MD, Joseph Shiber, MD
Submission history: Submitted March 28, 2020; Revision received April 16, 2020; Accepted April 17, 2020
Electronically published April 24, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.4.47462
[West J Emerg Med. 2020;21(3)542–545.]

Disclaimer: Due to the rapidly evolving nature of this outbreak, and in the interests of rapid dissemination of reliable, actionable information, this paper went through expedited peer review. Additionally, information should be considered current only at the time of publication and may evolve as the science develops.

To the Editor,

The COVID-19 pandemic has generated enhanced focus on the safety of healthcare providers and efforts to mitigate the risks of viral transmission.[1] Reports of previous viral epidemics have described substantially increased risk to providers performing laryngoscopy and tracheal intubation in patients infected with the virus.[2,3] Additionally, bronchoscopy and other endoscopic airway procedures are considered high-risk, aerosol-generating procedures.[1]

The King LT(S)-D laryngeal tube (King Systems, Noblesville, IN), abbreviated hereafter as the King LT, is a new-generation extraglottic device (Figure 1) used as a primary or backup airway device by many emergency medical systems systems. This device has been demonstrated to have advantageous attributes as compared to other extraglottic airway devices, with favorable safety outcomes and high rates of successful insertion.[4-7] However, the King LT is not a definitive airway device and is not intended for long-term use. Additionally, the King LT has been associated with post-insertion airway edema, which, in addition to risk factors inherent to the patient, may further impede subsequent laryngoscopy attempts.[8,9] Early exchange of a King-LT for an endotracheal tube is important in reducing this risk. An endoscopic Seldinger-style technique for tracheal tube placement using an Arndt airway exchange catheter (Cook Medical, Bloomington, IN) has been described.[9] However, this technique may increase generation of aerosols containing highly infectious viral particles. Additionally, many emergency physicians may be unfamiliar with this approach or lack the necessary endoscopic equipment. Given the current COVID-19 pandemic, emergency physicians need to have a straightforward, safe approach for definitive airway management in patients with a King-LT using airway equipment commonly found in the emergency department (ED).

In 2016, Dodd and colleagues introduced a novel, nonsurgical approach to facilitate definitive airway management in ED patients with a King LT in place.[10] The authors described use of a standard-geometry video laryngoscope and bougie to intubate the trachea with the King LT device remaining in situ. A bougie is used, instead of initial intubation with a tracheal tube, given its smaller diameter and the inherent space limitation that the King LT imposes within the pharynx where the devices are manipulated. Furthermore, the on-screen visualized supraglottic region might be obscured as the larger endotracheal tube passage is attempted, while use of a bougie results in less obstruction of the visualized field. The authors reported a 99.8% success rate with this nonsurgical and non-endoscopic technique, and noted that in rare cases of failed intubation, the King LT remains in a functional position allowing for balloon reinflation and resumption of ventilation. A subsequent, proof-of-concept cadaveric study demonstrated similar (100%) first-pass success, although the authors acknowledged the potential for overestimation given the small sample size.[11] This concept was demonstrated in real-world clinical practice in an observational study of 647 patients arriving to the ED with a prehospital-placed King LT.[12] In this study 112 of 647 patients underwent intubation with the King LT left in place, with the balloons deflated,

with first-attempt success in 102 (91%). Of the 10 patients with first-attempt failure, eight patients were intubated with the same technique on the second attempt; the remaining two were intubated with bougie facilitation after removing the King LT.

We believe that the King LT exchange method described by Dodd and colleagues represents a safe and simple approach that can be readily performed by clinicians who are skilled at video laryngoscopy. Further, we believe that this method, used in combination with administration of a high-dose, paralytic medication to mitigate spontaneous patient respiration and cough during the procedure, represents the safest method for both patients and care providers to exchange a King LT for a cuffed tracheal tube in a patient with known or suspected COVID-19. Lastly, the airway equipment required is readily available to most emergency providers, critical care providers, and anesthesiologists. We describe this procedure, with updates accounting for risks inherent to the COVID-19 pandemic, in Figures 2 and 3.

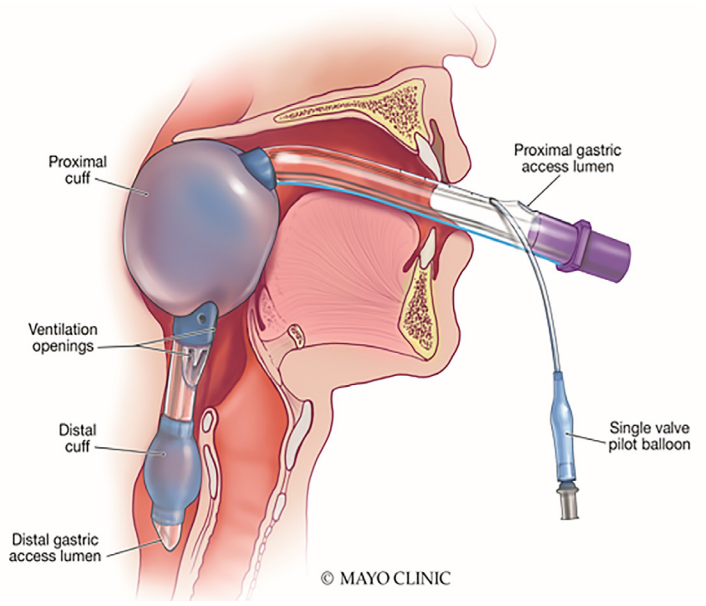


Figure 1. King LT(S)-D™ laryngeal tube (King Systems; Noblesville, IN, USA).
From Subramanian A, Garcia-Marcinkiewicz A, Brown D, et al. Definitive airway management of patients presenting with a pre-hospital inserted King LT(S)-D™ laryngeal tube airway: a historical cohort study. *Can J Anesth.* 2016;63(3):275–82.
Printed with permission of Mayo Foundation for Medical Education and Research, all rights reserved.

1. Patient should be in a negative pressure room, if available
2. Lean team to minimize provider exposure
3. Strictly adhere to enhanced respiratory PPE donning protocol with observer
4. Most experienced clinician intubates
5. Ensure a viral filter is attached to King LT
6. Immediately check pilot balloon and, if needed, adjust balloon pressure to prevent air leak
7. Ensure preoxygenation for 5 minutes with 100% FiO_2 via the existing King LT
8. Ensure appropriate sedation and administer high-dose NMBA, if not already given
9. Wait appropriate amount of time for paralytic onset (45-60 seconds)
10. Suspend ventilator at end-expiration, prior to video laryngoscope insertion or King LT manipulation, to minimize risk of air leak and aerosol-generation
11. Insert a standard geometry video laryngoscope into the mouth, between the tongue and inflated oropharyngeal balloon, advancing toward the vallecula until the balloon fills the VL screen
12. Completely deflate the King LT balloons, leaving the King LT in place
13. Manipulate the video laryngoscope to identify and engage the vallecula, visualizing arytenoid cartilages and vocal cords
14. Pass a bougie (or equivalent) into the oropharynx and indirectly visualize passage into the trachea, achieving further confirmation with feeling the tracheal rings
15. Advance a tracheal tube over the bougie, utilizing a 90-degree counterclockwise rotation to pass the arytenoid cartilages, and visualize passage into the trachea
16. Immediately inflate the tracheal tube cuff, withdraw the bougie, and attach a viral filter
17. Attach the closed-circuit ventilator, begin ventilation, and confirm tracheal tube placement with end tidal continuous capnography and chest rise (*do not use bag ventilation to check placement, in order to limit ventilator circuit disconnects)
18. Carefully withdraw the deflated King LT, maintaining indirect visual confirmation of tracheal tube placement
19. Withdraw the video laryngoscope and secure the tracheal tube
20. Strictly adhere to PPE doffing protocol with observer and perform hand hygiene

Figure 2. Safe Approach to King Exchange in Patients with COVID-19.
*If the procedure fails at any point, the King LT can be reinflated and used for oxygenation and ventilation.
PPE, personal protective equipment; *LT,* laryngeal tube; *FiO_2,* fraction of inspired oxygen; *NMBA,* neuromuscular blocking agent; *VL,* videolaryngoscopy.

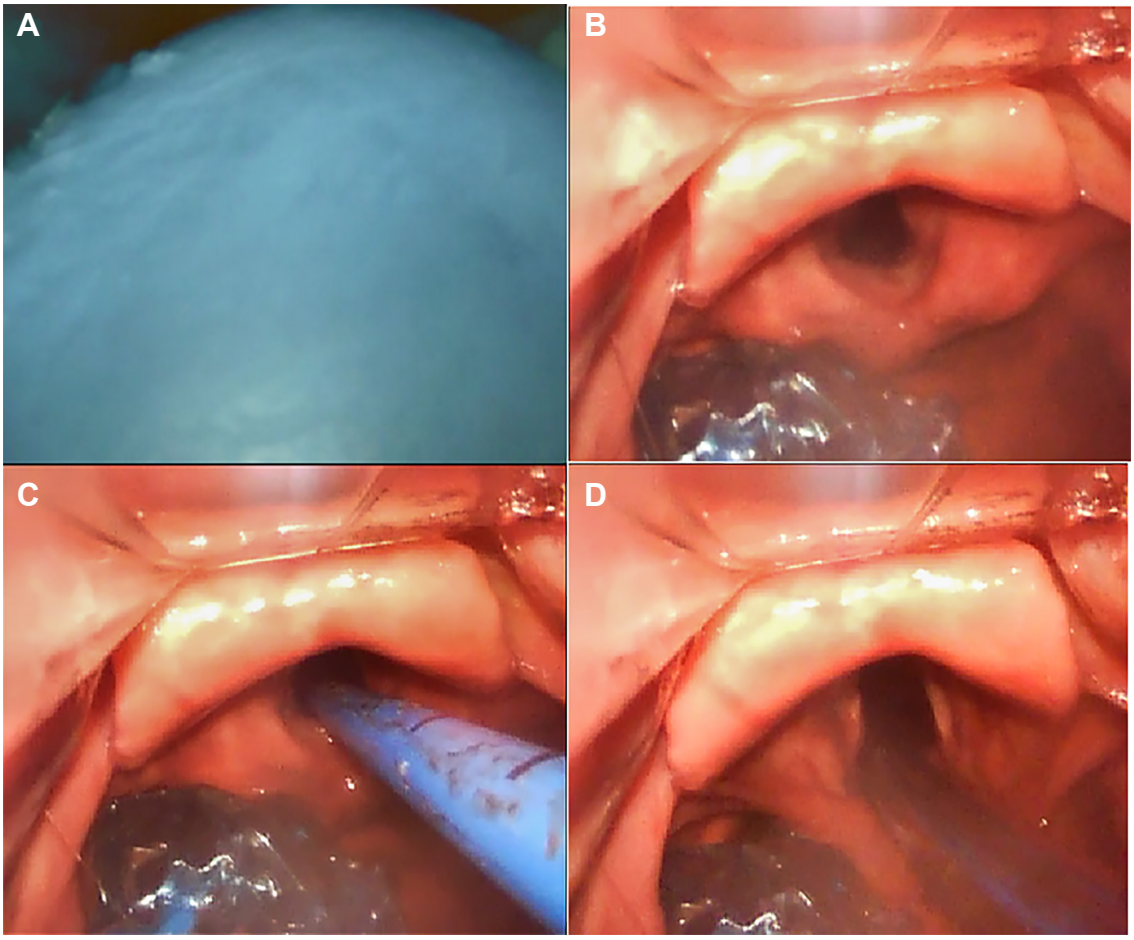


Figure 3. Steps for tracheal intubation with the King LT in situ.
A. After suspending ventilator at end-expiration, the clinician advances the video laryngoscope into the oropharynx, along the superior surface of the tongue (top) and anterior to the King LT (bottom). The oropharyngeal balloon can be visualized filling the screen.
B. The King LT balloons are deflated, and blade is advanced into the vallecula, with arytenoid cartilages and vocal cords visualized on the screen.
C. The clinician passes a bougie into the trachea, with visual confirmation and confirmation from feel of tracheal rings
D. The tracheal tube is advanced over the bougie, utilizing a 90-degree counterclockwise rotation to avoid encountering the arytenoid cartilages.
*After confirmation of tracheal intubation, the King LT is removed. If the procedure fails at any point, the King LT can be reinflated and used for oxygenation and ventilation.
Figure 3, Image A courtesy of Robert F. Reardon, MD and Figure 3; Images B-D courtesy of Benjamin J. Sandefur, MD.

Address for Correspondence: Benjamin J. Sandefur, MD, Mayo Clinic College of Medicine and Science, Department of Emergency Medicine, 200 First St. SW, Rochester, MN 55905. Email: sandefur.benjamin@mayo.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. World Health Organization. Clinical management of severe acute respiratory infection (SARI) when COVID-19 disease is suspected. Interim Guidance. Available at: https://apps.who.int/iris/rest/bitstreams/1272156/retrieve. Accessed 28 March, 2020.
2. Raboud J, Shigayeva A, McGeer A, et al. Risk Factors for SARS Transmission from Patients Requiring Intubation: A Multicentre Investigation in Toronto, Canada. *PLoS One*. 2010;5(5):e10717.
3. Tran K, Cimon K, Severn M, et al. Aerosol Generating Procedures and Risk of Transmission of Acute Respiratory Infections to Healthcare Workers: A Systematic Review. *PLoS One*. 2012;7(4):e35797
4. Russi CS, Miller L, Hartley MJ. A comparison of the King-LT to endotracheal intubation and Combitube in a simulated difficult airway. *Prehosp Emerg Care*. 2008;12(1):35-41.

5. Tumpach EA, Lutes M, Ford D, Lerner EB. The King LT versus the Combitube: flight crew performance and preference. *Prehosp Emerg Care*. 2009;13(3):324-8.
6. Schalk R, Byhahn C, Fausel F, et al. Out-of-hospital airway management by paramedics and emergency physicians using laryngeal tubes. *Resuscitation.* 2010;81(3):323-6.
7. Russi CS, Hartley MJ, Buresh CT. A pilot study of the King LT supralaryngeal airway use in a rural Iowa EMS system. *Int J Emerg Med.* 2008;1(2):135-8.
8. Gaither JB, Matheson J, Eberhardt A, Colwell CB. Tongue engorgement associated with prolonged use of the King-LT laryngeal tube device. *Ann Emerg Med.* 2010;55(4):367-9.
9. Subramanian A, Garcia-Marcinkiewicz A, Brown D, et al. Definitive airway management of patients presenting with a pre-hospital inserted King LT(S)-DTM laryngeal tube airway: a historical cohort study. *Can J Anesth.* 2016;63(3):275–82.
10. Dodd K, Klein L, Kornas R, et al. Definitive airway man-agement in emergency department patients with a King laryngeal tube in place: a simple and safe approach. *Can J Anesth.* 2016;63(5):638–9.
11. Dodd K, Kornas R, Prekker M, et al. Endotracheal intubation with the King laryngeal tube in situ using video laryngoscopy and a bougie: a retrospective case series and cadaveric crossover study. *J Emerg Med.* 2017;52(4):403-8.
12. Driver BE, Scharber SK, Horton GB, Braude DA, Simpson NS, Reardon RF. Emergency Department Management of Out-of-Hospital Laryngeal Tubes. *Ann Emerg Med*. 2019;74(3):403–9.

Keeping the Fire House Running: A Proposed Approach to Mitigate Spread of COVID-19 Among Public Safety Personnel

Robert J. Katzer, MD, MBA University of California, Irvine, Department of Emergency Medicine, Irvine, California

Section Editor: Mark I. Langdorf, MD, MHPE
Submission history: Submitted March14, 2020; Accepted March 14, 2020
Electronically published March 15, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.3.47298
[West J Emerg Med. 2020;21(3):546-548.]

Disclaimer: Due to the rapidly evolving nature of this outbreak, and in the interests of rapid dissemination of reliable, actionable information, this paper went through expedited peer review. Additionally, information should be considered current only at the time of publication and may evolve as the science develops. On February 11, 2020, the World Health Organization renamed the virus COVID-19.

BACKGROUND

Originating within the city of Wuhan, Hubei Province, China, in December 2019 and January 2020, the disease COVID-19 has spread widely throughout the world.[1-3] On March 11, 2020, the World Health Organization (WHO) classified COVID-19 as a pandemic. COVID-19 is caused by the coronavirus SARS-CoV-2, and is believed to have originated from bats.[4-6] Its overall case fatality rate has been reported between 1% and 3.8%, although this number is likely to evolve as broader testing becomes available for less severe cases.[1,6,7] The WHO-China Joint Mission on Coronavirus determined that 75-85% of case clusters in China occurred within families, presumably in the household.[4]

Across the world, efforts are underway to contain the spread and mitigate the impact of COVID-19. These include social distancing efforts such as working from home and meeting via teleconferences.[8] The nature of public safety both necessitates that first-responder personnel be present at the station and requires vigilance to keep them healthy to provide essential services to the community. As a result, the fire station represents a front line in the COVID-19 mitigation efforts. The impact on fire department staffing was demonstrated when 25 of 111 employees of the City of Kirkland, Washington, Fire Department were placed under quarantine after responding to calls at a single, skilled nursing facility later found to have a COVID-19 case cluster.[9]

Given the annual presence of the influenza virus, comparing influenza to COVID-19 provides some basis to evaluate the threat. Where COVID-19's estimated case fatality rate is between 1% and 3.8%, the United States Centers for Disease Control and Prevention (CDC) estimates influenza's overall case fatality rate at around 0.1%.[10] Furthermore, it is estimated that each case of COVID-19 will infect an average of between 2 and 2.5 other people.[6] This ratio is referred to as the reproductive number. A literature review found the reproductive number of seasonal influenza to be lower, at 1.19 and 1.37.[11]

The emergence of a contagious disease with a higher reproductive number and 10-40 times more lethal than seasonal influenza should concern all of us. Understanding how the disease is spread is paramount to mitigate its spread. As with many coronaviruses, evidence indicates that COVID-19 is spread via respiratory droplets.[4,8,12] COVID-19 can travel directly from an infected person to a nearby person after coughing or sneezing. It has been collected on the surfaces of a patient's hospital room after hours to days.[13] The same study established that using standard cleaning agents eliminated the virus from surfaces.

COVID-19 TRANSMISSION

As COVID-19 spreads through respiratory droplets, the main components of limiting spread in the workplace are source control and elimination of virus from surfaces. Source control has three main components: 1) preventing employees who are sick from being at work; 2) limiting the spread of droplets from coughing by applying masks to those with a cough and encouraging employees to cough into their elbow and not their hand or into the open air; and 3) encouraging frequent hand washing. The CDC recommends washing hands with soap and water for more than 20 seconds or using a hand sanitizer with at least 60-95% alcohol.[14] Minimizing the sharing of computers and tools between employees is recommended, as is frequent cleaning of surfaces that employees contact such as door knobs, countertops, keyboards, and phones. This recommendation aims to eliminate the virus' spread when source control may have failed.[15] Most of the common cleaning agents registered with the Environmental Protection Agency (EPA) are believed effective in disinfecting surfaces from COVID-19. Alternatively, a mix of five tablespoons household bleach in one

gallon of water can be used.[16] Current information on which cleaning agents can be used on SARS-CoV-2 can be found on the EPA website.[17]

MITIGATION STRATEGIES FOR PUBLIC SAFETY PERSONNEL

The following proposal applies the above information to mitigating the spread of COVID-19 among public safety personnel working at fire stations or analogous workplaces. It is based on known literature about the nature of SARS-CoV-2. Identifying infected personnel early in order to isolate them from other members should be a key aspect of any mitigation plan. This involves requesting that employees remain at home if they are sick.[14,15] Although this concept may be a sharp departure from cultural norms of being a team player and toughing out illness while at work, it is essential to protect the ability of the public safety workforce to provide adequate staffing to the community. Each agency should identify how absences due to illness will be categorized during this pandemic. For employees who may not have paid sick or vacation days available, finding a mechanism to provide compensation while the employee is unable to work may eliminate part of the incentive an employee may feel to hide his or her symptoms in order to remain at work.

The agency should also consider screening processes in the workplace as an added measure to identify potential COVID-19 cases (or other infections). Screening may include temperature measurement when employees arrive at work and potentially at appropriate intervals during prolonged shifts. It is estimated that 88% of those infected with COVID-19 will develop fever. The CDC defines fever as a temperature of at least 100.4°F/ 38°C. The screening process may also include questions about new symptoms of respiratory infection such as cough, shortness of breath, myalgias, and sore throat.[4]

Predetermined processes should be employed to manage employees who screen positive. These include determining whether employees who screen positive will be referred to their primary care physician or to the contracted occupational health organization for a medical evaluation, as well as the requirements for return to work. For employees who test positive for COVID-19 during their subsequent medical evaluation, the local public health agency will be an important partner in determining the return-to-work plan based on current national and local criteria. For employees who test negative for COVID-19 or who are believed to have a different etiology for their symptoms, the evaluating medical provider should provide the employee's return-to-work criteria.

In addition to screening essential personnel at work, agencies may encourage personnel who do not physically need to be in the station to work remotely, as well as limiting visitors to the station. This may further decrease the likelihood that someone with COVID-19 introduces virus into the station. Agencies may also consider a policy that would require employees with a cough to wear surgical masks while on duty. Hand washing or sanitizing should be emphasized both as personnel leave to respond to a call for service, and upon their return to the station. Personnel should also focus on avoiding contact between their hands and face.[8]

MODIFICATIONS TO SPECIFIC AREAS OF THE STATION

As personnel often cook, eat, work out, and sleep at fire stations, a greater potential for COVID-19 spread may exist in this work environment compared to typical work places. Knowing that COVID-19 spreads via droplet from coughing and hand contact between people, or with surfaces such as door knobs, allows each station to evaluate areas of emphasis to prevent transmission. The agency should identify the surfaces in the station that are contacted routinely. This includes equipment and apparatus parts that are handled, as well as common areas of the fire station or, gym. Scheduled disinfection of these surfaces should be added to the daily routine.

The bathrooms, kitchens, and eating areas should be a particular focus. Although it is not currently believed that COVID-19 is spread primarily via the oral-fecal route, the virus has been isolated in feces and on surfaces throughout the bathroom of an isolated patient.[4,13] With food preparation and eating there may be an increased risk of personnel bringing virus in contact with their mouths. In addition to scheduled surface disinfection or washing surfaces in these areas, an agency may consider requiring hand washing or use of hand sanitizer by personnel both upon entry and exit from those areas. Agencies may consider requiring gloves for food preparation. Steps should also be taken to minimize the sharing of dishes and utensils as much as is feasible.

If the fire station does not currently have single-occupancy bunk rooms, the agency may consider modifying the sleeping quarters so that no more than one person is sleeping in each room. That modification may mitigate the transmission of respiratory droplets between individuals while coughing at night. There should be a dedicated surface wipe down and laundering of linens if applicable during change of shift as well.

Finally, the agency should consider modifying exercise routines for crews. These modifications may include activities that increase distance between individuals and decrease the use of equipment that is touched sequentially. For equipment that is necessary for exercise, implement hand sanitizing and surface disinfection between users.

COVID-19 presents public health challenges to many aspects of society. Its duration and human impact are thus far unknown. During this pandemic, essential work personnel will not be able to work remotely or perform many of the social distancing modifications recommended for other employees.

In a pandemic where most of the case clusters occur in households, the fire station may be at particular risk of transmission of COVID-19. This proposal provides potential modifications to station life which can mitigate the spread of COVID-19 among public safety personnel, and preserves their agencies' ability to fully staff stations to provide for community needs.

Address for Correspondence: Robert J. Katzer, MD, MBA, University of California, Irvine, Department of Emergency Medicine, 333 City Blvd. West, Suite 640, Orange, CA 92868. Email:rkatzer@hs.uci.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Guan W, Ni Z, Hu W, et al. [Print] Clinical Characteristics of Coronavirus Disease 2019 in China. *N Engl J Med.* 2020. In Press.
2. Huang C, Wang Y, Li W, et al. Clinical Features of Patients Infected with 2019 Novel Coronavirus in Wuhan, China. *Lancet.* 2020;395:497-506.
3. Li Q, Med M, Guan X, et al. Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus–Infected Pneumonia. *N Engl J Med.* 2020. In Press.
4. World Health Organization. Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19). 2020. Available at: https://www.who.int/docs/default-source/coronaviruse/who-china-joint-mission-on-covid-19-final-report.pdf. Accessed March 4, 2020.
5. Coronaviridae Study Group of the International Committee on Taxonomy of Viruses. The species Severe acute respiratory syndrome-related coronavirus: classifying 2019-nCoV and naming it SARS-CoV-2. *Nat Microbiol.* 2020. In Press.
6. World Health Organization. WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020. 2020. Available at: https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020. Accessed March 12, 2020.
7. del Rio C, Malani PN. COVID-19—New Insights on a Rapidly Changing Epidemic. *JAMA.* 2020. In Press.
8. Centers for Disease Control and Prevention. Keeping workplaces, homes, schools, or commercial establishments safe. 2020. Available at: https://www.cdc.gov/coronavirus/2019-ncov/. Accessed March 12, 2020.
9. City of Kirkland Official Site. Kirkland Fire Department Fully Staffed and Responding to All Calls. 2020. Available at: https://www.kirklandwa.gov/NewsRoom/Kirkland_Fire_Department_Fully_Staffed_and_Responding_to_all_Calls.htm. Accessed March 12, 2020.
10. Centers for Disease Control and Prevention. Disease Burden of Influenza. 2020. Available at: https://www.cdc.gov/flu/about/burden/index.html. Accessed March 12, 2020.
11. Biggerstaff M, Cauchemez S, Reed C et al. Estimates of the reproductive number for seasonal, pandemic, and zoonotic influenza: a systematic review of the literature. *BMC Infect Dis.* 2014;4(14):480.
12. Adams JG, Walls RM. Supporting the Health Care Workforce During the COVID-19 Global Epidemic. *JAMA.* 2020. In Press.
13. Ong SWX, Tan YK, Chia PY, et al. Air, Surface Environmental, and Personal Protective Equipment Contamination by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) From a Symptomatic Patient. *JAMA.* 2020. In Press.
14. Centers for Disease Control and Prevention. Interim Guidance for Businesses and Employers. 2019. Available at: https://www.cdc.gov/coronavirus/2019-ncov/community/guidance-business-response.html. Accessed March 12, 2020.
15. Department of Labor. Occupational Safety and Health Administration. Guidance on Preparing Workplaces for COVID-19. 2020. Available at: https://www.osha.gov/Publications/OSHA3990.pdf. Accessed March 12, 2020.
16. Centers for Disease Control and Prevention Interim Guidance for Businesses and Employers. 2020. Available at: https://www.cdc.gov/coronavirus/2019-ncov/community/organizations/cleaning-disinfection.htm. Accessed March 12, 2020.
17. United States Environmental Protection Agency. List N: Disinfectants for Use Against SARS-CoV-2. Availble at: https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2. Accessed March 12, 2020.
18. Centers for Disease Control and Prevention. Definitions of Signs, Symptoms, and Conditions of Ill Traveler. 2017. Available at: https://www.cdc.gov/quarantine/maritime/definitions-signs-symptoms-conditions-ill-travelers.html. Accessed March 12, 2020.

Human Trafficking in the Emergency Department: Improving Our Response to a Vulnerable Population

Jennifer Tiller, MD
Stacy Reynolds, MD
Levine Children's Hospital and Carolinas Medical Center, Department of Emergency Medicine, Division of Pediatric Emergency Medicine, Charlotte, North Carolina

Section Editor: Tony Zitek, MD
Submission history: Submitted November 19, 2018; Revision received December 10, 2019; Accepted January 27, 2020
Electronically published April 16, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.1.41690

Human trafficking is a human rights violation affecting millions worldwide. Victims may go unrecognized during their emergency department (ED) visit, and may lose the opportunity to address their complex needs. Using a published toolkit based on existing guidelines and recommendations from experts, and models from other centers, we describe the implementation of an ED response protocol. In following the recommendations of the toolkit, we began with attempts to fully understand the local human trafficking problem and then networked with those working in anti-trafficking efforts. Collaboration with other specialties is highlighted as a key part of this process. Building upon the knowledge gained from these steps, we were able to develop a concise protocol to guide members of our department in more effectively caring for known or suspected victims of human trafficking. The first section of the protocol addresses ways in which providers can identify at-risk patients through both screening questions and general observations. Interviewing techniques are outlined with an emphasis on patient-centered and trauma-informed care. Additionally, the protocol discusses physician responsibility in documenting encounters and legal reporting, which may vary depending on location. We stress the importance of meeting the needs of the patient while prioritizing the safety of all involved. Additionally, the protocol provides a list of resources for the patient beyond medical care such as emergency housing, legal assistance, and food pantries. The overall purpose of this protocol is to provide coordinated response so that all providers may be consistent in caring for this vulnerable population. [West J Emerg Med. 2020;21(3)549–554.]

INTRODUCTION

It is 1AM in a single coverage emergency department (ED) when a 17-year-old female presents with her boyfriend complaining of stomach pain. Her boyfriend states the patient "just needs a pregnancy test" and wants to know how long this will take. You note that the patient is withdrawn with a flat affect and looks to her boyfriend for approval before answering questions. You observe that the boyfriend has the patient's identification and states the bill can be sent to his address. He provides his email address and cell phone as her contact information. He interjects repeatedly to ask about the pregnancy test, stating they are in a hurry.

You ask to examine the patient alone and the boyfriend and patient reluctantly agree. You complete a focused exam, including a pelvic examination, while the patient continues a videotelephone conversation with her boyfriend. You ask the patient to end the phone conversation, so you can speak with her privately. She reports being sexually active with multiple partners. She denies drug use. She is not from the area and has difficulty explaining how she supports herself. It is unclear whether she has any support from her family or friends. You are concerned that she is being exploited but you are unsure how to address your concern about human trafficking. You diagnose the patient with cervicitis and treat her in the ED. The pregnancy test is negative. The boyfriend returns and appears relieved at the news, quickly shuttling the patient out the door. Although the healthcare team recognized the controlling relationship between the patient and her boyfriend and the unstable social situation, the team did not know how to address its

concern for possible human trafficking or what to do if she was verified as being a human trafficking victim.

Case background: This patient was actually 14 years old and had used a fake identification card. The "boyfriend" was actually 27 years old, and as her pimp he was anxious for her to get her back to work in sex trafficking. The physical exam occurred while the patient was clothed, and the physician did not see the cigarette burns along her bra line or the branding on her abdomen. She was a runaway and had been missing for over six months. Although a report was made to the child protective services agency after the ED encounter, the patient was not found.

The physician and nurses caring for the patient considered the possibility of human trafficking, but they did not know how to help the patient, how to broach the topic, or what resources were available to help her. The purpose of this article is to provide guidelines on the implementation of a human trafficking recognition and response program in the community hospital setting. The goals of the human trafficking program are to expertly assess the victims' safety as they are being cared for as patients, to provide both medical care and social resources for human trafficking victims, and to advocate for their rights.

According to United States (US) federal law, human trafficking includes 1) sex trafficking: the recruitment, harboring, transportation, provision, obtaining, soliciting, or patronizing of a person for the purpose of a commercial sex act using force, fraud, or coercion, OR involving a child younger than 18 years; or 2) labor trafficking: the recruitment, harboring, transportation, provision, or obtaining of a person for labor or services, through the use of force, fraud, or coercion for the purpose of subjection to involuntary servitude, peonage, debt bondage, or slavery.[1,2] Human trafficking includes a variety of offenses that range from domestic servitude to childhood survival sex, ie, children engaging in sexual activity in exchange for basic needs such as food and shelter. Approximately 20 million persons worldwide are victims of forced exploitation generating billions of dollars annually.[3-5] Research estimates that between 100,000-300,000 children under 18 years old are at risk for commercial sexual exploitation annually, with the average age of entry into sex work in the US of 12-14 and 11-13 years of age for girls and boys, respectively.[6,7]

Studies show that up to 88% of trafficked persons see a healthcare provider during their time in captivity.[8-10] Lederer and Wetzel surveyed over 100 survivors of domestic sex trafficking and found that 63% of survivors reported going to an ED while being trafficked.[9-11] Emergency physicians play a crucial role in serving the medical, psychiatric, and social needs of human trafficking survivors, as we are often their only access to medical care and resources. It is imperative to improve the recognition and response of the medical community to this vulnerable and underserved patient population.

Macias highlights the importance of trauma-informed, patient-centered care and how established policies and protocols can help physicians safely and appropriately respond to the complex healthcare needs of these patients.[4] A trauma-informed approach recognizes the impact of trauma throughout the life of a patient, recognizes signs and symptoms of trauma, and responds appropriately while focusing on minimizing retraumatization.[4,12] This approach is paramount for victims as it can lead to more positive interactions between healthcare providers and patients when providers have a better understanding of the effects of trauma on behavior and can help foster healing and recovery.[4]

The HEAL Trafficking and Hope for Justice Protocol Toolkit is a 44-page document developed in 2016 by experts in the field of human trafficking to guide providers in developing a human trafficking protocol.[13] The healtrafficking.org website provides comprehensive protocol resources, as well as examples of tools and documents such as the Vera Institute of Justice "Out of the Shadows" tool, the Children's Healthcare of Atlanta Institute on Healthcare and Human Trafficking guidelines, and the Dignity Health *Shared Learnings Manual*.[14-16] These extensive protocols all require integration with community and systems-wide stakeholders, which may not be initially possible in all facilities. Here, we share our experience in narrowing the HEAL Trafficking Protocol Toolkit to develop a feasible, initial human trafficking recognition-and-response protocol for a location that does not yet have significant resources and community or system buy-in.

This paper reviews some of the current human trafficking literature and describes the implementation of the HEAL Toolkit based on our experience at an academic, urban, county ED serving 85,000 patients per year with a dedicated children's ED serving 35,000 patients per year. At the time that we developed our protocol, faculty in our department did not have a set of tools or resources available to help recognize and assist this population, and there were no faculty members actively engaged in anti-human trafficking work as their primary niche. Our providers needed a guideline on how to address the needs of survivors.

Human Trafficking in North Carolina

In 2017 the National Human Trafficking Hotline ranked North Carolina as eighth in the country for number of calls to the hotline with a total of 854 calls and 221 confirmed cases of human trafficking; these numbers have been steadily increasing over the past five years.[17] Several factors contribute to the problem of human trafficking in North Carolina. First, its largest city Charlotte is home to several sports teams and hosts major sporting events. There has been a documented increase in human trafficking in US cities that host sporting events.[18] Secondly, Charlotte is a refugee resettlement city and a transportation hub, meaning there is a vulnerable population

and easy access to transport victims in and out of the area. Additionally, there are major businesses and tourism that result in a demand for sex work, including a large military presence with associated businesses that fuel sex trafficking and an agricultural community where vulnerable laborers can be easily hidden in rural areas while being exploited. There are an estimated 2200 homeless teenagers in the city of Charlotte; 33% are expected to have become victims of sexual exploitation within 48 hours of becoming homeless.[19]

STEPS FOR PROTOCOL DEVELOPMENT-HOW TO GET STARTED

The HEAL Trafficking and Hope for Justice Protocol Toolkit helps healthcare providers develop a consistent response.[13] The toolkit focuses on interacting with patients in a trauma-informed manner, which recognizes the impact of trauma on its victims and aims to avoid re-traumatization during interactions with these patients. The following paragraphs outline steps of protocol development.

Step One: Understand Human Trafficking and Health Generally and Locally

Ideally all stakeholders are knowledgeable about health and trafficking and the scope of this problem locally. The HEAL Trafficking Toolkit lists several resources for education and networking.[13] The National Human Trafficking Hotline can locate local service agencies where one can engage with individuals who regularly encounter victims of human trafficking.[17] Attending trainings such as those sponsored by law enforcement agencies and networking with people or groups involved in anti-trafficking work can help one to characterize the local trafficking patterns. Additionally, legal contacts can help clarify anti-trafficking and mandatory reporting laws in each state.

We invited the ED faculty, learners, and ancillary staff to attend a lecture led by a law enforcement agent specializing in human trafficking. The session focused on explaining the types of trafficking, understanding the psychology of victims, and identifying and interviewing suspected victims. The agent discussed how to communicate with potential victims by using and understanding the language common within this lifestyle. For example, women involved in sex trafficking often refer to their trafficker as "boyfriend" or "daddy" and may refer to other women under the same man as "wifey." The patient may refer to "turning a trick," which is a term used to describe a sexual act for which payment is received.

Step Two: Understand How Survivors Gain Assistance from Non-Medical Stakeholders in the Community

The HEAL Toolkit recommends creating a database of local multidisciplinary responders and lists several resources.[13] Victims may need assistance with a variety of non-medical issues such as housing, counseling, legal services, and more. The National Human Trafficking Hotline (888-373-7888 or text "HELP" to 233733) can help in locating community-based, non-medical stakeholders.[17] Our team located local anti-trafficking agencies, legal service providers and translation services, as well as housing and substance abuse resources. We collaborated with the leader of the domestic violence advocacy program in our hospital, a social worker, as well as a local law enforcement victim advocate. These contacts proved invaluable for our protocol development.

Step Three: Organize the Medical Community to Provide a Safety Net for Survivors

The medical needs of human trafficking survivors will extend beyond the scope of the ED and include substance abuse and other mental health disorders, infections, reproductive health issues, injuries, and more.[3,4,21,22] Individuals who specialize in these areas can add to the protocol, and also help create a multidisciplinary referral program. In the interest of a timely protocol roll-out, our team did not initially create an internal multidisciplinary treatment team. However, approximately six months later we did develop a team that includes a listserv of 45 individuals from multiple specialties.

Step Four: Create and Convene an Interdisciplinary Protocol Committee

The authors of the HEAL Trafficking Toolkit recommend creating a committee comprised of both medical and non-medical stakeholders who will meet regularly to plan, implement, and revise the protocol.[13] This should be an ongoing process as knowledge and service gaps are revealed and resource availability fluctuates. The evidence behind hospital protocols is limited, as this is an area that requires more research. This consensus-based recommendation has been implemented by individuals and organizations such as Dignity Health that are highly involved in anti-trafficking work.[16] At the inception of planning and creating our protocol, only a few other specialties were involved. We learned that making this a truly collaborative approach from the start would have likely yielded more interest and participation in the project.

PROTOCOL COMPONENTS

After following the steps for protocol development as outlined by the HEAL Trafficking Toolkit and gathering all the necessary resources, it is important that the following components are incorporated into the protocol.[13]

Identifying Patients at Risk for Trafficking

There are currently no validated screening tools for use in the ED. Greenbaum, Shandro and several other experts in the field have published a variety of screening questions to identify persons involved in human trafficking. We adapted

our screening questions from this published data, focused on both labor and sex trafficking.[3,8,21,22] Victims and survivors are unlikely to self-identify. Therefore, one must commit to a criterion such as a positive answer to one of the screening questions, or any observed risk factors, that will trigger the healthcare team to do an in-depth screening.[3,20,21]

Each facility must determine how to identify their at-risk patients. Options for screening include observational screening, direct screening, or engaging those who self-identify. Our protocol lists "red flag" signs and symptoms recognizable through passive observation by anyone in contact with the patient, as well as specific indicators to look for during the medical assessment. These factors are highlighted in the Table, adapted from the Polaris Project.[17] The Polaris Project is an anti-trafficking organization whose goal is to help trafficking victims and survivors, and pursue and prosecute traffickers.

Although our initial plan was to screen all patients during the triage process, we were unable to get the necessary agreement from nursing to implement this protocol. Currently we implement a focused screening based on observed risk factors. Patients who demonstrate red flags from the Table are questioned further to determine whether they are at risk for trafficking. If so, the treating physician activates the protocol.

Interviewing High-Risk Patients

Providers should realize that victims of trauma, such as human trafficking survivors, may have emotional, physical, or cognitive reactions such as dissociation or depersonalization. These reactions may impede one's ability to communicate effectively regarding the victim's trauma.[23] The goal is to establish trust and prevent re-traumatization. Avoid multiple interviewers or focusing on traumatic details that will not affect immediate care. Despite good intentions, excessive questioning by a physician, often in the setting of invasive exams or procedures, can exacerbate traumatic stress. Research has demonstrated that retraumatization may decrease the likelihood of patients achieving good health, adopting healthy behaviors, and returning for help.[12]

Interviewing the patient alone is ideal.[3,13,21] Traffickers often accompany their victims, portraying themselves as friends or family, prohibiting the patient from asking for help.[3,4,13,22] For minors, one can involve law enforcement and separate the victim from the trafficker if other methods of separation fail. For adults, providers can work with patients to determine whether forceful separation is a safe option, as a threatened trafficker may hinder the victim's ability to return for help.[13] It is also important to note that for patients who

Table. Red Flag Indicators of Potential Human Trafficking.[17]

Poor Mental Health or Abnormal Behavior:
The individual(s) in question:

- Is fearful, anxious, depressed, submissive, tense, or nervous/paranoid
- Exhibits unusually fearful or anxious behavior after bringing up law enforcement
- Avoids eye contact

Poor Physical Health:
The individual(s) in question:

- Lacks health care
- Appears malnourished
- Shows signs of physical and/or sexual abuse, physical restraint, confinement, or torture

Lack of Control:
The individual(s) in question:

- Has few or no personal possessions
- Is not in control of his/her own money, no financial records, or bank account
- Is not in control of his/her own identification documents (ID or passport)
- Is not allowed or able to speak for themselves (a third party may insist on being present and/or translating)

Common Work and Living Conditions:
The individual(s) in question:

- Is not free to leave or come and go as he/she wishes
- Is under 18 and is providing commercial sex acts
- Is in the commercial sex industry and has a pimp/manager
- Is unpaid, paid very little, or paid only through tips
- Works excessively long and/or unusual hours
- Is not allowed breaks or suffers under unusual restrictions at work
- Owes a large debt and is unable to pay it off
- Was recruited through false promises concerning the nature and conditions of his/her work
- High security measures exist in the work and/or living locations (e.g., opaque windows, boarded up windows, bars on windows, barbed wire, security cameras, etc.)

Other:
The individual(s) in question:

- Claims of just visiting and inability to clarify where he/she is staying/address
- Lack of knowledge of whereabouts and/or do not know what city he/she is in
- Loss of sense of time
- Has numerous inconsistencies in his/her story

speak a foreign language, the provider should only use official interpreters to communicate with the patient.[3,13,21]

Currently at our institution, the provider interviews the patient. Suspected victims are interviewed alone, by as few individuals as possible. We encourage providers to mirror the language the victim uses in his or her self-identification, to maintain a non-judgmental tone, and to minimize questioning the patient about specific details of encounters that will not affect medical management. Our protocol prohibits use of companions as translators if one is suspicious of human trafficking, as it is possible that the companion is involved in their exploitation.

Safety Considerations

Safety is a major consideration when working with victims of human trafficking, as traffickers want to avoid prosecution and may threaten or harm victims who are attempting to escape. The HEAL Trafficking protocol recommends involving hospital security in human trafficking trainings given the criminal element involved in trafficking.[13]

We focused mainly on how to address the immediate safety and security of our patients and staff. When a known or suspected victim of human trafficking presents, our registration team is instructed to have the patient listed under an alias, and staff is made aware that this patient is potentially in danger. Our physicians are encouraged to call upon our security officers if there is a direct threat. Additionally, we have the option of placing our ED on lockdown if a patient is in imminent danger and notifying the local police. We recommend patients turn off cell phones to limit contact with his or her controller and prevent location tracking. Despite our recommendations, providers need to collaborate with the patient to ensure that we are not jeopardizing safety with our efforts to intervene.

Procedures for External Reporting

The HEAL Trafficking Protocol focuses on creating procedures for reporting that honor mandatory reporting laws, the Health Insurance Portability and Accountability Act (HIPAA), and autonomy for adult patients.[13] In several states, trafficked persons can be prosecuted for crimes committed during their captivity. Involving law enforcement against the will of an adult patient when not legally mandated may violate HIPAA and result in unintended legal consequences, as well as a breach of trust between patient and physician.[21] In North Carolina, healthcare providers are mandatory reporters for minors under the age of 18 suspected of being victims of human trafficking and this is reflected in our protocol. We encourage providers to involve the patient in the process and advise him or her of the agencies that will be notified. Anyone involved in a minor's care who has suspicions of trafficking or abuse can make a report.

Strategies for Responding to Patients Who Decline Assistance

Protocols should have resources for high-risk minors who do not meet any criteria for legal involvement, or adults who decline assistance. Patients should not be pressured; instead, they should be offered resources, such as the National Human Trafficking Hotline Number.[17] Information should be given in a discreet manner that can be hidden if necessary.[21] We compiled a list of external resources to address potential issues including legal and immigration assistance, housing, food insecurity, and substance abuse. We encourage our team to ask survivors what assistance they want, as they may decline help initially, return to their situations repeatedly, and only later be ready to exit permanently.[13]

Procedures Regarding Documentation

Documentation in the medical record can have legal ramifications, and guidelines should be created in consultation with legal experts.[13] Most trafficked persons experience some degree of violence while being trafficked.[5] Given the complex nature of trauma, survivors often suppress memories or withhold information.[23] These factors can lead to accounts of events changing over time, which may negatively impact legal credibility. We were advised not to alter our patient interview or documentation with potential legal consequences in mind and would encourage the reader to consult with their institution's legal team.

Guidelines for Forensic Examination

Protocols should outline the details of the interviewing, examination, and documentation process for the forensic examination.[13] Our facility has sexual assault nurse examiners (SANE) on call, who are responsible for the forensic examination and evidence collection. Any patient who has experienced sexual assault within 72 hours of presentation should be offered a SANE exam. Physicians are encouraged to participate in the examination and questioning by the SANE nurse to minimize retraumatization.

CONCLUSION

Sustainable Change: How to Maintain Momentum and Improve the Consistency of Care

It is crucial that emergency physicians be educated on how to identify victims and how to address their unique set of medical and social needs. We felt that having a protocol in place would be best to ensure that survivors and at-risk patients are treated appropriately and in a standardized manner regardless of the experience of the provider.

We are currently expanding our task force and our response to add medical treatment protocols and measures to make our response trauma-informed and unique to this patient population. Ideally, we will ultimately have a protocol and an extensive treatment and referral plan to meet the needs of all survivors.

Address for Correspondence: Jennifer Tiller, MD, UT Southwestern Medical Center, Department of Pediatrics, Department of Emergency Medicine, 5323 Harry Hines Blvd., Dallas, TX 75390. Email: jennifer.tiller@utsouthwestern.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. United States Government. Trafficking Victims Protection Act of 2000. Pub L No 106-386 Division A 103(8).
2. United States Government. Justice for Victims of Trafficking Act of 2015.
3. Becker HJ, Bechtel K. Recognizing victims of human trafficking in the pediatric emergency department. *Pediatr Emerg Care*. 2015;31(2):144-7.
4. Macias-Konstantopoulos W. Human trafficking: the role of medicine in interrupting the cycle of abuse and violence. *Ann Intern Med*. 2016;165(8):582-8.
5. International Labour Organization. Profits and Poverty: The Economics of Forced Labour. May 20, 2014.
6. National Council of Juvenile and Family Court Judges, National Center for Missing & Exploited Children. Missing Children, State Care, and Child Sex Trafficking: Engaging the Judiciary in Building a Collaborative Response. Published 2014. Available at: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwjnhbDgxannAhUrgK0KHYSEC8YQFjAAegQIAxAB&url=https%3A%2F%2Fwww.missingkidsorg%2Fcontent%2Fdam%2Fmissingkids%2Fpdfs%2Fpublications%2Fmissingchildrenstatecare.pdf&usg=AOvVaw08-CeOh7DGgWbFjJG1VOo4. Accessed November 6, 2018.
7. Estes RJ, Weiner NA. *The Commercial Sexual Exploitation of Children in the US, Canada and Mexico*. Philadelphia, PA: University of Pennsylvania School of Social Work. 2001.
8. Greenbaum VJ, Dodd M, Mccracken C. A short screening tool to identify victims of child sex trafficking in the health care setting. *Pediatr Emerg Care*. 2018;34(1):33-7.
9. Lederer L, Wetzel C. The health consequences of sex trafficking and their implications for identifying victims in healthcare facilities. *Ann Health Law.* 2014;(23):61-91.
10. Family Violence Prevention Fund; World Childhood Foundation. *Turning Pain Into Power: Trafficking Survivors' Perspectives on Early Intervention Strategies*. San Francisco, CA: Family Violence Prevention Fund; 2005. Published October 2005. Available at: https://www.futureswithoutviolence.org/userfiles/file/ImmigrantWomen/Turning%20Pain%20intoPower.pdf. Accessed January 23, 2018.
11. Armstrong S. Instruments to identify commercially sexually exploited children. *Pediatr Emerg Care*. 2017;33(12):794-9.
12. Substance Abuse and Mental Health Services Administration. SAMHSA's Concept of Trauma and Guidance for a Trauma-Informed Approach. HHS Publication No. (SMA) 14-4884. Rockville, MD: Substance Abuse and Mental Health Services Administration, 2014.
13. Protocol Toolkit for Developing a Response to Victims of Human Trafficking in Healthcare Settings. Heal Trafficking. Available at: https://healtrafficking.org. Accessed February 16, 2017.
14. National Institute of Justice, A screening tool for identifying trafficking victims. 2014. Available at: http://nij.gov/topics/crime/human-trafficking/Pages/screening-tool-for-identifying-human-trafficking-vicitms.aspx. Accessed January 23, 2018.
15. Clinical Practice Guideline for Assessment and Treatment of Potential Victims of Child Sex Trafficking and Commercial Sexual Exploitation (CSEC) ≥ 11yrs old. Children's Healthcare of Atlanta. 2015. Available at: https://healtrafficking.org/wp-content/uploads/2018/02/Child-Sex-Trafficking-FINAL-published-guideline-may-28-2015.pdf. Accessed August 10, 2018.
16. Dignity Health. *Human Trafficking Response Program Shared Learnings Manual*. 2017. Available at: https://www.dignityhealth.org/-/media/cm/media/documents/Human-Trafficking/Dignity Health_HTRP_SharedLearningsManual_170512.ashx. Accessed November 9, 2018.
17. National Human Trafficking Hotline. Polaris Project. Available at: https://humantraffickinghotline.org. Accessed December 5, 2017
18. Latonero M, Berhane G, Hernandez A, et al. Human trafficking online: the role of social networking sites and online classifieds. University of Southern California: USC Annenberg Center on Communication Leadership & Policy. 2011.
19. What is human trafficking? Lily Pad Haven: Charlotte, NC. Available at: http://lilypad-haven.org/what-is-human-trafficking. Accessed January 22, 2018.
20. Fang S, Coverdale J, Nguyen P, et al. Tattoo recognition in screening for victims of human trafficking. *J Nerv Ment Dis*. 2018;206(10):824-7.
21. Shandro J, Chisolm-Straker M, Duber HC, et al. Human trafficking: a guide to identification and approach for the emergency physician. *Ann Emerg Med*. 2016;68(4):501-8.
22. Greenbaum J. Identifying victims of human trafficking in the emergency department. *Clin Pediatr Emerg Med*. 2016;17(4):241-8.
23. Substance Abuse and Mental Health Services Administration. Trauma-Informed Care in Behavioral Health Services. Treatment Improvement Protocol (TIP) Series 57. HHS Publication No. (SMA) 13-4801. Rockville, MD: Substance Abuse and Mental Health Services Administration, 2014.

Wellness: Combating Burnout and Its Consequences in Emergency Medicine

Christine R. Stehman, MD*
Ryan L. Clark, DO†
Andrea Purpura, MD*
Adam R. Kellogg, MD†

*Indiana University School of Medicine, Department of Emergency Medicine, Indianapolis, Indiana
†University of Massachusetts Medical School – Baystate Health, Department of Emergency Medicine, Springfield, Massachusetts

Section Editor: John Burkhardt, MD
Submission history: Submitted September 17, 2018; Revision received December 11, 2019; Accepted January 10, 2020
Electronically published April 13, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.1.40971

Medicine recognizes burnout as a threat to quality patient care and physician quality of life. This issue exists throughout medicine but is notably prevalent in emergency medicine (EM). Because the concept of "wellness" lacks a clear definition, attempts at ameliorating burnout that focus on achieving wellness make success difficult to achieve and measure. Recent work within the wellness literature suggests that the end goal should be to achieve a culture of wellness by addressing all aspects of the physician's environment. A review of the available literature on burnout and wellness interventions in all medical specialties reveals that interventions focusing on individual physicians have varying levels of success. Efforts to compare these interventions are hampered by a lack of consistent endpoints. Studies with consistent endpoints do not demonstrate clear benefits of achieving them because improving scores on various scales may not equate to improvement in quality of care or physician quality of life. Successful interventions have uncertain, long-term effects. Outside of EM, the most successful interventions focus on changes to systems rather than to individual physicians. Within EM, the number of well-structured interventions that have been studied is limited. Future work to achieve the desired culture of wellness within EM requires establishment of a consistent endpoint that serves as a surrogate for clinical significance, addressing contributors to burnout at all levels, and integrating successful interventions into the fabric of EM. [West J Emerg Med. 2020;21(2)555-565.]

INTRODUCTION

In part one of this two-part series, we explored burnout – its definitions, causes, and consequences – with a specific focus on burnout in emergency medicine (EM).[1] To begin to address burnout, we must understand the end goal, which for many is the opposite of burnout, the nebulous construct of wellness.

The National Wellness Institute (NWI) defines wellness as "an active process through which people become aware of, and make choices toward, a more successful existence."[2] Developed in 1976, this is probably the most frequently used wellness paradigm; however, wellness models involve all aspects of a person's life, their environment, and surrounding community (Appendix 1). Recent research confirms that the domains used by the NWI offer guidance on improving and promoting *personal* wellness.[3-5] But personal wellness, the sole focus of the NWI and many wellness models, is just one part of a physician's life. As evidenced by the contributors to burnout described in part one of this series, including clinical pressures, shift work, and electronic health records (EHR), physicians operate in an organizational structure that may either enhance or degrade their personal and professional wellness.[1]

Multiple experts define wellness in medicine similarly to the World Health Organization (WHO) definition of health ("a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity").[6] Bart et al, in their systematic review of wellness literature in clinical medicine, showed that the current working definition of wellness revolves around the WHO definition and the 1998 Wheel of Wellness.[7-8] However, these authors and others agree that the term wellness in clinical medicine "lacks a singular definition."[7,9-10]

The ideal model for physician wellness should include both individual factors and the organizational structure and environment in which physicians work. Three such models exist: Stanford's WellMD Initiative; the Mayo Clinic's

Engagement Model; and the National Academy of Medicine (NAM) conceptual model of Clinician Well-being and Resilience (Table 1).[11-14] These models describe a complex interplay of personal and organizational factors, suggesting that interventions to combat burnout must address both factors surrounding the physicians *and* perceived physician shortcomings.

Developers of burnout interventions must be able to determine the success or failure of the intervention. Eckleberry-Hunt et al suggest measuring wellness rather than burnout to avoid the negativity associated with the term burnout and promote the positive aspects of achieving wellness.[10] While many wellness scales have been used in the physician population, these measures have not been evaluated as extensively as burnout scales such as the Maslach Burnout Inventory (MBI). Few show associations between improving scores and improving clinical outcomes (eg, fewer perceived medical errors), making it difficult to determine which interventions have clinical significance.[9,15]

We examine what has been done to address physician well being in general, as well as specifically in EM, and highlight the interventions showing a clinical improvement associated with their measurements. We then describe what the future interventions tailored to EM should be, as we endeavor to improve the culture, environment and overall well being of EM as a whole.

METHODS

Keywords

For this study we chose to combine words from three different categories to find interventions aimed at improving wellness/combating burnout: 1) words reflecting what was done – intervention, therapy, treatment, solutions; 2) words describing the problem being addressed – burnout, wellness, well-being, resilience, compassion fatigue, as well as specific contributors to burnout/lack of well being in EM (electronic health records [EHR], sleep, fatigue, shift work, shift work sleep disorder, second victim syndrome, litigation stress, financial stress, debt); and 3) relevant population keywords – physicians, medical students, residents. The term "emergency medicine" was added to find EM-specific literature.

Search

We searched all combinations of the three categories of keywords ("what was done" + "problem" + "population") from 1974 to the present in both Ovid Medline and PubMed. We also searched EM and critical care blogs for relevant articles/posts.

Article Inclusion Criteria

We categorized all search results into primary studies, meta-analyses/systematic reviews, commentary/opinion pieces, and general review articles. Primary research studies as well as the meta-analyses/systematic reviews, inclusive of their relevant references, provided the database of supporting information for the composition of this review. Additionally, we attempted to identify the primary literature for all Internet-based resources.

RESULTS

Interventions aimed at promoting well being and ameliorating burnout abound in all specialties, mostly focusing on person-directed interventions such as teaching mindfulness and improving resilience. Table 2 details the systematic reviews/meta-analyses of the extensive number of articles available. All interventions included in these articles focused on changes in the scores on various burnout/depression scales, usually the MBI. In general, the systematic reviews/meta-analyses confirm previous research: interventions appear to make small but statistically significant reductions in emotional exhaustion, burnout, and stress. A few of these articles specifically conclude that organization-level interventions impact physician scores as much as, if not more than, the person-based interventions and should be included in any intervention program.[16,19-20]

Fewer intervention studies have been published in EM (Table 3). These interventions focus on changes in scores on scales such as the MBI and have mixed results. Because the literature is so sparse in this area, we also included interventions in any discipline focusing on the specific contributors to EM burnout described in part one of this series (the EHR, sleep deprivation/fatigue/shift work, metrics/clinical pressures, second victim syndrome, litigation stress, and financial stressors).[1] Table 4 details the results of these searches. Again, there are limited targeted interventions applicable to EM.

DISCUSSION

Organizations have tried multiple types of interventions to improve wellness and combat burnout, often focusing on how individual physicians can improve their circumstances. These interventions serve to improve scores on various burnout and well-being scales, and, in some cases, showed improvement in quality of care measures (Tables 2 and 3).

For example, Braun et al. found that mindfulness-based interventions trended towards improvements in self-reported patient care, patient-centered care, patient satisfaction, and patient symptomatology.[25] Unfortunately, it is hard to extrapolate how these interventions might affect emergency physicians (EPs) since all those interventions centered on mental health professionals. One mindfulness-based intervention has been tried on students rotating through the emergency department (ED). Chung et al found self-reported, improved behaviors and attitudes in the students who experienced the curriculum.[28] This intervention, like many of the non-EM studies, was short term, which means it is uncertain how long, if at all, the results last.

The improvements in burnout and wellness scores seen in these and other studies show that this focus on person-based

Table 1. Models of wellness most applicable to emergency medicine.

Model	Definition of Well-being	Components
Stanford Wellness Framework[11-12]	Physician wellness = Professional fulfillment (experience happiness or meaningfulness, self-worth, self-efficacy, and satisfaction at work).	Culture of Wellness: behaviors, attitudes and values that promote self-care and growth (organizational responsibility). Efficiency of Practice: value of clinical practice/(time and energy spent); organizational responsibility. Personal Resilience: personal skills, behaviors and attitudes that contribute to personal well-being (personal obligation).
Mayo Clinic Engagement Model[13]	Defines the opposite of burnout as engagement (vigor, dedication and absorption in work)	Workload and Job Demands: eg, specialty, team structure, compensation, and all metrics. Efficiency and Resources: eg, personal, team and institutional efficiency, personal organization and delegation skills, EHR. Meaning in work: eg, opportunities for advancement, organizational culture, personal values, physician-patient relationship. Organizational Culture and Values: eg, physician's personal and professional values; organization's mission, norms, culture and values. Control and Flexibility: eg, physician personality/intentionality and organization's degree of flexibility on a number of issues. Social Support and Community at Work: eg, physician's relationship building skills, team structure, organizational collegiality, and promotion of community. Work-life Integration: eg, physician values and personal characteristics, organizational expectations, and requirements for call and cross-coverage.
National Academy of Medicine Conceptual Model[14]	Clinician well being is a multidisciplinary issue that requires a systems-thinking approach to address fully.	Health Care Role: eg, stage in career, patient population, all responsibilities, and alignment of authority and responsibility. Personal Factors: eg, values, personality traits, social support, and physical/mental/spiritual health. Skills and Abilities: eg, teamwork, resilience, coping skills, empathy and leadership skills. Socio-cultural Factors: eg, societal expectations of physicians, political and economic climate, mental health stigmatization, social determinants of health, culture of safety, implicit and explicit biases. Regulatory, Business, and Payer Environment: eg, compensation, documentation requirements, licensing, litigation risk, insurance company policies. Organizational Factors: eg, organizational culture, mission, leadership and values; bureaucracy, diversity and inclusion, level of organizational support, professional development. Learning and Practice Environment: eg, autonomy, relationships, mentorship, EHR, learning, practice setting and environment.

Table 2. Systematic reviews of general physician interventions for burnout and wellness.

Author	Year	Number of studies included	Population	Scales/Endpoints	Determination/Conclusion
Wiederhold[16]	2018	13	Physicians	MBI	Develop interventions at the personal and institutional levels.
Busireddy[17]	2017	19	Residents	MBI	ACGME work hour limits decreases emotional exhaustion and burnout.
Clough[18]	2017	23	Physicians	MBI and a variety of stress scales	Occupational stress and burnout helped by cognitive and behavioral interventions.
Panagiotti[19]	2017	19	Physicians	MBI	Small but significant decreases in emotional exhaustion; with larger effect from organizational interventions.
West[20]	2016	42	Physicians	MBI	Individualized and organizational interventions decreased burnout.
Burton[21]	2016	9	Health care professionals (5 studies included physicians)	Variety of measures of stress	Mindfulness-based Interventions decrease stress.
Williams[22]	2014	19	Medical students and residents	Multiple measures of burnout, depression, and suicide rates	Varied results.
Regehr[23]	2014	12	Medical students and Physicians	Variety of burnout, stress, and anxiety scales	Cognitive, behavioral, and mindfulness-based approaches reduce stress.
Awa[24]	2010	25	Health care providers (one physicians only)	Burnout measures, primarily MBI	Greatest and most lasting reductions in burnout were associated with combination of person- and organization-directed interventions.
Braun[25]	2018	26	Health care providers (one physician only)	Various patient care related outcomes such as patient care, patient satisfaction and safety	"There is great potential for [Mindfulness-based interventions] to improve [healthcare provider] functioning and therefore patient care."

MBI, Maslach Burnout Inventory; *ACGME*, Accreditation Council for Graduate Medical Education.

Table 3. Burnout and wellness interventions in emergency medicine.

Author	Year	Description of Intervention	Scale used, if any	Results (positive, negative, change in scale)
Hart[26]	2019	Corporate wellness program	MBI	Didn't like the intervention, worsened burnout
Braganza[27]	2018	Mindfulness workshop with ongoing activities	K10-Psychological distress; MBI	K-10 score decreased significantly; no change in MBI
Chung[28]	2018	Mindfulness curriculum medical students on EM rotation	Behaviors and attitudes (self-reported)	Improved
Schrager[29]	2017	Wearable physical activity trackers	Days per week of physical activity	Increase only among those with low pre-intervention levels
Williamson[30]	2017	Implemented a wellness curriculum at 5 residencies, including lectures, individual activities, and resources	None (descriptive)	Implementation was feasible
Mache[31]	2016	Mental health promotion program for junior Emergency Physicians	Variety of measures including MBI and Perceived Stress Questionnaire	Decreased perceived stress and emotional exhaustion
Gorgas[32]	2015	Emotional Intelligence training for EM residents	Hay 360 Emotional Competency Inventory	Increased EI scores

MBI, Maslach Burnout Inventory; *EM*, emergency medicine; *EI*, emotional intelligence.

Table 4. Interventions for known contributors to burnout in emergency medicine.

Author	Year	Area of Intervention	Discipline	Description of Intervention	Scale used, if any	Results (positive, negative change in scale)
Walker[33]	2019	EHR	EM	Scribe program implementation in 5 EDs	Patients per hour	Increased physicians' productivity.
Chung[34]	2018	SVS	EM	Educator toolkit for addressing SVS via mindfulness	None	None
Smith[35]	2016	Litigation	EM	Effect of adding empathetic statements to patient encounters on likelihood to consider litigation	Likelihood of suing a doctor for a misdiagnosis on VAS	Decreased likelihood of suing.
Smith-Coggins[36]	2006	Sleep/Fatigue	EM	Effect of nap at 3 AM on task performance and alertness	Variety of task completion, fatigue, and memory scales; driving simulation	Overall improvement, except brief decrease in memory immediately after the nap.
Croskerry[37]	2002	Sleep/Fatigue/Shift work	EM	Implemented Casino Nights (night shift ending at 0400)	Preference compared to standard night shift and amount of sleep	Casino shift preferred; increased sleep.
Shanafelt[13]	2017	General	General	Collection of organizational interventions implemented by the Mayo Clinic	MBI	7% decrease in burnout.
West[38]	2014	General	Internal Medicine	RCT of effect of a physician facilitated small group curriculum on well-being	MBI and sub-scales	Decreased rates of depersonalization, emotional exhaustion, and overall burnout.
Contratto[39]	2017	EHR	General IM (7 physicians)	Clerical support personnel for EPOE	Attitudes, satisfaction with EHR, productivity	Felt more supported, less fatigued.
Robinson[40]	2018	EHR	3500 physicians	EHR trainings	mixed -methods	Improved documentation, fewer medical errors, increased chart efficiency.
Liira[41]	2014	Sleep loss	Night shift workers	Systematic review of pharmacologic interventions to improve sleep and alertness on shift	Sleep length; the Karolinka Sleepiness Scale	Melatonin increases sleep length; Modafinil and Armodafinil improve alertness.
Linzer[42]	2015	Clinical Pressures	Primary Care	Diverse interventions in communication, workflow changes, and targeted quality improvement projects that included clinician input	5 item burnout scale; satisfaction; intention to leave in 2 years	Decreased burnout and improved satisfaction but no change in intention to leave.
Ey[43]	2016	SVS	General	Comprehensive wellness and suicide prevention program in a health system	Utilization by residents and faculty; satisfaction of trainees and program directors	Progressively increased utilization. High levels of satisfaction.

EHR, electronic health records; *EM*, emergency medicine; *ED*, emergency department; *SVS*, second victim syndrome; *VAS*, visual analog scale; *MBI*, Maslach Burnout Inventory; *RCT*, Randomized Controlled Trial; *IM*, internal medicine; *EPOE*, electronic provider order entry.

Table 4. Continued.

Author	Year	Area of Intervention	Discipline	Description of Intervention	Scale used, if any	Results (positive, negative change in scale)
Miller[44]	2019	SVS	Included 15 articles on interventions	Systematic review of SVS that included mindfulness interventions	Variety of stress and burnout scales	Improvement
Scott[45]	2010	SVS	General	Creation of a systemwide rapid response team for SVS with a multi-tiered deployment model	None	Feasible
Durand[46]	2015	Litigation stress	General	Systematic review of SDM on likelihood of malpractice claims	Varied by study	Some studies showed evidence for benefit with SDM, though provider preference was increased testing

SVS, second victim syndrome; *VAS*, visual analog scale; *SDM,* shared decision-making.

interventions remains important. Self-care and individual mindsets influence how differently people are affected by their environment, leading to variable development of burnout among physicians working under the same circumstances. Unfortunately (but possibly correctly), physicians tend to infer that the default to person-based interventions places the blame for burnout and the associated consequences solely on the physician.[47-48] In addition, years of these person-based interventions have demonstrated little to no improvement in the overall burnout levels of physicians,[49-50] indicating that person-based interventions are necessary but insufficient to fully address the problem.

The perception of many physicians, as supported by studies discussed in part one of this series, is that the key contributors to burnout lie outside of individual physician control.[1,13,50-55] The developers of the NAM Conceptual Model of Wellness highlight the influence that organizational, systemic, environmental, and societal issues have on burnout and suggest that attention must be paid to these details to truly have a long-term effect on this issue.[14]

Some organizations have started to implement interventions aimed at fixing such system and organizational issues. While data from these interventions is limited, they seem to have a more profound improvement on burnout scores than person-based interventions. Shanafelt et al details the improvements seen across the board with the implementation of such changes.[13] While none of these interventions took place explicitly in EM, they support the need for organizations and society as a whole to recognize their role in contributing to physician burnout in all specialties. In addition, organizations and societies will need to do more than be supportive of physician well being if their goal is to alleviate the problem of burnout.

When it comes to burnout and well being, EM is unique in a number of ways. EPS work fewer hours than physicians in most other specialties (a primary contributor to burnout in general) and their job satisfaction is frequently high despite high levels of burnout.[50,56] This uniqueness may limit how successful interventions in other specialties will apply to EPs. Because of the need to account for the seemingly contradictory facets of EM when considering interventions, studies need to be done with EPs. This has rarely been done. The interventions studied in EM tend to focus on person-based interventions and have had mixed results: Some show improvement in the varied endpoints chosen while others do not.

Other studies of EPs focus on interventions affecting the contributors to burnout in EM. These interventions examined a variety of endpoints with some subsequent improvement, although it is hard to understand how these changes affect burnout and wellness as changes to scales in these domains were rarely examined (Table 4).

There are two issues with all the studies regarding wellness and burnout interventions, both within EM and other specialties. First, each study involves an intervention lasting no longer than a year with limited post-intervention follow-up. The lack of long-term follow-up means that there is uncertainty about whether the changes, positive or negative, persist after the end of the intervention. If there is no lasting change from the intervention, then the intervention may end up being harmful as it created a false sense of improvement. The second, and probably more concerning, difficulty with these studies is that few interventions actually take the results a step further and evaluate more than just scores on various wellness and burnout scales. While research shows that physicians suffering from burnout provide worse patient care in multiple ways, no intervention studies have examined whether improvement in those scales after the intervention is associated with improved quality of care.[57-60]

Some of the mindfulness-based interventions studies reviewed by Braun et al suggest that these interventions improve patient care; however, they do not have associated changes in burnout or wellness scores for other studies to

compare with.[25] Robinson et a. evaluated the effect of EHR training on a large number of physicians and found fewer medical errors.[40] The authors drew the conclusion that improved interface with the EHR may improve burnout by decreasing the time spent with the computer rather than the patient, but they also did not check before and after scores on any of the burnout or well-being scales.[40] While statistically significant improvements in burnout and well-being scales are considered to be appropriate surrogates for the problem facing physicians, no one has yet shown actual clinical significance in these changes.

The development of the NAM Conceptual Model of Wellness, as well as the apparent successes at both Mayo and Stanford based on organizational changes, reinforces that improving physician well being/combating burnout will require the establishment of a culture of wellness.[11-14] A culture of wellness, defined by Stanford as "a work environment with a set of normative values, attitudes and behaviors that promote self-care, personal and professional growth, and compassion for colleagues, patients and self," is probably a distant goal for EM.[11] Before we as EPs can establish what values, attitudes, and behaviors would serve us best, we must determine a number of other things in the realm of physician well-being.

Measuring the Problem and Outcomes

Lall et al describe the numerous burnout and well-being scales previously used to assess physicians, and that are available for use in evaluating interventions.[9,61] They also describe the downsides of these scales and allude to the bigger problem: We do not yet know which is the most appropriate scale for use in EM.[9,61] Should we be highlighting the issue by using a burnout scale? While the most widely used "default" burnout scale is simple to use, there are a number of issues with how the MBI and other burnout measures are being used, as described by Eckleberry-Hunt et al.[62] In addition, knowing that a study is evaluating burnout risks may alter the participants' responses, as this term (along with wellness) has been used so frequently that many people are "sick of it."[62-63]

Should we instead be seeking the "bright spots" (people in high-risk environments who are thriving) by using a well-being scale?[64] Given how pervasive burnout seems to be in EM (ranging from 38% to as high as 74%), seeking the "bright spots" within the specialty would allow investigators to focus on the positive.[65-66] In addition, finding out what "bright spots" do differently may lead EPs to possible interventions that have not yet been considered.

Clinical Significance

Investigators need to determine whether changes in potential scales actually tie to clinically significant outcomes. Everything being done to treat the problem of burnout is because both physicians and patients are suffering.[49,53,57-60,67-69] It is not enough that interventions change burnout or wellness scores. Ultimately, they must improve physician quality of life and the quality of patient care provided; otherwise, investigators are either using the wrong surrogate for the problem or evaluating an ineffective intervention. This is a confounding variable that needs to be figured out before implementing large-scale interventions.

Interventions

After investigators establish a common measurement to use, work needs to be done on the interventions themselves. Person-based interventions likely do have a place in the treatment of burnout as these interventions have been shown to result in improvement in measurement scores and may result in real-life improvements as well. However, physicians are wary of them given that these interventions seem to place blame on the physicians for being burned out.[48] In order to continue to involve successful person-based interventions in future programs, experts will need to overcome this wariness. This will likely require demonstrating that these interventions are only part of a broader intervention. Investigators will need to encourage physician engagement, truly involving physicians in the development of these programs.

Finally, the focus of future, person-based interventions will likely need to shift. Physicians of all levels, as early as medical school, suffer from burnout.[70] Thus, it is likely that something predisposes us to burnout, possibly the same characteristics that push us to continue operating in toxic environments for the good of our patients. Simply improving mindfulness, changing the way physicians eat, sleep or workout, or focusing on resilience will likely have little long-term impact. However, a shift to physicians living their values and learning to set boundaries so they help change their environments will likely have a greater long-term impact on overall physician wellness, while encouraging physicians to engage more in the conversation.

In addition, these person-based interventions often ask physicians to cope with unsustainable work conditions, rather than fixing the conditions in which they work. As discussed in part one of this series, many organizational, environmental, and societal factors contribute to the development of burnout and the associated decreased quality of care.[1] More recent non-EM interventions have shown success by incorporating organizational and environmental changes to address these conditions.[13] Future work in EM will involve determining which of these factors relevant to EM are amenable to intervention, how to address these factors in the face of the inevitable pushback from those who have benefited from the status quo, and how to successfully combine changes to these factors with interventions aimed at person-based issues. This combination is the key to creating interventions that truly create a culture of wellness in EM.

One particular organizational and societal issue is felt keenly in EM. In the 45 years of our specialty, there has been a transition away from physician autonomy and the primacy of the physician-patient relationship. Now, outside entities dictate how

physicians practice medicine with the focus on making money rather than being motivated by patient care.[71] While society may need a less-patriarchal physician role in medical decision-making, physicians have trained for a long time to be able to make decisions for the good of their patients; so these decisions should not be made by those who are not trained in medicine. In EM, this lack of autonomy comes in the form of patient satisfaction scores and clinical metrics that check bureaucratic boxes rather than affecting patient care.[56] Interventions that address this lack of autonomy are likely to engage physicians to a greater extent than those that ignore this issue.

Intervention developers will likely need to look outside of medicine for inspiration to address one unique aspect of our job. While all physicians have patients that could potentially "haunt" them, few other specialties see people on the worst days of their lives multiple times a day. Each day, EPs experience secondary trauma: EPs are not in the car crash, but they see the results and experience the heartbreak along with the family; EPs see the devastation caused by drugs and alcohol as well as the side effects of homelessness, rising drug costs, lack of transportation, illiteracy, and more. EPs experience all of these things while being relatively helpless to cause positive change. In this aspect of their job, EPs are more akin to law enforcement and deployed military. How should EM address the daily secondary trauma from seeing the worst days of people's lives as well as barriers to care for which EPs sometimes can do nothing?

Also similar to law enforcement professionals, for an EP, achieving true downtime is difficult. Each EP notices situations that could be potentially hazardous and is ready to act in the event he or she is needed. EPs are resilient but their job requires at least one step beyond normal resilience. Some areas of law enforcement have found success in remediating this secondary trauma, the lack of being able to truly be "off" and its side effects which are similar to the burnout and depression seen in EPs (R. Nayi Partridge, Director of Resilience Training and Development at The Partridge Group, email and phone communication, June 2018). EM may find that incorporating variations of successful law-enforcement interventions could be beneficial in addressing these issues.

Finally, previously studied interventions have all been short term both in regard to the length of the intervention and the duration of follow-up after the intervention ends. Future studies need to look at longer duration interventions as well as longer follow-up to ensure that results are sustained. Eventually, the interventions that succeed will hopefully become part of the way EM functions, as the best would represent development of the culture of wellness that is the goal.

CONCLUSION

Interventions intended to combat burnout and improve wellness in physicians are difficult to interpret for a number of reasons, including short-term duration of interventions and follow-up, variable outcomes, and lack of proven clinical significance. While non-EM initiatives appear numerous, few EM initiatives have been tried. Those interventions showing promise involve changes at both the individual physician level and the organizational and environmental levels. This both shifts the "blame" for burnout and its consequences off the individual physician and acknowledges that burnout is a symptom of a culture problem in medicine, a culture that expects everything of the physician while giving little to nothing back.

Given that these issues seem to stem from the current problem culture of medicine, the ultimate goal of any wellness initiative needs to be a shift in that culture. Organizations seeking to improve physician wellness/combat physician burnout should aim to create a culture of wellness. Creating this culture means addressing every physician's whole environment: the physicians themselves, the organizations they practice in, and the societal issues they face.

Successful interventions will work to create a culture of wellness and will become part of that culture. However, that goal is distant for all of medicine. Decisions regarding which scale to use to measure success, how to decide whether intervention results are clinically significant, and an acceptable duration to achieve sustained results need to be made. The specialty of emergency medicine can base its interventions on successful non-EM medicine interventions while integrating specific factors that address the unique aspects of the EP's job, including secondary trauma.

After addressing all of these issues regarding the implementation and evaluation of wellness interventions, physicians will write a cohesive narrative of standards to meet, changes to pursue, and how to change course as needed. This narrative will weave together multiple interventions to read as a sustained, ongoing culture of wellness in EM.

Address for Correspondence: Adam R. Kellogg, MD, Baystate Medical Center, Department of Emergency Medicine, 759 Chestnut Street, Springfield, MA 01199. Email: adam.kellogg@baystatehealth.org.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Stehman CR, Testo Z, Gershaw RS, et al. Burnout, drop out, suicide: physician loss in emergency medicine, part I. *West J Emerg Med*. 2019;20(3):485-94.
2. About Wellness. National Wellness Institute website. Available at: https://www.nationalwellness.org/page/AboutWellness Accessed October 8, 2019.
3. Heaney CA, Avery EC, Rich T, et al. Stanford WELL for Life: learning what it means to be well. *Am J Health Promot*. 2017;31(5):449-50.
4. "The 10 Domains of Well-being." Be Well Stanford website. Available at: https://bewell.stanford.edu/domains-well-being/. Accessed November 30, 2018.
5. Dusheck J. Well Now: What humans need to flourish. Stanford Medicine. Available at: https://stanmed.stanford.edu/2016summer/well-now.html. Accessed November 30, 2018.
6. Constitution. World Health Organization website. Available at: https://www.who.int/about/who-we-are/constitution. Accessed October 9, 2019.
7. Bart R, Ishak WW, Ganjian S, et al. The assessment and measurement of wellness in the clinical medical setting: a systematic review. *Innov Clin Neurosci*. 2018;15(09-10):14-23.
8. Myers JE, Sweeney TJ, Witmer JM. The Wheel of Wellness Counseling for Wellness: a holistic model for treatment planning. *J Couns Dev*. 2000;78(3):251-66.
9. Lall MD, Gaeta TJ, Chung AS, et al. Assessment of physician well-being, part two: beyond burnout. *West J Emerg Med*. 2019;20(2):291-304.
10. Eckleberry-Hunt J, Van Dyke A, Lick D, Tucciarone J. Changing the conversation from burnout to wellness: physician well-being in residency training programs. *J Grad Med Ed*. 2009;1(2):225-30.
11. Bohman B, Dyrbye L, Sinsky CA, et. al. Physician Well-Being: The reciprocity of practice efficiency, culture of wellness and personal resilience. *NEJM Catalyst*. August 7, 2017. Available at: https://catalyst.nejm.org/physician-well-being-efficiency-wellness-resilience/ Accessed August 19, 2018.
12. Murphy ML, de Vries P, Trockel M, et al. WellMD Center Status Report. Stanford Medicine: WellMD Center website. Available at: https://wellmd.stanford.edu/content/dam/sm/wellmd/documents/2017-wellmd-status-report-dist-1.pdf. Accessed August 19, 2018.
13. Shanafelt TD, Noseworthy JH. Executive leadership and physician well-being: nine organizational strategies to promote engagement and reduce burnout. *Mayo Clinic Proc*. 2017;92(1):129-46.
14. Brigham T, Barden C, Dopp AL, et al. A journey to construct an all-encompassing conceptual model of factors affecting clinician well-being and resilience. National Academy of Medicine website. Available at: https://nam.edu/journey-construct-encompassing-conceptual-model-factors-affecting-clinician-well-resilience/ Accessed October 8, 2019.
15. Maslach C, Schaufeli WB, Leiter MP. Job burnout. *Annu Rev Psychol*. 2001;52:397-422.
16. Wiederhold BK, Cipresso P, Pizzioli D, et al. Intervention for physician burnout: a systematic review. *Open Medicine*. 2018;13(1):253-63.
17. Busireddy KR, Miller JA, Ellison K, et al. Efficacy of interventions to reduce resident physician burnout: a systematic review. *J Grad Med Ed*. 2017;9(3):294-301.
18. Clough BA, March S, Chan RJ, et al. Psychosocial interventions for managing occupational stress and burnout among medical doctors: a systematic review. *Syst Rev*. 2017;6(1):144.
19. Panagioti M, Panagopoulou E, Bower P, et al. Controlled interventions to reduce burnout in physicians: a systematic review and meta-analysis. *JAMA Intern Med*. 2017;177(2):195-205.
20. West CP, Dyrbye LN, Erwin PJ, et al. Interventions to prevent and reduce physician burnout: a systematic review and meta-analysis. *Lancet*. 2016;388(10057):2272-81.
21. Burton A, Burgess C, Dean S, et al. How effective are mindfulness-based interventions for reducing stress among healthcare professionals? A systematic review and meta-analysis. *Stress Health*. 2017;33(1):3-13.
22. Williams D, Tricomi G, Gupta J, et al. Efficacy of burnout interventions in the medical education pipeline. *Acad Psychiatry*. 2015;39(1):47-54.
23. Regehr C, Glancy D, Pitts A, et al. Interventions to reduce the consequences of stress in physicians: a review and meta-analysis. *Journal Nerv Ment Dis*. 2014;202(5):353-9.
24. Awa WL, Plaumann M, Walter U. Burnout prevention: a review of intervention programs. *Patient Educ Couns*. 2010;78(2):184-90.
25. Braun SE, Kinser PA, Rybarczyk B. Can mindfulness in health care professionals improve patient care? An integrative review and proposed model. *Transl Behav Med*. 2018;9(2):187-201.
26. Hart D, Paetow G, Zarzar R. Does implementation of a corporate wellness initiative improve burnout?. *West J Emerg Med*. 2019;20(1):138.
27. Braganza S, Young J, Sweeny A, et al. oneED: Embedding a mindfulness-based wellness programme into an emergency department. *Emerg Med Australas*. 2018;30(5):678-86.
28. Chung AS, Felber R, Han E, et al. A targeted mindfulness curriculum for medical students during their emergency medicine clerkship experience. *West J Emerg Med*. 2018;19(4):762.
29. Schrager JD, Shayne P, Wolf S, et al. Assessing the influence of a Fitbit physical activity monitor on the exercise practices of emergency medicine residents: a pilot study. *JMIR Mhealth Uhealth*. 2017;5(1):e2.
30. Williamson K, Lank PM, Lovell EO. Development of an emergency medicine wellness curriculum. *AEM Educ Train*. 2018;2(1):20-5.
31. Mache S, Bernburg M, Baresi L, et al. Mental health promotion for junior physicians working in emergency medicine: evaluation of a pilot study. *Eur J Emerg Med*. 2018;25(3):191-8.
32. Gorgas DL, Greenberger S, Bahner DP, et al. Teaching emotional intelligence: a control group study of a brief educational intervention for emergency medicine residents. *West J Emerg Med*. 2015;16(6):899.

33. Walker K, Ben-Meir M, Dunlop W, et al. Impact of scribes on emergency medicine doctors' productivity and patient throughput: multicentre randomised trial. *BMJ*. 2019;364:121.
34. Chung AS, Smart J, Zdradzinski M, et al. Educator toolkits on second victim syndrome, mindfulness and meditation, and positive psychology: the 2017 Resident Wellness Consensus Summit. *West J Emerg Med*. 2018;19(2):327.
35. Smith DD, Kellar J, Walters EL, et al. Does emergency physician empathy reduce thoughts of litigation? A randomised trial. *Emerg Med J*. 2016;33(8):548-52.
36. Smith-Coggins R, Howard SK, Mac DT, et al. Improving alertness and performance in emergency department physicians and nurses: the use of planned naps. *Ann Emerg Med*. 2006;48(5):596-604.
37. Croskerry P, Sinclair D. Casino shift scheduling in the emergency department: a strategy for abolishing the night shift. *Emerg Med J*. 2002;19(Suppl 1):A9-19.
38. West CP, Dyrbye LN, Rabatin JT, et al. Intervention to promote physician well-being, job satisfaction, and professionalism: a randomized clinical trial. *JAMA Intern Med*. 2014;174(4):527-33.
39. Contratto E, Romp K, Estrada CA, et al. Physician order entry clerical support improves physician satisfaction and productivity. *South Med J*. 2017;110(5):363-8.
40. Robinson KE, Kersey JA. Novel electronic health record (EHR) education intervention in large healthcare organization improves quality, efficiency, time, and impact on burnout. *Medicine*. 2018;97(38):e12319.
41. Liira J, Verbeek J, Ruotsalainen J. Pharmacological interventions for sleepiness and sleep disturbances caused by shift work. *JAMA*. 2015;313(9):961-2.
42. Linzer M, Poplau S, Grossman E, et al. A cluster randomized trial of interventions to improve work conditions and clinician burnout in primary care: results from the Healthy Work Place (HWP) study. *J Gen Intern Med*. 2015;30(8):1105-11.
43. Ey S, Moffit M, Kinzie JM, Brunett PH. Feasibility of a comprehensive wellness and suicide prevention program: a decade of caring for physicians in training and practice. *J Grad Med Ed*. 2016;8(5):747-53.
44. Miller CS, Scott SD, Beck M. Second victims and mindfulness: a systematic review. *J Patient Saf Risk Manag*. 2019:2516043519838176.
45. Scott SD, Hirschinger LE, Cox KR, et al. Caring for our own: deploying a systemwide second victim rapid response team. *Jt Comm J Qual Patient Saf*. 2010;36(5):233-40.
46. Durand MA, Moulton B, Cockle E, et al. Can shared decision-making reduce medical malpractice litigation? A systematic review. *BMC Health Serv Res*. 2015 Dec;15(1):167.
47. Jha AK, Iliff AR, Chaoui AA, et al. A crisis in health care: a call to action on physician burnout. Massachusetts Medical Society website. Available at: http://www.massmed.org/News-and-Publications/MMS-News-Releases/Physician-Burnout-Report-2018/. Accessed on October 10, 2019.
48. Drozdowicz L. Physician wellness programs are lipstick on a pig. KevinMD Web site. Available at: https://www.kevinmd.com/blog/2017/11/physician-wellness-programs-lipstick-pig.html. Accessed August 19, 2018.
49. Shanafelt TD, Boone S, Tan L, et al. Burnout and satisfaction with work-life balance among US physicians relative to the general US population. *Arch Intern Med*. 2012;172(18):1377-85.
50. Peckham C. Medscape National Physician Burnout & Depression Report 2019. Medscape website. Available at: https://www.medscape.com/slideshow/2019-lifestyle-burnout-depression-6011056#2. Accessed February 23, 2019.
51. Daskivich TJ, Jardine DA, Tseng J, et al. Promotion of wellness and mental health awareness among physicians in training: perspective of a national, multispecialty panel of residents and fellows. *J Grad Med Ed*. 2015;7(1):143-7.
52. Swensen S, Kabcenell A, Shanafelt T. Physician-organization collaboration reduces physician burnout and promotes engagement: the Mayo Clinic experience. *J Healthc Manag.* 2016;61(2):105–27.
53. Dyrbye LN, Shanafelt TD, Sinsky CA, et al. Burnout among health care professionals: a call to explore and address this underrecognized threat to safe, high-quality care. National Academy of Medicine website. Available at: https://nam.edu/burnout-among-health-care-professionals-a-call-to-explore-and-address-this-underrecognized-threat-to-safe-high-quality-care/. Accessed March 16, 2019.
54. Montgomery A, Panagopoulou E, Esmail A, et al. Burnout in healthcare: the case for organisational change. *BMJ*. 2019;366:l4774.
55. West CP, Dyrbye LN, Shanafelt TD. Physician burnout: contributors, consequences and solutions. *J Intern Med*. 2018;283(6):516-29.
56. Kuhn G, Goldberg R, Compton S. Tolerance for uncertainty, burnout, and satisfaction with the career of emergency medicine. *Ann Emerg Med*. 2009;54(1):106-113.
57. Shanafelt TD, Balch CM, Bechamps G, et al. Burnout and medical errors among American surgeons. *Ann Surg*. 2010;251(6):995-1000.
58. Salyers MP, Bonfils KA, Luther L, et al. The relationship between professional burnout and quality and safety in healthcare: A meta-analysis. *J Gen Intern Med*. 2017;32(4):475-82.
59. Halbesleben JR, Rathert C. Linking physician burnout and patient outcomes: exploring the dyadic relationship between physicians and patients. *Health Care Manage Rev*. 2008;33(1):29-39.
60. Haas JS, Cook EF, Puopolo AL, et al. Is the professional satisfaction of general internists associated with patient satisfaction?. *J Gen Intern Med*. 2000;15(2):122-8.
61. Lall MD, Gaeta TJ, Chung AS, et al. Assessment of physician well-being, part one: burnout and other negative states. *West J Emerg Med.* 2019;20(2):278-90.
62. Eckleberry-Hunt J, Kirkpatrick H, Barbera T. The problems with burnout research. *Acad Med*. 2018;93(3):367-70.
63. Maslach C, Jackson SE, Leiter MP. Maslach Burnout Inventory. 3rd ed. Mountain View, CA: Consulting Psychologists Press. 1996.
64. Heath C, Heath D. Switch: how to change things when change is hard. Broadway Books. New York, NY. 2010.

65. Popa F, Arafat R, Purcărea VL, et al. Occupational Burnout levels in Emergency Medicine–a nationwide study and analysis. *J Med Life*. 2010;3(3):207.
66. Kimo Takayesu J, Ramoska EA, Clark TR, et al. Factors associated with burnout during emergency medicine residency. *Acad Emerg Med*. 2014;21(9):1031-5.
67. Landon BE, Reschovsky JD, Pham HH, et al. Leaving medicine: the consequences of physician dissatisfaction. *Med Care*. 2006;44(3):234-42.
68. Sinsky CA, Dyrbye LN, West CP, et al. Professional satisfaction and the career plans of US physicians. *Mayo Clin Proc*. 2017;92(11):1625-35.
69. Dewa CS, Loong D, Bonato S, et al. How does burnout affect physician productivity? A systematic literature review. *BMC Health Serv Res*. 2014;14:325.
70. Dyrbye LN, Massie FS, Eacker A, et al. Relationship between burnout and professional conduct and attitudes among US medical students. *JAMA*. 2010;304(11):1173-80.
71. Katari R. Regarding wellness and burnout initiatives in emergency medicine. *Acad Emerg Med*. 2018;25(5):607-8.

Oncologic Emergencies: Immune-Based Cancer Therapies and Complications

Brit Long, MD*
Elizabeth Brém, MD†
Alex Koyfman, MD‡

*Brooke Army Medical Center, Department of Emergency Medicine, Fort Sam Houston, Texas
†University of California, Irvine Health, Division of Hematology/Oncology, Orange, California
‡The University of Texas Southwestern Medical Center, Department of Emergency Medicine, Dallas, Texas

Section Editor: Kenneth S. Whitlow, MD
Submission history: Submitted November 15, 2019; Revision received January 28, 2020; Accepted January 29, 2020
Electronically published April 13, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.1.45898

Cancer therapies have undergone several recent advancements. Current cancer treatments include immune-based therapies comprised of checkpoint inhibitors, and adoptive immunotherapy; each treatment has the potential for complications that differ from chemotherapy and radiation. This review evaluates immune-based therapies and their complications for emergency clinicians. Therapy complications include immune-related adverse events (irAE), cytokine release syndrome (CRS), autoimmune toxicity, and chimeric antigen receptor (CAR) T-cell-related encephalopathy syndrome (CRES). Immune-related adverse events are most commonly encountered with checkpoint inhibitors and include dermatologic complications, pneumonitis, colitis/diarrhea, hepatitis, and endocrinopathies. Less common irAEs include nephritis, myocardial injury, neurologic toxicity, ocular diseases, and musculoskeletal complications. CRS and CRES are more commonly associated with CAR T-cell therapy. CRS commonly presents with flu-like illness and symptoms resembling sepsis, but severe myocardial and pulmonary disease may occur. Critically ill patients require resuscitation, broad-spectrum antibiotics, and hematology/oncology consultation. [West J Emerg Med. 2020;21(3)566-580.]

INTRODUCTION

Emergency clinicians manage a wide variety of complications associated with malignancy, including cardiovascular, gastrointestinal (GI), pulmonary, infectious, and other complications. Cancer therapies have expanded and improved over the last decade. Immune-based therapies function through a different set of mechanisms compared to prior therapies; thus, this class is associated with different complications.[1-4] Medications and new therapeutic techniques are being continually introduced, and emergency clinicians must understand these medications and their complications.

METHODS

This is a narrative review evaluating complications from current immune-based therapies in cancer. To complete this review on immune-based therapy complications, we undertook a literature search of PubMed, Google Scholar, and MEDLINE using search terms "immunotherapy," "immune-based," "checkpoint inhibitor," "CAR T," AND "malignancy" OR "cancer." We included guidelines, randomized controlled trials, cohort/observational studies, narrative reviews, and systematic reviews/meta-analyses. Studies were limited to English and adult patients. Our initial literature search revealed over 620 resources. We excluded studies not focusing on emergency department (ED) evaluation and management, resulting in inclusion of 134 resources.

DISCUSSION

Besides Chemotherapy and Radiation, What Are Other Types of Cancer Therapies?

Immune-based therapies differ from cytotoxic chemotherapy in that immunotherapy works to break the body's tolerance of the malignant cells. There are several immune-based strategies, each of which acts with different mechanisms (Table 1).[1-3] These treatments can be used in isolation or in combination with chemotherapy and/or radiation.[2-6] However, these therapies can result in either autoimmune or cytokine-associated toxicities that are not seen with chemotherapy and radiation.

Interleukin-2 (IL-2) stimulates the growth of T-cells and natural killer cells, which engage malignant cells and target

them for destruction by the immune system. IL-2 was first identified in 1980 and approved in the 1990s for metastatic melanoma and metastatic renal cell cancer, and it currently is used for non-small cell lung cancer as well.[1,7-9] IL-2 has demonstrated efficacy in inducing regression in advanced solid cancers.[7-9] While patient responses to therapy can be dramatic when they occur, the true response rate is quite low (objective response rate 15% and five-year overall survival 8% in one European series).[10] Administration of high-dose IL-2 is done in the inpatient setting as it creates a systemic inflammatory response, often requiring fluids, vasopressors, and intensive monitoring. Few centers administer this therapy. Given the low rate of sustained remissions and high toxicity, the role of high dose IL-2 has substantially decreased with the development of checkpoint inhibitors.

Checkpoint Inhibitors

Checkpoint inhibitors are monoclonal antibodies that impede the activity of inhibitory molecules on the surface of tumor cells that typically reduce immune response; they take the "brakes" off the immune system so that tumor cells can be recognized.[2,11] Clinical antibodies are available for three ligands: cytotoxic T-lymphocyte antigen 4 (CTLA-4), programmed death 1 (PD-1), and programmed death ligand 1 (PDL-1) (Figure 1). In the absence of malignancy, receptors CTLA-4, PD-1/PD-2, and PDL-1 reduce T-cell proinflammatory response and decrease tissue damage from the immune system, improving self-tolerance.[2,11-13] When cancers develop, malignant cells upregulate these receptors, which decreases immune system clearance of these cells.

Checkpoint inhibitors activate T cells by blocking the action of these receptors, removing inhibitory signals and resulting in destruction of tumor cells.[14-16] Inhibition of immune checkpoints can lead to T cells affecting nonmalignant cells, resulting in tissue injury and organ dysfunction.[17,18] Checkpoint inhibitors, specifically ipilimumab, were first approved for metastatic melanoma, although the indications for these agents have drastically expanded, including small cell and non-small-cell lung cancer, ovarian cancer, renal cell carcinoma, gastric and colorectal cancer, urothelial cancer, Hodgkin lymphoma, and others.[2-4,19,20] These agents have demonstrated significant improvements in survival.[4,21,22]

Population Health Research Capsule

What do we already know about this issue?
Current cancer treatments include immune-based therapies, comprised of checkpoint inhibitors and adoptive immunotherapy, each with the potential for complications.

What was the research question?
We evaluate immune-based therapies and their complications for emergency clinicians.

What was the major finding of the study?
Complications include immune-related adverse events, cytokine release syndrome, and CAR-related encephalopathy syndrome.

How does this improve population health?
Knowledge of the complications associated with immune-based therapies can improve emergency providers' management of these patients.

Chimeric Antigen Receptor (CAR) Therapies

This method of adoptive immunotherapy uses genetically modified T cells with a chimeric antigen receptor (CAR) that targets malignant cells.[23-27] The patient's own T cells are obtained through leukapheresis and then modified *ex vivo* with a tumor-specific receptor. The cells with the highest antitumor activity are selected for expansion. Following lymphocyte-depleting chemotherapy, the replicated T cells are then administered to the patient (Figure 2).[23-27] The first CAR T-cell therapies included tisagenlecleucel and axicabtagene ciloleucel, approved in 2017 for lymphoblastic leukemia and advanced lymphoma.[23-34] The Food and Drug Administration-approved CAR T-cell therapies target CD19, a protein expressed on the surface of both malignant and normal B lymphocytes. CAR T-cells targeting a range of other proteins are currently under study for Hodgkin lymphoma, multiple myeloma, glioblastoma, melanoma, breast cancer, and sarcoma.[23-34] Also under development are "natural killer" cells engineered in a similar way to recognize tumor cell antigens.

Table 1. Immune-based agents and mechanisms used in cancer therapy.[1-3]

Class	Mechanism	Therapeutic agent
Stimulator	Stimulates effector cells	Interleukin-2
Checkpoint inhibitor	Inhibits regulatory factors	Anti-CTLA4 (ipilimumab), Anti-PD-1 (nivolumab, pembrolizumab), Anti-PD-L1 (atezolizumab, avelumab, durvalumab)
Adoptive immunotherapy	Activated immune cell passive transfer, which have antitumor activity	CAR T-cell (axicabtagene ciloleucel, tisagenlecleucel)

CAR, chimeric antigen receptor; *CTLA4,* cytotoxic T-lymphocyte-associated protein 4; *PD-1,* programmed cell death protein 1; *PD-L1,* programmed death-ligand 1.

What Can Go Wrong with These Therapies?

As the mechanisms of these newer therapies, particularly checkpoint inhibitors and CAR T-cell therapy, significantly differ from normal chemotherapy, adverse effects and complications also differ.[35-40] These complications are typically termed irAEs, which are a result of immune system over-activity, rather than a depleted immune system that occurs with chemotherapy. Immune-related adverse events most commonly affect systems with significant cell turnover.[35-40] Most irAEs occur within 3-6 months of starting therapy, but it should be noted that irAEs can occur at any time, even after the patient discontinues treatment.[35-42] Of patients receiving an anti-CTLA-4 medication, 60-90% experience an irAE, while 39-70% of those administered an anti-PD-1/PD-L1 medication experience an irAE.[5,43-46]

While mortality is rare, morbidity associated with these agents can be severe.[35-42] Immune-related adverse events associated with this class range in severity, based on a scale from the National Cancer Institute (NCI).[47] This scale ranges from mild (1) to death (5), based on the Common Terminology Criteria for Adverse Events (CTCAE). Grades 1 and 2, or mild to moderate irAEs, occur frequently and can be treated symptomatically as outpatients. Grade 3 and 4 irAEs, while less frequent, can be severe and require admission (Table 2).[47] The risk of irAEs and severity is greater with combination therapy, compared to monotherapy.[48-51] Higher doses of ipilimumab and pembrolizumab are also associated with greater risk of irAEs.[52-54] However, other anti-PD-1 and PD-LI medications do not demonstrate a dose-related response with irAE.[19,35-40] Interestingly, the occurrence of irAEs is associated with improved clinical outcomes in patients with malignancy.[18]

The most commonly encountered irAEs affect the GI, dermatologic, endocrine, and pulmonary systems. The cardiovascular, hematologic, renal, neurologic, and musculoskeletal systems are not as commonly affected.[35-42] Colitis is associated with better prognosis compared to pneumonitis.[55,56] Dermatologic irAEs are typically seen two to three weeks after therapy initiation, followed by the GI system at six to seven weeks, and the endocrine system at nine to ten weeks.[35-42,56] Severe irAEs associated with anti-CTLA-4 medications occur earlier compared to anti-PD-1/PD-L1 medications.[35-45] Laboratory and imaging assessment depend on the specific organ involved. Management focuses on systemic corticosteroids for the majority, except several endocrinopathies (Table 2).[35-42,48,49] Clinicians should assess for infection and progression of the malignancy, which can present with similar symptoms as an irAE. With appropriate therapy, most irAEs, even grade 3-4, will resolve, except endocrinopathies.[35-42,48,49]

Dermatologic

Dermatologic toxicities are some of the most common irAEs, especially in patients with melanoma, and are often seen early after starting therapy (two to three weeks).[35-37,48,54] Reactions may include maculopapular rash, bullae, maculopustular rash, vitiligo, Stevens-Johnson syndrome (SJS), toxic epidermal necrolysis (TEN), or drug reaction with eosinophilia and systemic symptoms. The differential includes

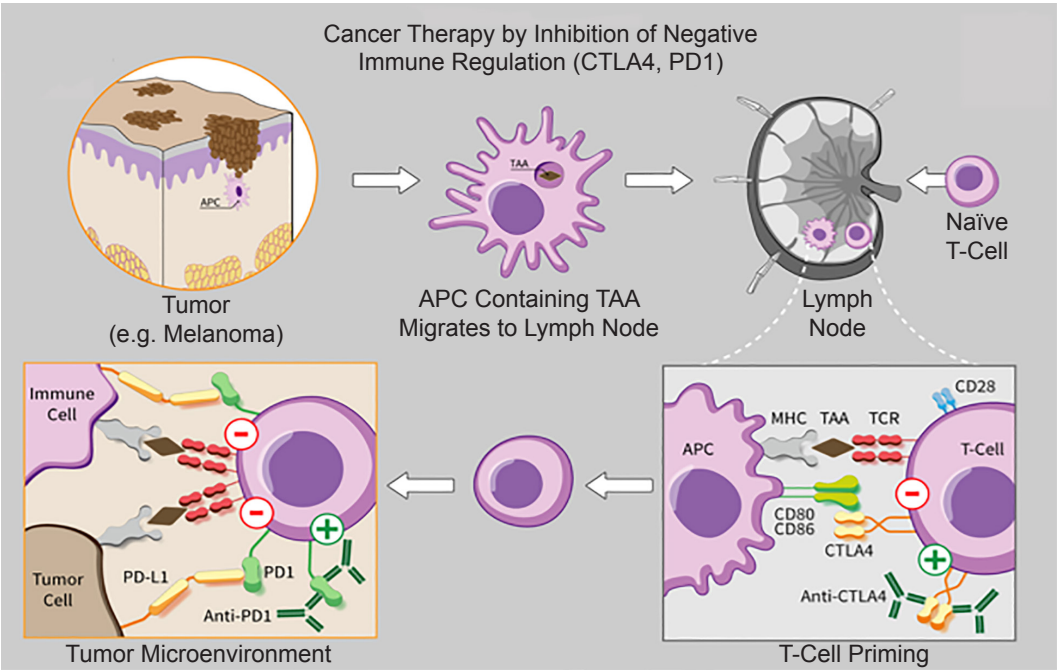


Figure 1. Checkpoint inhibitor mechanisms (CTLA-4 and PD-1).
Modified from https://commons.wikimedia.org/wiki/File:11_Hegasy_CTLA4_PD1_Immuntherapie.png. Accessed April 7, 2019.
CTLA4, cytotoxic T-lymphocyte antigen 4; *PD-1,* programmed cell death protein 1; *PD-L1,* programmed death-ligand 1; *APC,* antigen-presenting cell; *TAA,* tumor-associated antigen; *TCR,* t-cell receptor; *CD,* cluster of differentiation.

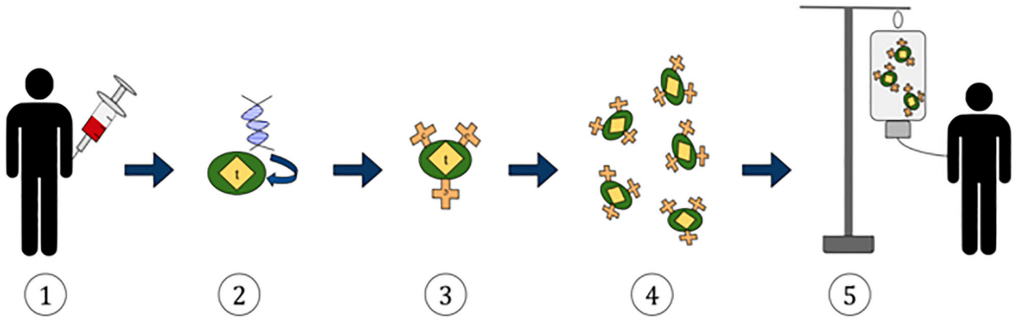


Figure 2. Chimeric antigen receptor (CAR) T-cell therapy process
1) T cells present in the blood are removed from the patient. 2) These T cells are incorporated with the gene-encoding specific antigen receptors. 3) This results in CAR receptors present on the surface of T cells. 4)These modified T cells are harvested and grown in a laboratory setting. 5) The engineered T cells are finally administered to the original patient.
Modified from https://commons.wikimedia.org/wiki/File:CAR_T-cell_Therapy.svg. Accessed April 7, 2019.

vasculitis, atopic/contact dermatitis, viral exanthem, drug toxicity, erythema multiforme, or infectious causes.[35-45,55-58] Physicians should evaluate the patient's medication list, hemodynamics, systemic symptoms, mucosal involvement, and total body surface area involved. Laboratory assessment for patients with severe disease includes complete blood count (CBC) with differential, renal and liver function, coagulation panel, creatine kinase (CK), and electrolytes. Dermatology consultation is recommended. Most patients have grade 1-2 rashes. Mild rashes can be treated with oral antihistamines and topical steroids, but for those with severe rashes (including SJS or TEN), systemic steroids are recommended.[55-58]

Cardiac

A variety of cardiac effects can occur including dysrhythmias (blocks, supraventricular or ventricular tachycardias), myocarditis (new systolic heart failure and cardiogenic shock), Takotsubo cardiomyopathy, and pericarditis/myopericarditis.[1-4,59,60] Patients should be evaluated with electrocardiogram, echocardiography (assessing ventricular function, wall abnormalities, cardiac effusion), thyroid stimulating hormone (TSH), troponin, and chest radiograph. Patients may require cardiac catheterization. Corticosteroid therapy is recommended for myocarditis and ventricular dysrhythmias due to irAE. Prednisone 1-2 milligrams per kilogram per day (mg/kg/day) (or its equivalent) for mild-moderate disease is recommended, but in severe cardiac irAE or in patients who do not respond, methylprednisolone 1 gram intravenous (IV) per day is recommended.[60-62] Other immunologic agents such as infliximab, mycophenolate mofetil, or antithymocyte globulin may be required.[60-62] Dysrhythmias from cardiac conduction pathology may require pacemaker insertion. Heart failure should be treated with standard therapies. Pericardial tamponade requires IV fluid resuscitation and drainage.

Pulmonary

Pneumonitis is the predominant irAE of the pulmonary system, ranging from no or mild symptoms to respiratory failure requiring intubation and ventilatory support.[1-5] Pneumonitis is the most common irAE requiring discontinuation of checkpoint inhibitor therapy, as well as the most common cause of death related to irAE.[63-65] Dyspnea, cough, fever, and chest pain may be present, with dyspnea occurring in 53% and cough in 35% of patients.[40,63-65] Productive cough is rare and suggests another diagnosis.[40] The differential includes infection (opportunistic infection, pneumonia), heart failure (myocarditis), pulmonary embolism, extension of the malignancy, underlying interstitial lung disease or obstructive disease, diffuse alveolar hemorrhage, neuromuscular disease, or pneumonitis due to other therapies.

Laboratory assessment includes CBC, electrolytes, blood cultures, and urine testing for pneumococcal and legionella antigens. Sputum cultures and gram stain are also recommended, although these can be obtained in the critical care unit.[40,63-65] If the patient presents during influenza season, testing for viral upper respiratory infections is recommended. Neuromuscular weakness should be assessed with negative inspiratory force and forced vital capacity.[65,66] Regarding imaging, chest radiograph demonstrates a sensitivity of approximately 75% for diagnosis of pneumonitis.[63-66] Computed tomography (CT) is recommended with contrast. The findings on CT vary, including ground glass opacities (37%), cryptogenic organizing pneumonia, interstitial infiltrates, and pneumonitis not otherwise specified.[65,66]

If an infiltrate is present but the patient is asymptomatic, the patient does not require therapy beyond discontinuing the checkpoint inhibitor and obtaining oncology follow-up. Patients with critical illness or grade 3-4 irAEs require other therapies.[63-65] In the patient with severe respiratory symptoms, empiric therapy with antimicrobials is recommended, as grade 3-4 pneumonitis will not be immediately diagnosable. Procalcitonin can be used in the critical care setting to determine whether antibiotics should be continued, but this laboratory assessment should not be used in isolation for determining need for initial antibiotics.[1-5] *Pneumocystis jirovecii* (PJP) can cause similar clinical and radiographic findings, and empiric treatment with trimethoprim-sulfamethoxazole is recommended if the patient is at high risk with corresponding radiographic findings.[63-65] Antifungal

therapy is reasonable in the intensive care unit (ICU) if patients do not improve despite use of other therapies. Regarding pneumonitis, 1-2 mg/kg/day of prednisone or methylprednisolone is recommended. Over 80% of patients will improve in several days if an irAE is present.[67,68] However, up to 14% of patients will not respond to corticosteroid therapy.[37,67] Higher doses can be attempted (4 mg/kg/day), as well as other agents including infliximab or mycophenylate.[37]

Table 2. Immune-related adverse effects on the organs of cancer patients undergoing immunotherapy.[35-42,48,49]

Organ System	Grade	Definition	Management	Disposition
Dermatologic Most common agents: anti-CTLA-4 inhibitors (Ipilimumab), especially melanoma, but also associated with anti-PD-1/PD-L1 therapy	1	- Nonlocalized, diffuse rash, < 10% BSA - Mild pruritis	- Provide oral antihistamines, class I topical corticosteroid (class V/VI for face)	- Discharge with oncology follow- up and dermatology referral - Provide return precautions - If symptoms worsen, treat as grade 3/4
	2	- Maculopapular rash with 10-30% BSA - Intense, widespread rash pruritis, may have excoriations	- Similar to grade 1 - Add systemic corticosteroids (prednisone 0.5-1 mg/kg/day)	- Similar to grade 1 - If symptoms worsen, treat as grade 3/4
	3-4	- Maculopapular rash > 30% BSA - Intense pruritis, limits ADLs, sleep - Stevens-Johnson syndrome or toxic epidermal necrolysis - Full thickness dermal ulceration or necrotic, bullous, or hemorrhagic findings	- Evaluate and exclude systemic hypersensitivity - Obtain serum tests with CBC with differential, complete metabolic panel - Provide systemic corticosteroids - Provide oral antihistamines and GABA agonist (pregabalin or gabapentin)	- Admit with monitoring - Emergent dermatology consult
Gastrointestinal Most common agents: anti-CTLA-4 inhibitors (Ipilimumab), but also associated with anti-PD-1/PD-L1 therapy	1	- Diarrhea ≤ 4 stools/day - Asymptomatic colitis	- Observe patient, obtain stool and serum studies - May provide antidiarrheal medications, but no strong recommendations	- Ensure follow up with oncology as outpatient - Provide return precautions - Treat as grade 2 if worsening symptoms
	2	- Diarrhea 4-6 stools/day - Colitis with abdominal pain, blood/mucous in stool	- Observe patient if diarrhea only, obtain serum and stool studies - CRP, ESR, fecal calprotectin, lactoferrin, imaging optional - Antidiarrheal medications not recommended - If diarrhea and colitis present, provide prednisone 1 mg/kg/day	- Obtain follow up with oncology - Provide return precautions - If no improvement in 2 days, increase prednisone to 2 mg/kg/day
	3-4	- Diarrhea > 7 stools/day, incontinence, requiring IV fluids for > 1 day, unable to do ADLs - Colitis with severe pain, ileus, fever - Grade 4 with peritoneal findings	- Admit patient, obtain serum and stool markers, inflammatory markers, imaging, and GI consult - Prednisone 1-2 mg/kg/day - Provide antibiotics - May require other anti-inflammatory medications	- Oncology and GI consult with admission - Infliximab may be needed (do not use in perforation or septic shock)
Hepatitis Most common agents: combined anti-CTLA-4 inhibitor plus anti-PD-1/ PD-L1 therapy; isolated therapy less commonly associated	1	- Elevated AST, ALT to 3 X ULN - Elevated total bilirubin up to 1.5 X ULN	- Evaluate and exclude infection, drug injury, thrombotic, or malignant causes	- Follow up with oncology or primary provider for repeat examination and testing
	2	- Elevated AST, ALT > 3 X ULN to 5 X ULN - Elevated total bilirubin 1.5 X ULN to 3 X ULN	- Evaluate and exclude infection, drug injury, thrombotic, or malignant causes - Prednisone 0.5-1 mg/kg/day	- Follow up with oncology or primary provider for repeat examination and testing in 1-2 days
	3-4	- Elevated AST, ALT > 5 X ULN - Elevated total bilirubin > 3 X ULN	- Prednisone 1-2 mg/kg/day - Provide antibiotics for opportunistic infections - Consult GI	- Admit patient - If patient does not improve in 3-5 days, other immunosuppressant medications needed

Table 2. Continued.

Organ System	Grade	Definition	Management	Disposition
Pulmonary Most common agents: combined anti-CTLA-4 inhibitor plus anti-PD-1/ PD-L1 therapy; isolated therapy less commonly associated	1	- Asymptomatic	- Monitor symptoms/oxygen saturation - Consider imaging before reinitiating checkpoint inhibitor	- Consider pulmonary, ID consult - Ensure follow up with oncology as outpatient; provide return precautions - If saturation falls < 92%, recommend home pulse oximetry
	2	- Symptoms limiting ADLs, mild/moderate hypoxia	- Systemic corticosteroids (prednisone 1 mg/kg/day) - Consider prophylactic antibiotics - Bronchoscopy or lung biopsy may be required	- Consider pulmonary, ID consult - Discuss with oncology - Admit to observation unit
	3-4	- Severe new symptoms, worsening/severe hypoxia	- Methylprednisolone 2 mg/kg/day IV - Patients with severe symptoms may require infliximab, cyclophosphamide, IVIG, or mycophenolate - Consider prophylactic antibiotics - Bronchoscopy or lung biopsy may be required	- Consult pulmonary and ID specialists - Admit with monitoring, consider ICU care
Nephritis Less commonly affected than other systems; most commonly with combined anti-PD-1/PD-L1 and anti-CTLA-4 inhibitor therapy	1	- Asymptomatic - Creatinine increase > 0.3 mg/dL or Creatinine > 1.5 -2 X ULN	- No treatment needed - Consider discontinuing checkpoint inhibitor	- Follow up with oncology and obtain outpatient referral
	2	- Creatinine > 2-3 X ULN	- Discontinue checkpoint inhibitor - Evaluate for other etiologies of renal injury with laboratory assessment and ultrasound - Prednisone 0.5-1 mg/kg/day	- Follow up with oncology and obtain nephrology referral
	3-4	- Creatinine > 4 mg/dL or Creatinine > 3 X ULN - Grade 4 marked by life-threatening electrolyte abnormalities	- Discontinue checkpoint inhibitor - Evaluate for other etiologies of renal injury with laboratory assessment and ultrasound - Prednisone 1-2 mg/kg/day - Biopsy typically required	- Admit to hospital - Consult oncology and nephrology specialists
Endocrine Most common agents: anti-PD-1/PD-L1 therapy and anti-CTLA-4 inhibitor therapy	1	- Asymptomatic or mild symptoms	- No treatment needed	- Follow up with oncology and obtain outpatient endocrine referral
	2-3	- Evidence of endocrine dysfunctions with weakness, fatigue	- Treat based on condition - Hypophysitis: Obtain TSH, T4, cortisol; MR sella; prednisone 1-2 mg/kg/day if imaging abnormal - Adrenal insufficiency (central): hydrocortisone 100 mg IV - Diabetes (insulin-dependent): Start insulin, evaluate for DKA - Hypothyroidism: Start levothyroxine - Hyperthyroidism: Treat with beta-blockers if symptoms present, treat Graves' disease if present	- Endocrinology consult - Admit to hospital
	4	- Adrenal crisis may be present (dehydration, shock) - Visual field deficits, severe headache	- Evaluate and exclude sepsis - Manage adrenal crisis (hydrocortisone) - Resuscitate with IV fluids - Treat with prophylactic antibiotics	- Emergent endocrinology consultation - Admit to ICU for further evaluation and monitoring

CTLA4, cytotoxic T-lymphocyte antigen 4; *PD-1,* programmed cell death protein 1; *PD-L1,* programmed death-ligand 1; *BSA*, body surface area; *GABA,* gamma-aminobutyric acid; *AST*, aspartate aminotransferase; *ALT,* alanine aminotransferase; *ADLs,* activities of daily living; *mg*, milligram; *kg*, kilogram; *CBC,* complete blood count, *GI,* gastrointestinal; *ID,* infectious diseases; *IV* intravenous; *IG,* immunoglobulin; *MR,* magnetic resonance; *TSH,* thyroid stimulating hormone; *ULN*, upper limit of normal; *ICU*, intensive care unit; *DKA,* diabetic ketoacidosis; *CRP*, C-reactive protein; *ESR,* erythrocyte sedimentation rate.

Patients with grades 3-4 pneumonitis or critical illness will require ICU admission. Bronchoscopy may be needed; however, there is no specific finding on bronchoscopy that definitely diagnoses pneumonitis due to checkpoint inhibitor toxicity, and it is not associated with improved survival.[56,57,66-68] Bronchoscopy can be used to evaluate for infection as the etiology.[56,57] The decision for bronchoscopy is ultimately left to the pulmonologist and critical care physician.

Gastrointestinal Presentations

GI presentations of irAE typically include diarrhea and colitis, which can occur in up to 40% on ipilimumab.[1-4] These most often occur 6-7 weeks after initiation of therapy.[1-4,40] In the ED, differentiating mild-moderate symptoms from severe diarrhea and colitis is vital, as well as considering the wide differential including infectious diarrhea, enteritis, inflammatory bowel disease, and perforation. Nausea and vomiting may be present with upper GI tract involvement. Colitis tends to present with pancolitis, diverticulosis and segmental colitis, or isolated rectosigmoid colitis but no diverticulosis.[70] Severe colitis with fever, peritonitis, and perforation is rare but may occur.[57,58,71] Stool testing is recommended based on the grade of severity to include bacterial pathogens, viral etiologies, and *Clostridium difficile*.[57,58,70,71] Imaging with CT of the abdomen/pelvis is recommended in patients with critical illness to evaluate disease severity and complications and may demonstrate thickening of the bowel wall, mesenteric fullness, stranding, and/or perforation.[70-73] Colonoscopy for patients with severe illness may be used to evaluate for alternative diagnoses and guide management. Upper endoscopy may be needed during admission if CT does not reveal findings of colitis but the patient has diarrhea.[72,73]

Volume-depleted patients require fluid resuscitation. Opioids and medications such as loperamide should be avoided, if possible. Corticosteroids are recommended for patients with ≥ 6 stools, patients who are admitted for colitis, and other complications, with prednisone at doses of 1-2 mg/kg/day.[37,57,58,73,74] Patients with severe disease may require infliximab.[37,57] Patients with perforation or toxic megacolon require surgical consultation. Empiric antibiotics are recommended for those with severe illness.

Hepatitis

Patients with hepatitis due to an irAE are usually asymptomatic and detected by routine liver function assessments, although patients may present with fever, jaundice, and abdominal pain.[37,75] Immune-related adverse events affecting the liver typically occur 6-14 weeks after beginning therapy.[35-37,75] Liver function tests including aspartate transaminase and alanine aminotransferase, as well as bilirubin, are increased, and the symptoms and levels of elevation determine the severity.[37,75] Fulminant hepatic failure and death are rare. Evaluating for other conditions is recommended, such as alcoholic hepatitis, acetaminophen toxicity, viral hepatitis, chronic hepatitis reactivation, biliary obstruction, shock liver, liver metastases, or vascular occlusion. Laboratory assessment should include viral hepatitis panel and autoimmune hepatitis panel (anti-smooth muscle antibodies, antinuclear antibody, liver-kidney microsomal antibody). Ultrasound of the liver, gallbladder, and biliary tract with doppler examination is needed to evaluate for liver and/or biliary disease.[37,75] Treatment includes stopping medications that may result in hepatoxicity. Those with grade 2 disease or higher should receive corticosteroids. Infliximab may result in hepatotoxicity, limiting its use in hepatitis due to irAE.[2,35-37]

Nephritis

Acute tubulointerstitial nephritis is the most common form of renal toxicity, although glomerulonephritis can also occur.[2,35-40] Patients are typically asymptomatic, with laboratory abnormality the only finding. Renal failure can present with uremic encephalopathy, volume overload, and electrolyte abnormalities.[2,76,77] As renal injury due to irAE is rare, evaluation for other causes of renal failure is recommended to include CBC and blood smear (microangiopathic hemolytic anemias), CK (myositis and rhabdomyolysis), and urinalysis are recommended. Urinalysis may be normal or include sterile pyuria, mild proteinuria, microscopic hematuria, and granular casts.[76,77] Renal ultrasound is recommended with vascular studies. If no other cause is found for renal injury, biopsy is recommended. Corticosteroids should be initiated if the renal injury is due to irAE. Other immunosuppressant medications may be needed if the patient does not improve. Hemodialysis is recommended for grade 4 irAEs.[2,35-40,76,77]

Endocrinopathies

Endocrinopathy affects approximately 10% of patients; it can be either central involving the pituitary gland, or peripheral involving the thyroid or adrenal glands.[2,48] Immune-related adverse events affecting the endocrine system are difficult to diagnose, and clinicians should consider these conditions in patients with non-specific symptoms such as fatigue, weakness, headache, nausea, and vomiting.[2,40,48,54] These complications typically arise 9-10 weeks after initiation of therapy. Endocrinopathies differ from other irAEs with organ dysfunction, as treatment with corticosteroids is not typically used, and organ dysfunction is often persistent due to disruption of the adrenal axis.[2,35-40,61] Thus, treatment typically involves hormone replacement on a long-term basis.

Primary hypothyroidism is the most common endocrinopathy and may present with fatigue, cold intolerance, weight gain, constipation, and depression.[2,37,48,78] Diagnosis involves elevated TSH and low free T4, and treatment includes thyroid hormone replacement. Hyperthyroidism comes in two forms: thyroiditis and Graves' disease. Symptoms of hyperthyroidism include heat intolerance, diaphoresis, dyspnea, diarrhea, palpitations, tremor, and weight loss, although Graves' disease can present with ophthalmopathy.[2,40,48,79] Thyroiditis presents with mild symptoms of hyperthyroidism in the acute phase, followed by

chronic hypothyroidism due to gland destruction. Graves' disease is much less common and presents with persistent, more severe hyperthyroidism.[2,48,79] Diagnosis includes reduced TSH and elevated free T4. TSH-receptor antibody can be used as well. Treatment includes a thionamide and endocrinology consult for those with mild-moderate symptoms.[2,37,40] Severe symptoms require therapy for thyrotoxicosis and thyroid storm if present, as well as corticosteroids.[37]

Adrenal insufficiency can present with fatigue and weight loss or with adrenal crisis and distributive shock. Electrolytes, renal and liver function, cortisol, adrenocorticotropic hormone (ACTH), and CT of the abdomen/pelvis are recommended. Treatment includes hydrocortisone, with dosing dependent on patient hemodynamic status and symptoms. Adrenal crisis requires hydrocortisone 100 mg IV, as well as evaluation for infection, broad-spectrum antibiotics, and IV fluids with glucose.[2,35-40,48]

Pituitary dysfunction, or hypophysitis, typically presents with symptoms of hypothyroidism but may also present with arthralgias, vision changes, hypogonadism, hypothyroidism, diabetes insipidus, and/or adrenal insufficiency.[2,35-40,48,54,79] Headache occurs in 85% of patients.[40] Electrolytes, cortisol, ACTH, TSH, free T4, luteinizing hormone, follicle-stimulating hormone, and either testosterone/estrogen level are recommended, as well as central nervous imaging with brain MRI.[37-40] Diagnosis is based on at least one hormone deficiency plus MRI abnormality, or ≥ 2 hormone deficiencies with headache.[37-40] Treatment is based on patient presentation, symptoms, and laboratory results.[37,40] Insulin-dependent diabetes is another irAE.[2,37,80] Treatment focuses on insulin and management of diabetic ketoacidosis if present.[37]

Neurologic

Neurologic irAEs are rare (1-6%) but may include myasthenia gravis with fatigable and fluctuating weakness primarily affecting ocular and bulbar muscles.[40,81-86] Conditions that may present in a similar manner include myositis, spinal cord pathology, and Guillain-Barré syndrome (Miller-Fisher variant).[81-85] Laboratory assessment includes CK, electrolytes, and MRI of the brain and/or spine dependent on the patient presentation.[81-86] Admitted patients should be tested for acetylcholine receptor and anti-striated muscle antibodies, as well as electrodiagnostic studies. Treatment includes prednisone 1-1.5 mg/kg/day and pyridostigmine. Intravenous immunoglobulin (IVIG) or plasmapheresis for severe symptoms is recommended.[81-86] Medications such as beta blockers, magnesium IV, fluoroquinolones, macrolides, and other medications that can worsen myasthenia must be avoided.

Guillain-Barré syndrome can present with progressive, ascending muscle weakness, often beginning with neuropathic pain and/or sensory changes in the lower extremities.[2,37,81,83,87] Reflexes are typically absent. This disease may cause respiratory failure with respiratory muscle involvement and dysautonomia. CK, spine MRI, lumbar puncture (LP) (elevated protein), and electrodiagnostic studies are recommended.[88-90] Treatment includes IVIG or plasmapheresis.[87-90]

Transverse myelitis presents with bilateral acute/subacute weakness or sensory changes.[89,90] Reflexes are increased, as opposed to Guillain-Barré syndrome.[40,81-85] Assessment with MRI of the spine and LP is recommended, with management including methylprednisolone 2 mg/kg/day or 1 g/day IV.[81-85,90]

Encephalitis may present with confusion, headache, seizures, focal weakness, or other focal findings such as altered speech.[2,37,81,83] LP with central nervous system imaging is recommended. LP may reveal lymphocytic pleocytosis and elevated protein, and imaging is often normal, although brain MRI may reveal T2-weighted-fluid-attenuated inversion recovery signals.[89-91] Patients should be treated with antibiotics and acyclovir until infection is excluded.[40,81-85] Methylprednisolone 1-2 mg/kg IV is recommended, although patients with the presence of severe symptoms or oligoclonal bands should be managed with methylprednisolone 1 g with IVIG.[81-85]

Other neurologic conditions include neuropathies, aseptic meningitis, multiple sclerosis, optic neuritis, and posterior reversible encephalopathy syndrome.[81-85,90,91]

Hematologic

Checkpoint inhibitors can affect all blood cell lines, resulting in a variety of hematologic abnormalities.[92-102] Anemia can be due do an autoimmune hemolytic type or aplastic.[92-97] Autoimmune hemolytic anemia can present with weakness, jaundice, pallor, dark urine, and fatigue. Evaluation includes CBC with differential, peripheral smear, reticulocyte count, lactate dehydrogenase, haptoglobin, coagulation panel, fibrinogen, and direct agglutinin test.[92-96] Treatment for confirmed hemolytic anemia includes prednisone 1-2 mg/kg/day with folic acid. Transfusion with irradiated and filtered products is recommended if hemoglobin is < 7 milligrams per deciliter (mg/dL).[32,92-97]

Immune thrombocytopenia presents with petechiae and bleeding.[2,37,97,98] Laboratory assessment is similar to that in hemolytic anemia, though testing for HIV and hepatitis B/C is recommended. Treatment includes prednisone and IVIG. Bone marrow aspiration may be required during admission.[2,37,97,98]

Lymphopenia may lead to opportunistic infections such as *Pneumocystis jirovecii* pneumonia (PJP), as well as other infections similar to human immunodeficiency virus (HIV).[2,3,37,97-100] Patients should be evaluated for HIV and cytomegalovirus (CMV). Chest radiograph, HIV testing, and CD4 T cell count are recommended.[2,3,37,97] If patients present with a lymphocyte count < 250 cells per millimeter cubed (cells/mm^3), then prophylaxis for PJP and mycobacterium avium complex is recommended.

Aplastic anemia presents with findings of anemia, thrombocytopenia, and lymphopenia/neutropenia.[2,3,97-101] Evaluation for viral diseases such as CMV, Epstein-Barr virus, HIV, and parvovirus is recommended, along with B12/folate levels and bone marrow aspiration during admission. Patients with severe aplastic anemia without a clear secondary cause may require anti-thymocyte globulin and cyclosporine.[2,3,40,97-101]

A dangerous hemolytic irAE is acquired thrombotic thrombocytopenic purpura (TTP) or atypical hemolytic uremic syndrome (aHUS).[2,3,40,92,97] Both conditions can present with non-palpable purpura, fever, abdominal pain/vomiting, and renal failure. TTP tends to present with neurologic abnormalities. Lactate dehydrogenase, haptoglobin, coagulation panel, fibrinogen, ADAMTS13 activity and inhibitor titer, complement, and urinalysis are recommended, along with the other common laboratory assessments for anemia. If diarrhea is present, testing for bacterial pathogens is recommended. Treatment depends on the diagnosis. Prednisone or methylprednisolone can be used, but for TTP, plasma exchange is recommended, while for aHUS eculizumab is recommended.[2,3,40,92,97]

Acquired hemophilia can occur due to inhibition of factor VIII.[97,101,102] Mixing studies and quantification of inhibitor levels are used to make the diagnosis. Treatment includes prednisone and/or other immunosuppressive therapies.[37,97]

Rheumatologic

Myalgias and arthralgias are present in 2-12% of patients, most commonly in those receiving anti-PD-1 agents.[37,40,91] However, vasculitis, myositis, and giant cell arteritis may occur. Patients with mild to moderate symptoms can be treated with acetaminophen and/or non-steroidal anti-inflammatory drugs. Prednisone can also be used. Severe symptoms should be treated with high-dose corticosteroids, with consultation with oncology and rheumatology.[2,3,37,40,91]

Ocular

Ocular toxicity is rare, occurring in 1% of patients.[2,3,103] These are divided into ocular inflammation including keratitis, uveitis and orbital inflammation, and retinal/choroidal disease. Patients may present with eye pain and vision changes. Treatment requires ophthalmology consultation with topical corticosteroids for episcleritis or anterior uveitis. Systemic corticosteroids are recommended for severe inflammation.[2,3,103]

Unique Toxicities of CAR T-Cell Therapy

Regarding CAR T-cell therapy, B cell aplasia is common with use of CD19-directed CAR T-cell therapy, given that CD19 is all expressed on normal mature B cells.[23-27] Hypogammaglobulinemia may be present due to B cell depletion. Other hematologic toxicities can occur such as anemia or thrombocytopenia.[23-27] Major side effects include cytokine release syndrome (CRS) and neurologic effects such as CAR T-cell-related encephalopathy syndrome (CRES).[27,104-106]

CRS occurs with massive release of cytokines.[104-106] It may affect up to 90% of patients receiving CAR T-cell therapy, with half severe, requiring critical care and vasopressors and/or ventilation.[107-110] Cytokines are proteins that act as signaling among cells and result in systemic inflammation. Interleukin (IL)-1 and IL-6 are central factors in CRS toxicity.[110-115] This may result in a variety of symptoms, ranging from mild flu-like symptoms to hypotension and death (Table 3).[104-106] Symptom onset in CRS varies, depending primarily on the agent and severity of immune cell activation. CRS most commonly occurs one to five days after CAR T-cell infusion, although it may occur weeks later.[104-115] Patients with large tumor burdens may experience more severe symptoms. There is no correlation between CRS and clinical response to therapy.[104-106]

As Table 3 demonstrates, signs and symptoms of CRS overlap with sepsis, macrophage activation syndrome (hemophagocytic lymphohistiocytosis), neutropenic fever, and tumor lysis syndrome.[104-106,116-120] Due to the increased levels of inflammatory markers, patients develop systemic inflammation, beginning with fever, which may reach over 40.0° C.[121] Fever usually precedes the onset of CRS by at least one day.[104-106,116-120] Those with fever receiving CAR T-cell therapy should be admitted and monitored for CRS. The severity can range from mild, treated with supportive care, to life-threatening, with a wide variety of signs and symptoms.[104-106,116-120] Flu-like symptoms such as fatigue, headache, rash, arthralgias, and myalgias are common. Severe cases can include hypotension and shock, disseminated intravascular coagulation, and multiorgan failure.[104-106,116-120] Respiratory symptoms such as cough and tachypnea can progress to acute respiratory distress syndrome. Cardiac toxicity can be life-threatening and presents in a similar manner to sepsis or stress cardiomyopathy; however, it is often reversible.[104-106,122,123]

The NCI has developed a grading system for severity (Table 4).[104-106] Laboratory results often reveal elevated liver function tests and bilirubin, increased or decreased white blood cells and platelets, low fibrinogen, elevated blood urea nitrogen (BUN), and increased D-dimer. Chest radiograph, urinalysis, and blood cultures are recommended due to the high risk of infection.[104-106,118] C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR) may be elevated, but normal results cannot exclude CRS. CRP is often elevated in CRS, as it is

Table 3. Cytokine release syndrome (CRS) signs and symptoms.[104-106]

Organ System	Patients signs and symptoms
Constitutional	Fever, fatigue, malaise, myalgias, arthralgias, anorexia
Cardiac	Tachycardia, hypotension, wide pulse pressure, cardiac dysfunction, cardiomyopathy
Dermatologic	Rash, pruritis
Pulmonary	Tachypnea, hypoxemia, dyspnea, acute respiratory distress síndrome
Gastrointestinal	Nausea/vomiting, diarrhea, transaminitis, elevated bilirubin, jaundice
Renal	Decreased urine output, azotemia, renal injury
Vascular	Hypofibrinogenemia, elevated D-dimer, coagulopathy, bleeding, disseminated intravascular coagulation
Neurologic	Headache, confusion, altered mental status, delirium, aphasia, hallucination, tremor, seizure, dysmetria, ataxia

associated with IL-6 production[117,124-127] However, CRP cannot differentiate between CRS and infection.[124-127] While not typically obtained in the ED, ferritin is often elevated in CRS, similar to that seen in macrophage activation syndrome.[104-106,128]

Management of CRS requires symptomatic care and cytokine inhibition. Depending on signs, symptoms, and patient hemodynamic status, patients may require IV fluids, vasopressors, and broad-spectrum antibiotics, as sepsis is possible (Table 4).[104-106,117,118] Management of CRS focuses on two medications: corticosteroids and tocilizumab, a humanized immunoglobulin that prevents IL-6 binding to other receptors and further cell signaling.[104-106] Literature suggests tocilizumab is an effective therapy for severe CRS, with improvement within hours of infusion.[129-131] Corticosteroids are generally avoided in CRS and should only be used in conjunction with oncology consultation, as these medications can adversely affect antitumor effects. This differs from checkpoint inhibitor therapy, in which corticosteroids do not affect the therapeutic effects on the malignancy.[117,132,133] However, if evidence of adrenal crisis is present, stress-dose corticosteroids are recommended. Patients with CRS require admission and consultation with oncology due to the potential severe nature of the condition.[104-106]

Differentiating CRS from infection and sepsis is difficult, as patients will typically meet systemic inflammatory response syndrome criteria and have greater than two points on the sequential organ failure assessment score.[118,121] One study found that 23% of patients developed infection in the first month of CAR T-cell therapy, with many infections occurring with onset of CRS.[118] Bacterial infections predominate, primarily of the respiratory tract. Thus, patients should be presumed to have infection, and antibiotics and resuscitation are recommended in the ED.[104-106]

Cytokine storm is due to nonspecific activation of T cells, usually rapidly after CAR T-cell infusion.[119,120] This condition is a separate entity from CRS, although the presentation is similar. Tumor necrosis factor and interferon gamma are the predominant factors resulting in cytokine storm.[104-106,119,120] As opposed to CRS, the primary therapy for cytokine storm includes corticosteroids with resuscitation. However, corticosteroids should only be initiated with oncologist consultation, as steroids can deplete CAR T-cells.[104-106]

Neurologic complications from CAR T-cell therapy present in a wide range, from mild headache to severe altered mental status and seizures.[104,120] Neurotoxicity is the second most common major adverse event with CAR T-cell therapy, officially known as CRES.[104-106] CRES does not always coincide with CRS, and symptoms can occur before, during, or after CRS.[104] A mechanism has not been definitely determined, although IL-1 may play a role. Tocilizumab is not effective in CRES as it does not cross the blood–brain barrier; however, anakinra, which blocks IL-1 receptors, may be beneficial.[105] Patients with severe neurologic symptoms should be managed with corticosteroids, primarily dexamethasone 10 mg IV due to its ability to cross the blood–brain barrier.[104,134]

What's the Emergency Physician to Do?

While irAEs from checkpoint inhibitors and complications of CAR T-cell therapy can be severe, physicians must consider several other causes of the patient's symptoms. Patients may be experiencing acute illness unrelated to the malignancy and therapy, complications of the malignancy itself (disease progression or other complication such as tumor lysis syndrome), complications of more traditional cancer therapies including chemotherapy and radiotherapy (radiation pneumonitis, opportunistic infections/neutropenic fever), and complications of the immune-based therapy itself (irAEs, underlying rheumatologic disorder, immune reconstitution syndrome).[1-3,12,35-40] With this wide differential of potentially dangerous conditions, patients may require emergent resuscitation.

Obtaining history of immune-based therapy is vital in the consideration of irAEs, CRS, or CRES. In the ED, biomarkers

Table 4. Grading cytokine release syndrome to guide treatment.[104-106]

Grade	Toxicity/Symptoms	Treatment
1	Symptoms are not life-threatening and include fever, nausea, fatigue, headache, myalgias	Provide symptomatic therapy, assess for infection, can continue infusion
2	Symptoms require but respond to moderate intervention: -Oxygen requirement < 40% or -Hypotension responsive to fluid or low dose of one vasopressor or -Grade 2 organ toxicity	Discontinue infusion, provide oxygen and symptomatic therapy (acetaminophen, IV fluids, NSAIDs), assess for infection
3	Symptoms require and respond to aggressive intervention: -Oxygen requirement > 40% or -Hypotension requiring high dose or multiple vasopressors or -Grade 3 organ toxicity or grade 4 transaminitis	Stop infusion, treat for infection, admit patient, provide oxygen, administer fluids and vasopressors, consider tocilizumab with steroids
4	Life-threatening symptoms: -Requirement for ventilator support or -Grade 4 organ toxicity (excluding transaminitis)	Treat as Grade 3, treat other complications (ventilator support often required)
5	Death	

such as interleukin levels are not readily available. Laboratory assessment should include CBC with differential, renal function and electrolytes, coagulation studies, liver function testing, cortisol, TSH, and urinalysis. Inflammatory markers such as CRP and ESR may be beneficial but cannot definitively diagnose the condition or exclude infection. Suspicion of an infectious etiology requires blood cultures and antibiotics. Bedside echocardiography can assist in assessment of the cardiopulmonary system.[1-4,12,35-40]

Management focuses on the specific organ involved, with resuscitation and antibiotics. For severe, critical illness, the checkpoint inhibitor should be discontinued if an irAE is likely. Early initiation of a corticosteroid improves prognosis with irAEs due to checkpoint inhibitors, except for those with endocrinopathies, and most patients improve within 2-3 days. If patients do not improve, there are other immunosuppressive agents that can be used.[1-3,71] Recurrence of an irAE can be seen with corticosteroid tapering and checkpoint inhibitor reinitiation.[1-3,12,37] Regarding CRS related to CAR T-cell therapy, patients should be admitted to the ICU for tocilizumab, and CRES requires ICU admission and corticosteroids.[35-40]

CONCLUSION

Immune-based therapies consist of immune stimulators, checkpoint inhibitors, and adoptive immunotherapy. These therapies differ in mechanism compared to other anticancer therapies, namely chemotherapy and radiation. Complications include irAEs, CRS, autoimmune toxicity, and CRES. Immune-related adverse events, most commonly encountered with checkpoint inhibitors, may result in dermatologic complications, pneumonitis, colitis/diarrhea, hepatitis, and endocrinopathies. Less common irAEs include nephritis, myocardial injury, neurologic toxicity, ocular diseases, and musculoskeletal complications. Cytokine release syndrome and CRES are more commonly associated with CAR T-cell therapy. Cytokine release syndrome may present with flu-like illness, but severe myocardial and pulmonary disease may occur. Critically ill patients require resuscitation, broad-spectrum antibiotics, and hematology/oncology consultation.

ACKNOWLEDGMENTS

BL, EB, and AK conceived the idea for this manuscript and contributed substantially to the writing and editing of the review. This manuscript did not use any grants or funding, and it has not been presented in abstract form. This review does not reflect the views or opinions of the U.S. government, Department of Defense, U.S. Army, U.S. Air Force, Brooke Army Medical Center, or SAUSHEC EM Residency Program.

Address for Correspondence: Brit Long, MD, Brooke Army Medical Center, Department of Emergency Medicine, 3841 Roger Brooke Dr, Fort Sam Houston, TX 78234. Email: brit.long@yahoo.com.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Dubbs SB. The latest cancer agents and their complications. *Emerg Med Clin North Am*. 2018;36:485-92.
2. Brahmer JR, Lacchetti C, Schneider BJ, et al; National Comprehensive Cancer Network. Management of Immune-Related Adverse Events in Patients Treated With Immune Checkpoint Inhibitor Therapy: American Society of Clinical Oncology Clinical Practice Guideline. *J Clin Oncol*. 2018;36(17):1714-1768.
3. Haanen JBAG, Carbonnel F, Robert C, et al; ESMO Guidelines Committee. Management of toxicities from immunotherapy: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Ann Oncol*. 2017;28(suppl_4):iv119-iv142.
4. Hodi FS, O'Day SJ, McDermott DF, et al. Improved survival with ipilimumab in patients with metastatic melanoma. *N Engl J Med*. 2010;363(8):711-723.
5. Topalian SL, Hodi FS, Brahmer JR, et al. Safety, activity, and immune correlates of anti-PD-1 antibody in cancer. *N Engl J Med*. 2012;366(26):2443-2454.
6. Page DB, Postow MA, Callahan MK, et al. Immune modulation in cancer with antibodies. *Annu Rev Med*. 2014;65:185-202.
7. Smith KA, Gilbride KJ, Favata MF. Lymphocyte activating factor promotes T-cell growth factor production by cloned murine lymphoma cells. *Nature*. 1980;287:853–5.
8. Rosenberg SA, Grimm EA, McGrogan M, et al. Biological activity of recombinant human interleukin-2 produced in *Escherichia coli*. *Science*. 1984;223:1412–4.
9. Rosenberg SA, Lotze MT, Muul LM, et al. Observations on the systemic administration of autologous lymphokine-activated killer cells and recombinant interleukin-2 to patients with metastatic cancer. *N Engl J Med*. 1985;313:1485–92.

10. Negrier S, Maral J, Drevon M, et al. Long-term follow-up of patients with metastatic renal cell carcinoma treated with intravenous recombinant interleukin-2 in Europe. *Cancer J Sci Am*. 2000;6 Suppl 1:S93-8.
11. Hryniewicki AT, Wang C, Shatsky RA, et al. Management of immune checkpoint inhibitor toxicities: a review and clinical guideline for emergency physicians. *J Emerg Med*. 2018;55(4):489-502.
12. Simmons D, Lang E. The most recent oncologic emergency: what emergency physicians need to know about the potential complications of immune checkpoint inhibitors. *Cureus.* 2017;9(10):e1774.
13. Pardoll DM. The blockade of immune checkpoints in cancer immunotherapy. *Nat Rev Cancer*. 2012;12:252–264.
14. Kroschinsky F, Stolzel F, von Bonin S, et al. New drugs, new toxicities: severe side effects of modern targeted and immunotherapy of cancer and their management. *Crit Care.* 2017;21:89.
15. Topalian SL, Drake CG, Pardoll DM. Targeting the PD-1/B7-H1(PD-L1) pathway to activate anti-tumor immunity. *Curr Opin Immunol*. 2012;24:207–12.
16. Tumeh PC, Harview CL, Yearley JH, et al. PD-1 blockade induces responses by inhibiting adaptive immune resistance. *Nature*. 2014; 515:568–71.
17. Kostine M, Chiche L, Lazaro E, et al. Opportunistic autoimmunity secondary to cancer immunotherapy (OASI): an emerging challenge. *Rev Med Interne*. 2017;38:513–25.
18. Judd J, Zibelman M, Handorf E, et al. Immune-related adverse events as a biomarker in non-melanoma patients treated with programmed cell death 1 inhibitors. *Oncologist.* 2017;22:1232–7.
19. Kumar V, Chaudhary N, Garg M, et al. Current diagnosis and management of immune related adverse events (irAEs) induced by immune checkpoint inhibitor therapy. *Front Pharmacol*. 2017;8:49.
20. Blumenthal GM, Pazdur R. Approvals in 2016: the march of the checkpoint inhibitors. *Nat Rev Clin Onco.l* 2017;14:131–2.
21. Peng TR, Wu TW. Efficacy of PD-1/PD-L1 inhibitors in patients with advanced non-small cell lung cancer: a meta-analysis of randomized clinical trials. *Thorac Cancer*. 2019;10(5):1176-81.
22. Khan M[1], Lin J[1], Liao G[1], et al. Comparative analysis of immune checkpoint inhibitors and chemotherapy in the treatment of advanced non-small cell lung cancer: a meta-analysis of randomized controlled trials. *Medicine (Baltimore).* 2018 Aug;97(33):e11936.
23. June CH, O'Connor RS, Kawalekar OU, et al. CAR T cell immunotherapy for human cancer. *Science*. 2018;359(6382):1361–5.
24. June CH, Sadelain M. Chimeric antigen receptor therapy. *N Engl J Med*. 2018;379(1):64–73.
25. Sadelain M, Brentjens R, Riviere I. The basic principles of chimeric antigen receptor design. *Cancer Discov*. 2013;3(4):388–98.
26. Sadelain M, Brentjens R, Riviere I, et al. CD19 CAR therapy for acute lymphoblastic leukemia. *Am Soc Clin Oncol Educ Book*. 2015:e360–3
27. Zhao Z, Chen Y, Francisco NM, et al. The application of CAR-T cell therapy in hematological malignancies: advantages and challenges. *Acta Pharm Sin B*. 2018;8(4):539–551.
28. Neelapu SS, Locke FL, Bartlett NL, et al. Kte-C19 (anti-CD19 CAR T cells) induces complete remissions in patients with refractory diffuse large B-cell lymphoma (DLBCL): results from the pivotal phase 2 Zuma-1. *Blood.* 2016;128(22):LBA-6-LBA-6.
29. Shibahara I, Saito R, Zhang R, et al. OX40 ligand expressed in glioblastoma modulates adaptive immunity depending on the microenvironment: a clue for successful immunotherapy. *Mol Cancer*. 2015;14:41.
30. Turtle CJ, Hanafi LA, Berger C, et al. Immunotherapy of non-Hodgkin's lymphoma with a defined ratio of CD8+ and CD4+ CD19-specific chimeric antigen receptor-modified T cells. *Sci Transl Med*. 2016;8(355):355ra116.
31. Wang Y, Chen M, Wu Z, et al. CD133-redirected chimeric antigen receptor engineered autologous T-cell treatment in patients with advanced and metastatic malignancies. *J Clin Oncol*. 2017;35(15_ suppl):3042.
32. Hegde M, Wakefield A, Brawley VS, et al. Genetic modification of T cells with a novel bispecific chimeric antigen receptor to enhance the control of high-grade glioma (HGG). *J Clin Oncol*. 2014;32(15_suppl):10027.
33. Hege KM, Bergsland EK, Fisher GA, et al. Safety, tumor trafficking and immunogenicity of chimeric antigen receptor (CAR)-T cells specific for TAG-72 in colorectal cancer. *J Immunother Cancer*. 2017;5:22.
34. Filley AC, Henriquez M, Dey M. CART Immunotherapy: development, success, and translation to malignant gliomas and other solid tumors. *Front Oncol*. 2018;8:453.
35. Postow MA. Managing immune checkpoint-blocking antibody side effects. *Am Soc Clin Oncol Educ Book*. 2015;35:76–83.
36. Friedman CF, Proverbs-Singh TA, Postow MA. Treatment of the immune-related adverse effects of immune checkpoint inhibitors: a review. *JAMA Oncol*. 2016;2:1346–1353.
37. Spain L, Diem S, Larkin J. Management of toxicities of immune checkpoint inhibitors. *Cancer Treat Rev*. 2016;44:51–60.
38. Postow MA, Sidlow R, Hellmann MD. Immune-related adverse events associated with immune checkpoint blockade. *N Engl J Med*. 2018;378:158–168.
39. Michot JM, Bigenwald C, Champiat S, et al. Immune-related adverse events with immune checkpoint blockade: a comprehensive review. *Eur J Cancer.* 2016;54:139–48.
40. Puzanov I, Diab A, Abdallah K, et al. Managing toxicities associated with immune checkpoint inhibitors: consensus recommendations from the Society for Immunotherapy of Cancer (SITC) Toxicity Management Working Group. *J Immunother Cancer*. 2017;5:95.
41. Weber JS, Hodi FS, Wolchok JD, et al. Safety profile of nivolumab monotherapy: a pooled analysis of patients with advanced melanoma. *J Clin Oncol*. 2017;35:785–792.
42. Culakova E, Thota R, Poniewierski MS, et al. Patterns of chemotherapy-associated toxicity and supportive care in US oncology practice: a nationwide prospective cohort study. *Cancer Med*. 2014;3:434–444.
43. Brahmer JR, Tykodi SS, Chow LQM, et al. Safety and activity of anti-PD-L1 antibody in patients with advanced cancer. *N Engl J Med.* 2012;366:2455–65.
44. Fujii T, Colen RR, Bilen MA, et al. Incidence of immune-related adverse events and its association with treatment outcomes: the MD Anderson Cancer Center experience. *Invest New Drugs.* 2018;36(4):638-46.
45. Villadolid J, Amin A. Immune checkpoint inhibitors in clinical practice:

update on management of immune-related toxicities. *Transl Lung Cancer Res*. 2015;4:560–75.

46. Bertrand A, Kostine M, Barnetche T, et al. Immune related adverse events associated with anti-CTLA-4 antibodies: systematic review and meta-analysis. *BMC Med.* 2015;13:211.
47. U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute. Common Terminology Criteria for Adverse Events (CTCAE), 4.03. Bethesda, MD: National Institutes of Health; 2010.
48. Friedman CF, Proverbs-Singh TA, Postow MA. Treatment of the immune-related adverse effects of immune checkpoint inhibitors: a review. *JAMA Oncol*. 2016;2:1346–53.
49. Champiat S, Lambotte O, Barreau E, et al. Management of immune checkpoint blockade dysimmune toxicities: a collaborative position paper. *Ann Oncol*. 2016;27:559–574.
50. Larkin J, Hodi FS, Wolchok JD. Combined nivolumab and ipilimumab or monotherapy in untreated melanoma. *N Engl J Med*. 2015; 373:1270–1.
51. Wu Y, Shi H, Jiang M, et al. The clinical value of combination of immune checkpoint inhibitors in cancer patients: a meta-analysis of efficacy and safety. *Int J Cancer*. 2017;141:2562–70.
52. Lin Z, Chen X, Li Z, et al. PD-1 antibody monotherapy for malignant melanoma: a systematic review and meta-analysis. *PLoS One*. 2016;11:e0160485.
53. Eggermont AM, Chiarion-Sileni V, Grob JJ, et al. Prolonged survival in stage III melanoma with ipilimumab adjuvant therapy. *N Engl J Med*. 2016;375:1845–55.
54. Naidoo J, Page DB, Li BT, et al. Toxicities of the anti-PD-1 and anti-PD-L1 immune checkpoint antibodies. *Ann Oncol*. 2015;26:2375–2391.
55. El Majzoub I, Qdaisat A, Thein KZ, et al. Adverse effects of immune checkpoint therapy in cancer patients visiting the emergency department of a comprehensive cancer center. *Ann Emerg Med*. 2019;73(1):79-87.
56. Weber JS, Kahler KC, Hauschild A. Management of immune related adverse events and kinetics of response with ipilimumab. *J Clin Oncol*. 2012;30:2691–7.
57. Weber JS, Postow M, Lao CD, et al. Management of adverse events following treatment with anti-programmed death-1 agents. *Oncologist*. 2016;21:1230–1240.
58. Ludlow SP, Kay N. Delayed dermatologic hypersensitivity reaction secondary to ipilimumab. *J Immunother*. 2015;38:165–6.
59. Varricchi G, Galdiero MR, Marone G, et al. Cardiotoxicity of immune checkpoint inhibitors. *ESMO Open*. 2017;2(4):e000247.
60. Wang DY, Okoye GD, Neilan TG, et al. Cardiovascular toxicities associated with cancer immunotherapies. *Curr Cardiol Rep*. 2017;19:21.
61. Johnson DB, Sullivan RJ, Menzies AM. Immune checkpoint inhibitors in challenging populations. *Cancer*. 2017;123:1904–11.
62. Jain D, Russell RR, Schwartz RG, et al. Cardiac complications of cancer therapy: pathophysiology, identification, prevention, treatment, and future directions. *Curr Cardiol Rep*. 2017;19:36.
63. Eigentler TK, Hassel JC, Berking C, et al. Diagnosis, monitoring and management of immune-related adverse drug reactions of anti-PD-1 antibody therapy. *Cancer Treat Rev*. 2016;45:7–18.
64. Postow MA, Callahan MK, Wolchok JD. Immune checkpoint blockade in cancer therapy. *J Clin Oncol.* 2015;33:1974–82.
65. Naidoo J, Wang X, Woo K, et al. Pneumonitis in patients treated with anti-programmed death-1/programmed death ligand 1 therapy. *J Clin Oncol*. 2017;35(7):709-717.
66. Nishino M, Giobbie-Hurder A, Hatabu H, et al. Incidence of programmed cell death 1 inhibitor-related pneumonitis in patients with advanced cancer: a systematic review and meta-analysis. *JAMA Oncol*. 2016;2:1607–16.
67. Suresh K, Naidoo J, Lin C, Danoff S. Immune checkpoint immunotherapy for non-small cell lung cancer: benefits and pulmonary toxicities. *Chest*. 2018;154(6):1416-1423.
68. Nishino M, Chambers E, Chong C, et al. Anti-PD-1 Inhibitor-related pneumonitis in non-small cell lung cancer. *Cancer Immunol Res*. 2016;4(4):289-293.
69. Divatia J, Khan P, Myatra S. Tracheal intubation in the ICU: life saving or life threatening? *Indian J Anaesth*. 2011;55(5):470-475.
70. Grover S, Rahma O, Hashemi N, Lim R. Gastrointestinal and hepatic toxicities of checkpoint inhibitors: algorithms for management. *Am Soc Clin Oncol Educ Book*. 2018;(38):13-19.
71. Horvat TZ, Adel NG, Dang TO, et al. Immune-related adverse events, need for systemic immunosuppression, and effects on survival and time to treatment failure in patients with melanoma treated with ipilimumab at Memorial Sloan Kettering Cancer Center. *J Clin Oncol*. 2015;33:3193–3198.
72. Kim KW, Ramaiya NH, Krajewski KM, et al. Ipilimumab-associated colitis: CT findings. *AJR Am J Roentgenol*. 2013;200:W468–74.
73. Pagès C, Gornet JM, Monsel G, et al. Ipilimumab-induced acute severe colitis treated by infliximab. *Melanoma Res*. 2013;23:227–230.
74. Merrill SP, Reynolds P, Kalra A, et al. Early administration of infliximab for severe ipilimumab-related diarrhea in a critically ill patient. *Ann Pharmacother*. 2014;48:806–810.
75. Belli C, Zuin M, Mazzarella L, et al. Liver toxicity in the era of immune checkpoint inhibitors: a practical approach. *Crit Rev Oncol Hematol*. 2018;132:125-129.
76. Escandon J, Peacock S, Trabolsi A, et al. Interstitial nephritis in melanoma patients secondary to PD-1 checkpoint inhibitor. *J Immunother Cancer*. 2017;5:3.
77. Belliere J, Meyer N, Mazieres J, et al. Acute interstitial nephritis related to immune checkpoint inhibitors. *Br J Cancer*. 2016;115(12):1457-1461.
78. Wolchok JD, Chiarion-Sileni V, Gonzalez R et al. Overall survival with combined nivolumab and ipilimumab in advanced melanoma. *N Engl J Med.* 2017; 377:1345-56.
79. Yu C, Chopra IJ, Ha E. A novel melanoma therapy stirs up a storm: ipilimumab-induced thyrotoxicosis. *Endocrinol Diabetes Metab Case Rep*. 2015;2015:140092.
80. Martin-Liberal J, Furness AJS, Joshi K, et al. Anti-programmed cell death-1 therapy and insulin-dependent diabetes: a case report. *Cancer Immunol Immunother*. 2015;64:765–767.
81. Fellner A, Makranz C, Lotem M, et al. Neurologic complications of immune checkpoint inhibitors. *J Neuro-Oncology*. 2018;137:601–609.
82. Astaras C, Michell R, Moura B, et al. Neurological adverse events associated with immune checkpoint inhibitors: diagnosis and

management. *Curr Neurol Neurosci Rep*. 2018;18:3.
83. Hottinger AF. Neurologic complications of immune checkpoint inhibitors. *Curr Opin Neurol*. 2016; 29: 806–812.
84. Wick W, Hertenstein A, Platten M. Neurological sequelae of cancer immunotherapies and targeted therapies. *Lancet Oncol*. 2016; 17: e529–e541.
85. Kao JC, Liao B, Markovic SN, et al. Neurological complications associated with anti-programmed death 1 (PD-1) antibodies. *JAMA Neurol*. 2017;74:1216–1222.
86. Gonzalez NL, Puwanant A, Lu A, et al. Myasthenia triggered by immune checkpoint inhibitors: new case and literature review. *Neuromuscul Disord*. 2017;27:266–268.
87. Wilgenhof S, Neyns B. Anti-CTLA-4 antibody-induced Guillain–Barré syndrome in a melanoma patient. *Ann Oncol*. 2011;22:991–993.
88. Spain L, Walls G, Julve M, et al. Neurotoxicity from immune-checkpoint inhibition in the treatment of melanoma: a single centre experience and review of the literature. *Ann Oncol*. 2017;28:377–385.
89. Yshii LM, Hohlfeld R, Liblau RS. Inflammatory CNS disease caused by immune checkpoint inhibitors: status and perspectives. *Nat Rev Neurol*. 2017;13(12):755–763.
90. Cuzzubbo S, Javeri F, Tissier M, et al. Neurological adverse events associated with immune checkpoint inhibitors: review of the literature. *Eur J Cancer.* 2017;73:1–8.
91. Zimmer L, Goldinger SM, Hofmann L, et al. Neurological, respiratory, musculoskeletal, cardiac and ocular side-effects of anti-PD-1 therapy. *Eur J Cancer.* 2016;60:210–225.
92. Davis EJ, Salem JE, Young A, et al. Hematologic complications of immune checkpoint linhibitors. *Oncologist*. 2019;24(5):584-588.
93. Kong BY, Micklethwaite KP, Swaminathan S, et al. Autoimmune hemolytic anemia induced by anti-PD-1 therapy in metastatic melanoma. *Melanoma Res*. 2016;26:202–204.
94. Nair R, Gheith S, Nair SG. Immunotherapy associated hemolytic anemia with pure red-cell aplasia. *N Engl J Med*. 2016;374:1096–1097.
95. Palla AR, Kennedy D, Mosharraf H et al. Autoimmune hemolytic anemia as a complication of nivolumab therapy. *Case Rep Oncol*. 2016;9:691–697.
96. Helgadottir H, Kis L, Ljungman P et al. Lethal aplastic anemia caused by dual immune checkpoint blockade in metastatic melanoma. *Ann Oncol*. 2017; 28:1672–1673.
97. Delanoy N, Michot JM, Comont T, et al. Haematological immune-related adverse events induced by anti-PD-1 or anti-PD-L1 immunotherapy: a descriptive observational study. *Lancet Haematol*. 2019;6(1):e48-e57.
98. Shiuan E, Beckermann KE, Ozgun A, et al. Thrombocytopenia in patients with melanoma receiving immune checkpoint inhibitor therapy. *J Immunother Cancer*. 2017;5:8.
99. Inadomi K, Kumagai H, Arita S, et al. Bicytopenia possibly induced by anti-PD-1 antibody for primary malignant melanoma of the esophagus: A case report. *Medicine (Baltimore)*. 2016;95:e4283.
100. Cooling LL, Sherbeck J, Mowers JC, et al. Development of red blood cell autoantibodies following treatment with checkpoint inhibitors: A new class of anti-neoplastic, immunotherapeutic agents associated with immune dysregulation. *Immunohematology*. 2017;33:15-21.
101. Delyon J, Mateus C, Lambert T. Hemophilia A induced by ipilimumab. *N Engl J Med*. 2011;365:1747-1748.
102. Lozier J. More on hemophilia A induced by ipilimumab. *N Engl J Med.* 2012;366:280-281.
103. Antoun J, Titah C, Cochereau I. Ocular and orbital side-effects of checkpoint inhibitors: a review article. *Curr Opin Oncol.* 2016;28:288–294.
104. Lee DW, Gardner R, Porter DL, et al. Current concepts in the diagnosis and management of cytokine release syndrome [published correction appears in Blood. 2015 Aug 20;126(8):1048. Dosage error in article text]. *Blood*. 2014;124(2):188–195.
105. Liu D, Zhao J. Cytokine release syndrome: grading, modeling, and new therapy. *J Hematol Oncol*. 2018;11(1):121.
106. Shimabukuro-Vornhagen A, Gödel P, Subklewe M, et al. Cytokine release syndrome. *J Immunother Cancer*. 2018;6(1):56.
107. Maude SL, Laetsch TW, Buechner J, et al. Tisagenlecleucel in children and young adults with B-cell lymphoblastic leukemia. *N Engl J Med*. 2018;378(5):439–48.
108. Park JH, Rivière I, Gonen M, et al. Long-term follow-up of CD19 CAR therapy in acute lymphoblastic leukemia. *N Engl J Med*. 2018;378:449–59.
109. Santomasso BD, Park JH, Salloum D, et al. Clinical and biologic correlates of neurotoxicity associated with CAR T cell therapy in patients with B-cell acute lymphoblastic leukemia (B-ALL). *Cancer Discov*. 2018;8(8):958–971.
110. Zhang L-N, Song Y, Liu D. CD19 CAR-T cell therapy for relapsed/refractory acute lymphoblastic leukemia: factors affecting toxicities and long-term efficacies. *J Hematol Onc*. 2018;11(1):41.
111. Scheller J, Chalaris A, Schmidt-Arras D, et al. The pro- and anti-inflammatory properties of the cytokine interleukin-6. *Biochim Biophys Acta*. 2011;1813(5):878-888.
112. Winkler U, Jensen M, Manzke O, et al. Cytokine release syndrome in patients with B-cell chronic lymphocytic leukemia and high lymphocyte counts after treatment with an anti-CD20 monoclonal antibody (rituximab, IDEC-C2B8). *Blood.* 1999;94(7):2217-24.
113. Teachey DT, Rheingold SR, Maude SL, et al. Cytokine release syndrome after blinatumomab treatment related to abnormal macrophage activation and ameliorated with cytokine-directed therapy. *Blood*. 2013;121(26):5154-7.
114. Brentjens RJ, Davila ML, Riviere I, et al. CD19-targeted T cells rapidly induce molecular remissions in adults with chemotherapy-refractory acute lymphoblastic leukemia. *Sci Transl Med*. 2013;5(177):177ra38.
115. Tanaka T, Narazaki M, Kishimoto T. Immunotherapeutic implications of IL-6 blockade for cytokine storm. *Immunotherapy*. 2016;8(8):959-70.
116. Klinger M, Brandl C, Zugmaier G, et al. Immunopharmacologic response of patients with B-lineage acute lymphoblastic leukemia to continuous infusion of T cell-engaging CD19/CD3-bispecific BiTE antibody blinatumomab. *Blood*. 2012;119:6226–33.
117. Davila ML, Riviere I, Wang X, et al. Efficacy and toxicity management of 19-28z CAR T cell therapy in B cell acute lymphoblastic leukemia. *Sci Transl Med*. 2014;6:224ra25.
118. Hill JA, Li D, Hay KA, Green ML, et al. Infectious complications of CD19-targeted chimeric antigen receptor-modified T cell immunotherapy.

Blood. 2018;131(1):121-130.

119. Porter D, Frey N, Wood PA, Weng Y, Grupp SA. Grading of cytokine release syndrome associated with the CAR T cell therapy tisagenlecleucel. *J Hematol Oncol.* 2018;11(1):35.
120. Neelapu SS, Tummala S, Kebriaei P, et al. Chimeric antigen receptor T-cell therapy - assessment and management of toxicities. *Nat Rev Clin Oncol*. 2018;15:47–62.
121. Singer M, Deutschman CS, Seymour CW, et al. The third international consensus definitions for sepsis and septic shock (Sepsis-3). *JAMA*. 2016;315:801–10.
122. Romero-Bermejo FJ, Ruiz-Bailen M, Gil-Cebrian J, et al. Sepsis-induced cardiomyopathy. *Curr Cardiol Rev*. 2011;7(3):163-183.
123. Singh K, Carson K, Shah R, et al. Meta-analysis of clinical correlates of acute mortality in takotsubo cardiomyopathy. *Am J Cardiol*. 2014;113(8):1420-1428.
124. Schultz DR, Arnold PI. Properties of four acute phase proteins: C-reactive protein, serum amyloid A protein, alpha 1-acid glycoprotein, and fibrinogen. *Semin Arthritis Rheum*. 1990;20(3):129-147.
125. Pepys MB, Hirschfield GM. C-reactive protein: a critical update. *J Clin Invest*. 2003;111(12):1805-1812.
126. Arkader R, Troster EJ, Lopes MR, et al. Procalcitonin does discriminate between sepsis and systemic inflammatory response syndrome. *Arch Dis Child*. 2006;91(2):117-120.
127. Teachey DT, Lacey SF, Shaw PA, et al. Identification of predictive biomarkers for cytokine release syndrome after chimeric antigen receptor T cell therapy for acute lymphoblastic leukemia. *Cancer Discov*. 2016;6(6):664-79.
128. Kantarjian H, Stein A, Gökbuget N, et al. Blinatumomab versus chemotherapy for advanced acute lymphoblastic leukemia. *N Engl J Med*. 2017;376:836–47.
129. Grupp SA, Kalos M, Barrett D, et al. Chimeric antigen receptor-modified T cells for acute lymphoid leukemia. *N Engl J Med*. 2013;368(16):1509-1518.
130. Winkler U, Jensen M, Manzke O, et al. Cytokine-release syndrome in patients with B-cell chronic lymphocytic leukemia and high lymphocyte counts after treatment with an anti-CD20 monoclonal antibody (rituximab, IDEC-C2B8). *Blood*. 1999;94(7):2217-2224.
131. Reagan JL, Fast LD, Safran H, et al. Cellular immunotherapy for refractory hematological malignancies. *J Transl Med*. 2013;11:150.
132. Kolb HJ. Graft-versus-leukemia effects of transplantation and donor lymphocytes. *Blood*. 2008;112(12):4371-4383
133. Fecher LA, Agarwala SS, Hodi FS, et al. Ipilimumab and its toxicities: a multidisciplinary approach. *Oncologist.* 2013;18(6):733-743.
134. Mitchell CD, Richards SM, Kinsey SE, et al. Medical Research Council Childhood Leukaemia Working Party. Benefit of dexamethasone compared with prednisolone for childhood acute lymphoblastic leukaemia: results of the UK Medical Research Council ALL97 randomized trial. *Br J Haematol*. 2005;129(6):734-745.

Standards of Care for Children in Emergency Departments: International Federation of Emergency Medicine Agenda for the Care of Children

Camilo E. Gutierrez, MD*
Marianne Gausche-Hill, MD†
Rodrick K. Lim, MD‡

*Children's National Hospital, George Washington University School of Medicine and Health Sciences, Division of Emergency Medicine and Trauma Center, Washington, District of Columbia
†Los Angeles County Emergency Medical Services Agency, Harbor-UCLA Medical Center, David Geffen School of Medicine at UCLA, Department of Emergency Medicine, Los Angeles, California
‡Children's Hospital at LHSC, Department of Pediatrics and Medicine, Schulich School of Medicine & Dentistry-Western University, London, Ontario, Canada

Section Editor: Mark I. Langdorf, MD, MHPE
Submission history: Submitted January 22, 2020; Revision received January 25, 2020; Accepted February 11, 2020
Electronically published April 21, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.2.46917
[West J Emerg Med. 2020;21(3)581-582.]

Pediatric emergency medicine (PEM) is a relatively recent subspecialty, recognized in the United States in 1992.[1] This came almost 13 years after emergency medicine (EM) was recognized as a specialty,[2] and after the healthcare system recognized that the care of children requires specific knowledge and skills different from adults. Over the next decade, PEM progressed in the US and in parallel in Canada, the United Kingdom, and Australia as EM systems matured. To date, PEM is still an under-represented specialty, with only a dozen countries recognizing it as a distinct specialty, and only half of those offering accredited PEM training program.

Regardless of the maturity of PEM systems in developing countries, there is widespread disparity in mortality by geography and income. The burden of deaths of children in regions of the world such as sub-Saharan Africa and South Asia[3] is overwhelming. It is estimated that, in a given year, almost 4.5 million children under five would have survived had the mortality rate in their country been as low as the lowest in their region, and lower still if they could match that of Australia and New Zealand.[4]

The International Federation of Emergency Medicine (IFEM) is the umbrella association of EM globally, and is composed of over 60 national EM associations.[5] IFEM represents a coordinated consortium of these organizations with the vision to lead, promote access, and advance the growth of EM. The Pediatric Emergency Medicine Special Interest Group (PEMSIG) is one of the leading special-interest groups in IFEM. Part of its mission is to promote best practices in PEM education and training, as well as aid in the development of PEM globally. PEMSIG achieves this through promoting the need for specialized care for children, and supporting individuals and societies to develop acute care systems for the care of children.

As part of its effort to support and improve pediatric care globally, PEMSIG developed the third revision of the *Standards for the Care of Children in the Emergency Department* (*StandardsV3*).[6] In this document, PEMSIG offers a thorough examination of the key aspects of emergency care of children and offers recommendations regarding the standards that should be attained by those managing emergency departments where children are seen. Recommendations include that emergency clinicians be aware of issues around consent for care, reporting of child maltreatment, and safe discharge of children. They also address the need for education of emergency clinicians in the immediate care of children requiring resuscitation, and establishing information systems, data collection, and quality improvement processes. A complete list of essential and aspirational recommendations is found in the *StandardsV3* document (https://www.ifem.cc/wp-content/uploads/2019/06/Standards-of-Care-for-Children-in-Emergency-Departments-V3-2019.pdf).[6]

It is important to understand that these *StandardsV3* are not the ultimate and most comprehensive guideline for pediatric emergency care. Rather, they form the foundation by providing recommendations and standards for any clinician and service that cares for children. Our hope is that the promulgation and dissemination of these *StandardsV3* will augment clinical knowledge and basic equipment requirements, but also aid clinicians, managers, and policy-makers to advocate for improvements in the quality of emergency care of children. This in turn will promote more formal development of PEM systems at local and national levels.

Address for Correspondence: Camilo E. Gutierrez, MD, Children's National Hospital, Division of Emergency Medicine and Trauma Center, 111 Michigan Avenue, NW, Washington, DC 20010. Email: cgutierrez@childrensnational.org.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Pena EM, Snyder BL. Pediatric emergency medicine. The history of a growing discipline. *Emerg Clin North Am.* 1995;13(2):235.
2. Zink BJ. *Anyone, Anything, Anytime: A History of Emergency Medicine* (2nd ed). 2006. Elsevier Health Sciences. Philidelphia, PA.
3. Li Z, Hsiao Y, Godwin J, et al. Changes in the spatial distribution of the under-five mortality rate: small area analysis of 122 DHS surveys in 262 subregions of 35 countries in Africa. *PLoS One*. 2019;14(1):e0210645.
4. United Nations Inter-agency Group for Child Mortality Estimation (UN IGME). 2018. Levels and Trends in Child Mortality: Report 2018; estimates developed by the United Nations Inter-agency Group for Child Mortality Estimation. United Nations Children's Fund, New York.
5. Member Organizations. International Federation for Emergency Medicine. Available at: https://www.ifem.cc/membership/member-organisations/. Accessed January 22, 2020.
6. Standards of Care for Children in Emergency Departments Version 3.0. International Federation for Emergency Medicine. Available at: https://www.ifem.cc/wp-content/uploads/2019/06/Standards-of-Care-for-Children-in-Emergency-Departments-V3-2019.pdf. Accessed August 23, 2019.

HIPAA Versus CIPA (California Invasion of Privacy Act): Are Physicians Protected from Live Social Media Streaming in the Emergency Department?

Nicolas T. Sawyer, MD, MBA* *University of California, Davis, Department of Emergency Medicine, Davis, California
Maria Nguyen, BS† †University of California, Irvine, Department of Emergency Medicine, Orange, California

Section Editor: Mark I. Langdorf, MD, MHPE
Submission history: Submitted January 19, 2020; Revision received February 12, 2020; Accepted February 14, 2020
Electronically published April 13, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.2.47022
[West J Emerg Med. 2020;21(3)583–585.]

The Problem

In a 2015 study by Elwin et al, approximately one in six patients stated they had secretly recorded a clinical interaction with their physician. Some patients stated they did it in hopes of replaying or relistening to the recording, while others stated they recorded their encounter to provide proof of their perceived negative healthcare experience. In the current age of ubiquitous Internet connectivity and the ability to share anything on social media at a moment's notice, it is critical that physicians be aware of laws enacted to protect our safety and integrity as practicing clinicians in the 21st century.[1]

What would *you* do if you discovered a patient had broadcast your clinical encounter in the emergency department (ED) live on social media? Who would you look to for help, and would they feel compelled to help you? What does the law say? In October 2018 this happened to me, and the answers to these questions may surprise you.

The Scenario

Our team had briefly heard about the patient during sign out – she was a woman in her 30s who had been brought to the ED by police for agitation and public intoxication. Recent methamphetamine use exacerbated her untreated bipolar disorder, and our emergency psychiatric services team subsequently placed her on an involuntary 5150 hold for grave disability. During her medical clearance evaluation, she was incidentally found to be pregnant. From an obstetrics standpoint, she was asymptomatic and her medical workup was otherwise negative. She had been deemed medically cleared for transfer to an acute psychiatric hospital (APH) for inpatient mental health treatment and stabilization. Unfortunately, when the time came for transfer to the psychiatric hospital the patient refused transport and, thus, a member of our nursing staff asked if I would speak with her.

I walked over to the treatment area where the patient was being held. Originally intended for the evaluation and treatment of patients seeking emergency care, it had been converted into a boarding area used almost exclusively for holding psychiatric patients awaiting transport to an APH. All the room's walls are stripped bare of the usual supplies, examining instruments, and monitors to prevent patients from attempting to hurt themselves or others. At times, unfunded patients and patients on Medi-Cal have remained in our ED awaiting placement for over 1000 hours due to APHs holding beds for private payers. Not only does this create a two-tiered system of psychiatric care, it is in violation of the EMTALA statute – a situation we have previously described as the "EMTALA loophole" in psychiatric care.[2]

Nothing appeared particularly out of the ordinary as I entered the patient's room. A disheveled female of approximate stated age sat on the gurney with her legs crossed wearing a hospital gown, and a blanket was crumpled between her legs. She was clearly upset, ranting loudly, which I presumed was her responding to internal stimuli. "Hello Ms. Smith, I'm Dr. Sawyer, it is nice meeting you," I said as I entered the room. "You too. Excuse me I'm exposed," she said as she proceeded to readjust the blanket between her legs. Little did I know that the patient's shouting I had heard as I entered the room was not her responding to internal stimuli or mere agitation, but rather she was speaking into her cell phone that was hidden in the blanket between her legs with the camera looking upward at her face. She was broadcasting her frustrations on Facebook Live.

As I sat down to speak with the patient, I began by saying that I had been told she had refused transport. She responded, "I certainly do. I disagree with everything, there was no reason for this, it was totally uncalled for. I was just on my phone a second ago and I was trying to get help from my council member. All you did was cause a bill that was uncalled for." I explained that our emergency psychiatric services team who evaluated her was concerned enough to place her on an involuntary hold. I explained that the best way

to resolve the issue was to allow for transfer and evaluation by the specialists at the APH. She again refused. Ultimately, we reached an impasse, and I explained that I would get the psychiatric team to come speak with us to help get the issue resolved. But before I left the room, she revealed the phone she had been hiding in the sheets between her legs—battery now dead—and told me she had broadcast our entire conversation on Facebook Live.

She wasn't bluffing. After leaving the patient's room I searched her name on Facebook and found the video of our conversation on her public page. Similar to other social media platforms that support live streaming, including Twitter's Periscope, YouTube Live, and Instagram's live video streaming option, not only are the user's followers notified when the user "goes live," but after the live broadcast concludes, the recording remains on the user's page in perpetuity unless the user chooses to delete it. At that time, I made a screen recording of her Facebook Live post, which allowed me to transcribe her words for this article verbatim.

I wasn't concerned about my interaction with the patient. Even before reviewing the video, I was confident that I had conducted myself in a professional manner. However, secretly broadcasting this otherwise-private conversation without my knowledge or consent was highly concerning for two reasons: 1) she was coherent enough to make allegations that, when taken out of context, could be interpreted as physician mistreatment of a vulnerable patient; and 2) I knew I had introduced myself by name—as I always do—and this could focus any potential public backlash directly on me. This potential scenario was confirmed almost instantly—she had over 500 followers, her post was open to the public and shareable, and within one hour of publication had 52 views and nine comments. The first eight comments focused on the patient's well being, but the ninth comment was filled with expletives and criticism aimed at me and the hospital where I practice.

The Consequences and Conundrum

I returned to the patient's room and asked her if she would delete her post. She stated that her phone's battery was now dead and even if it were not, she would not delete it. She appeared satisfied in her decision to broadcast her conversation, as if she had won some twisted new game she had created and used to ensnare me. I had no idea what to do. I called in the police.

In the interim, I managed to get the patient's phone from her by explaining that I would charge it and return it to her. I was hoping the phone would not be password protected (an admittedly insanely low probability), and I could enter her Facebook app and delete the post myself. At that time, emergency medical services arrived to transfer the patient to the APH. Unsurprisingly, the patient was no longer refusing transport but upon multiple requests continued to refuse my requests to delete her Facebook post. I asked them not to leave as the two police officers had just arrived and I wanted to speak with them first.

What ensued was a complicated series of interactions with our hospital's dedicated police officers, our nursing supervisor, our department's medical director, and ultimately risk management. Our attorney informed me that the risk management department would contact Facebook the following morning to request the video be taken offline, but there was no guarantee that Facebook would take any action. While I appreciated the assistance of all involved, as well as the difficulty of navigating this novel situation without guidance from standing policies and procedures, the recurring message I received was that all existing policies tended to favor patient confidentiality as mandated by the Health Insurance Portability and Accountability Act of 1996 (HIPAA). With the exception of our department's medical director, I felt there was very little, if any, consideration regarding the prospect of endangering the physician involved. But what does the law say?

The Law on this Situation

According to an article published in 2017 by Elwyn et al in the *Journal of the American Medical Association* entitled, "Can patients make recordings of medical encounters? What does the law say?," state wiretapping or eavesdropping laws provide guidance as to whether a patient may record his or her interaction with a medical provider without the provider's consent.[3] In Texas, Oregon, and 37 other states, the consent of just one party in the interaction is sufficient for the recording and its distribution to be lawful (Figure). Therefore, a patient in one of these "one-party" states has the right to record a clinical encounter without the healthcare provider's consent, and without the likelihood of legal sanction.

However, within the remaining 11 states including California and Washington—also known as "all-party jurisdiction states"—state law dictates that *all* parties recorded must express their consent. This thereby makes covert recordings illegal. The California Invasion of Privacy Act (CIPA), was enacted in 1967 "to protect the right of privacy of the people of this state." Noting the advent of new devices and technology used "for the purposes of eavesdropping upon private communications," the California State Legislature stated that the "use of such devices and techniques has created a serious threat to the free exercise of personal liabilities and cannot be tolerated in a free and civilized society."[4] CIPA was updated in 2016 with the passage of Assembly Bill (AB) 1671 in response to the covert recording of Planned Parenthood providers used to create a false narrative about the organization.[5] AB 1671, which became effective on January 1, 2017, states that any person who "discloses or distributes, in any manner...including, but not limited to, internet web sites and social media...the contents of a confidential communication with a health care provider...be punished by a fine not exceeding $2,500 per violation, or imprisonment in

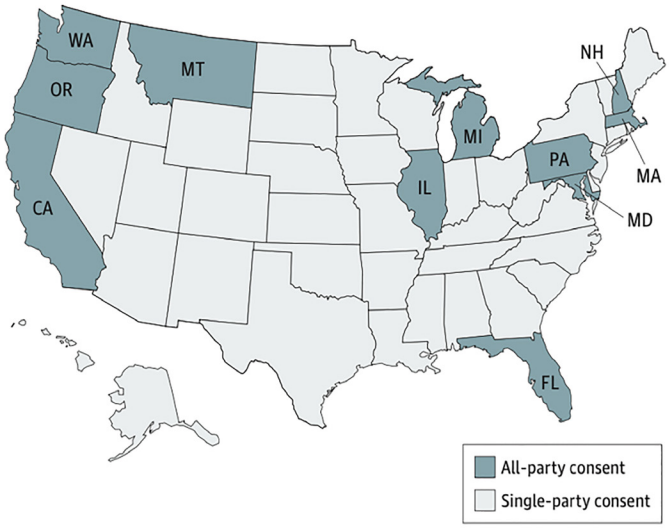


Figure. US States requiring all-party or single-party consent for audio recording of conversations.[3]
Figure obtained from: Elwyn G, Barr PJ, Castaldo M. Can patients make recordings of medical encounters? What does the law say? *JAMA*. 2017;318(6):513-14.

a county jail not exceeding one year."[6]

Unfortunately, no one I spoke with that evening was aware of the protections afforded to practitioners under AB 1671 nor had any of us encountered this situation before. While I believe that everyone involved did their best to help resolve this unique dilemma, I was uncomfortable with the idea that the video would remain on Facebook overnight and potentially forever. So, in a last-ditch effort to resolve the issue I returned to the patient's room, sat down, apologized for any misunderstandings and asked the patient if she would please delete the recording. After about 15 minutes of intensive active listening and engagement, I was able to earn her trust and she allowed me to take her through the steps required to delete the video from her Facebook account. I felt tremendously relieved, but I also wanted to ensure that this didn't happen to my colleagues or if it did, that they would be aware of their rights.

The Aftermath: Development of Institutional Policy

Since then, I have worked with our hospital's leadership to ensure not only that our governing policies reflect the privacy laws protecting our state's healthcare providers, but also that our employees are made aware of these laws. We have neared completion of a revised institutional authorization and consent to photograph or interview policy to now outline in a step-by-step manner the actions an employee should take if he or she is ever recorded without their consent. It now also acknowledges live broadcasting on social media platforms as a form of recording, which, like any digital image or recording device, is prohibited and subject to legal sanctions without the all party's consent. Furthermore, we have summarized these policies in a digital flier that outlines our employees' privacy rights, the concerns to be aware of should they agree to be recorded, and the actions to take if they learn that they have been recorded. In the near future, our policy will serve to protect not only our patients, but those who work tirelessly to care for them.

Address for Correspondence: Nicolas T. Sawyer, MD, MBA, University of California, Davis, Department of Emergency Medicine, 4150 V Street PSSB Suite 2100, Sacramento, CA 95817. Email: ntsawyer@gmail.com.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Elwyn G. Barr PJ. Grande SW. Patients recording clinical encounters: a path to empowerment? Assessment by mixed methods. *BMJ Open*. 2015;5(8).
2. Schmalz A, Sawyer NT. The "EMTALA loophole" in psychiatric care. *West J Emerg Med*. 2020;21(2):244-6.
3. Elwyn G, Barr PJ, Castaldo M. Can patients make recordings of medical encounters? What does the law say? *JAMA*. 2017;318(6):513-14.
4. Ellis ME. A brief overview of call recording in California. Ellis Law Group LLP. Available at: http://www.ellislawgrp.com/article13callrecordings.html. Accessed May 26, 2018.
5. AB-1671 Confidential communications: disclosure. California Legislative Information. Available at: https://leginfo.legislature.ca.gov/faces/billAnalysisClient.xhtml?bill_id=201520160AB1671#. Accessed May 26, 2018.
6. California Legislative Information. Chapter 1.5. Invasion of Privacy [630-638.55]. leginfo.legislature.ca.gov. Available at: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160AB1671. Accessed May 26, 2018.

Impact of Hurricane Harvey on Healthcare Utilization and Emergency Department Operations

Kimberly A. Chambers, MD*
Irfan Husain, MD, MPH†
Yashwant Chathampally, MD, MSc*
Alan Vierling, DNP, RN, NEA-BC‡
Marylou Cardenas-Turanzas, MD, DrPH*
Fanni Cardenas, MPH§
Kunal Sharma, MD*
Samuel Prater, MD*
Jonathan Rogg, MD, MBA*

*McGovern Medical School at UTHealth, Department of Emergency Medicine, Houston, Texas
†Emory University School of Medicine, Department of Emergency Medicine, Atlanta, Georgia
‡Lyndon B. Johnson Hospital, Harris Health System, Houston, Texas
§McGovern Medical School at UTHealth, Houston, Texas

Section Editor: Tony Zitek, MD
Submission history: Submitted September 16, 2018; Revision received December 20, 2019; Accepted January 27, 2020
Electronically published April 13, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.1.41055

Introduction: Hurricanes have increased in severity over the past 35 years, and climate change has led to an increased frequency of catastrophic flooding. The impact of floods on emergency department (ED) operations and patient health has not been well studied. We sought to detail challenges and lessons learned from the severe weather event caused by Hurricane Harvey in Houston, Texas, in August 2017.

Methods: This report combines narrative data from interviews with retrospective data on patient volumes, mode of arrival, and ED lengths of stay (LOS). We compared the five-week peri-storm period for the 2017 hurricane to similar periods in 2015 and 2016.

Results: For five days, flooding limited access to the hospital, with a consequent negative impact on provider staffing availability, disposition and transfer processes, and resource consumption. Interruption of patient transfer capabilities threatened patient safety, but flexibility of operations prevented poor outcomes. The total ED patient census for the study period decreased in 2017 (7062 patients) compared to 2015 (7665 patients) and 2016 (7770) patients). Over the five-week study period, the arrival-by-ambulance rate was 12.45% in 2017 compared to 10.1% in 2016 ($p < 0.0001$) and 13.7% in 2015 ($p < 0.0001$). The median ED length of stay (LOS) in minutes for admitted patients was 976 minutes in 2015 ($p < 0.0001$) compared to 723 minutes in 2016 and 591 in 2017 ($p < 0.0001$). For discharged patients, median ED LOS was 336 minutes in 2016 compared to 356 in 2015 ($p < 0.0001$) and 261 in 2017 ($p < 0.0001$). Median boarding time for admitted ED patients was 284 minutes in 2016 compared to 470 in 2015 ($p < 0.0001$) and 234.5 in 2017 ($p < 0.001$). Water damage resulted in a loss of 133 of 179 inpatient beds (74%). Rapid and dynamic ED process changes were made to share ED beds with admitted patients and to maximize transfers post-flooding to decrease ED boarding times.

Conclusion: A number of pre-storm preparations could have allowed for smoother and safer ride-out functioning for both hospital personnel and patients. These measures include surplus provisioning of staff and supplies to account for limited facility access. During a disaster, innovative flexibility of both ED and hospital operations may be critical when disposition and transfer capibilities or bedding capacity are compromised. [West J Emerg Med. 2020;21(3)586-594.]

INTRODUCTION

Since the 1980s, Atlantic hurricanes have increased in severity, duration, and frequency, resulting in more category IV and V hurricanes with devastating impacts.[1] Hurricane Harvey, which made landfall on August 25, 2017, as a category IV hurricane, reached the Houston area by August 26, 2017. Over four days, one trillion gallons of rain fell over Harris County, leaving 70% of the county under at least 1.5 feet of water.[2]

Hurricane Harvey and Hurricane Katrina share the title of costliest hurricanes in United States (US) history, with the National Oceanic and Atmospheric Administration estimating $125 billion in damage.[3] Sixty-eight deaths are directly attributable to Hurricane Harvey, of which 96% were due to flooding. A 2017 systematic review by Saulnier et al concluded that given the challenges associated with gathering data during natural disasters, information describing the relationship between health and flooding events is limited but important to understand given that about half of weather-related disasters in the last 20 years were floods.[4]

In addition to a hurricane's direct impact on life and property, hurricanes can have important effects on healthcare operations, particularly hospital emergency departments (ED).[5,6] Previous studies have reported a bimodal patient-volume surge.[7] Pre-storm, increased patient volume may ensue in hospitals that receive patients from surrounding hospitals and facilities that face mandatory evacuation.[7] In contrast, a relative decrease in ED patient arrival has been observed during hurricane landfall, which may be attributed to transportation difficulties during heavy rainfall and widespread flooding.[8] Post-storm, patient volumes usually rise in affected areas and may persist, highlighting the potential for long-term impact on an ED following high-intensity hurricanes.[7,8,9]

The primary objective of this report was to describe the experience during Hurricane Harvey in narrative form at Lyndon Baines Johnson (LBJ) General Hospital's ED, providing details of the challenges and preparation strategies that may have value for future storm events. The secondary objective was to describe patient volumes and lengths of stay (LOS) during and after Hurricane Harvey in comparison to control time periods without major storms.

Population Health Research Capsule

What do we already know about this issue?
Studies suggest that ED patient volume falls during a major storm event and rises after. Travel to the hospital is a challenge for both patients and staff.

What was the research question?
What impact did Hurricane Harvey have on ED operations at an urban county hospital and what lessons can we learn?

What was the major finding of the study?
Advanced preparation is critical, as are flexibility and innovation in situations such as multi-day flooding and damage to hospital infrastructure.

How does this improve population health?
As flooding becomes more common in the US, anticipating the need to function independently when normal operations are impaired will protect the well being of patients and staff.

METHODS

This retrospective, mixed-methods study was approved for waiver of consent by the University of Texas Houston Health Science Center Institutional Review Board. The study and narrative reports were captured from an urban, academic county hospital with 91,000 annual visits. LBJ General Hospital is a Level 3 trauma center, which had a single intensive care unit at the time of the storm. Certain specialty services are shared with a partner county hospital. Under normal circumstances, patients in need of neurosurgery or spinal surgery, for example, are transported from LBJ to a partnering hospital.

Prior to Hurricane Harvey, LBJ was the second busiest ED in Houston. The nearest hospital with an overlapping catchment area, East Houston Regional Medical Center, closed during Hurricane Harvey due to flood damage and never reopened. LBJ absorbed many of its patients, quickly becoming the busiest ED in the city.

Qualtitative Data Acquisition

We conducted semi-structured interviews with an emergency medicine (EM) faculty member and the hospital administrator who were both present in the facility during Hurricane Harvey. Three nurses, selected at random, and two residents were also interviewed and provided review to ensure consistency of recollections. To ensure accuracy we also consulted written works published immediately post-storm[10]. No variations were found.

Quantitative Data Acquisition

LBJ's information technology (IT) department queried the existing electronic health records (EHR) for the requested time intervals, which were a five-week time period surrounding Hurricane Harvey's 2017 landfall, as well as control periods in 2015 and 2016. Specifically, we obtained data for the week prior to the storm, the week of the storm, and three weeks post-storm for analysis. Time periods corresponding to the same weeks of the year during 2015 and 2016 were used for comparison. We collected data on ED census (volume of visits per day), demographic details (age, race/ethnicity, gender), arrival mode (ambulance vs non-ambulance), Emergency Severity Index, ED disposition, and LOS. ED disposition was further categorized into admitted and non-admitted patients. Admitted patients included

those hospitalized or transferred to another facility. Patients were classified as non-admitted if they were deceased, discharged, screened and referred, or sent to Labor and Delivery, as well as those who left against medical advice or left without being seen or completing treatment. All data points were provided in aggregate from IT from existing records; no EHR or other resources were directly searched or reviewed by research personnel.

The data set included 22,487 cases in total. Of these, 7665 cases corresponded to the 2015 study period, 7760 cases in 2016, and 7062 in 2017. Overall, the data included 105 days of observations, with 35 days corresponding to each year of study. Days of each of the included years were further ordered as values from -7 to 28, with value 0 representing the date Hurricane Harvey arrived (8/26/2017). The correspondent dates for years 2015 and 2016 were set as 8/29/15 and 8/27/16, respectively.

Data Analysis

We reported the frequencies, measures of central tendency, and percentages for categorical variables, such as gender, ethnicity, admissions, and arrivals by ambulance per year of study. Univariate analysis was used to compare characteristics of the periods of study, with the reference period as 2016. We compared categorical variables using chi-square testing, and we analyzed continuous variables using t-tests or the Wilcoxon-Mann Whitney test if the distribution was not assumed to be normal (ie, when comparing LOS).

Additionally, we performed an analysis of covariance to understand the trends between the periods of study by using days as the unit of analysis. Data was collapsed by adding events occurring on the same day for nominal variables and by calculating the overall median of each LOS category per day. We set the period of days under study per year as independent categorical variables using days of year 2016 as reference values, while the variables of interest, such as admissions per day or arrivals by ambulance per day, were dependent variables in each analysis. A probability value of < 0.05 (two-tail) was considered statistically significant for all tests. We performed all analyses using Stata IC 15 (StataCorp LLC, College Station, TX).

RESULTS

Facilities and Operations

Heavy rains and high winds ravaged the areas surrounding LBJ beginning August 25, 2017, and within two days,vehicles and ambulances could no longer access the hospital, which was surrounded by six feet of water for the following five days. Patients arrived on foot and via trucks, high-water vehicles, helicopters, boats, and makeshift rafts. Once the streets surrounding the hospital became accessible, those living in communities closest to the hospital began to arrive. However, highways continued to be impassable, and hospital employees living outside the area could not relieve in-hospital personnel.

During Hurricane Harvey, LBJ sustained 250 water penetrations. Of the 179 total inpatient beds, 133 were closed secondary to damage. As a result, one of the two 16-bed bays in the ED was reallocated as an inpatient unit following approval from the State of Texas. In addition to patients seeking treatment, LBJ was inundated with displaced storm refugees seeking shelter. However, some individuals who initially only sought food and shelter also developed mediical needs since they were without necessary medications. During the five-day course, 183 storm refugees were sheltered in a large annex area separate from the ED, consuming some of the hospital's resources.

Notable Cases

While searching for a missing family member during the storm, a patient sustained a head injury after a fall from his all-terrain vehicle. Emergency medical services (EMS) placed him in a cervical collar but were unable to reach LBJ, instead transferring him to a dump truck for transport. Upon arrival, his head computed tomography (CT) revealed a large subdural hematoma. The ongoing storm rendered immediate EMS transport to a hospital with neurosurgical capabilities impossible, prompting hospital executive leadership to contact the Coast Guard. However, the patient's neurological status declined rapidly, and physicians realized the Coast Guard helicopter would likely not arrive in time.

The on-call trauma surgeon had completed two years of neurosurgery training before changing surgical subspecialties. Given the concern for increasing intracranial pressure and the risk of herniation and death, it was determined that while efforts to evacuate the patient were ongoing, the surgeon would perform an emergent craniotomy. After assembling a makeshift neurosurgical tray with the necessary equipment from an array of services, the surgeon performed the first ever craniotomy at LBJ. Approximately two hours post-surgery, the Coast Guard landed at an improvised landing area, and the patient was transported to a hospital with neurosurgical capabilities where he recovered without deficits.[11]

A second notable case was that of a patient in third-degree heart block with a ventricular escape rhythm. Emergency physicians placed a transvenous pacemaker (TVP), but there were no cardiology fellows or faculty onsite to manage post-admission complications. Because LBJ does not have a coronary care unit, patients requiring a higher level of cardiac care are usually transferred—an impossible task during the immediate aftermath of the storm. Despite not routinely managing TVPs, the medical intensive care unit (MICU) cared for the patient for several days before ultimately transferring him for permanent pacemaker placement.

Most internal medicine (IM) faculty had left post-rounds on August 26, so house staff were alone on site during and post-storm, with the exception of a lone hospitalist and MICU faculty. Fortunately, power and telecommunications were never lost, so IM faculty were able to review EHRs remotely and communicate with their residents.

ED Staffing and Basic Needs/Personal Care

At LBJ, hospital leadership executed disaster planning for

hospital staff well in advance of the storm. A full complement of nurses, technicians, and ancillary staff were present for the storm ride-out and aftermath. In preparation for possible flash flooding, the hospital leadership had made arrangements early in the day on Friday, August 25, to gather and sequester ride-out teams who arrived prepared with supplies. Therefore, hospital staffing was robust during the storm's aftermath.

In contrast, medical staffing at LBJ was less structured in its approach to disaster planning. Because it was believed there would be enough time to make arrangements once flooding materialized, early staffing contingencies were not solidified. Because the change of shifts occurred on Saturday, August 26, before the heavy rainfall ensued, faculty left the hospital, and only two EM faculty physicians were on duty when the storm began. Additional faculty who attempted to drive to the hospital encountered impassable roads.

In addition to two EM faculty, there was an EM third-year resident, two advanced practice practitioners, and two interns one month into their residency. The team's relative inexperience meant EM faculty needed to provide a high-level of supervision while the team managed boarding and arriving patients. Sleep schedules were developed to allow 8-12 hours between periods of clinical work, but because there were only two faculty members their periods of uninterrupted rest were limited.

The hospital administrator had arranged for cots and meals for staff. However, calculations for dietary supplies were based on initial hospital census plus ride-out staffing but did not account for the storm refugees and patients who arrived. Given that supply delivery was not possible due to inaccessibility, items in the vending machines were quickly consumed. To mitigate the risk of running out of food, meal service was decreased from four to three times per day, and the hospital cafeteria switched from serving individual items to casseroles, which was a more efficient use of ingredients.

Personal care needs presented more complications for the hospital. The hospital did not have laundry service on site; hence, clean linen supplies and towels were exhausted over time. The paper scrub supply was also depleted as scrubs were given to storm refugees who were soaked from wading through flood waters. The hospital administrator authorized distribution of surplus items, such as T-shirts left over from hospital celebrations. Further, there were limited showering facilities, creating two-hour queues for those trying to shower near their units.

From outside the hospital, the ED chair worked to bring relief for staff and faculty, but many of the city's resources were dedicated to evacuating people from flooded homes. Eventually, a high-water vehicle was designated to assist, and the water receded enough for replacement personnel to arrive after five full days.

Patient Characteristics and Volume

Table 1 displays baseline LBJ ED volumes and patient characteristics during 2015, 2016, and 2017 over a five-week period, beginning one week prior to Hurricane Harvey. Over the full time period, the LOS for both admitted and discharged patients declined in 2017, despite a five-day boarding period during the storm. The proportion of patients arriving by ambulance was higher in 2017 when compared to 2016, although not higher than the similar time period in 2015. A better understanding of the patient volume and mode of transport differences can be gained by looking in more detail at the timeline presented in the figures.

In 2017, there was a large decrease in patient volume and a corresponding increase in the percentage of patients brought in by ambulance beginning at approximately time 0, when Hurricane Harvey battered Houston (Figures 1 and 2).

When the flood waters receded post-storm, there continued to be a relative paucity of ED beds because water-damaged inpatient rooms remained closed, leading to increased ED boarding and fewer ED beds that could be used for ED throughput. Adaptive and innovative strategies were undertaken to manage having fewer beds, which will be described in greater detail in the following section.

DISCUSSION

This is the only study we are aware of that has specifically assessed the impact of Hurricane Harvey on ED operations. Through both qualitative and quantitative assessment, we found useful data that may help other EDs prepare for a storm. Most centers experience a volume surge after a hurricane. After Hurricane Hugo (1989), ED volumes increased by 19% during the three weeks following the storm and remained high for three months,[6] while Hurricane Andrew (1989), Hurricane Isabel (2003), and Superstorm Sandy (2012) led to even greater post-storm patient-volume surges of 35-40% in certain emergency centers.[7,9,12] In the case of LBJ, a patient surge was not seen. Some potential patients may not have been in the area since thousands of storm refugees were housed in the city's convention center and at other central locations farther from the hospital.

LBJ passed environmental testing to begin reopening closed inpatient beds seven weeks after the storm's landfall. As a result, the ED adapted by transferring patients to other hospitals around or outside the city until hospital capacity normalized. Another strategy to manage fewer ED and inpatient beds was to change ED patient flow. A flex area was created, which acted as "quick care" for minor problems and housed ED patients who were awaiting the results of diagnostic testing and reassessment. Keeping patients who were not critically ill "vertical" in chairs (rather than lying in beds) was a key strategy, allowing for the treatment of a maximum number of patients who needed emergency care at LBJ.[13]

The processes of keeping ED patients "vertical" and initiating transfers early were associated with a lower LOS in 2017 when compared to previous years. As shown in Figure 1, approximately one week post-storm, the patient volume returned to normal, pre-storm levels. Other hospital-level changes, including postponing elective admissions and procedures, as well as a new focus on capacity management by

Table 1. Comparison of differences in patient's characteristics, length of stay, and boarding time for years 2015 and 2017, with 2016 as the reference year.

Variable	2015 8/22-9/25	P-value	2016 8/20-9/23 (Reference)	P-value	2017 8/19-9/22
Total patients	7665		7760		7062
Age	41.1 (18.5)	0.002	42.0 (17.8)	<0.0001	43.13 (18.32)
Ethnicity		<0.0001		0.85	
Hispanic	4236 (55.9)		4595 (59.8)		4137 (59.41)
Non-Hispanic	3346 (48.9)		3088 (40.2)		2827 (40.59)
Arrival by ambulance, n (%)		<0.0001		<0.0001	
Yes	1009 (13.7)		772 (10.1)		844 (12.45)
No	6331 (86.3)		6900 (89.9)		5936 (87.55)
ESI, mean (SD)	2.9 (0.72)	< 0.0001	3.0 (0.75)	0.40	3 (0.77)
ED disposition, n (%)		0.09		0.43	
Admitted/observation	1216 (15.9)		1154 (14.9)		1023 (14.49)
Discharged	6448 (84.1)		6606 (85.1)		6038 (85.51)
ED LOS: admitted patients, median minutes (IQR)	n = 1216 976 (606-1490)	< 0.0001	n = 1154 723 (481-1099)	< 0.0001	n = 1023 591 (412-953)
ED LOS: discharged patients, median minutes (IQR)	n = 6448 356 (226-543)	< 0.0001	n = 6604 336 (216-505)	< 0.0001	n = 6036 261 (157-412)
Boarding time: admitted or observation, median minutes (IQR)	n = 1183 470 (211-921)	< 0.0001	n = 1120 284 (142-554)	< 0.001	n = 974 234.5 (117-508)
Boarding time: discharged patients, median minutes (IQR)	n = 5731 22 (11-42)	0.22	n = 5782 23 (12-40)	0.10	n = 5544 22 (12-39)

ESI, Emergency Severity Index; *ED,* emergency department; *LOS,* length of stay; *IQR,* interquartile range; *SD,* standard deviation.

nursing leadership, further contributed to generating capacity for ED patients. Despite having fewer available beds, Figures 3 and 4 show that approximately 10 days post-storm when changes were implemented, there was a sharp decline in patients' median ED boarding time.

EDs and hospitals should be prepared to be self-sufficient during and directly after a severe storm, as our experience and others' experiences have shown.[5,14,15] Disaster planning drills have been found to be effective in preparing staff for their roles,[14,16-18] and had there been more drills with their associated focus on pre-planning and defined policies and roles, provider staffing during the ride-out could have been considerably different.

Roads may be impassable both during and after the storm.[14,15,19] As we saw, both EM and other providers were unable to reach the facility. Pre-disaster, consideration should be given to which subspecialists and supplies may become necessary if normal transfer processes are unavailable. In-hospital call might be needed for certain specialists, since the specialists may be unable to reach the hospital, or the hospital could endure power outages, thereby limiting communication.[14] Early arrival times should be considered if shift/call start times coincide with the storm's anticipated arrival so that staff members are not endangered by storm conditions. Key leadership should also consider being on site during a major storm's ride-out for operational decision-making.[6,15,20]

Selection of personnel for anticipated prolonged duty in an environment requiring adaptability and personal discomfort should be part of hospital disaster planning. Accounting for staff well being is crucial when planning for multi-day disasters, as performing duties outside of normal routine is common.[21] Overall, work shifts should be centered on safety and staff endurance.[6,15,21] Therefore, staffing decisions should consider providers' need for rest, meaning that more providers than usual will likely be required to be in-house to sustain a safe work rotation.

Arrangements for sleeping quarters and provisioning of food, water, and other unique needs should be established in advance. When considering supplies, administrators should base estimates accounting for storm refugees who may arrive at the hospital for shelter. In the wake of a disaster, estimating food and water provisions is challenging given that supplies will probably be needed for more individuals than those originally accounted for.[14,15,21,22]

Individuals should consider ways that they can be self-sufficient in the event that conditions require it. Bringing non-perishable food, bottled water, personal hygiene items, personal medications, and sleeping gear may be helpful.[14,15,21] The Harris Health System, which includes LBJ Hospital, has

a disaster plan that outlines that its employees are responsible for bringing personal items, including food and water, when participating in a hurricane ride-out. However, as evidenced by the depletion of vending machines and the rationing of food for patients, refugees, and staff, additional supplies brought by employees were not enough for the duration of the storm. Following Hurricane Katrina, a post-storm survey revealed that staff at Charity Hospital did not fully understand that bringing a seven-day supply of food was their responsibility.[21] As only 20% of responders indicated that they understood this responsibility, Brevard et al recommend that details of personal responsibilities, such as bringing personal supplies, should be reinforced annually when refreshing employees on disaster-planning protocols and performing disaster drills.[21]

Disaster planners should also recognize that staff may themselves be victims of the storm.[15,19,23] During Hurricane Harvey, one member of the ED staff lost a son. Another member of the housestaff had to arrange the rescue of his wife and family while trapped at LBJ. These occurrences led the hospital administrator to recommend that a mental health counselor be part of the ride-out team to support staff and patients who are in need, which has been suggested in previous literature.[19,24,25]

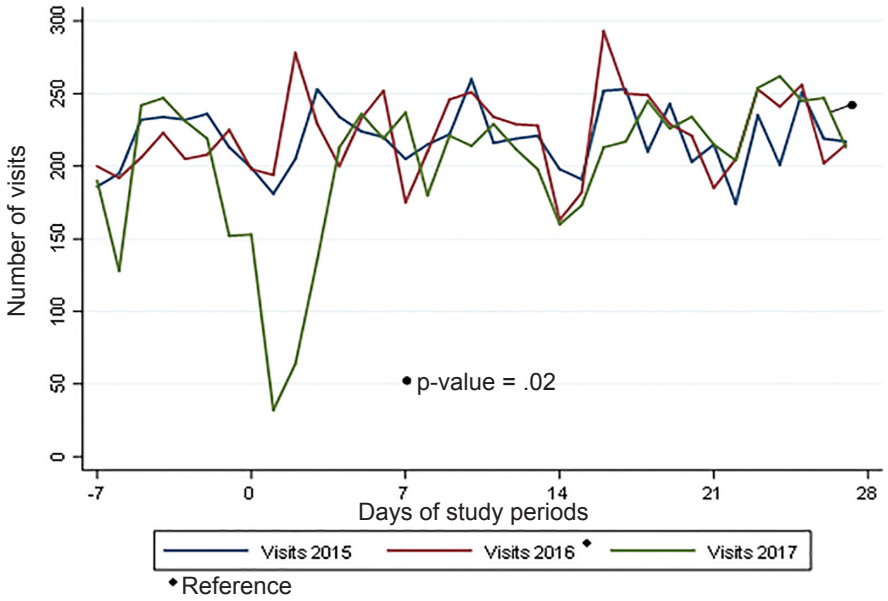


Figure 1. Number of visits to the Lyndon B. Johnson Hospital emergency department by period of study.

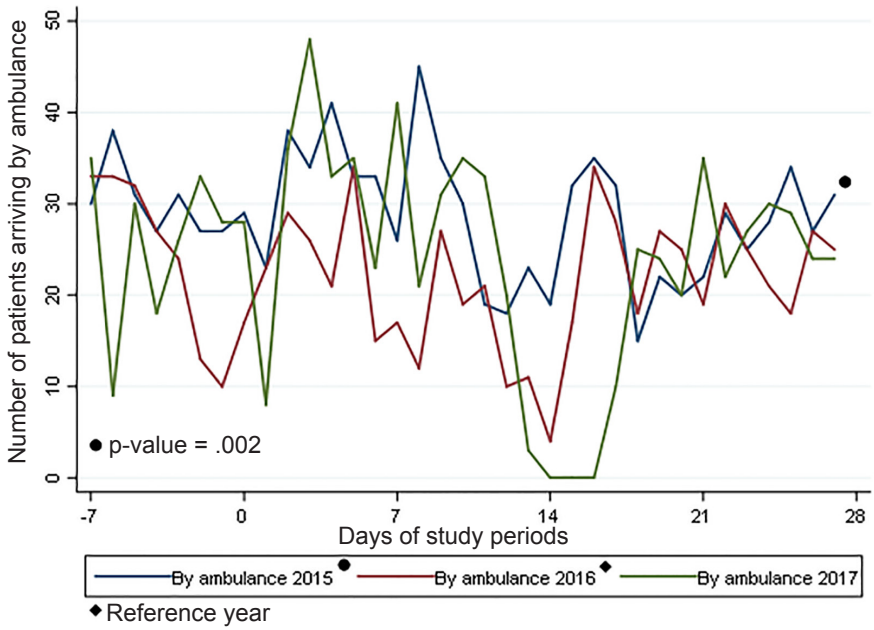


Figure 2. Number of patients who arrived by ambulance by period of study.

LIMITATIONS

This report has several important limitations. The qualitative data that is presented in narrative form is retrospective in nature; therefore, interviews are subject to recall bias. Wherever possible, the providers' accounts were verified by multiple sources, including articles written closer to the time of the event. A larger sampling of staff could also have been useful to provide additional data for qualitiative analysis.

The analyzed data were also collected retrospectively. While investigators attempted to match the storm's time period to similar ones in prior years by selecting the same days of the week and season of the year, it is possible that other time periods would have been more representative. Further, it may have been of use to track a longer timeline than five weeks, since disaster conditions in the city continued for much longer. Prospective data collection would be preferred, with details on the challenges recorded during and immediately after the storm.

CONCLUSION

Early and thorough preparation by leadership and individual team members can alleviate some stresses that result from being on duty in the ED during severe storm and flooding

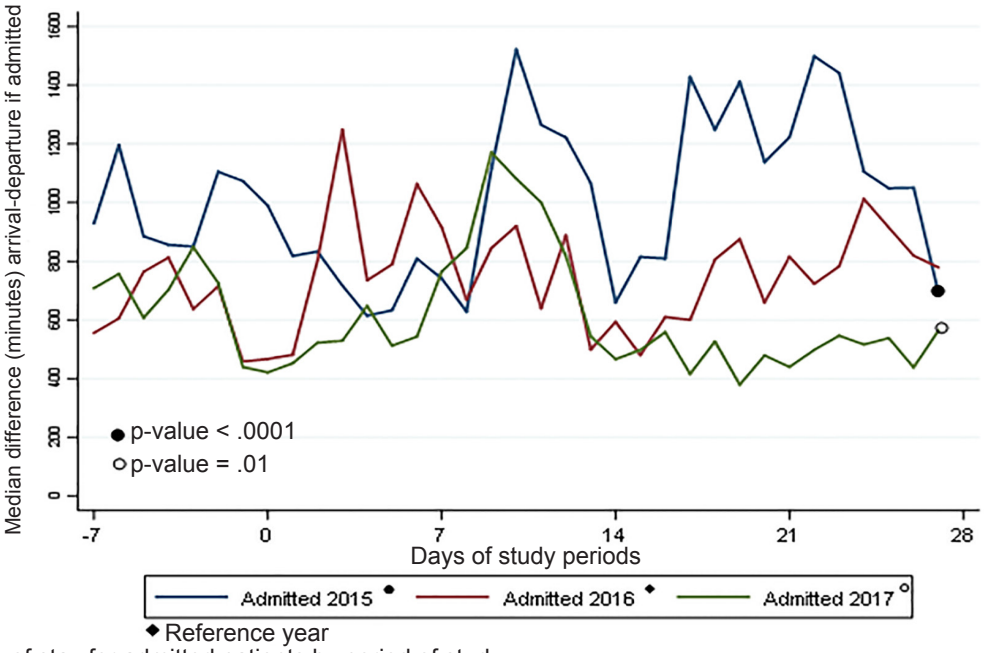


Figure 3. Median length of stay for admitted patients by period of study.

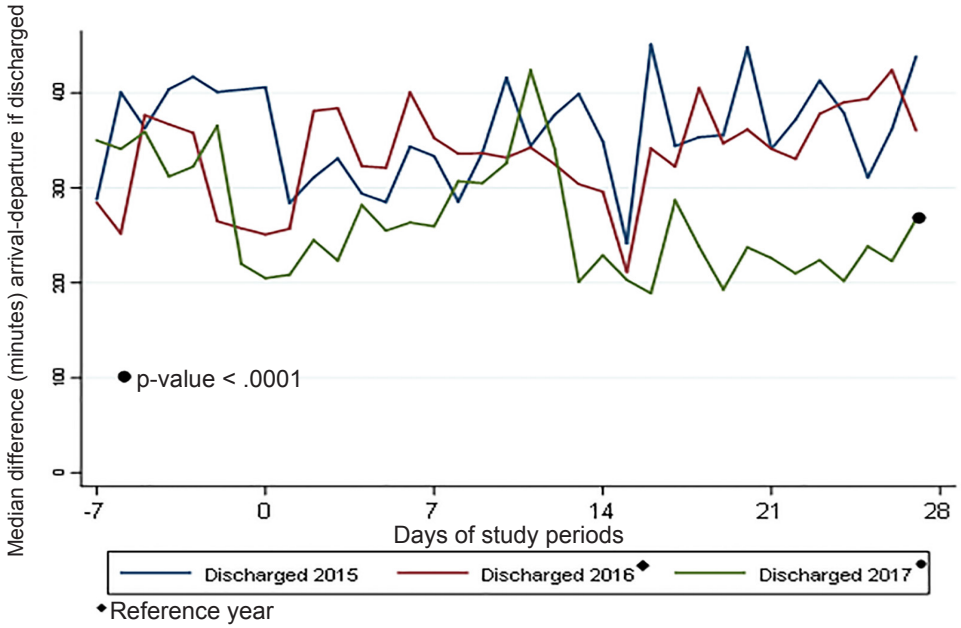


Figure 4. Median length of stay for discharged patients by period of study.

events. Both the hospital and the medical staff should have defined disaster-operations procedures in place before a storm event, with goals of being self-sufficient on both a facility and individual level and of having excess resources on site. Our experience of water damage and decreased accessibility to the hospital was similar to what other facilities have described. We did not experience patient-volume surges that other studies have reported; however, we had a relative surge in the ED volume since many beds were occupied by non-ED patients and normal admission processes were curtailed. Despite bed closures, ED LOS and boarding decreased relative to similar time periods, which may have been due to the dynamic operational changes and the shifting of resources initiated by the administration team during the disaster. Flexibility and innovation are key in adapting ED operations to overcome the challenges created by disaster conditions.

ACKNOWLEDGMENTS

Harris County Hospital District, Dr. James J. McCarthy, Dr. Katheryn Larimore, and Dr. Richard Witkov.

Address for Correspondence: Kimberly A. Chambers, MD, McGovern Medical School at UTHealth, Department of Emergency Medicine, 6431 Fannin Street, JJL 271, Houston, TX 77030. Email: kimberly.a.chambers@uth.tmc.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Walsh J, Wuebbles D, Hayhoe K, et al. Ch. 2: "Our changing climate." In: Melillo JM, Richmond TC, Yohe GW, eds. *Climate Change Impacts in the United States: The Third National Climate Assessment*. Washington D.C.: U.S. Global Change Research Program; 2014. Accessed May 26, 2018.
2. Di Liberto T. Reviewing Hurricane Harvey's catastrophic rain and flooding. Climate.gov. 2017. Available at: https://www.climate.gov/news-features/event-tracker/reviewing-hurricane-harveys-catastrophic-rain-and-flooding. Accessed May 26, 2018.
3. Blake ES, Zelinsky DA. National Hurricane Center tropical cyclone report: Hurricane Harvey (AL092017). 2018. Available at: https://www.nhc.noaa.gov/data/tcr/AL092017_Harvey.pdf. Accessed May 26, 2018.
4. Saulnier DD, Ribacke KB, von Schreeb J. No calm after the storm: a systematic review of human health following flood and storm disasters. *Prehosp Disaster Med*. 2017;32(5):568-79.
5. Stratton SJ, Tyler RD. Characteristics of medical surge capacity demand for sudden-impact disasters. *Acad Emerg Med.* 2006;13(11):1193-7.
6. Sheppa CM, Stevens J, Philbrick JT, et al. The effect of a class IV hurricane on emergency department operations. *Am J Emerg Med.* 1993;11(5):464-7.
7. Stryckman B, Walsh L, Carr BG, et al. Impact of Superstorm Sandy on Medicare patients' utilization of hospitals and emergency departments. *West J Emerg Med*. 2017;18(6):1035-41.
8. Platz E, Cooper HP, Silvestri S, et al. The impact of a series of hurricanes on the visits to two central Florida emergency departments. *J Emerg Med*. 2007;33(1):39-46.
9. Quinn B, Baker R, Pratt J. Hurricane Andrew and a pediatric emergency department. *Ann Emerg Med.* 1994;23(4):737-41.
10. When Harvey hit. *TMC Pulse: News of the Texas Medical Center*. October 9, 2017;4(9):12. Available at: http://www.tmc.edu/news/wp-content/uploads/sites/3/october_pulse_press_low-res-final.pdf. Accessed May 26, 2018.
11. Galehouse M. The craniotomy crew. *TMC Pulse: News of the Texas Medical Center.* October 9, 2017;4(9):22-23. Available at: http://www.tmc.edu/news/wp-content/uploads/sites/3/october_pulse_press_low-res-final.pdf. Accessed May 26, 2018.
12. Smith CM, Graffeo CS. Regional impact of Hurricane Isabel on emergency departments in coastal southeastern Virginia. *Acad Emerg Med.* 2005;12(12):1201-5.
13. Chambers KA, Rogg J, Sharma K, et al. How Hurricane Harvey spurred a Houston hospital to rethink emergency care. *Harvard Business Review*. May 7, 2018. Available at: https://hbr.org/2018/05/how-hurricane-harvey-spurred-a-houston-hospital-to-rethink-emergency-care. Accessed September 11, 2018.
14. Levinson, DR. Hospital emergency preparedness and response during Superstorm Sandy. Office of Inspector General Report. *J Healthc Prot Manage*. 2015;31(1):31-50.
15. U.S. Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response. (2018). ASPR Healthcare System Recovery Guide: Hurricane Harvey. Available at: https://www.phe.gov/emergency/events/hurricanes2017/Documents/TX-HC-Recovery-Guide-10July2018.pdf. Accessed August 15, 2019.
16. Flynn, SE. Higher ground: the sophisticated healthcare response of the SouthEast Texas Regional Advisory Council (SETRAC) to Hurricane Harvey. Global Resilience Institute at Northeastern University. February 2018.
17. Scott, LA, Swartzentruber DA, Davis CA, et al. Competency in chaos: lifesaving performances of care providers utilizing a competency-based multi-actor emergency preparedness training curriculum. *Prehosp Disaster Med*. 2013;28(4):322-33.
18. Kaji AH, Lewis RJ. Assessment of the reliability of the Johns Hopkins/Agency for Healthcare Research and Quality hospital disaster drill evaluation tool. *Ann Emerg Med*. 2008;52(3):204-10, 210.e1-8.
19. Morris AM, Ricci KA, Griffin KC, et al. Personal and professional challenges confronted by hospital staff following Hurricane Sandy: a

qualitative assessment of management perspectives. *BMC Emerg Med*. 2016;16(1):18.

20. Pole T, Marcozzi D, Hunt RC. Interrupting my shift: disaster preparedness and response. *Ann Emerg Med.* 2014;63(5):584-8.
21. Brevard SB, Weintraub SL, Aiken JB, et al. Analysis of disaster response plans and the aftermath of Hurricane Katrina: Lessons learned from a level I trauma center. *J Trauma.* 2008;65(5):1126-32.
22. Lane K, Charles-Guzman K, Wheeler K, et al. Health effects of coastal storms and flooding in urban areas: a review and vulnerability assessment. *J Environ Public Health.* 2013;2013:913064.
23. Haynes BE, Freeman C, Rubin JL, et al. Medical response to catastrophic events: California's planning and the Loma Prieta earthquake. *Ann Emerg Med.*1992;21(4):368-74.
24. Neria Y, Nandi A, and Galea S. Post-traumatic stress disorder following disasters: a systematic review. *Psychol Med*. 2008; 38(4):467-80.
25. Schwartz RM, Tuminello S, Kerath SM, et al. Preliminary assessment of Hurricane Harvey exposure and mental health impact. *Int J Environ Res Public Health*. 2018;15(5):974.

Evaluating the Diversity of Emergency Medicine Foundation (EMF) Grant Recipients in the Last Decade

Richard D. Gordon, MD* *UTHealth McGovern, Department of Emergency Medicine, Houston, Texas
Nancy S. Kwon, MD, MPA† †Long Island Jewish Medical Center, Department of Emergency Medicine, New Hyde Park, New York
Phillip D. Levy, MD, MPH‡ ‡Wayne State University, Department of Emergency Medicine and Integrative Biosciences Center, Detroit, Michigan
Tracy E. Madsen, MD, ScM§ §Alpert Medical School of Brown University, Deptartment of Emergency Medicine, Providence, Rhode Island
Marna Rayl Greenberg, DO, MPH¶ ¶Lehigh Valley Hospital/University of South Florida Morsani College of Medicine, Department of Emergency & Hospital Medicine, Allentown, Pennsylvania
On behalf of the ACEP Research Committee

Section Editor: Mark I. Langdorf, MD, MHPE
Submission history: Submitted January 11, 2020; Revision received February 21, 2020; Accepted February 21, 2020
Electronically published April 16, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.2.46497

Introduction: To study diversity of researchers and barriers to success among Emergency Medicine Foundation (EMF) grant recipients in the last 10 years.

Methods: EMF grant awardees were approached to complete a brief survey, which included demographics, queries related to contributions to the literature, success in obtaining grants, and any perceived barriers they encountered.

Results: Of the 342 researchers contacted by email, a total of 147 completed the survey for a response rate of 43%. The respondents were predominately mid to late career white-male-heterosexual-Christian with an average age of 44 years (range 25-69 years of age). With regards to training and education, the majority of respondents (50%) were either Associate or Professor clinical rank (8% instructor/resident/fellow and 31% Assistant). Sixty-two percent of the respondents reported perceived barriers to career advancement since completion of residency. The largest perceived barrier to success was medical specialty (26%), followed by gender (21%) and age (16%).

Conclusion: Our survey of EMF grant recipients in the last 10 years shows a considerable lack of diversity. The most commonly perceived barriers to career advancement by this cohort were medical specialty, gender, and age. An opportunity exists for further definition of barriers and development of mechanisms to overcome them, with a goal of increased success for those that are underrepresented. [West J Emerg Med. 2020;21(3)595–599.]

INTRODUCTION

The United States (US) biomedical research workforce does not currently mirror the nation's population demographically despite numerous attempts to increase diversity. This imbalance limits the promise of our biomedical enterprise for building knowledge and improving the nation's health.[1] Diverse perspectives can bring improved collective understanding and problem-solving. Furthermore, groups of diverse problem solvers can outperform groups of high ability problem solvers.[2]

Despite efforts to enhance diversity, challenges in broadening the research workforce remain. In prior reported data, National Institutes of Health (NIH) R01 applicants who self-identified their race as White were more likely to receive an award than Asian (-4 percentage points) or Black applicants (-13 percentage points).[3] Certain racial/ethnic groups are

represented only minimally in biomedical research. Of the nations' scientific research faculty positions—of those that were doctorate holders that were employed full time as ranked professors with federal support, 29.7% were female, 18.5% were Asian, 3% are African American, 4% are Hispanic, 0.01% are Native American, and 0.01% are Hawaiian /Pacific Islander.[4] There has been little increase in representation by sex, or racial and ethnic minority groups over the last 10 years despite them collectively being the most rapidly growing portion of the US population.[1] A disparity between sexes in academic medicine has also been described,[5] prompting the American Association of American Medical Colleges (AAMC) to publish committee recommendations to try an impact these differences.[6]

It is unlikely that the emergency medicine (EM) research workforce differs significantly in this lack of equitable representation between race, ethnicity, and/or gender. For that reason, an American College of Emergency Physician (ACEP) Research Committee objective was put forth to collaborate with the American College of Osteopathic Emergency Physicians (ACOEP) and the Diversity and Inclusion ACEP task force on the topic of diversity in emergency medical research. As part of this objective, we had the goals of identifying the face of the current EM research workforce, researching the barriers that exist with regards to diversity, and supporting the growth of future leaders in emergency medicine research. To that end, we began with the Emergency Medicine Foundation (EMF). Founded in 1972, EMF is a 501(c) 3 nonprofit organization that is affiliated with the American College of Emergency Physicians (ACEP). EMF is a principal sponsor of funded research in EM, having awarded more than $16 million in grants to advance emergency medicine science and health policy. Recipients of these funds were felt to be reflective of EM investigators at various stages of their careers who have, by and large, chosen to focus on research, and who have the potential for obtaining future grant funding. Recognizing that extramural funding is a vital part of a research scholar's success, we set out to determine the diversity in this representative subset of researchers in the EM community – specifically, the cohort of grant recipients from The Emergency Medicine Foundation (EMF) in the last 10 years.

Population Health Research Capsule

What do we already know about this issue?
The United States biomedical research workforce does not currently mirror the nation's population demographically despite numerous attempts to increase diversity.

What was the research question?
We set out to study diversity of researchers and barriers to success among Emergency Medicine Foundation (EMF) grant recipients.

What was the major finding of the study?
Our limited survey of EMF grant recipients in the last 10 years shows a considerable lack of diversity.

How does this improve population health?
These findings pose a risk to population health and optimally will be useful to inform future directions to enhance diversity of the EM research community.

METHODS

A brief survey was developed by the ACEP Subcommittee on Diversity in Research with the goal of determining the demographics of EMF grant recipients over the last 10 years and identifying any perceived barriers faced by grantees. ACEP partnered with the Society for Academic Emergency Medicine's (SAEM) Research Committee and an iterative process to edit the survey occurred. Using SurveyMonkey, the survey was piloted for content validity to a handful of grant recipients (non-EMF), and further iterations were made. The finished survey (Appendix) was sent in July 2018 with an email and an electronic link to EMF recipients who received funding in the last 10 years. A total of 371 EMF grant awardees were approached to complete the survey, which included queries related to contributions to the literature, success in obtaining grants, and any perceived barriers they encountered. The survey was voluntary and return responses were anonymous. Data were analyzed by simple descriptive statistics using frequencies and percentages using Microsoft Excel.

RESULTS

Of the 371 researchers who were contacted by email, 29 bounced back due to invalid email, leaving 342 surveys reaching an inbox. Of the 342 researchers, 55 completed the survey on first contact and 92 on second contact for a total of 147 responses, 43% response rate. Self-reported demographics are listed in Table 1. The respondents are predominately mid to late career white-male-heterosexual-Christian with an average age of 44 years (range 25-69 years of age).

With regards to training and education, the majority of respondents (50%) were either Associate or Professor clinical rank (8% instructor/resident/fellow and 31% Assistant). Of the respondents, 95% had either MD, MD-PhD, MD-Master's degrees (2% DO, (<1%)% DO-PhD, (<1%)% Pa-C-PhD). 87% were board certified or board eligible, and 97% received EM residency training (4% grandfathered and 15% with additional residency training in other fields).

Responses show the EMF researchers have secured

Table 1. Self-reported demographics from all survey participants.

Demographic	Results
Gender	
Male	92 (67%)
Female	40 (29%)
Transgender woman	1 (0.72%)
Genderqueer/ Gender non-conforming	1 (0.72%)
Prefer not to answer	4 (3%)
Race/ethnicity	
White/European	101 (73%)
Asian	14 (10%)
Asian-Indian	7 (5%)
Black/African American	3 (2%)
Mixed race/ethnicity	9 (6%)
Prefer not to answer	5 (4%)
Religion	
Christian	62 (45%)
Agnostic	35 (25%)
Jewish	14 (10%)
Atheist	10 (7%)
Buddhist	3 (2%)
Hindu	2 (1%)
Muslim	1(<1%)
Baha'i	1(<1%)
Unitarian Universalism	1(<1%)
Prefer not to answer	10 (7%)
Sexual preference	
Heterosexual	120 (87%)
Bisexual	5 (4%)
Lesbian	2 (1%)
Gay	2 (1%)
Questioning	2 (1%)
Fluid	1 (<1%)
Queer	1 (<1%)
Prefer not to answer	5 (4%)

financial support from a wide spectrum of sources with university funding being the most common, after foundation funding. Of the respondents, 52% report securing Federal NIH funding and 45% report securing non-NIH Federal Funding (AHRQ, DOD, CDC). Additionally, 41% of respondents report participation in industry funded research. With regard to publications, 54% have more than 20 abstract presentations; 58% have more than 20 peer-reviewed manuscripts with 49% of respondents reporting this work is original research. Finally, 33% and 24% reported greater than 20 first and senior author publications respectively. Of note, a significant percentage of the respondents pursued additional training with 57% having completed fellowships (100% within the US), 45% of which had a research focus. Additionally, 58% of respondents have completed advanced research degrees, and 16% completed the ACEP sponsored Emergency Medicine Basic Research Skills (EMBRS) course.

With regards to the location of training and education, the majority of respondents are US citizens and received their education in the US (97% US citizen [4% naturalized] and 2% on Visa). All were College educated and 98% completed medical school in the US).

Most of the respondents' (62%) perceived biases were barriers to achieving success throughout their careers. The largest perceived barriers to success were chosen medical specialty (26%), gender (21%), and age (16%). Of those who considered gender a barrier to career advancement, 31% were men, and 69% were women. However, 50% of the women who responded to the survey identified gender as a perceived barrier to their career advancement (vs 10% of men). The median age of those who considered age a barrier to success was 43 years. The remaining responses to perceived barriers include the following: race (7%), country of origin (2%), medical school/ degree (3%), residency training site (2%), and a combination of biases (19%); 38% reported perceiving no biases.

Regarding the women who responded to the survey about the quality of their career mentorship, 80% (N=31/39) described it as either good or excellent, while 12% (N=6/39) felt it was only fair. There were only two women that felt their mentoring was poor. Comparatively, only 65% (N=58/89) of the men who responded to the survey topic rated the quality of their career mentorship good or excellent, and 27% (N=24/89) felt it was fair. Seven (8%) of the men felt the quality of their career mentorship was poor.

DISCUSSION

At the October 2017 meeting of the ACEP Research Committee which took place in Washington DC, the challenges of developing a diverse group of EM researchers was discussed. The Committee concluded that the evidence-based literature acknowledges that a lack of diversity exists in the academic research community. An objective was set to develop a survey to better inform the EM research community about gaps in training and mentorship, with an eye towards developing interventions aimed at addressing these gaps. This survey identified several important aspects that affect diversity amongst researchers in the EM community. Based on the group that responded, a majority were of Associate Professor or Professor ranking (50%), male (67%), white (73%), US Citizens (97%) and heterosexual (87%). The majority perceived biases as barriers to success throughout their career (62%), with the largest barriers being medical specialty (26%) and gender (21%). The results of this EMF survey are not surprising and support the perception that our specialty is

facing barriers to the development of a diversified research workforce, and that focused efforts need to be initiated to achieve this goal.

Some evidence suggests that creating a diverse research environment requires an integrated set of interventions. Similarly to biomedical research itself, these interventions would rely on a reasoned evidence-based approach that is rooted in the scientific methods [1] One approach would be utilization of the pipeline metaphor: "the pipeline is filled with talent waiting to be developed, and that increased emphasis must be placed on providing ongoing, active guidance rather than relatively passive provision of experiences."[7] Despite some evidence supporting interventions to improve diversity, other data support that intervention programs may lack effectiveness in closing this gap.[8]

Our data provide insight into the unique difficulties for certain populations to be competitive for grant funding. While women were underrepresented in our respondent sample, it is notable that nearly half (compared to just under 20% of men) found gender to be a barrier to success. The category of "other" barriers included a range of narrative responses that offer specific insight into this finding, with comments such as "being a mother," "maternity leave," "lack of a nuclear family," and "backstabbing insecure leadership being provided." These poignant reflections suggest that future research must incorporate a qualitative approach to define further what obstacles exist. The solution to diversity in funding can't be adequately evaluated if we don't truly understand the impediments for the full complement of academic emergency physicians.

Diversity in Emergency Medicine research should also be considered in the context of the merger between the American Osteopathic Association (AOA) and the Accreditation Council for Graduate Medical Education (ACGME). The ACEP Research Committee's objective also included assessing the scholarly work of researchers from both training backgrounds (DO and MD). We found that only a minority of EMF grant recipients were doctors of osteopathic medicine. Studies have shown that osteopathic EM residencies are under-represented in top tier EM journal publications and very few editors of top tier academic journals are osteopathic physicians.[9,10] Additionally very few osteopathic physicians have published in the *Journal of Emergency Medicine*, *Academic Emergency Medicine*, or *Annals of Emergency Medicine* over the last two decades despite a trend for increased publication by publication of allopathic physicians; notably, there was not a similar trend for increased publication of osteopathic physicians in emergency medicine.[11] A recent study aimed at determining if a medical degree disparity (between allopathic and osteopathic) existed between those who successfully received an EM R01 grant and those who did not. This study found that allopathic physicians comprised the majority of recipients who were awarded an R01 grant in EM over the last decade. Those physicians typically had numerous prior publications and an advanced degree.[12] It would seem that moving forward, discussions should also include how to encourage the development of seasoned osteopathic researchers in our EM community.

A significant limitation of this survey is the response rate of 43%, and participants may not reflect perspectives from the overall cohort. Our survey instrument was anonymous so that respondents would answer as openly as possible; unfortunately, this precluded the ability to re-send the survey to non-responders. Consequently, there was a small response rate from subgroups with more diverse representation, making it difficult to derive information for minority groups and some (e.g., Hispanics, female to male transgender) were not represented at all. Despite this limitation, our data do provide unique information that remains useful to inform future directions to enhance the diversity of the EM research community.

CONCLUSION

Our survey of EMF grant recipients in the last 10 years shows a considerable lack of diversity. The most commonly perceived barriers to career advancement by this cohort were medical specialty, gender, and age. An opportunity exists for further definition of barriers and development of mechanisms to overcome them, with a goal of increased success for those that are underrepresented.

ACKNOWLEDGEMENTS

This manuscript was created by a workgroup of the ACEP Research committee in February, 2019 and reviewed by the SAEM Board of Directors in February of 2019 and the ACEP Board of Directors in March, 2019.

Address for Correspondence: Marna Rayl Greenberg, DO, MPH, Lehigh Valley Health Network, LVH-M-5th floor EM Residency Suite, 2545 Schoenersville Road, Bethlehem, PA 18017 Email: Marna.Greenberg@lvh.com.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Valantine HA, Collins FS. National Institutes of Health addresses the science of diversity. *Proc Natl Acad Sci U S A*. 2015;112(40):12240-2.
2. Hong L, Page SE. Groups of diverse problem solvers can outperform groups of high-ability problem solvers. *Proc Natl Acad Sci U S A*. 2004;101(46):16385-9.
3. Ginther DK, Schaffer WT, Schnell J, et al. Race, ethnicity, and NIH research awards. *Science.* 2011;333(6045):1015-9.
4. Women, minorities, and persons with disabilities in science and engineering: Table 9-30. *National Science Foundation*, 2015. Available at: http://www.nsf.gov/statistics/2017/nsf17310/static/data/tab9-30-updated-2018-06.pdf. Accessed February 21, 2020.
5. Jagsi R, Guancial EA, Worobey CC, et al. The "gender gap" in authorship of academic medical literature--a 35-year perspective. *N Engl J Med.* 2006;355(3):281-7.
6. Bickel J, Wara D, Atkinson BF, et al. Increasing women's leadership in academic medicine: report of the AAMC Project Implementation Committee. *Acad Med.* 2002;77(10):1043-61.
7. McGee R, Saran S, Krulwich T. Diversity in the Biomedical Research Workforce: Developing Talent. *Mt Sinai J Med*. 2012;79(3):397-411.
8. Schultz P, Hernandez P, Woodcock A, et al. Patching the Pipeline: Reducing Educational Disparities in the Sciences Through Minority Training Programs. *Educ Eval Policy Anal*. 2011;33(1).
9. Ashurst JV, Galuska M. Osteopathic Physicians on the Editorial Boards of Major Medical Journals Over the Past 30 Years. *J Am Osteopath Assoc.* 2016;116(2):92-5.
10. Baskin SM, Lin C, Carlson JN. Osteopathic emergency medicine programs infrequently publish in high-impact emergency medicine journals. *West J Emerg Med.* 2014;15(7):908-12.
11. Lammers R, Simunich T, Ashurst J. Authorship Trends of Emergency Medicine Publications over the Last Two Decades. *West J Emerg Med.* 2016;17(3):367-71.
12. Antony M, Savino J, Ashurst J. Difference in R01 Grant Funding Among Osteopathic and Allopathic Emergency Physicians over the Last Decade. *West J Emerg Med.* 2017;18(4):621-3.

The Emergency Medicine Group Standardized Letter of Evaluation as a Workplace-based Assessment: The Validity Is in the Detail

Jeffrey N. Love, MD, MHPE* *Georgetown University Hospital, Department of Emergency Medicine, Washington, District of Columbia
Christopher I. Doty, MD† †University of Kentucky College of Medicine, Department of Emergency Medicine, Lexington, Kentucky
Jessica L. Smith, MD‡ ‡Alpert Medical School, Brown University, Department of Emergency Medicine, Providence, Rhode Island
Nicole M. Deiorio, MD§ §Virginia Commonwealth University School of Medicine, Department of Emergency Medicine, Richmond, Virginia
Jaime Jordan, MD¶ ¶David Geffen School of Medicine, Harbor UCLA Medical Center, Department of Emergency Medicine, Torrance, California
Michael W. Van Meter, MD‖ ‖McGovern Medical School, University of Texas-Houston, Department of Emergency Medicine, Houston, Texas
Mary Ann Edens, MD# #Louisiana State University School of Medicine-Shreveport, Department of Emergency Medicine, Shreveport, Louisiana
Cullen B. Hegarty, MD** **University of Minnesota-HealthPartners Institute/Region Hospital, Department of Emergency Medicine, Saint Paul, Minnesota

Section Editor: Danya Khoujah, MBBS
Submission history: Submitted October 19, 2019; Revision received March 26, 2020; Accepted March 27, 2020
Electronically published April 21, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.3.45077

Introduction: Interest is growing in specialty-specific assessments of student candidates based on clinical clerkship performance to assist in the selection process for postgraduate training. The most established and extensively used is the emergency medicine (EM) Standardized Letter of Evaluation (SLOE), serving as a substitute for the letter of recommendation. Typically developed by a program's leadership, the group SLOE strives to provide a unified institutional perspective on performance. The group SLOE lacks guidelines to direct its development raising questions regarding the assessments, processes, and standardization programs employ. This study surveys EM programs to gather validity evidence regarding the inputs and processes involved in developing group SLOEs.

Methods: A structured telephone interview was administered to assess the input data and processes employed by United States EM programs when generating group SLOEs.

Results: With 156/178 (87.6%) of Accreditation Council of Graduate Medical Education-approved programs responding, 146 (93.6%) reported developing group SLOEs. Issues identified in development include the following: (1) 84.9% (124/146) of programs limit the consensus process by not employing rigorous methodology; (2) several stakeholder groups (nurses, patients) do not participate in candidate assessment placing final decisions at risk for construct under-representation; and (3) clinical shift assessments don't reflect the task-specific expertise of each stakeholder group nor has the validity of each been assessed.

Conclusion: Success of the group SLOE in its role as a summative workplace-based assessment is dependent upon valid input data and appropriate processes. This study of current program practices provides specific recommendations that would strengthen the validity arguments for the group SLOE. [West J Emerg Med. 2020;21(3)600–609.]

INTRODUCTION

Based on the challenge of selecting candidates whose performance and characteristics are a good fit, postgraduate programs are increasingly turning to specialty-specific assessments of clinical performance to determine who to interview. Although emergency medicine (EM) developed this approach in 1997, many specialties have recently either explored or initiated a similar tool: otolaryngology;[1,2] dermatology;[3] pediatrics;[4] ophthalmology;[5] internal medicine;[6] plastic surgery;[7] and general surgery.[8] These assessments generally involve the development of a specialty-specific template. Authors are asked to complete the template, assessing clinical performance based on direct observation in predetermined competencies (eg, interpersonal skills, decision-making, etc) important to the practice of that specialty. Each competency is rated on a normative basis to serve the intended purpose of differentiating performance. The template provides a degree of standardization by creating a shared mental model of assessment.

According to Messick and others, all validity is construct validity consisting of five categories of evidence: content; response process; internal structure; relationship to other variables; and consequences.[9-11] Originally developed for assessment by a single author based solely on that faculty member's personal experience, early work demonstrated content-related validity[12] that has been verified.[13] Internal structure evidence has also been shown in the improved inter-rater reliability and discrimination of the Standardized Letter of Evaluation (SLOE) as compared to traditional narrative letters of recommendation that it has replaced.[12,14] Finally, validity evidence of relations with other variables stems from a single study that the SLOE is one of the best predictors of clinical performance as a resident[15]

Although the SLOE is primarily an assessment of clinical performance, it has not previously been held to the standard of workplace-based assessments (WBA).[16] Valid WBAs are based on a number of underlying tenets that reflect a global perspective on complex, multifaceted performance through "pixilation." This process employs multisource assessments during a specified period in time to paint a picture of performance, understanding that it varies case-by-case based on factors related to the learner, patient, environment, and assessor.[17-21] Appropriate development of WBAs includes the following:

1. Different perspectives on the same performance represents alternative, complimentary interpretations that are valid. As such, consensus must be reached regarding these varying perspectives to accurately reflect global performance.[20-22]
2. The input of all groups engaged in the provision of clinical care through 360° assessment based on direct observation.[19,22,23]
3. The use of assessment instruments that ask the right questions of assessors reflecting their task- specific expertise.[20,24,25]
4. An appropriate number of assessments from each expertise group to establish reliability.[26,27]
5. A balance of quantitative and qualitative performance data that capture the context-specific aspects of performance.[20,22,28,]

Population Health Research Capsule

What do we already know about this issue?
The group SLOE, an assessment of clinical performance, is the most important factor in determining which medical students to interview for postgraduate training in emergency medicine.

What was the research question?
To explore the inputs and processes in group SLOE development to evaluate its response process and internal structure validity.

What was the major finding of the study?
The inputs and processes employed by programs in group SLOE development are not well aligned with tenets of workplace assessments.

How does this improve population health?
Based on the findings of this study, expert consensus guidelines were developed and presented that would improve the validity of this summative, high stakes assessment.

A fortuitous development from the single-author version, the group SLOE has become the preferred version of the SLOE by EM program directors (PD).[13,29] As a summative assessment completed by departmental leadership, based on multisource feedback, the group SLOE should theoretically be less prone to individual bias and better positioned to provide a global perspective on clinical performance than the single- author version.[20,30,31] Based largely on a variety of clinical assessments of performance, the group SLOE demonstrates internal structure evidence such as (1) committee member feels that his or her perspective is reflected in the final assessments,[32] and (2) the group SLOE is more discriminating than the single-author version[13] Although the single-author version has guidelines for completion (https://www.cordem.org/resources/residency-management/sloe/esloe/) and both versions are standardized based on the SLOE template (Figure 1), there are no guidelines in place that direct the multisource assessments and the process by which a group SLOE is drafted.[16]

As a high stakes-summative assessment, a strong

OFFICIAL CORD STANDARDIZED LETTER OF EVALUATION (SLOE)

2015-2016 APPLICATION SEASON

Emergency Medicine Faculty ONLY

I have read this year's instructions @ www.cordem.org ◯Yes ◯No

Applicant's Name: | AAMC ERAS ID No.

Letter Writers' Institution: | Email:

Reference Provided By: | Telephone:

Present Position: Select One

A. Background Information

1. How long have you known the applicant?

2. Nature of contact with applicant: (Check all that apply)

☐ Know indirectly through others/evaluations ☐ Extended, direct observation in the ED

☐ Clinical contact outside the ED ☐ Advisor

☐ Occasional contact (<10 hours) in the ED Other:

3. a. Did this candidate rotate in your ED? ◯Yes ◯No

b. If so, what grade was given?

◯Honors ◯High Pass ◯Pass ◯Low Pass ◯Fail

4. Is this the student's first, second or third EM rotation? Select One

What date(s) did this student rotate at your institution? (mm/yy)

5. Indicate what % of students rotating in your Emergency Department received the following grades last academic year:

Honors %

High Pass %

Pass %

Low Pass %

Fail %

100 % Total

Total # students last year:

EM is a required rotation for all students at our institution? ◯Yes ◯No

Figure 1. Standardized letter of evaluation template.

B. Qualifications for EM. Compare the applicant to other EM applicants/peers.

1. Commitment to Emergency Medicine. Has carefully thought out this career choice.

◯ Above Peers (Top 1/3) ◯ At level of peers (Middle 1/3) ◯ Below peers (Lower 1/3)

2. Work ethic, willingness to assume responsibility.

◯ Above Peers (Top 1/3) ◯ At level of peers (Middle 1/3) ◯ Below peers (Lower 1/3)

3. Ability to develop and justify an appropriate differential and a cohesive treatment plan.

◯ Above Peers (Top 1/3) ◯ At level of peers (Middle 1/3) ◯ Below peers (Lower 1/3)

4. Ability to work with a team.

◯ Above Peers (Top 1/3) ◯ At level of peers (Middle 1/3) ◯ Below peers (Lower 1/3)

5. Ability to communicate a caring nature to patients.

◯ Above Peers (Top 1/3) ◯ At level of peers (Middle 1/3) ◯ Below peers (Lower 1/3)

6. How much guidance do you predict this applicant will need during residency?

◯ Less than peers ◯ The same as peers ◯ More than peers

7. Given the necessary guidance, what is your prediction of success for the applicant?

◯ Outstanding ◯ Excellent ◯ Good

C. Global Assessment

1. Compared to other EM residency candidates you have recommended in the last academic year, this candidate is in the:

Ranking	# Recommended in each category last academic year
◯ Top 10%	
◯ Top 1/3	
◯ Middle 1/3	
◯ Lower 1/3	

Total Number of letters you wrote last year:

2. a. Are you currently on the committee that determines the final rank list? ◯ Yes ◯ No

b. How highly would you estimate the candidate will reside on your rank list? (see instructions if questions)

◯ Top 10%
◯ Top 1/3
◯ Middle 1/3
◯ Lower 1/3
◯ Unlikely to be on our ranklist

Figure 1. Continued.

D. Written Comments:

Please concisely summarize this applicant's candidacy including... (1) Areas that will require attention, (2) Any low rankings from the SLOE, and **(3) Any relevant noncognitive attributes such as leadership, compassion, positive attitude, professionalism, maturity, self-motivation, likelihood to go above and beyond, altruism, recognition of limits, conscientiousness, etc.** (please limit your response to 250 words or less)

STUDENT HAS WAIVED RIGHT TO SEE THIS LETTER ◯ Yes ◯ No

Date: Signature:

*Once form is signed it cannot be edited. To save an editable version of the form please save this form before signing.

Print Form

Figure 1. Continued.

validity argument is particularly important to all stakeholders of the group SLOE. The goal of this study was to explore the inputs and processes involved in group SLOE decision-making to assess its response process and internal structure validity arguments.

METHODS

Study Setting and Participants

A list of Accreditation Council for Graduate Medical Education (ACGME)-approved EM residencies was accessed on September 12, 2016, (https://apps.acgme.org/ads/Public/Programs/Search) identifying 178 unique programs. Potential participants were group SLOE authors, identified through review of group SLOEs that were submitted to the study team's residency programs in the 2017 residency application cycle. One faculty member from each institution was invited to participate to avoid duplication, and all 178 programs were represented. Preference was given to the faculty member listed as the "contact author." When a "contact author" could not be identified, we contacted that institution's PD to determine the most appropriate faculty member to participate. Data were collected between February 17–June 2, 2017. The Georgetown School of Medicine Institional Review Board (IRB) determined this study protocol to be exempt from ongoing IRB review.

Study Design

This was a cross-sectional study based on structured interviews. Study team members were assigned 18-19 programs based on geographic region. Standardized email invitations to participate were sent to assigned programs. In instances of no response after several attempts, study team members familiar with specific programs personnel reached out to those individuals to facilitate completion. Program representatives who agreed to participate were then scheduled for a telephone interview. It was estimated that participation would take approximately 20 minutes but frequently went longer based on the interviewee's responses. Early in the formal data collection phase, the study team frequently conferred with each other to standardize management of unexpected responses or questions. The interviewer recorded participant responses by hand and then data were entered into a central database by each team member.

Instrument and Decision Making

We initiated questionnaire development by a systematic review of the SLOE template to develop questions that ascertained input information (eg, assessors, assessment methods, and numbers) and the processes by which group SLOE committee decisions were made. To optimize content-related validity evidence of the questionnaire, we employed an iterative process. Final consensus of the eight-member investigation team included discussions regarding the degree to which inputs and processes were aligned with WBAs. Each member of this team had extensive experience as a SLOE author (mean 9.7 years) and leadership positions in resident training or medical student clerkships (mean 12.3 years). The final questionnaire consisted of multiple-choice questions. For each question there was a prompt for additional comments to clarify or expand on the answer provided (Appendix A).

Each item was read aloud and discussed among study authors to develop response process validity evidence of the questionnaire. Additionally, each author piloted the instrument with two or more experienced program leaders who were not involved in the study as author or participant (N = 20). As a result of this pilot, we changed a number of questions and developed a standardized script and strategy for the telephone interviews to improve the consistency of survey administration.

Statistical Analysis

We calculated descriptive statistics including proportions and percentages for multiple-choice and completion items with numerical values using IBM SPSS Statistics for Macintosh, v. 20 (IBM Corporation, Armonk, NY). Free-response data were also collected for each question when appropriate.

RESULTS

Of the 178 programs invited to participate, 156 responded to our inquiry (87.6%). Ten of 156 (6.4%) responding programs reported that they did not develop a group SLOE for candidates with the remaining 146 (93.6%) participating in the telephone interview that served as the basis for this study. Free-response data were insufficient to develop themes; instead they were used to raise issues and reinforce points regarding specific questions.

Group SLOE Committees

The "contact authors" interviewed were 65.1% clerkship directors (95/146), 17.8% PDs (26/146), and the remaining 15.8% (23/146) consisted of associate PDs, vice chairs, or general faculty. Details of both the program's and the "contact author's" experience with the group SLOE are reported in Table 1. Group SLOE committees most commonly develop 16-45 SLOEs annually (96/146; 68.5%) with a range of 3-100. Table 2 lists the data identified as important to group SLOE decision-making and the relative importance of each.

"Shift cards" are assessments of clinical performance completed at the end of each clinical shift ; they may be structured, open-ended, or both. Excluding the two programs that did not use them, the average number of shift cards used per individual SLOE was program dependent (Table 3). Shift cards are authored exclusively by faculty in 20.8% (30/144), by residents in 2.1% (3/144), and varying combinations of faculty and residents in 77.1% (111/144) of programs. Although the content of shift cards was not specifically queried, comments made by interviewees suggested variability across programs, with the majority using the seven questions regarding "qualifications for EM" from the SLOE template (Figure 1, Section B). There appears to

Table 1. Emergency medicine program's and contact author's experience with standardized letters of evaluation (SLOE).

Question	0 years N=146	1-5 years N=146	6-10 years N=146	11-15 years N=146	>15 years N=146
Program's experience with group SLOEs	X	74 (50.7%)	55 (37.7%)	11 (7.5%)	6 (4%)
Contact author's experience with single-author SLOEs	48 (32.9%)	49 (33.6%)	34 (23.3%)	11 (7.5%)	4 (2.7%)
	≤ 1 year	2-3 years	4-6 years	6-9 years	> 9 years
Contact author's experience with group SLOEs	14 (9.6%)	56 (38.4%)	45 (30.8%)	19 (13.0%)	12 (8.2%)

Table 2. Inputs to the group standardized letter of evaluation (SLOE) and their relative importance.

Inputs	Important in the overall decision making regarding the group SLOE (percentage of total agreeing to significance) N=146	Mean relative importance overall (3-very, 2-moderately, 1-minor importance)
Shift cards	144 (98.6%)	2.8
Firsthand clinical experience of group SLOE committee members	143 (97.9%)	2.4
Resident assessments	125 (85.6%)	2.1
Personal traits & information	114 (78.1%)	1.3
EM shelf exam	96 (65.8%)	1.2
Simulation	79 (54.1%)	1.5
USMLE	63 (43.2%)	1.2
Core clinical rotation grades	27 (18.5%)	0.3
Formal nurses' assessments	14 (9.6%)	0.2
Medical school class rank	9 (6.2%)	0.1

EM, emergency medicine; *USMLE*, United States Medical Licensing Examination.

Table 3. Average number of shift cards used by programs to develop each standardized letter of evaluation.

Number of shift cards	Percentage of programs N=144
1-5	8 (5.6%)
6-10	53 (36.8%)
11-15	63 (43.8%)
16-20	16 (11.1%)
>20	4 (2.8%)

be no difference between the templated shift cards completed by faculty and those by residents. Of the 32 programs that did not have residents complete shift cards, 11 collected clinical observations of student performance based on experiences with the teaching resident, pairing the candidate with a single resident for assessment, or formal meetings with residents monthly to obtain feedback.

Group SLOE Process

When asked which one of the following processes comes closest to what is used in developing programs' group SLOEs, "contact authors/spokesmen" responded: (1) One faculty leader reviews the data, generates the content and makes the decisions: 20.6% (30/146), (2) Two faculty leaders have these responsibilities: 47.9% (70/146), (3) Three or more committee members divide responsibilities which are then assembled: 16.4% (24/146), and (4) Three or more committee members come together to generate the entire content by consensus: 15.1% (22/146). Regardless of the process used, many programs added that they shared the draft version for comment by others. In instances where one faculty leader was responsible for the entire process (n = 30), 20 were clerkship directors, five PDs, and the remaining five had various other roles in the program.

When asked about how programs go about rating candidates on the seven qualifications/competencies for EM (Figure 1, Section B), 63.7% (93/146) reported using gestalt judgment, 27.4% (40/146) a combination of gestalt and a more formal approach, and 8.2% (12/146) based these assessments on a formal approach only. When a structured approach was used, 45/52 instances involved specific ratings requested on shift cards mirroring questions and ratings on section B of the group SLOE template (Figure 1).

In developing the written comments section for the group SLOE (Figure 1, Section D), authors use the following sources of information: 98.6% (144/146)-themes developed from shift cards, 97.9% (143/146)-first hand clinical experience, 72.6% (106/146)-verbatim comments from shift cards, 64.4% (94/146)-advising meeting between faculty and student and 12.3% (18/146)-suggestions made by the student. In the latter instance, 13/18 added that they would use such suggestions only if they were consistent with the authors' experience.

Work Group Process

The study authors reviewed the data and through iterative discussion came to a consensus on five key recommendations, which are summarized in Table 4.

DISCUSSION

According to Johnston, "truth" in WBAs is a "matter of consensus among assessors who arrive at judgments on performance that are as informed and sophisticated as can be for that point in time."[31] To be an effective consensus process, committee decisions should follow established methodology. One such example is the nominal group technique.[33-35] Active discussion that includes a diversity of faculty perspectives (eg, PDs, clerkship directors, other faculty) possessing firsthand clinical experience with candidates is important to final decisions. Several faculty members simply approving a final assessment authored by one or two faculty members does not constitute a rigorous consensus effort despite the use of multisource feedback in those decisions. In this study, only 15.1% of the programs developed group SLOE content by consensus-building with three or more members at the table. Recommendations #1 and #2 in Table 4 reflect the work group's attention to this concept.

Expertise is the sine qua non of assessment, placing faculty squarely at the center of group SLOE development.[25,36,37] Consistent with this principle, the single most important factor in group SLOE decision-making is shift cards with faculty participating in these assessments in 96.6% of programs. The second most important factor in group SLOE decision-making is clinical experience of committee members who bring their perspective to deliberations regarding the candidate being assessed. Experienced clinicians are less prone to the cognitive bias of the halo effect, are better judges of specific domains of complex performance, and are more appropriate judges of summative measures of global performance.[20,36]

While EM programs demonstrate an understanding of the importance of resident assessment of students when developing group SLOEs, this study reveals that many programs use faculty and resident assessment interchangeably to a varying degree (77.1%) when completing shift cards. Not only are residents less able to assess complex performance such as sophistication in developing evaluation/treatment plans or global performance, several studies suggest that they are also prone to leniency bias relative to faculty when assessing the same performance.[38-41] This inter-institutional variability in who completes shift cards likely limits the equivalence and validity of group SLOE assessments. In addition, only 9.6% of programs included nursing assessments and none reported using patient feedback when developing group SLOEs, thereby risking construct under-representation in areas such as interpersonal skills and ability to work in teams (Recommendation #3, Table 4).

The validity of the group SLOE assessments would be improved by the development of simple, brief shift cards specific to each assessment group with questions reflecting the task specific expertise of each[19] (Recommendation #3, Table 4). Until reliability numbers can be established, an average of one shift card per shift (~10-18/month) from each assessment group appears to be a practical and sufficient sampling size to minimize the risk of sampling error.[26,27]

Prior work shows that EM PDs find value in each of the seven SLOE questions regarding "qualifications for training in the specialty" (Figure 1, Section B).[13] Nonetheless, in this study multiple respondents voiced a concern about the high degree of intercorrelation between scoring these seven competencies for any given candidate. This may be in part due to research that suggests only two dominant domains are consistent determinants of performance: interpersonal skills/humanism, and knowledge/problem-solving.[42-45] Another potential cause of this lack of discrimination across qualifications may result from 67% of programs reporting that they used gestalt alone in determining the normative rating and an additional 27.4% used gestalt in combination with some standardized scoring on shift cards. Such an approach is prone to halo bias and appears to have limited value. Comments from survey participants suggest difficulty in obtaining stratified ratings from shift cards, which appear to be a current limitation of these assessment tools. A potential solution to this issue is provided by studies on clinical assessments of performance with construct-aligned scales demonstrating improved agreement and discrimination in assessments.[19,46] Such scales use construct-based anchors that reflect performance of increasing sophistication and independence and are consistent with how assessors view development. Both evaluation of the number of performance domains and the development of instruments as suggested by Crossley et al[46] may be helpful in developing appropriate assessments to assist in group SLOE decision-making regarding "qualifications for EM training" (Recommendation #4, Table 4).

The SLOE, consistent with tenets of summative WBAs, was designed to balance quantitative performance data and qualitative written comments that capture the context-specific aspects of performance.[20,22,28] In reviewing the means by which group SLOE committees create a candidate's written comments, they appear aligned with these tenets as long as development includes the same active consensus-building process necessary in other aspects of the group SLOE.

Table 4. Recommendations for improving the response process and internal structure validity of the group standard letter of evaluation (SLOE).

1. Group SLOE committee deliberations should be based on established consensus methodology.
2. To promote a global perspective on performance, group SLOE committee membership should be broad and inclusive (with clerkship and program leadership as a requirement).
3. All stakeholder groups involved in the provision of care (ie, faculty, residents, nurses, and patients) should participate in the assessment of student performance based on direct observation in the clinical environment.
4. Unique shift assessments, reflecting the task expertise of each stakeholder group, need to be developed and validated.
5. Guidelines should be established as standards are developed to guide programs in the assessment data and the processes by which group SLOEs are developed.

STUDY STRENGTHS AND LIMITATIONS

With a response rate of 87.6%, this study does not appear to suffer from coverage, sampling, or nonresponse errors that are potential limitations of any survey. The educational leadership in emergency medicine is a relatively small community. This increases the likelihood that at least some interviewees knew the interviewers they were talking to introducting the potential for bias in the answers provided. In addition, an essential assumption of any valid assessment of clinical performance is that it is based on direct observation, which this study assumed but did not evaluate. These issues should be considered when interpreting our data.

CONCLUSION/FUTURE DIRECTIONS

Validity is always an argument regarding degree; it is never absolute. The greater the validity evidence available, the stronger the argument. The EM group SLOE is a high stakes, summative assessment. As such, it must be held to a high standard by rigorous methodology, assessing validity evidence and enacting needed change to the template, inputs, and processes related to group SLOE development.

By aligning the process of group SLOE construction with tenets of WBAs, this study representing the practice of EM programs provides specific insights regarding initiatives and related studies that would improve the response process and internal structure validity evidence of group SLOE assessments. Substantial progress on these validity determinations would set the stage for standardization across programs (Recommendation #5, Table 4). In the meantime, programs should be mindful of the issues elucidated by this study when developing and interpreting group SLOEs.

ACKNOWLEDGEMENTS

The authosr would like to exxpress our appreciation to Larry Gruppen, PhD, John Shatzer, PhD, and John Norcini, PhD for their support in developing the concept, content, and expression of this paper.

Address for Correspondence: Jeffrey N. Love, MD, MHPE, Georgetown University, Department of Emergency Medicine, 2800 Reservoir Rd, NW, Washington, DC 20010. Email: Jlove01@georgetown.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Perkins JN, Liang C, McFann K, et al. Standardized letter of recommendation for otolaryngology residency selection. *Laryngoscope*. 2013;123:123-33.
2. Kiminsky AH, Bryson PC, Benninger MS, et al. Variability of ratings in the otolaryngology standardized letter of recommendation. *Otolaryngol Head Neck Surg.* 2016;154:287-93.
3. Kaffenberger JA, Mosser J, Lee G, et al. A retrospective analysis comparing the new standardized letter of recommendation in dermatology with the classic narrative letter of recommendation. *J Clin Aesthet Dermatol.* 2016;9:36-42.
4. Bajwa MN, Yudkowsky R, Bell D, et al. Validity evidence for a residency admissions standardized assessment letter for pediatrics. *Teach Learn Med.* 2018;30:173-183.
5. Lee AC, Golnik, KC, Oetting, TA, et al. Re-engineering the resident application process in ophthalmology: a literature review and recommendations for improvement. *Surv Ophthalmol.* 2008 ;53:164-76.
6. Alweis R, Collichio F, Milne CK, et al. Guidelines for a standardized fellowship letter of recommendation. *Am J Med* 2017;130:606-11.
7. Shultz K., Mahabit RC, Song J, et al. Evaluation of the current perspectives on letters of recommendation for residency applicants among plastic surgery program directors. *Plast Surg Int.* 2012:1-5.
8. Joshi ART, Vargo D, Mathis A, et al. Surgical residency recruitment: opportunities for improvement. *J Surg Educ.* 2016; 73:,e104-10.
9. Messick S. Validation of inferences from persons' responses and performances as scientific inquiry into score meaning. *Am Psychol*. 1995;50:741-9.
10. Downing SM. Validity: On the meaningful interpretation of assessment data. *Med Educ.* 2003;37:830-7.

11. Cook DA, Beckman TJ. Current concepts in validity and reliability for psychometric instruments: theory and application. *Am J Med.* 1006;119:166.e7-166.e16.
12. Keim SM, Rein JA, Chisholm C et al. A standardized letter of recommendation for residency application. *Acad Emerg Med.* 1999:6:1141-6.
13. Love JN, Smith J, Weizberg M et al. Council of Emergency Medicine Residency Directors' Sstandardized letter of Rrecommendation: the program directors' perspective. *Acad Emerg Med.* 2014;21:680-7.
14. Girzadas DV, Harwood RC, Dearie J, et al. A comparison of standardized and narrative letters of recommendation. *Acad Emerg Med.* 1998;5:1101-4.
15. Bhat R, Takenaka K, Levine B, et al. Predictors of a top performer during emergency medicine residency. *J Emerg Med.* 2015;49:505-12.
16. Love JN, Ronan-Bentle S, Lane DR, et al. The standardized letter of evaluation for postgraduate training: a concept whose time has come? *Acad Med.* 2016*;* 91:1480-2.
17. Mohr KD, Kenny DA. The how and why of disagreement among perceivers: an exploration of person models. *J Exp Soc Psychol.* 2006;4:337-49.
18. Norcini JJ. 2010 Workplace assessment. (In Tim Swanick (Ed.) *Understanding Medical Education: Evidence, Theory and Practice* (pp.232-245). The Association for the Study of Medical Education.
19. Crossley J, Jolly B. Making sense of work-based assessment: Ask the right questions, in the right way, about the right things, of the right people. *Med Educ.* 2012;46:28-37.
20. Govaerts M, van der Vleuten CPM. Validity in work-based assessment: expanding our horizons. *Med Educ.* 2013;47:1164-74.
21. Gingerich A, van der Vleuten CP, Eva KW, et al. More consensus than idiosyncrasy: categorizing social judgments to examine variability in mini-CEX ratings. *Acad Med.* 2014;89:1510-9.
22. Shay SB. The assessment of complex performance: a socially situated interpretative act. *HER.* 2004;4:307-29.
23. Lance CE, Hoffman BJ, Gentry WA, et al. Rater source factors represent important subcomponents of the criterion construct space, not rater bias. *Hum Resour Manag Rev.* 2008;18:223-32.
24. Butterfield PS, Mazzaferri EL. A new rating form for use by nurses in assessing resident's humanistic behavior. *J Gen Intern Med.* 1991;6:155-61.
25. Ericsson KA. 2018. The differential influence of experience, practice and deliberate practice on the development of superior individual performance of experts. (In KA Ericsson, RR Hoffman, A Kozbelt, AM Williams (Eds.). *The Cambridge Handbook of Expertise and Expert Performance* (pp. 745-769). Cambridge: Cambridge University Press.
26. Hawkins RE, Margolis MJ, Durnin SJ, et al. Constructing a validity argument for the mini-clinical evaluation exercise: a review of the research. *Acad Med.* 2010;85:1453-61.
27. Aleves de Lima A, Conde D, Costabel J, et al. A laboratory study on the reliability estimation of the mini-CEX. *Adv Health Sci Educ.* 2013;18:5-13.
28. Schuwirth ZWT, van der Vleuten CPM. A plea for new psychometric models in educational assessment. *Med Educ.* 2006;40:296-300.
29. Love JN, Deiorio NM, Ronan-Bentle S, et al. Characterization of the CORD standardized letter of recommendation in 2011-2012. *Acad Emerg Med.* 2013;20:926-32.
30. Delandshere G, Petrosky AR. Assessment of complex performance: limitations of key measurement assumptions. *Educ Res.* 1998;27:14-24.
31. Johnston B. Summative assessment of portfolios: an examination of different approaches to agreement over outcomes. *Stud High Educ.* 2004;29:395-412.
32. Hegarty CB, Lane DR, Love JN, et al. Council of Emergency Medicine Residency Directors standardized letter of recommendation writers' questionnaire. *JGME.* 2014;6:301–6.
33. Fink A, Kosecoff J, Chassin M, et al. Consensus methods: characteristics and guidelines for use. *Am J Public Health.* 1984;74:979-83.
34. Potter M, Gordon S, Hamer P. The nominal group technique: a useful consensus methodology in physiotherapy research. *N Z J Physiother.* 2004;32:126-30.
35. Waggoner J., Carline JD, Durning SJ. Is there consensus on consensus methodology? Description and recommendations for future consensus research. *Acad Med.* 2016;91:663-8.
36. Regehr G, MacRae H, Reznick RK, et al. Comparing the psychometric properties of checklists and global rating scales for assessing performance on an OSCE-format examination. *Acad Med.* 1998;73:993-7.
37. Govaerts MJB, Schuwirth LWT, van der Vleuten CPM et al. Workplace-based assessment: effects of rater expertise. *Adv Health Sci Educ.* 1980;16:151-65.
38. Hatala R, Norman RG. In-training evaluation during an internal medicine clerkship. *Acad Med.* 1999;74:S118-20.
39. Kogan JR, Bellini ML, Shea JA. Feasibility, reliability and validity of the mini-clinical evaluation exercise in a medicine core clerkship. *Acad Med.* 2003;78:S33-5.
40. Torre DM, Simpson, DE, Elnicki DM, et al. Feasibility, reliability and user satisfaction with a PDA-based mini-CEX to evaluate the clinical skills of third year medical students. *Teach Learn Med.* 2007;19:271-7.
41. Bullock AD, Hassell A., Markham WA, et al. How ratings vary by staff group in multi-source feedback assessment of junior doctors. *Medl Educ.* 2009;43:516-20.
42. Davidge AM, Davis WK, Hull AL. A system for the evaluation of medical students' clinical competence. *Acad Med.* 1980;55:65-7.
43. Risucci DA, Tortolania AJ, Ward RJ. Ratings of surgical residents by self, supervisors and peers. *Surg Gynecol Obstet.*
44. Ramsey PG, Wenrich MD, Carline JD, et al. Use of peer ratings to evaluate physician performance. *JAMA.* 1993;269:1655-60.
45. Silber CG, Nasca TJ, Paskin DL, et al. Do global rating forms enable program directors to assess the ACGME competencies? *Acad Med.* 2004:79:549-56.
46. Crossley J, Johnson G, Booth J, et al. Good questions, good answers: Construct alignment improves the performance of workplace-based assessment scales. *Med Educ.* 2011:45:560-9.

A 2-Question Summative Score Correlates with the Maslach Burnout Inventory

Simiao Li-Sauerwine, MD, MS*
Katie Rebillot, DO†
Matthew Melamed, MD, MPH‡
Newton Addo, BSc§
Michelle Lin, MD§

*The Ohio State University, Department of Emergency Medicine, Columbus, Ohio
†Los Angeles County + University of Southern California, Department of Emergency Medicine, Los Angeles, California
‡New York Presbyterian Brooklyn Methodist Hospital, Department of Emergency Medicine, Brooklyn, New York
§University of California, San Francisco, Department of Emergency Medicine, San Francisco, California

Section Editor: Danya Khoujah, MBBS
Submission history: Submitted September 10, 2019; Revision received January 14, 2020; Accepted February 2, 2020
Electronically published April 21, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.2.45139

Introduction: There is a high prevalence of burnout among emergency medicine (EM) residents. The Maslach Burnout Inventory - Human Services Survey (MBI-HSS) is a widely used tool to measure burnout. The objective of this study was to compare the MBI-HSS and a two-question tool to determine burnout in the EM resident population.

Methods: Based on data from the 2017 National Emergency Medicine Resident Wellness Survey study, we determined the correlation between two single-item questions with their respective MBI subscales and the full MBI-HSS. We then compared a 2-Question Summative Score to the full MBI-HSS with respect to primary, more restrictive, and more inclusive definitions of burnout previously reported in the literature.

Results: Of 1,522 residents who completed the survey 37.0% reported "I feel burned out from my work," and 47.1% reported "I have become more callous toward people since I took this job" once a week or more (each item >3 on a scale of 0-6). A 2-Question Summative Score totaling >3 correlated most closely with the primary definition of burnout (Spearman's rho 0.65 [95% confidence interval 0.62-0.68]). Using the summative score, 77.7% of residents were identified as burned out, compared to 76.1% using the full MBI-HSS, with a sensitivity and specificity of 93.6% and 73.0%, respectively.

Conclusion: An abbreviated 2-Question Summative Score correlates well with the full MBI-HSS tool in assessing EM resident physician burnout and could be considered a rapid screening tool to identify at-risk residents experiencing burnout. [West J Emerg Med. 2020;21(3)610-617]

INTRODUCTION

Background

Physician burnout is a well-described problem that has been demonstrated to impact physician performance, patient care, and institutional expenditure, and begins in training as early as intern year.[1,2] The narrative definition of burnout is a complex, multidimensional, psychological syndrome resulting from long-term stress during one's career.[3,4] The World Health Organization defines burnout as an occupational phenomenon based on the *International Classification of Diseases*, 11th revision (ICD-11), which states that burnout is "a syndrome conceptualized as resulting from chronic workplace stress that has not been successfully managed" and includes the three dimensions of feeling "energy depletion or exhaustion; increased mental distance from one's job, or feelings of negativism or cynicism related to one's job; and reduced professional efficacy."[5] Because of its significant impact on various facets of healthcare delivery, much interest has been

dedicated to the best means to quantify burnout, in order to develop a meaningful measure to address its prevalence and the impact of interventions to reduce burnout.

The Maslach Burnout Inventory-Human Services Survey (MBI-HSS) is a widely used tool to measure burnout and has been validated in the physician population.[6] Its three subscale domains are emotional exhaustion (a state of emotional depletion at work [EE]), depersonalization (a lack of feelings or negative and/or cynical feelings toward others [DP]), and personal accomplishment (a sense of success at work [PA]). In interpreting the burnout scale, various definitions have been proposed, from low, primary, and high subscales for each domain to a dichotomous "burned out/not burned out" definition.

Population Health Research Capsule

What do we already know about this issue?
There is a high prevalence of burnout among emergency medicine (EM) residents. The Maslach Burnout Inventory (MBI) is a widely used and well-validated tool to measure burnout.

What was the research question?
Can we create a robust, rapid tool to measure burnout in EM residents?

What was the major finding of the study?
A 2-Question Summative Score >3 correlated with the MBI, with a sensitivity and specificity of 93.6% and 73.0%, respectively.

How does this improve population health?
The brief 2-Question Summative Score correlates with the MBI and can be used as a rapid screening tool to identify at-risk residents experiencing burnout.

Importance

Burnout rates are highest in the emergency physician population and burnout is broadly acknowledged to be a prevalent and significant problem with respect to physician health and impact on patient care.[6-8] In a recent national cross-sectional survey of the prevalence of burnout in emergency medicine (EM) residents, three-quarters of them met criteria for burnout;[9] this both illustrates that the EM resident population is vulnerable to the negative effects of burnout and highlights this population as one ripe for intervention. However, certain obstacles exist in studying burnout prevalence and effects of interventions in this population, chief among them the burden of administering the lengthy MBI-HSS instrument to a population stressed by limited time and competing demands.

Goals of This Investigation

Brief measures of burnout based on the MBI-HSS have been studied in physician populations. A two-item abbreviated MBI addressing the domains of EE and DP correlates highly with the full MBI-HSS in various cohorts of medical students, non-EM residents, and practicing physicians.[10-12] We aimed to validate the use of the same two-item MBI in a national cohort of EM residents in order to provide a rapid tool that may be used by researchers, residency program leadership, and EM residents themselves to assess and track burnout trends. To our knowledge, this is the first study to validate the two-item MBI in a national sample of EM residents.

METHODS

Survey Tool

The 2017 National EM Wellness Survey was administered by the Academic Life in Emergency Medicine (ALiEM) organization and its Wellness Think Tank volunteer initiative. ALiEM is a nonprofit, health professions education organization focused on social media technologies and community building. The Wellness Think Tank is an online community comprised of United States (US) EM residents and faculty advisors interested in physician wellness. Using the ALiEM website, social media, and listservs including those of the Council of EM Residency Directors and the EM Residents Association, we conducted our 2017 National EM Resident Wellness Survey March 20-31, 2017, focusing only on US EM residents. The survey included the full MBI-HSS questionnaire[13] and was hosted online on REDCap version 8.1.4 (Research Electronic Data Capture, Vanderbilt University, Nashville, TN), a secure web application for building and managing online surveys and databases.[14] The study was granted expedited review by the institutional review board of New York Presbyterian Brooklyn Methodist Hospital.

Although physician burnout is defined in a variety of ways using the MBI-HSS tool,[6] the commonly used definition, which we also used in our original study, was a high EE (≥27) or high DP (≥10) score. Two alternative definitions are high EE (≥27) or high DP (≥10) or low PA (≤33), which we label as "more inclusive," and high EE (≥27) and high DP (≥10) and low PA (≤33), which we label as "more restrictive."[9,10] Detailed methodologies on identifying, recruiting, and administering the confidential, online, full MBI-HSS survey tool can be found in the original publication.[9] The prevalence of burnout among EM residents from the original study was 76.1% (95% confidence interval [CI], 74.0-78.3%). Using the more inclusive and more restrictive definitions, 80.9% (78.9-82.9%) and 18.2% (16.3-0.1%) of EM residents were burned out, respectively.

Outcome Measures

Based on previously published data on 1,522 US EM residents from the 2017 National EM Wellness Survey, we assessed the performance of the validated, two-item abbreviated item MBI tool relative to the full MBI-HSS tool for measuring burnout in EM residents. Based on previous studies, the two nested questions that have demonstrated the highest factor loading for the EE and DP domains were "I feel burned out from my work" (EE1) and "I have become more callous toward people since I took this job" (DP1), respectively. Although each are scored on a seven-point Likert scale (0-6), these two items were dichotomized as burned out if respondents described a frequency of once a week or more often, based on previously reported thresholds.[10] Thus, a score >3 for EE1 or DP1 was defined as burned out for either item.

Data Analysis

With the main aim to assess the performance of EE1 and DP1 relative to their subscales and their association with resident burnout, we calculated the response distributions using standard descriptive statistics and evaluated the bivariate associations by calculating Spearman's correlations between the two single-items (EE1 and DP1), their respective subscales, and each of the burnout definitions. Of note, the subscales corresponding to "emotional exhaustion" (EE) and "depersonalization" (DP) were adjusted with the two single-item questions removed and are reported as EE(-EE1) and DP(-DP1), respectively. We calculated test characteristics for a "2Q Summative Score," which adds the EE1 and DP1 item scores. Cutoffs of EE1 >3 and DP1 >3 were used for calculating both odds ratios and classification accuracy measures (sensitivity, specificity, positive predictive value, negative predictive value) for resident burnout based on the primary, more inclusive, and more restrictive definitions.

RESULTS

Characteristics of Study Subjects

A total of 1522 of 7186 US EM residents (21.2%) representing 193 of 247 residency programs (78.1%) participated in the survey. Further details regarding the study population, including inverse probability weighting to adjust for non-response bias, are available in the original publication.[9]

Main Results

The frequency of responses for questions EE1 and DP1 are reported in Table 1 with 37.0% and 46.8% of residents experiencing these once a week or more (score >3), respectively. The prevalence of resident burnout using the full MBI-HSS tool compared to resident responses to these two single-item questions is displayed in Figures 1 and 2. The single-item measure EE1 correlates with the EE(-EE1) subscale, and DP1 correlates with the DP(-DP1) subscale with Spearman's rho of 0.81 (95% CI, 0.79-0.83) and 0.73 (95% CI, 0.70- 0.75), respectively. Additional Spearman's correlation data, comparing the primary and alternative definitions of burnout using the full MBI-HSS with single-item and subscale scores are reported in Table 2. Test characteristics for the 2-Question Summative Score (EE1+DP1) using different cutoff scores are reported in Table 3. The receiver operating characteristic (ROC) curve for primary, more inclusive, and more restrictive definitions of burnout based on the 2-Question Summative Score using different cutoffs is displayed in Figure 3. Using the primary definition of burnout, a summative score >3 demonstrated a sensitivity and specificity of 93.6% and 73.0%, respectively, compared to the full MBI-HSS. Applying this cutoff score of >3, 1183 of 1522 (77.7%) of residents would have been identified as burned out based on the responses from our original survey.

Table 1. Frequency of responses to the single-item questions "I feel burned out from my work" (EE1) and "I have become more callous toward people since I took this job" (DP1).

MBI-HSS Survey Response (Score)	EE1 Frequency (%)	DP1 Frequency (%)
Never (0)	81 (5.3)	124 (8.1)
A few times a year or less (1)	281 (18.5)	222 (14.6)
Once a month or less (2)	279 (18.3)	209 (13.7)
A few times a month (3)	318 (20.9)	255 (16.8)
Once a week (4)	257 (16.9)	289 (19.0)
A few times a week (5)	212 (13.9)	267 (17.5)
Every day (6)	94 (6.2)	156 (10.2)

MBI-HSS, Maslach Burnout Inventory-Human Services Survey; *EE,* emotional exhaustion; *DP,* depersonalization.

DISCUSSION

In this study, we propose a rapid screen of burnout in the EM resident population, characterized as a 2-Question Summative Score based on self-reported frequency of emotional exhaustion and depersonalization. This simplified 2-Question Summative Score consists of two nested questions (EE1, DP1) in the MBI-HSS. A cutoff score >3 correlates best with the primary definition of burnout and the full MBI-HSS based on Spearman and ROC calculations (Table 2, Figure 3). A score of >3 can be obtained, for instance, if a resident reports feeling either burned out from work (EE1) or becoming more callous toward people since taking the job (DP1) at least once per week. Alternatively, burned-out residents would also be identified if they experienced both of these feelings but less frequently at once per month (e.g., each with a score of 2). This cutoff score demonstrates the best test

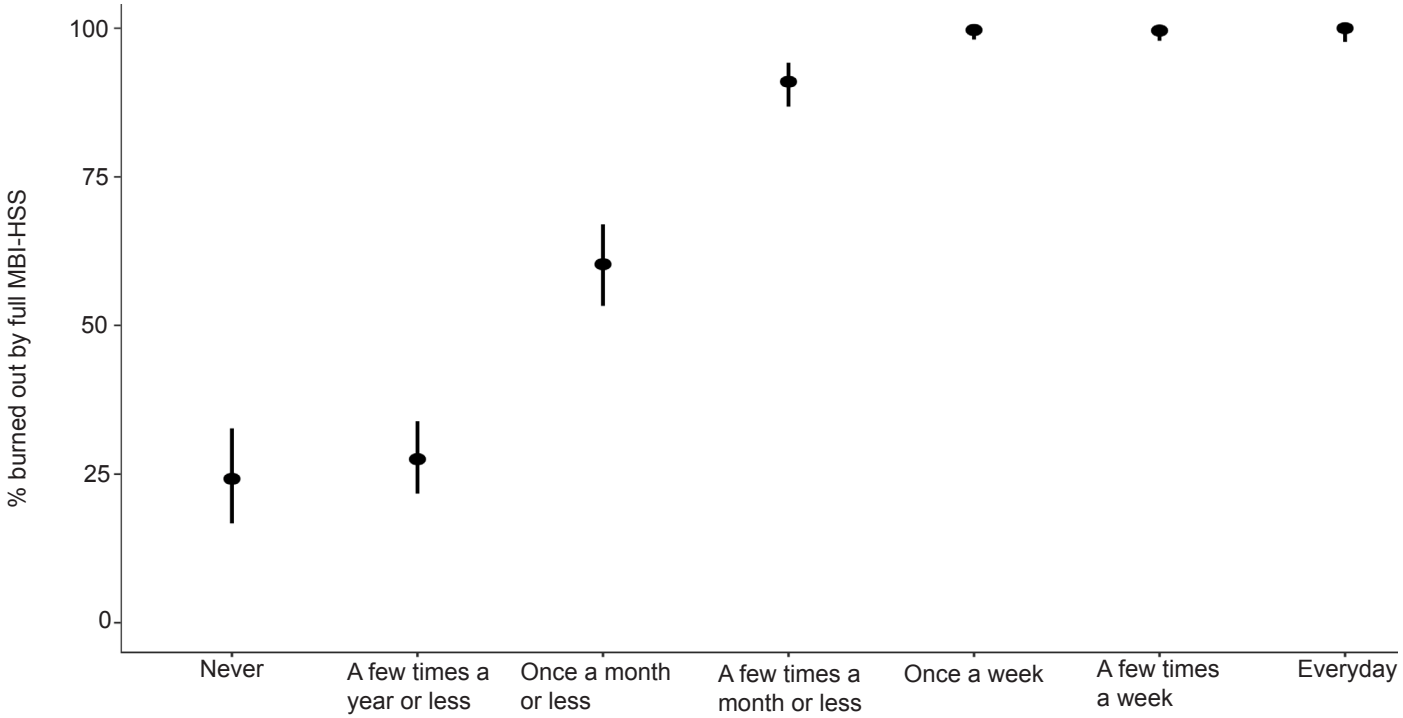


Figure 1. Prevalence of resident burnout stratified by emergency medicine resident response to the question "I feel burned out from my work" (EE1).
MBI-HSS, Maslach Burnout Inventory-Human Services Survey.

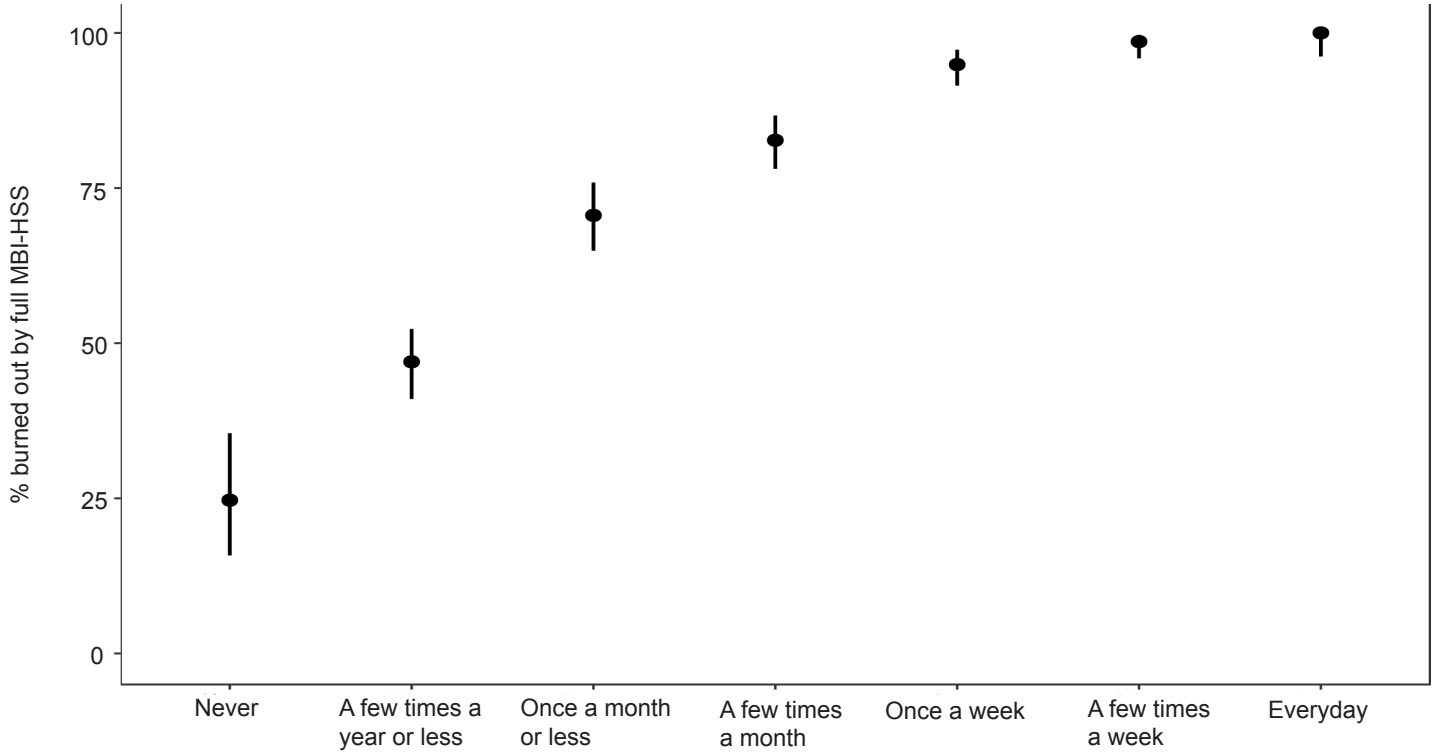


Figure 2. Prevalence of resident burnout stratified by emergency medicine resident response to the question "I have become more callous toward people since I took this job" (DP1).
MBI-HSS, Maslach Burnout Inventory-Human Services Survey.

Table 2. Spearman's rho correlation (95% confidence intervals) of MBI-HSS single-item measures and subscales compared to the primary, more inclusive, and more restrictive definitions of burnout from the 2017 Emergency Medicine Resident Wellness Survey.

MBI-HSS Items and Subscales	Primary definition	More inclusive definition	More restrictive definition
EE1	0.49 (0.45-0.53)	0.43 (0.39-0.46)	0.43 (0.40-0.47)
DP1	0.63 (0.60-0.66)	0.55 (0.52-0.58)	0.34 (0.30-0.38)
EE(-EE1)	0.59 (0.56-0.62)	0.51 (0.48-0.55)	0.48 (0.45-0.51)
DP(-DP1)	0.69 (0.66-0.71)	0.60 (0.57-0.63)	0.36 (0.32-0.40)
EE1+DP1	0.65 (0.62-0.68)	0.57 (0.53-0.60)	0.44 (0.41-0.48)

"I feel burned out from my work" (EE1). "I have become more callous toward people since I took this job" (DP1).
MBI-HSS, Maslach Burnout Inventory-Human Services Survey; *EE,* emotional exhaustion; *DP,* depersonalization.

characteristics compared to other cutoffs to the full MBI-HSS with a sensitivity, specificity, positive predictive value, and negative predictive value of 93.6%, 73.0%, 91.7%, and 78.2%, respectively, using the primary definition of burnout (Table 3). A cutoff with a high sensitivity was chosen because of the intent to use the summative score as a screening tool for burnout.

While other studies have examined the utility of abbreviated burnout measures in various physician and healthcare worker populations,[12,15-17] to our knowledge this is the first study to determine the validity of an abbreviated, summative two-item burnout screening approach in the EM resident population. Among survey respondents, 77.7% of residents were identified as burned out by the 2-Question Summative Score, based on the single-item EE1 or DP1 scores. This is comparable to our previous study finding of a 76.1% burnout rate among EM residents using the full MBI-HSS.[9]

While prior studies report performance measures of single-item questions with their respective subscales in

Table 3. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) the 2-Question Summative Score compared to the primary, more inclusive, and more restrictive definitions of burnout by the full Maslach Burnout Inventory-Human Services Survey.

Score	Test characteristic	Primary definition	More inclusive definition	More restrictive definition
>3	Sensitivity	93.6	90.0	100.0
	Specificity	73.0	74.2	27.2
	PPV	91.7	93.7	23.4
	NPV	78.2	63.7	100.0
>4	Sensitivity	85.9	81.4	98.2
	Specificity	87.3	86.6	38.2
	PPV	95.6	96.3	26.1
	NPV	65.9	52.4	99.0
>5	Sensitivity	74.7	70.5	95.3
	Specificity	95.0	94.5	50.2
	PPV	98.0	98.2	29.9
	NPV	54.1	43.1	98.0
>6	Sensitivity	60.1	56.5	87.0
	Specificity	99.7	99.7	63.4
	PPV	99.9	99.9	34.6
	NPV	43.9	35.2	95.6

PPV, postivie predictive value; *NPV,* negative predictive value.

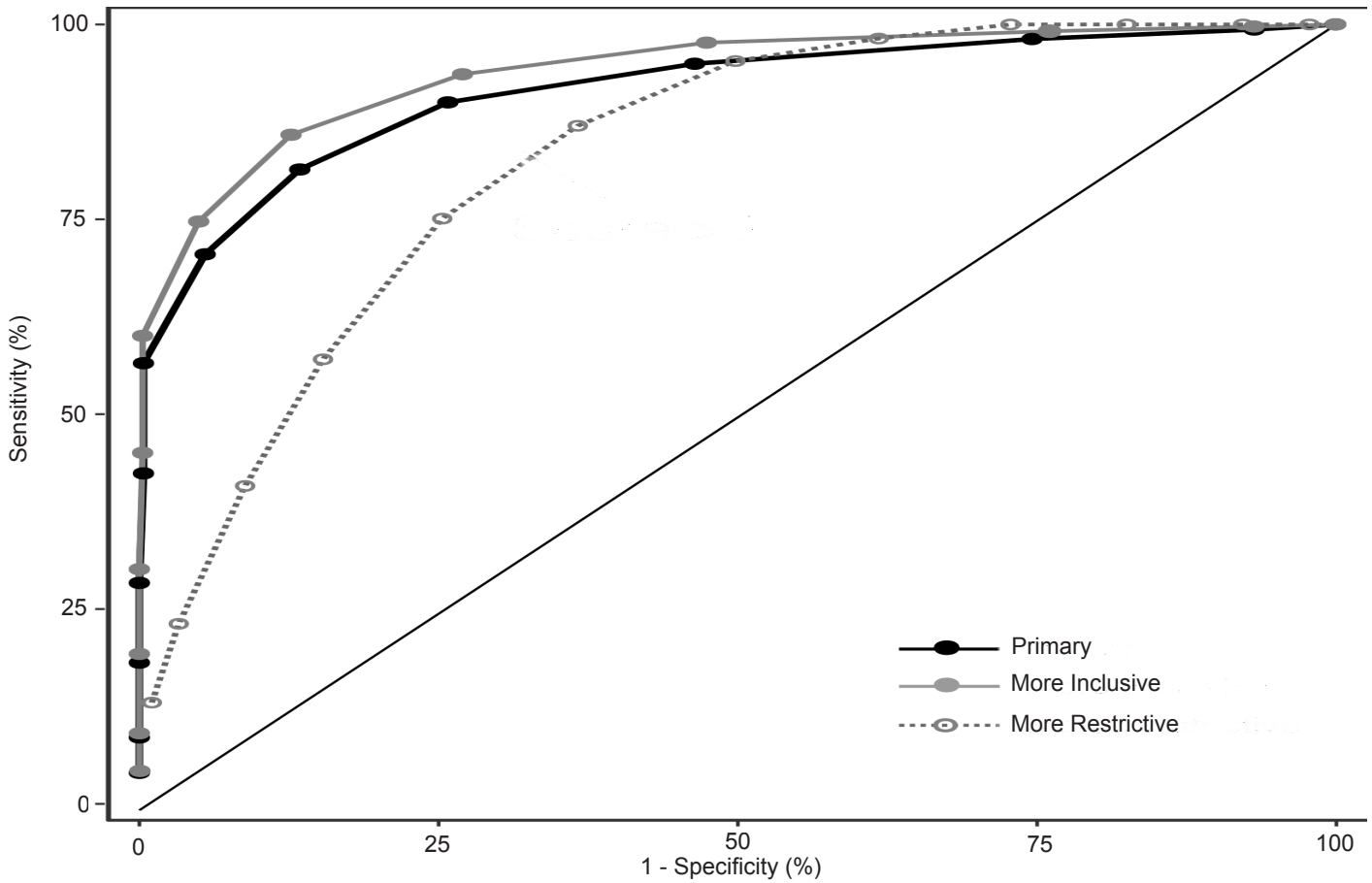


Figure 3. Receiver operating characteristic of primary, more inclusive, and more restrictive definitions of burnout based on the 2-Question Summative Score cutoffs. Dots represent a cutoff score of 0 to 12 from right to left on each curve.

heterogeneous and non-EM populations,[12,15-17] we initially hypothesized that such performance characteristics may be different in our population of EM-only residents. For instance, EM residents had shown a much higher prevalence of depersonalization (72.5%) compared to other resident burnout studies.[18-21] However, our correlation values of 0.81 and 0.73 align with prior literature comparing EE1 and DP1 with full EE(-EE1) and DP(-DP1) subscales.[10,12]

It is important to acknowledge that there are numerous definitions of burnout as described in previous literature. For the purposes of this study, we chose a primary definition of burnout consistent with the original publication to determine the correlation of the 2-Question Summative Score with the full 22-item MBI instrument. However, we chose to also include analyses using more inclusive and more restrictive definitions of burnout to determine whether a correlation could also be demonstrated using existing alternative definitions. For both the primary and more inclusive burnout definitions, a 2-Question Summative Score >3 demonstrated adequate test characteristics with high sensitivities (Figure 3), suggesting that this cutoff may be applicable across either definition of burnout using the MBI-HSS tool. For the more restrictive definition of burnout, higher score cutoffs seem to demonstrate better agreement with the definition. Thus, stakeholders can apply different cutoffs based on their desire to identify burned out residents with a more inclusive or restrictive lens.

The 2-Question Summative Score is not meant to provide a comprehensive assessment of burnout and should not be considered a replacement for the full 22-item MBI instrument. Burnout is such a multidimensional phenomenon that two questions alone likely will not detect subtle differences and trends. Rather, this abbreviated score provides a reasonable alternative screening tool, supported by adequate correlative performance characteristics, to be used when the full tool is not available or not feasible to distribute.

LIMITATIONS

Our study has limitations with respect to generalizability and nonresponse bias given the original survey methodology, which were addressed in the original publication.[9] While prior publications studying the utility of a 2-item burnout screen obtained aggregate data from medical students,

internal medicine residents, and practicing surgeons[10] and pediatric residents,[12] our study focuses on EM residents. Our results may not be generalizable outside the EM resident population. Specific analyses of subgroups (eg, male vs female, geographic region) with respect to the correlation of the 2-Question Summative Scale to the full MBI-HSS tool were not repeated as they were not found to have significant differences in the original publication.

Burnout is a multidimensional construct; simplifying the MBI into an abbreviated 2-question survey may miss the more nuanced and early characteristics of burnout among physicians, which would be captured using the full 22-item tool. Additionally, the 2-Question Summative Score is a tool limited by self-reporting bias and does not capture longitudinal facets of burnout.[22]

CONCLUSION

In summary, with its brevity and ease of administration, the 2-Question Summative Score instrument has the ability to identify at-risk EM residents beginning to show signs of burnout. This simplified screening tool, which uses two MBI-HSS questions, has the potential to result in more widespread, consistent, and longitudinal monitoring of EM resident burnout on a local, regional, and national level by asking residents how often they feel burned out from work and how often they feel that have become more callous toward people since taking the job. This aligns with the 2017 Accreditation Council for Graduate Medical Education Common Program Requirements mandate focusing on improved resident well being and wellness education across health profession specialties.[23] While tracking early burnout trends may help program leadership to implement early individual interventions, it is our hope that national organizations also use these trends to implement systemwide infrastructure and operational changes.[24-29]

Address for Correspondence: Simiao Li-Sauerwine, MD, MS, The Ohio State University, Department of Emergency Medicine, 775 Prior Hall, 376 W. 10th Ave., Columbus, OH 43210. Email: simiao.li-sauerwine@osumc.edu.

Conflicts of Interest: By the WestJEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. The authors acknowledge US Acute Care Solutions, which sponsors the Wellness Think Tank, and ALiEM for purchasing licensing rights to the Maslach Burnout Inventory tool; and Hippo Education, Emergent Medical Associates, and ALiEM for funding rewards and gift cards to provide incentive for survey completion. The authors disclose that senior author ML is the CEO of ALiEM, the umbrella organization for the Wellness Think Tank, and that all authors are members of the Wellness Think Tank; authors otherwise have no commercial associations or sources of support that might pose a conflict of interest as per ICMJE conflict of interest guidelines.

REFERENCES

1. Ishak WW, Lederer S, Mandili C, et al. Burnout during residency training: a literature review. *J Grad Med Educ*. 2009;1(2):236–42.
2. Ratanawongsa N, Wright SM, Carrese JA. Well-being in residency: effects on relationships with patients, interactions with colleagues, performance, and motivation. *Patient Educ Couns*. 2008;72(2):194–200.
3. Eckleberry-Hunt J, Kirkpatrick H, Barbera T. The problems with burnout research. *Acad Med.* 2018;93(3):367–70.
4. Bianchi R, Schonfeld IS. Defining physician burnout, and differentiating between burnout and depression—I. *Mayo Clin Proc*. 2017;92(9):1455.
5. Burn-out an "occupational phenomenon": *International Classification of Diseases* [Internet]. World Health Organization. 2019; Available at: https://www.who.int/mental_health/evidence/burn-out/en/. Accessed February 4, 2020.
6. Rotenstein LS, Torre M, Ramos MA, et al. Prevalence of burnout among physicians. *JAMA*. 2018;320(11):1131.
7. Dyrbye LN, Burke SE, Hardeman RR, et al. Association of clinical specialty with symptoms of burnout and career choice regret among US resident physicians. *JAMA*. 2018;320(11):1114.
8. Shanafelt TD, Mungo M, Schmitgen J, et al. Longitudinal study evaluating the association between physician burnout and changes in professional work effort. *Mayo Clin Proc*. 2016;91(4):422–31.
9. Lin M, Battaglioli N, Melamed M, et al. High prevalence of burnout among US emergency medicine residents: results from the 2017 National Emergency Medicine Wellness Survey. *Ann Emerg Med*. 2019. pii: S0196-0644(19)30064-2.
10. West CP, Dyrbye LN, Sloan JA, et al. Single Item measures of emotional exhaustion and depersonalization are useful for assessing burnout in medical professionals. *J Gen Intern Med*. 2009;24(12):1318–21.
11. West CP, Dyrbye LN, Satele DV, et al. Concurrent validity of single-item measures of emotional exhaustion and depersonalization in burnout assessment. *J Gen Intern Med*. 2012;27(11):1445–52.
12. Kemper KJ, Wilson PM, Schwartz A, et al. Burnout in pediatric residents: comparing brief screening questions to the Maslach Burnout Inventory. *Acad Pediatr*. 2019;19(3):251–5.
13. Maslach Burnout Inventory - Human Services Survey (MBI-HSS) - Assessments, Tests: Mind Garden [Internet]. Mind Garden. Available at: https://www.mindgarden.com/314-mbi-human-services-survey. Accessed February 4, 2020.

14. Harris PA, Taylor R, Thielke R, et al. Research Electronic Data Capture (REDCap): a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. 2009;42:377-81.
15. Dolan ED, Mohr D, Lempa M, et al. Using a single item to measure burnout in primary care staff: a psychometric evaluation. *J Gen Intern Med*. 2014;30(5):582–7.
16. Rohland BM, Kruse GR, Rohrer JE. Validation of a single-item measure of burnout against the Maslach Burnout Inventory among physicians. *Stress Health*. 2004;20(2):75–9.
17. Hansen V, Pit S. The single item burnout measure is a psychometrically sound screening tool for occupational burnout. *Health Scope*. 2016;5(2):e32164.
18. Elmore LC, Jeffe DB, Jin L, et al. National Survey of Burnout Among US General Surgery Residents. *J Am Coll Surg*. 2016;223(3):440–51.
19. Kemper KJ, McClafferty H, Wilson PM, et al; Pediatric Resident Burnout-Resilience Study Consortium. Do mindfulness and self-compassion predict burnout in pediatric residents? *Acad Med*. 2019;94(6):876-84.
20. Garza JA, Schneider KM, Promecene P, et al. Burnout in residency: a statewide study. *South Med J.* 2004;97(12):1171-3.
21. Trockel M, Bohman B, Lesure E, et al. A brief instrument to assess both burnout and professional fulfillment in physicians: reliability and validity, including correlation with self-reported medical errors, in a sample of resident and practicing physicians. *Acad Psych*. 2018;42(1):11–24.
22. Lebares CC, Guvva EV, Ascher NL, et al. Burnout and stress among US surgery residents: psychological distress and resilience. *J Am Coll Surg*. 2018;226(1):80-90.
23. Common Program Requirements [Internet]. ACGME. Available at: https://www.acgme.org/What-We-Do/Accreditation/Common-Program-Requirements. Accessed February 4, 2020.
24. Deckard G, Meterko M, Field D. Physician burnout: An examination of personal, professional, and organizational relationships. *Med Care*. 1994;32(7):745–54.
25. Edmondson EK, Kumar AA, Smith SM. Creating a culture of wellness in residency. *Acad Med*. 2018;93(7):966–8.
26. Hale AJ, Ricotta DN, Freed J, et al. Adapting Maslow's hierarchy of needs as a framework for resident wellness. *Teach Learn Med*. 2018;31(1):109–18.
27. Shanafelt TD, West CP, Sinsky C, et al. Changes in burnout and satisfaction with work-life integration in physicians and the general US working population between 2011 and 2017. *Mayo Clin Proc*. 2019;94(9):1681-94.
28. Swensen SJ, Shanafelt T. An organizational framework to reduce professional burnout and bring back joy in practice. *Jt Comm J Qual Patient Saf*. 2017;43(6):308–13.
29. West CP, Dyrbye LN, Erwin PJ, et al. Interventions to prevent and reduce physician burnout: a systematic review and meta-analysis. *Lancet*. 2016;388(10057):2272–81.

Ridesharing as an Alternative to Ambulance Transport for Voluntary Psychiatric Patients in the Emergency Department

Andrea Blome, MD
Jennifer Rosenbaum, MD
Nicole Lucas, MD
Kraftin Schreyer, MD

Temple University Hospital, Department of Emergency Medicine, Philadelphia, Pennsylvania

Section Editor: Erin Dehon, MD
Submission history: Submitted October 11, 2019; Revision received February 15, 2020; Accepted February 18, 2020
Electronically published April 21, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.2.45526

Introduction: Emergency department (ED) crowding is a growing problem. Psychiatric patients have long ED lengths of stay awaiting placement and transportation to a psychiatric facility after disposition.

Methods: Retrospective analysis of length of ED stay after disposition for voluntary psychiatric patients before and after the use of Lyft ridesharing services for inter-facility transport.

Results: Using Lyft transport to an outside crisis center shortens time to discharge both statistically and clinically from 113 minutes to 91 minutes (p = 0.028) for voluntary psychiatric patients. Discharge time also decreased for involuntary patients from 146 minutes to 127 minutes (p = 0.0053).

Conclusion: Ridesharing services may be a useful alternative to medical transportation for voluntary psychiatric patients.[West J Emerg Med. 2020;21(3)618–621.]

INTRODUCTION

Emergency department (ED) crowding threatens patient safety and public health.[1] Crowding exists when there is a lack of space or resources in an ED required to meet the timely needs of the next patient.[2] Such an environment leads to medical errors and inferior care.[3,4] One study demonstrated that ED crowding is associated with increased mortality in patients awaiting transfer to an intensive care unit.[5] The issue of ED crowding is growing on a national scale, with the Centers for Disease Control and Prevention estimating that 50% of EDs experience crowding and 45% of United States hospitals have been on ambulance diversion sometime in the previous year.[6,7] Consequently, EDs are focusing on finding solutions. Efforts such as performing registration at the bedside and placing a physician in triage have been shown to improve ED efficiency.[8,9] Despite an understanding that patients requiring transportation to their discharge destination have longer discharge times, little research has been performed looking at solutions to this crucial step in eliminating ED crowding.[10,11]

Patients, especially the elderly, disabled, or economically disadvantaged, may experience difficulty obtaining transportation home.[12] Psychiatric patients, in particular, are also known to have lengthy disposition times while awaiting placement and transportation to a psychiatric facility. One study suggested psychiatric patients spent an average of 11 hours in the ED when seeking care.[13] There are many barriers that contribute to this long length of stay (LOS) including insurance status/type, day of presentation to the ED, hand-offs, Emergency Medical Treatment and Labor Act paperwork, patient behavior/use of medications, and delays in medical transportation.[14,15] This transportation barrier has been shown to have many negative downstream effects for other patients, including delays in diagnosis and treatment, as well as contributing to ED crowding.[14]

The advent and broad availability of ridesharing services

such as Lyft and Uber may be of use to patients with limited access to transportation. One study estimated that 85% of patients were aware of ridesharing services, and of that percentage, 5% planned to use this transportation method upon discharge.[15] Ridesharing services may be a great option for older adults who are unable to drive or patients with limited financial means. However, studies have shown that elderly patients and patients with less income and education have limited knowledge and utilization of these services.[15,16] These ridesharing services have also piqued the interest of hospital systems aiming to provide non-emergency medical transportation services to their patients.[17-19] These efforts are bolstered by studies in primary care demonstrating improved show-rates when using ridesharing services, although other studies have not definitively demonstrated benefits in decreasing no-show rates.[22,23]

Despite the broad availability of ridesharing services and their increasing utilization by hospital systems, there are no studies on the use of taxi services and limited research on the effect of ridesharing on ED LOS after discharge or interfacility transport. This study aims to determine the role of ridesharing services on ED LOS for patients awaiting voluntary transportation to a psychiatric facility.

METHODS

We performed a retrospective analysis of time from disposition until a patient's respective discharge on a cohort of patients requiring transportation to psychiatric services before and after a hospital ridesharing initiative was implemented. The study was performed during an eight-month period between December 1, 2018–July 29, 2019, at an urban, university-associated ED and Level I trauma center serving an average annual patient population of approximately 85,000 in Philadelphia, Pennsylvania. The chart abstractors were not blinded to the study hypothesis. The study coincided with the advent of an ED initiative of organizing and paying for ridesharing services using Lyft for discharged patients requesting voluntary transfer to a psychiatric facility. This service was provided to all patients requesting to go to a psychiatric facility on a voluntary basis, as well as those requesting detox or drug rehabilitation.

At the study ED, patients presenting with psychiatric concerns are evaluated and determined to require either involuntary evaluation and treatment or voluntary transfer to a psychiatric facility. Any patient 14 years of age or older who is experiencing a mental health crisis and wishes to seek inpatient care for their safety may request voluntary commitment. The ED is affiliated with a local crisis response center (CRC) that is a 24-hour psychiatric emergency service where patients are seen as walk-ins and includes a 23-hour observation unit that can admit to an inpatient behavioral health center.

Before the introduction of the ridesharing initiative, all patients were provided medical transportation, in either an ambulance van or wheelchair van by a contracted medical transportation company to the CRC regardless of their voluntary or involuntary status. After the initiative, all patients requesting psychiatric services voluntarily, detox or drug rehabilitation, were eligible for a free Lyft transport to the CRC. Medical transportation was still obtained for all patients who were determined to require involuntary evaluation.

All patients transferred from the ED to the CRC were reviewed during this eight-month study period. Using R statistical programming software, we used two sample t-tests to evaluate the effect of using Lyft transport on the mean discharge time in minutes, for all eligible and ineligible subjects. In addition, we collected data to determine whether patients transferred to the CRC were evaluated by a psychiatrist or left prior to evaluation. A chi-squared test was completed to assess whether there was a statistically significant change in the number of patients who completed a psychiatric evaluation at the CRC before and after the Lyft transport protocols were commenced.

RESULTS

We included 814 patients in this study. Patients eligible for Lyft transport included those who voluntarily committed to a psychiatric evaluation at the CRC, as well as those who requested transport for drug rehabilitation or detox. Ineligible patients were those who were involuntarily sent for a CRC evaluation. A total of 410 patients were included prior to the initiation of the Lyft initiative, from December 1, 2018 until March 21, 2019. Of these patients 242 were ineligible and 168 were eligible for Lyft transport. In addition, 404 patients were included after the Lyft initiative commencement, from March 21– June 29, 2019. There were 286 patients who were not eligible for Lyft and 118 who were eligible.

We used two sample t-tests to evaluate the effect of Lyft transport on patient discharge time in minutes. Eligible patients, n = 286, saw a statistically significant drop in mean minutes to discharge, decreasing from 113 minutes to 91 minutes ($p = 0.028$). The ineligible patients, n = 582, also saw a statistically significant reduction in discharge times. When Lyft was used for other eligible patients, the mean discharge time for ineligible patients decreased from 146 minutes before the initiation of Lyft to 127 minutes during the Lyft initiative ($p = 0.0053$) (Table 1). We used a chi-square test to determine whether there was a significant difference between the number of patients seen in the CRC before and after the initiation of Lyft. Prior to the Lyft initiative, 90.5% of eligible patients were seen by psychiatrists at the CRC after ambulance transport. After commencement of the initiative, 83.9% of eligible patients completed a psychiatric evaluation at the CRC. Per chi-squared testing, this change in value was not statistically significant ($p = 0.0947$) (Table 2).

Table 1. Pre- and Post-Lyft Comparison of Length-of-Stay for Eligible and Ineligible Patients.

Patient group	Number of patients		Mean length of stay after disposition (minutes)		Mean change in length of stay after disposition (μ1-μ2)	P-value: μ1 > μ2
	Pre-Lyft	Post-Lyft	Pre-Lyft (μ1)	Post-Lyft (μ2)		
Ineligible	242	286	146.3	126.5	19.75 95% CI: (5.901, 33.59)	0.0053
Eligible	168	118	112.8	91.38	21.41 95% CI: (2.364, 40.45)	0.0278

CI, confidence interval.

DISCUSSION

This study showed that using Lyft transport to transfer voluntary psychiatric patients to a crisis center decreases the discharge times after disposition of both voluntary and involuntary psychiatric patients. These findings are both statistically and clinically significant. ED psychiatric patients are known to experience lengthy time to discharge due to the lack of available inpatient psychiatric beds. For those patients who simply require transportation to a psychiatric facility and have already been medically cleared by an emergency physician, ridesharing serves as an adequate alternative to traditional medical transportation.

Ridesharing is an efficient alternative and has the potential for significant cost savings for any hospital and patient, as these services cost less than any mode of medical transportation. This more efficient discharge process is also specifically important for patients with substance use disorder or mental illness. The process streamlines obtaining help for drug or alcohol addiction in patients at risk for experiencing withdrawal symptoms while waiting. There was also no statistically significant change in the number of patients who ultimately received a CRC psychiatric evaluation, indicating that the change in transportation mode likely did not influence the chance that a patient would be evaluated in the CRC.

In addition, the use of Lyft vehicles reduces the utilization of ambulance transport services, which in turn increases availability for other patient transports. In our study, ineligible patients (ie, those under involuntary status) also showed a clinically and statistically significant decreased transport time by about 20 minutes. Lastly, the reduced turnaround times for psychiatric patients frees additional treatment space for other patients waiting to be seen.

Table 2. Comparison of Eligible Patients Using Lyft and Completion of Respective Psychiatric Evaluations.

	Completed psychiatric evaluation	No psychiatric evaluation
Pre-Lyft	152	16
Post-Lyft	99	19

Chi-square statistic: p = 0.095

LIMITATIONS

One limitation of the study was a potential lack of generalizability to non-psychiatric patients. In addition, the chart abstractors were not blinded to the study hypothesis. Nor did the study address the issue of patients boarding due to unavailability of an inpatient bed. Furthermore, although there was a non-statistically significant 7% decrease in the number of patients who were ultimately evaluated by a psychiatrist in the CRC in those patients using a Lyft, we were unable to determine the reason(s) for not obtaining a psychiatric evaluation. Therefore, it is unlikely, but unknown whether this decrease was a direct result of using Lyft transportation. CRC-specific information, including CRC wait times and CRC boarding times for inpatient beds were not analyzed in this study. It is unknown whether expedited transfers objectively decreased a patient's wait time to their final disposition from the CRC. Lastly, other potential confounders were not analyzed, such as the effect of volume on the data.

CONCLUSION

Patients seeking or requiring psychiatric services from the ED often have lengthy wait times. This retrospective analysis sought to identify whether using a ridesharing service decreased length of stay for psychiatric patients who are seeking voluntary psychiatric evaluations. Using Lyft decreased the time that patient's waited for transportation after disposition from the ED with both clinical and statistical significance. As a result, the time that voluntary psychiatric patients spent waiting for transportation was reduced, with an additional significant reduction in times for involuntary patients. Ridesharing is a viable, cost-effective option for psychiatric patients seeking voluntary treatment and for whom transportation is the only barrier.

Address for Correspondence: Andrea Blome, MD, Temple University, Department of Emergency Medicine, 3401 N Broad St., Philadelphia, PA 19104. Email: andrea.blome@tuhs.temple.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. The ridesharing company Lyft had no input into study design, execution or report. None of the authors have any proprietary interest in Lyft.

REFERENCES

1. Trzeciak, S. Emergency department overcrowding in the United States: an emerging threat to patient safety and public health. *EMJ*. 2003;20(5):402-5.
2. Salway R, Valenzuela R, Shoenberger J, et al. Emergency department (ED) overcrowding: evidence-based answers to frequently asked questions. *Revista Médica Clínica Las Condes*. 2017;28(2):213-19.
3. Kulstad EB, Sikka R, Sweis RT, et al. ED overcrowding is associated with an increased frequency of medication errors. *Am J Emerg Med*. 2010;28(3):304-9.
4. Bernstein SL, Aronsky D, Duseja R, et al. The effect of emergency department crowding on clinically oriented outcomes. *Acad Emerg Med*. 2009;16(1):1-10.
5. Trzeciak S. Clinical and economic impact of intensive care unit transfer delays for critically ill emergency department patients. *Acad Emerg Med*. 2005;12(Supplement 1):9-9.
6. Burt CW, McCraig LF. Staffing, capacity, and ambulance diversion in emergency departments: United States, 2003-04. *Advanced Data*. 2006;376:1-23.
7. Burt, CW, Mccaig, LF, Valverde RH. Analysis of ambulance transports and diversions among US emergency departments. *Ann Emerg Med*. 2006;47(4):317-26.
8. Gorelick MH, Yen K, Yun HJ. The effect of in-room registration on emergency department length of stay. *Ann Emerg Med*. 2005;45(2):128-33.
9. Han JH, France DJ, Levin SR, et al. The effect of physician triage on emergency department length of stay. *J Emerg Med*. 2010;39(2):227-33.
10. Hu S-C. Computerized monitoring of emergency department patient flow. *Am J Emerg Med*. 1993;11(1):8-11.
11. Stolte E, Iwanow R, Hall C. Capacity-related interfacility patient transports: patients affected, wait times involved and associated morbidity. *CJEM*. 2006;8(04):262-8.
12. Lefler V, Castillo F. Designing our future transportation workforce for supporting seniors and individuals with disabilities. *Empowering the New Mobility Workforce*. 2019:269-88.
13. Weiss AP, Chang G, Rauch SL, et al. Patient- and practice-related determinants of emergency department length of stay for patients with psychiatric illness. *Ann Emerg Med*. 2012;60(2):162-71.e5.
14. Wilson MP, Brennan JJ, Modesti L, et al. Lengths of stay for involuntarily held psychiatric patients in the ED are affected by both patient characteristics and medication use. *Am J Emerg Med*. 2015;33(4):527-30.
15. Pearlmutter MD, Dwyer KH, Burke LG, et al. Analysis of emergency department length of stay for mental health patients at ten massachusetts emergency departments. *Ann Emerg Med*. 2017;70(2):193-202.e16.
16. Syed ST, Gerber BS, Sharp LK. Traveling towards disease: transportation barriers to health care access. *J Community Health*. 2013;38(5):976-93.
17. Tomar A, Ganesh S, Richards J. Transportation preferences of patients discharged from the emergency department in the era of ridesharing apps. *West J Emerg Med*. 2019;20(4):672-80.
18. Vivoda JM, Harmon AC, Babulal GM, et al. E-hail (rideshare) knowledge, use, reliance, and future expectations among older adults. *Transp Res Part F Traffic Psychol Behav*. 2018;55:426-434.
19. Powers BW, Rinefort S, Jain SH. Nonemergency medical transportation. *JAMA*. 2016;316(9):921.
20. Morrissey J. Hospitals seek solutions for patient transportation. Health Progress. Available at: https://www.chausa.org/docs/default-source/health-progress/hospitals-seek-solutions-for-patient-transportation.pdf?sfvrsn=0. Accessed November 30, 2019.
21. Gdiesing. Case study: Denver Health Medical Center collaborates with Lyft to improve transportation for patients. *AHA News*. American Hospital Association. Available at: https://www.aha.org/news/insights-and-analysis/2018-03-01-case-study-denver-health-medical-center-collaborates-lyft. Accessed November 30, 2019.
22. Chaiyachati KH, Hubbard RA, Yeager A, et al. Rideshare-based medical transportation for Medicaid patients and primary care show rates: a difference-in-difference analysis of a pilot program. *J Gen Int Med*. 2018;33(6):863-8.
23. Chaiyachati KH, Hubbard RA, Yeager A, et al. Association of rideshare-based transportation services and missed primary care appointments. *JAMA Int Med*. 2018;178(3):383.

Ultrasound Identification of Retrobulbar Hematomas by Emergency Physicians in a Cadaveric Model

Edward Carlin, MD*†
Alexa Palmieri, PA-C*
Tanya Bajaj, DO*
Mathew Nelson, DO*†

*North Shore University Hospital, Department of Emergency Medicine, Manhasset, New York
†North Shore University Hospital, Department of Emergency Medicine, Division of Emergency Ultrasound, Manhasset, New York

Section Editor: Jeffrey Druck, MD
Submission history: Submitted September 5, 2019; Revision received December 12, 2019; Accepted January 18, 2020
Electronically published April 13, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.1.45081

Introduction: Retrobulbar hemorrhage (RBH) is a rare complication of facial trauma that can lead to dangerous orbital compartment pressures and must be rapidly recognized to prevent permanent vision loss. Point-of-care ultrasound (POCUS) offers a rapid modality for evaluating a wide variety of ocular pathologies, and prior case reports demonstrate the ability of clinicians to recognize RBH using ultrasound. This study aimed to assess the ability of clinicians at various stages of training to identify a RBH using POCUS in a cadaveric model. Clinicians also were assessed for self-reported comfort using ultrasound for ocular pathology before and after the study.

Methods: Participants included 17 physicians who evaluated 10 eyes (from five cadavers) that were independently randomized to have either a modeled RBH or no hemorrhage. Participants' final diagnosis of each eye was recorded (RBH present or not), and participants also completed pre- and post-activity surveys.

Results: The overall sensitivity and specificity to correctly diagnose retrobulbar fluid was 87% and 88%, respectively. Sensitivity and specificity were higher after excluding clinicians in their early phase of training. Additionally, self-reported comfort level with ocular ultrasound was significantly improved by this activity.

Conclusion: Emergency physicians at a variety of training levels can correctly identify a cadaveric model of retrobulbar hemorrhage. Use of this cadaveric model can improve exposure of clinicians to the appearance of a rare but vision-threatening ocular pathology such as RBH. [West J Emerg Med. 2020;21(3)622-625.]

INTRODUCTION

Retrobulbar hemorrhage (RBH) is a rare complication of facial trauma; however, it must be rapidly recognized to prevent permanent vision loss from increased orbital compartment pressures.[1-3] Typically, emergency physicians must identify this entity based upon the patient's clinical presentation, or on delayed imaging with computed tomography (CT).[4] Uncertainty during the clinical examination and delays in obtaining a CT may lead to further progression of RBH and vision loss. Point-of-care ultrasound (POCUS) represents a rapid, repeatable method of imaging ocular pathology, without need for transport out of the emergency department (ED), and can be done concurrent with other traumatic injury management.[5] RBH has been identified using bedside ocular ultrasound in several case reports; however, no systematic studies of this condition exist, likely due to the rare nature of this injury.[5]

Cadaver models represent a useful way to simulate rare pathologies for both research and educational purposes.[6,7] This is important not only for advancing our understanding of certain disease processes, but also to allow clinicians to become exposed to pathology not seen in day-to-day practice.[6-8] Previous work has shown the practicality of reproducing a variety of ocular pathologies for visualization under ultrasound, including RBH.[8] In this pilot study, we demonstrate the feasibility of simulating

RBH in cadaver models for imaging with POCUS. As a primary endpoint, we analyzed the ability of residents, emergency ultrasound fellows, and ED faculty physicians to accurately diagnose the presence of retrobulbar fluid in our models. As a secondary endpoint, we surveyed the participants about their comfort level with and likelihood to use ocular ultrasound before and after the activity.

Population Health Research Capsule

What do we already know about this issue?
Retrobulbar hemorrhage, a rare complication of facial trauma, must be rapidly recognized to prevent permanent vision loss.

What was the research question?
This study assessed if clinicians could identify a cadaver model of retrobulbar hemorrhage using point-of-care ultrasound.

What was the major finding of the study?
Emergency physicians could accurately identify the ultrasound findings of a retrobulbar hemorrhage in a cadaver model.

How does this improve population health?
This model can improve the familiarity of clinicians to the ultrasound findings seen in patients with retrobulbar hemorrhage.

METHODS

This study was accomplished in the Bioskills laboratory of Northwell Health Systems, using fresh frozen cadavers and in compliance with department policies and institutional review board standards. To prepare the eyes for analysis, 5-10 milliliters (mL) of normal saline was injected into the posterior chamber using a 22-gauge needle to restore the normal anatomic shape (as cadaveric eyes become desiccated). Five cadavers were available for this study, and each eye (10 in total) was independently randomized to be either normal or have RBH. For the eyes randomized to the RBH group, 10-20 mL of a normal saline and gel mixture (1:1) was instilled posterior to the eye under ultrasound guidance (Figure 1A). Participants included residents of various levels of training (postgraduate year [PGY]-1 to PGY-3), two ultrasound fellows, and five attendings (Table 1).

Each participant was given a pre-activity survey and a brief instructional introduction on the use of POCUS for ocular pathology and the appearance of RBH on ultrasound. During the introduction, participants were given a 15-minute didactic presentation summarizing techniques for ocular POCUS, representative normal images, and examples of RBH. Each participant had the opportunity to use either a SonoSite M-Turbo ultrasound (Bothell, WA) equipped with a linear 10 megahertz array, or a Philips Lumify L12-4 linear array (Amsterdam, The Netherlands) (attached to an Android-based LCD screen) on each cadaveric eye. Participants then recorded the presence or absence of a RBH for each eye. Participants completed a post-activity survey regarding their comfort level with ocular ultrasound and likelihood to use in clinical practice. Following completion of the study, each participant's surveys and score sheet were given a unique randomized number without additional identifying information.

Results of participants' evaluation of each eye were recorded and analyzed for sensitivity and specificity, and further analyzed by subgroups according to level of training. Additionally, survey responses for all groups were recorded and a comparison was made for each question regarding comfort level and likelihood to use POCUS for evaluation of ocular pathology.

RESULTS

In this pilot study, a total of 17 participants evaluated 10 eyes (five cadavers) prepared for this investigation (five eyes with "normal" anatomy and five eyes modeled to have RBH). Figure 1 shows representative images obtained during this activity. Figure 1B demonstrates an eye after instillation of saline to approximate normal anatomy; it should be noted that there is evidence of retinal detachment, which was incidentally seen on most eyes and likely represents damage sustained post-mortem or from frozen storage. Figure 1C demonstrates an eye with an anechoic collection posterior to the globe, representing the modeled RBH.

The participants were able to distinguish those eyes with a modeled RBH from "normal" anatomy, with an overall sensitivity and specificity of 0.87 and 0.88, respectively (Table 1). This increased among participants at PGY-3 training level or higher. PGY-3 participants had a sensitivity and specificity of 1.00 and 0.93, respectively, while two ultrasound fellows had 1.00 and 1.00. Paradoxically, among participating faculty members the sensitivity and specificity decreased to 0.92 and 0.92. For pooled

Table 1. Sensitivity and specificity for diagnosing retrobulbar hemorrhage on point-of-care ultrasound on POCUS by physician training level.

Level of training	Number of participants	Sensitivity	Specificity
PGY-1	4	0.88	0.67
PGY-2	3	0.80	0.87
PGY-3	3	1.00	0.93
Fellow	2	1.00	1.00
Attending	5	0.92	0.92
Overall	17	0.87	0.88
PGY-3+	*10*	*0.96*	*0.94*

PGY, postgraduate year.

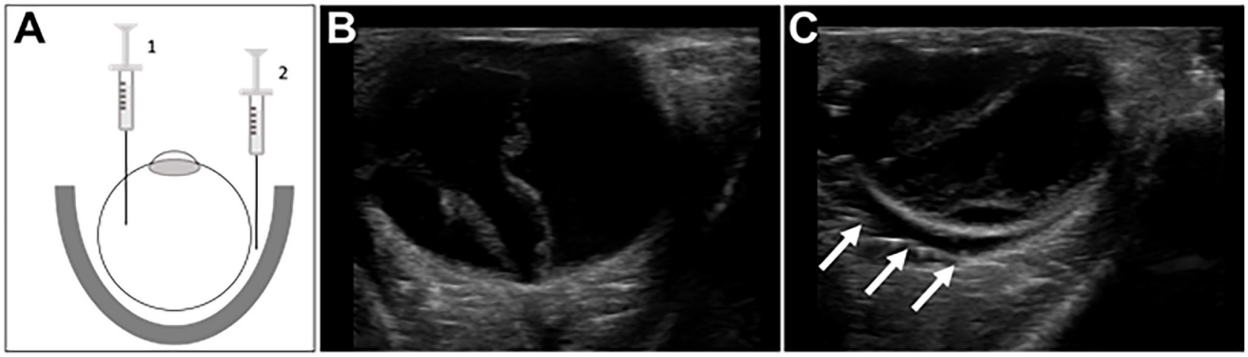


Figure 1. Preparation and representative images of the retrobulbar hemorrage model.
(A) Fresh frozen cadavers were first prepared by injecting 5-10 cubic centimeters (cc) of normal saline into the posterior chamber (1) to recreate normal anatomic arrangement of the globe. Subsequently, 10-20 cc of a mixture of gel and saline was instilled within the retrobulbar area (2) by carefully inserting a 20-gauge needle between the globe and lateral aspect of the orbit. (B-C) Examples of images obtained from the cadaveric models. Panel B shows a "normal" eye, and Panel C shows an eye following placement of retrobulbar fluid (arrows). In both cases there are hyperechoic linear foci within the posterior body, which was seen in all cadavers and appears consistent with a retinal detachment.

results for participants at PGY-3 or higher, the sensitivity was 0.96 and specificity was 0.94.

The participants reported their comfort level with using physical exam and POCUS for evaluating ocular pathology before and after the exercise, using a five-point Likert scale. Both saw statistically significant increases in comfort level after completion, based upon an increased, self-reported comfort level.

DISCUSSION

RBH is a rare but potentially devastating injury that must be rapidly recognized to treat effectively; however, concomitant craniofacial injuries can affect an examiner's ability to recognize signs of RBH on physical exam. Additionally, the time associated with obtaining and reading CT images can lead to dangerous delays in diagnosis. POCUS can be used to rapidly screen for RBH at the patient's bedside and without the patient having to leave the department for imaging. Previous case reports have documented the use of POCUS to identify RBH; however, the rarity of this pathology has made more systematic research difficult.

Our pilot study indicates that human cadaver models can be used to effectively train emergency medicine practitioners to recognize sonographic signs of a RBH. After the completion of a focused training session, the participants successfully identified a RBH on ultrasound with a sensitivity and specificity that increased with the level of postgraduate training. We noted a sensitivity of 0.96 and a specificity of 0.94 with recognizing RBH in those PGY-3 level of training or higher. Physicians currently enrolled in the ultrasound fellowship who participated in this study had a sensitivity and specificity of 100%, suggesting that more advanced training can further increase the diagnostic utility of ocular ultrasound. Attending scores decreased slightly to 0.92 (sensitivity and specificity), likely reflecting higher proficiency among ultrasound fellows with more recent, advanced training.

Using our pre- and post-study questionnaires, our study showed a significant increase in participants' comfort level in using POCUS to diagnose RBH. Physician likelihood to use ocular ultrasound was unchanged from the activity; however, given that the ranking was initially high (4 out of 5), any increase in likelihood-to-use may not be measurable with the low sample size obtained. Based upon these findings, fresh frozen cadavers can provide an accurate educational simulation of RBH on ultrasound.

LIMITATIONS

Our study had several limitations. The sample size was small and lacked the ability to test the same number of residents and attendings per PGY level. Although using fresh frozen cadavers provided simulation of true pathology, the lack of eye movement seen in live patients may have allowed for easier detection of RBH. The cadaver models did not represent several other aspects of real-life diagnosis, such as patient discomfort, uncooperative patients, or concomitant traumatic injuries (including orbital or facial trauma, which may prevent visual inspection of the eye or measurement of intraocular pressure). Additionally, this cadaver model contained other ocular pathology on ultrasound, such as the appearance of retinal detachments (likely resulting from cadaver preparation). This study was also limited to the evaluation of RBH greater than 10 cubic centimeters in volume, and there is likely a decrease in sensitivity and specificity with smaller volumes. Future studies could assess the accuracy of identifying different retrobulbar volumes. Despite these limitations, this approach represents a feasible method for reliably representing a rare pathology for physician education.

CONCLUSION

Emergency physicians can use POCUS to correctly identify a cadaveric model of RBH. Higher levels of training seem to

correlate with improved accuracy in diagnosing this condition. Use of this model can improve clinicians' exposure to the appearance of rare, vision-threatening ocular pathology, such as RBH. More study will be needed to assess the accuracy of POCUS for identifying retrobulbar hemorrhage in live patients.

ACKNOWLEDGMENTS

We would like to thank Dr Timmy Li for assistance with the statistical analysis in this manuscript.

Address for Correspondence: Edward Carlin, MD, North Shore University Hospital - Northwell Health, Department of Emergency Medicine, 300 Community Drive, Manhasset, NY 11030. Email: ecarlin@northwell.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Holt GR, Holt JE. Incidence of eye injuries in facial fractures: an analysis of 727 cases. *Otolaryngol Head Neck Surg*. 1983;91(3):276-9.
2. Hislop WS, Dutton GN, Douglas PS. Treatment of retrobulbar haemorrhage in accident and emergency departments. *Br J Oral Maxillofac Surg*. 1996;34(4):289-92.
3. Fattahi T, Brewer K, Retana A, et al. Incidence of retrobulbar hemorrhage in the emergency department. *J Oral Maxillofac Surg*. 2014;72(12):2500-2.
4. Pamukcu C. Acute retrobulbar hemorrhage: an ophthalmologic emergency for emergency physician. *Turkish J Trauma Emerg Surg*. 2015;21(4):309-14.
5. Kniess CK, Fong TC, Reilly AJ, et al. Early detection of traumatic retrobulbar hemorrhage using bedside ocular ultrasound. *J Emerg Med*. 2015;49(1):58-60.
6. Adhikari S, Zeger W, Wadman M, et al. Assessment of a human cadaver model for training emergency medicine residents in the ultrasound diagnosis of pneumothorax. *Biomed Res Int*. 2014; 2014:724050.
7. Demers G, Migliore S, Bennett DR, et al. Ultrasound evaluation of cranial and long bone fractures in a cadaver model. *Mil Med*. 2012;177(7):836-9
8. Zaia BE, Briese B, Williams SR, et al. Use of cadaver models in point-of-care emergency ultrasound education for diagnostic applications. *J Emerg Med*. 2012;43(4):683-91.

Can Emergency Physicians Perform Carotid Artery Point-of-Care Ultrasound to Detect Stenosis in Patients with TIA and Stroke? A Pilot Study

Robert Suttie, MD*
Michael Y. Woo, MD*†
Lily Park, BHSc*
Marie-Joe Nemnom, MSc†
Grant Stotts, MD†‡
Jeffrey J. Perry, MD, MSc*†

*University of Ottawa, Department of Emergency Medicine, Ontario, Canada
†The Ottawa Hospital Research Institute, Ontario, Canada
‡University of Ottawa, Department of Medicine, Division of Neurology, Ontario, Canada

Section Editor: William Whetstone, MD
Submission history: Submitted September 10, 2019; Revision received February 6, 2020; Accepted February 11 2020
Electronically published April 13, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.2.45137

Introduction: Patients with severe, symptomatic carotid stenosis can have their subsequent stroke risk reduced by surgical intervention if performed soon after a transient ischemic attack (TIA) or stroke. Patients presenting to an emergency department (ED) without computed tomography angiography (CTA) with TIA/stroke, may require transfer to another hospital for imaging to rule out carotid artery stenosis. The objective of this study was to determine the test characteristics of carotid artery point-of-care ultrasound (POCUS) in detecting greater than 50% stenosis in patients presenting with TIA/stroke.

Methods: We conducted a prospective cohort study on a convenience sample of adult patients presenting to a comprehensive stroke centre with TIA or stroke between June–October 2017. Carotid POCUS was performed. Primary outcome measure, stenosis ≥ 50%, was determined by the final radiology report of CTA. A blinded POCUS expert separately reviewed the archived carotid POCUS scans. We calculated sensitivity and specificity for stenosis ≥ 50%.

Results: We conducted POCUS on 75 patients, of which 70 were included in our analyses. Of those 70, 14.3% were diagnosed with greater than 50% stenosis. Carotid POCUS performed as follows: sensitivity 70.0% (95% confidence interval [CI], 34.8%-93.3%); specificity 86.7% (95% CI, 75.4%-94.1%); positive likelihood ratio (LR +) 5.3 (95% CI, 1.2-9.3); negative likelihood ratio (LR -) 0.4 (95% CI, 0.0-0.7). The inter-rater reliability between POCUS performer interpretation and expert interpretation had moderate agreement (k = 0.68). Scans took a mean 6.2 ± 2.2 minutes to complete.

Conclusion: Carotid POCUS has low to moderate association with CTA for detection of carotid artery stenosis ≥ 50%. Further research and investigation is needed prior to widespread use of carotid POCUS in patients with acute cerebral ischemia. Additionally, external validity is likely affected by availability of training, maintenance of competency, and experience in more rural centres. [West J Emerg Med. 2020;21(3)626–632.]

INTRODUCTION

Stroke and transient ischemic attack (TIA) are relatively common reasons for emergency department (ED) visits. While TIA patients, by definition, fully recover, up to 23% will go on to have a subsequent stroke with 92% occurring in the following seven days.[1-3] Carotid artery stenosis is a well-established etiology of TIA and stroke.[4] Secondary stroke and death risk can be significantly reduced with carotid revascularization. This

intervention is most beneficial for patients with 70-99% stenosis, with maximal benefit if completed within 14 days of the ischemic event and no further benefit after three months.[1-3,5] There is also some benefit for patients with moderate stenosis (50-69%); however, the benefit is only present if surgery is performed within two weeks of the cerebral ischemic event.[1-3,5]

While the benefit of carotid revascularization is optimal when performed quickly, this is not occurring. Three Canadian studies have found that median delay to surgery from symptom onset varies from 25 to 79 days.[2,5,6] Similar trends are observed in Europe with median times to surgery ranging from 53 to 82 days.[7-10] Furthermore, studies have found that inpatients undergo carotid endarterectomy (CEA) more quickly with 54% receiving CEA within two weeks vs 20% compared to outpatients.[6] The longest delay in care in one study was found to occur between symptom onset and vascular referral, which included delays to obtaining imaging given wait times for outpatient studies.[5] In a second study, time to carotid imaging was the major factor determining time to revascularization.[10] Having immediate access to comprehensive imaging may reduce delays to intervention.[5,10] This point is further emphasized in the recent Canadian Stroke Best Practice Guidelines from 2018.[11]

Computed tomography angiography (CTA) has long been the gold standard for the detection of intravascular stenosis of large arteries in the head and neck. However, to best serve ED patients it requires 24/7 access to a CT scanner as well as technologists and radiologists capable of accurately reading the scans. Unfortunately, only about 15% of Canadian rural EDs have access to a CT scanner 24/7.[12] In the USA, similar trends are observed with less access to CT in smaller, rural hospitals.[42] Another tool available is carotid duplex ultrasonography (DUS) with sensitivity for stenosis ≥ 50% of 96-98% and specificities of 83-88%.[22,23] However, DUS is quite complicated; it is usually performed by a dedicated ultrasound technician and requires extensive training. Additionally, DUS is often not available acutely or after hours.

Point-of-care ultrasonography (POCUS) is available in many EDs across the US and Canada and could be an adjunct to CT/DUS in hospitals with limited access.[13,41] In addition to clinical information, risk-stratification of patients in the ED using POCUS could aid emergency physicians (EP) in their decision as to whether same day CTA is required. This would be particularly valuable to physicians in rural and community hospitals as this tool would help to efficiently determine who should be transferred to a tertiary care center for definitive imaging with CTA. Thus, the goal of this pilot study was to determine whether it is feasible for POCUS to detect carotid stenosis in patients with symptomatic TIA or stroke when compared with CTA.

Population Health Research Capsule

What do we already know about this issue?
In some patients with carotid stenosis, stroke risk is reduced if surgery is performed quickly. Definitive imaging modalities aren't always available .

What was the research question?
How well can carotid point-of-care ultrasound (POCUS) detect ≥ 50% stenosis in transient ischemic attack (TIA)/stroke patients?

What was the major finding of the study?
Compared to computed tomography angiography, carotid POCUS demonstrated a sensitivity of 70.0% with a specificity of 86.7%.

How does this improve population health?
For TIA/stroke patients in rural settings, carotid POCUS is a potential tool to expedite risk-stratification and transfer.

METHODS

Study Design and Time Period, Study Setting and Population

We prospectively enrolled a convenience sample of ED patients seen at a tertiary care, comprehensive stroke center for either stroke or TIA from June to October 2017. Patients were recruited by the study team. Eligible patients had a diagnosis of stroke or TIA. Patients were excluded if they did not receive a CTA or if the POCUS was deemed indeterminate, which meant that the interpretation could not be deemed positive or negative. We obtained 68 final diagnoses and outcomes from chart review six months following the index ED visit. This consisted of an informal review of ED neurology consultations or outpatient Stroke Prevention Clinic documentation.

POCUS exams were completed in the ED during the index visit. A POCUS scanning protocol for the carotid artery was developed after a review of the literature and expert opinion. Standard B-mode and colour Doppler images were obtained for each patient following this protocol. The protocol did not include spectral Doppler or velocity calculations. The scanning protocol is included in Appendix 1.

Patients were recruited in a convenience fashion. During dedicated scanning shifts Monday to Friday from 9 AM to 5 PM, a medical student recruited all stroke codes and patients evaluated for TIA/stroke when paged by the treating clinician. Additional patients were recruited by an emergency medicine (EM) resident during off-hours in the same fashion. Finally, a minority of patients were recruited by the treating clinician if they had been trained to complete the protocol (Figure 1).

Intervention

Patients were scanned in the supine position using a high-frequency linear transducer Z-One Ultra (5-10 megahertz [MHz]) (Zonare, Mountain View, CA). Scans included the entire course of the common carotid and extracranial internal carotid

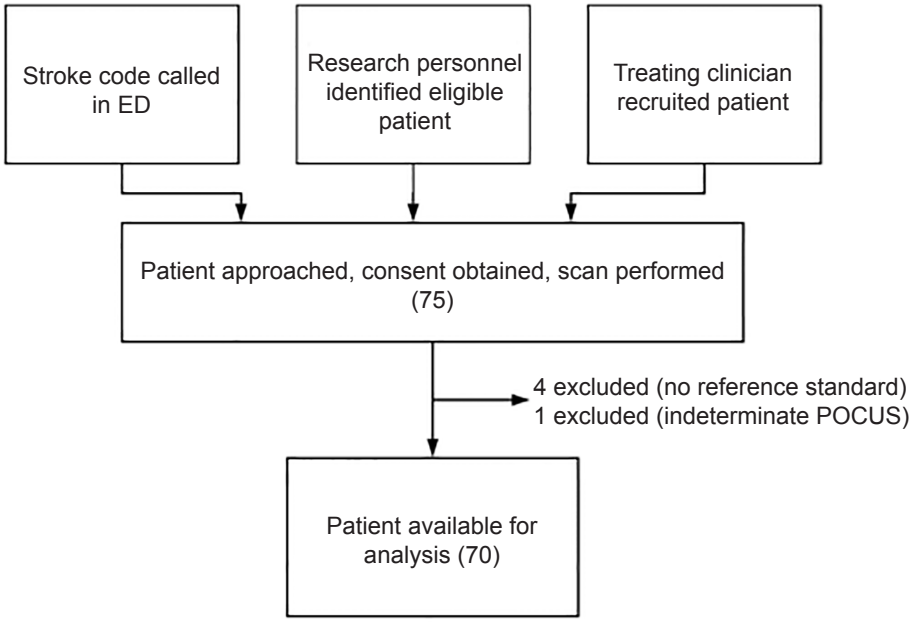


Figure 1. Recruitment flow chart for a study of the potential use of point-of-care ultrasound in patients presenting with stroke symptoms at rural hospitals.
ED, emergency department; *POCUS,* point-of-care ultrasound.

artery (ICA) (Appendix 2, Images 1 and 2). An example of severe carotid stenosis is shown in Appendix 2, Images 3 and 4.

POCUS operators included a trained medical student, an EM resident and credentialed EPs at The Ottawa Hospital. Given there is no gold standard protocol available EPs were able to recruit after a one-hour didactic session with no hands-on practice. Most recruiting EPs were fellowship-trained in POCUS. The recruiting resident was responsible for developing the protocol and thus was responsible for leading the session. Training for the student consisted of two hours of didactic teaching and a four-hour supervised scanning shift, initially learning the basics of ultrasound and then the protocol, with credentialed POCUS EPs. The student completed 10 determinate carotid scans prior to recruitment. All images were archived for review by a blinded POCUS expert.

Outcome Measures

The primary outcome of interest was carotid stenosis ≥50%. We chose ≥50% as opposed to ≥70% to ensure more conservative test characteristics. Degree of stenosis on POCUS was determined using an "eyeball" estimation. We used the final CTA report to ascertain the presence of stenosis and the percentage of stenosis if present. Radiologists were unaware of this study and blinded to the POCUS assessment. CTA was chosen as the reference standard as opposed to duplex ultrasound not because it is more accurate but because it is the current standard of care in the ED for these patients. Furthermore, our goal was to compare POCUS with the most widely used imaging practice. The secondary outcome was time required to complete a POCUS, which was generated from the image clips where the times of first and last scan were listed.

Data Analyses

Data were collected from POCUS results and CTA for each patient, which was then compiled into a Microsoft Excel document (Microsoft Corporation, Redmond, WA) and imported into Statistical Analysis System (SAS Institute, Cary, NC) for analysis. We calculated sensitivity, specificity, predictive values, and likelihood ratios including 95% confidence intervals (CI). A kappa statistic described the inter-rater reliability between initial POCUS assessment and subsequent blinded expert review of the archived POCUS images.

RESULTS

A total of 75 patients were scanned with 70 available for analysis (Table 1). Of the five patients excluded from the final analysis, four were excluded as they did not receive a CTA at the discretion of the treating physician because the etiology of their symptoms was not stroke/TIA and one was excluded for an indeterminate POCUS. Of the included patients, the average age was 70.4 years; 40 (57.1%) patients were male, 33 (47.1%) were diagnosed with stroke, 20 (28.6%) diagnosed with TIA, and 17 (24.3%) with a stroke mimic, including migraine, seizure, orthostatic hypotension, or encephalopathy. The majority of patients presented with mild deficits with 64 (91.4%) patients scoring a 6 or below on the National Institutes of Health Stroke Scale (NIHSS). Most patients had motor and sensory symptoms, with 27 patients (38.6%) presenting with language symptoms only and six (8.6%) presenting with ataxia only. Almost half of the cases (33 [47.1%] patients) were a stroke code activated by the EP.

At The Ottawa Hospital, a stroke code is called for expedited neurology assessment if the patient scores NIHSS 4 or more and has no contraindications to thrombolysis. Forty patients

Table 1. Characteristics of the patients available for analysis.

Characteristics	Number of patients (%)	Characteristics	Number of patients (%)
Mean age, years (SD)	70.4 (13.4)	Symptoms (may have more than one), n (%)	
Male, n (%)	40 (57.1)	Motor	41 (58.6)
Co-morbidities, n (%)		Sensory	40 (57.1)
Previous TIA/stroke	21 (30)	Language	27 (38.6)
Atrial fibrillation	14 (20)	Ataxia	6 (8.6)
Diabetes including type 1 & 2	16 (23)	Other‡	3 (4.2)
Dyslipidemia	26 (37)	Time from symptom onset to ED presentation, minutes‡	
Hypertension	32 (45)	Range	30-7200
Peripheral vascular disease	7 (10)	Mean	767
Mechanical heart valve	1 (1.4)	Mean excluding outliers§	142
Current medications, n (%)		Stroke code n, (%)	33 (47.1)
Anti-platelet*	33 (47)	CTA, n (%)	
Warfarin	4 (5.7)	Under 50%	60 (85.7)
DOAC	9 (13)	50% or over	10 (14.3)
Statin	31 (44)	Severe stenosis (over ≥ 50%) by NIHSS, n (% of cohort)	
Eventual final diagnosis		0	3 (11.5)
Stroke, n (%)	33 (47.1)	1-4	6 (17.6)
TIA, n (%)	20 (28.6)	5-15	0 (0)
Other	17 (24.3)	16-20	0 (0)
NIHSS on presentation, n (%)		21-42	1 (100)
0	26 (37.1)	Admitted, n (%)	30 (42.9)
1-4	34 (48.6)	Carotid revascularization within 2 weeks of index event of those with carotid stenosis, n (%)	3 (30.0)
5-15	7 (10.0)		
16-20	0 (0.0)		
21-42	1 (1.4)		
Unable to record†	1 (1.4)		

SD, standard deviation; *TIA,* transient ischemic attack; *NIHSS,* National Institutes of Health Stroke Scale; *CT,* computed tomography; *DOAC,* direct oral anticoagulant; *PVD,* peripheral vascular disease; *POCUS,* point of care ultrasound; *ED,* emergency department.
*Includes ASA, clopidogrel, dipyramidole either single or dual antiplatelet
†Patient intubated and sedated prior to arrival at tertiary care center.
‡Excluded 7 patients (no documented time of onset) and 2 patients (onset occurred within ED).
§Excludes patients presenting over 24 hours (n = 13).

(57.1%) were discharged home. Of these patients, nine were diagnosed with stroke, 16 with TIA, and 12 with a stroke mimic. Ten patients had stenosis 50% or more diagnosed on CTA. Five patients were 50-69%, three patients were 70-99%, and two were 100% occluded. None of the patients with carotid stenosis between 50-69% or 100% had carotid revascularization within two weeks of the index event while all three cases between 70-99% received carotid revascularization. None of the patients with false negative POCUS went to surgery.

Carotid POCUS was poor to moderate in comparison to CTA (Table 2). Test characteristics were as follows: sensitivity 70.0% (95% CI, 34.8%-93.3%); specificity 86.7% (95% CI, 75.4%-94.1%); positive likelihood ratio (LR +) 5.3 (95% CI, 1.2-9.3); and LR - 0.4 (95% CI, 0.0-0.7). We calculated a kappa value of 0.68 (95% CI, 0.46-0.90) to compare initial interpretation and expert POCUS interpretation of scans, describing moderate agreement. There were three false negatives on POCUS: one with 100% stenosis and two with exactly 50% stenosis with all three occurring in the internal carotid artery.

Performance of carotid POCUS took a mean time of 6.2 ± 2.2 minutes to complete. Maximum time was 12 minutes and minimum time was two minutes. This did not include the time to set up the ultrasound machine or any potential pre-scanning to the first saved image.

DISCUSSION

Based on these results in patients with symptomatic TIA or stroke, carotid POCUS has a low to moderate association

with CTA for the detection of 50% or greater carotid stenosis. Our patient cohort had a 14.3% prevalence of ≥ 50% stenosis, or 10 total patients. This seems to agree with existing literature that reports carotid artery stenosis as a cause of ischemic TIA and stroke in 10-15% of patients.[15-17] Only three of 10 patients received intervention with either CEA or carotid stenting. Of the seven remaining patients all had moderate stenosis of 50-69% or a 100% occluded carotid; none of these were operated on at time of publication. Two had 100% chronically occluded arteries for which carotid revascularization was contraindicated.[43] A third patient was eventually diagnosed with a seizure as the cause of his neurological symptoms, and thus the neurology team felt the carotid stenosis was incidental. One patient declined follow up due to ongoing health issues and thus was never assessed for surgery. Finally, three patients, all with exactly 50% carotid stenosis, were not intervened upon at the discretion of the treating inpatient team in keeping with most guidelines.[43] All three patients with carotid stenosis 70-99% received intervention within two weeks.

The test characteristics only demonstrated low to moderate sensitivity and specificity, which was due to the three false negatives. An investigation of these three cases was performed. Two patients were found to have 50% stenosis of the left ICA with the other found to have 100% stenosis of the ICA just distal to its origin. All three of these patients were admitted. None of the three patients went on to have carotid revascularization at any point in their hospital stay or within three months following their hospitalization as it is not indicated for this patient group.[43]

One of the patients with a 50% stenosis was thought to have a free-floating thrombus after a small luminal defect was found. This patient had a unique ED course in that symptoms fluctuated in a crescendo TIA pattern and was seen by the neurology team twice in the same ED visit. On the first assessment, the CTA preliminary report did not identify the luminal defect and the patient was set to be discharged home. Neurology was called back to assess the patient due to recurrence of symptoms and on reassessment of the CTA, the defect was found. After anticoagulation, repeat CTA five days later did not demonstrate the defect. This was a high-risk, unstable TIA patient and in that clinical context a negative ultrasound should not change the patient course.

Table 2. Two-by-two table of carotid point-of-care ultrasound vs computed tomography angiography for carotid stenosis.

		Carotid stenosis (≥ 50%)		Total
		(+)	(-)	
Carotid POCUS	(+)	7	8	15
	(-)	3	52	55
Total		10	60	70
		SS = 0.70	SP = 0.867	

POCUS, point-of-care ultrasound; *PPV,* positive predictive value; *NPV,* negative predictive value; *SS,* sensitivity; *SP,* specificity.

The second false negative patient was found to have a 100% stenosis, which was not intervened upon as there is no indication for revascularization of chronic occlusions.[38, 43] This was likely missed due to significant amounts of plaque calcification that the US waves are unable to penetrate. The final false negative experienced a cerebellar event and, therefore, the carotid stenosis was deemed incidental and asymptomatic and thus not appropriate for carotid revascularization.

This is the first study describing the potential use of a novel carotid POCUS protocol to determine >50% carotid stenosis in patients presenting with TIA or stroke. When comparing comprehensive carotid duplex scanning in radiology departments, which includes velocity calculations to either angiography or CTA, sensitivity for carotid duplex scan for stenosis ≥50% has been previously found to be 96-98%, with specificities of 83-88%.[22,23] While the specificity of POCUS is similar to duplex scanning, based on our study the sensitivity of POCUS appears to be quite a bit lower. It should also be stressed that this tool would only apply to TIA and non-disabling stroke in a clinical context where rapid outpatient imaging is available. With normal carotid imaging, patients presenting with stroke with disabling deficits should still be screened with CTA to determine candidacy for endovascular thrombectomy.

Additionally, images were generated by both novice and experienced POCUS sonographers after a short training period. While the results were modest, this speaks to the potential generalizability of carotid POCUS to this patient population. However, to simplify the protocol we elected to omit Doppler flow velocities and objective diameter measurements in lieu of an "eyeball" method. This may have had an effect on the overall validity of the test.

LIMITATIONS

The small sample size and convenience sample are limitations in that there was likely some selection bias. Additionally, the study was underpowered secondary to the sample size and thus limits the reliability of the test characteristics. While the sensitivity generated was 70% it may have been as low as 34.8% due to wide confidence intervals. The results, however, do demonstrate a similar rate of stenosis compared with other reported studies. Almost half of the patients recruited were stroke codes that could limit the generalizability to a TIA population. A proportion of the patients recruited were not diagnosed with stroke or TIA by a stroke neurologist in lieu of a common stroke mimic, but this may be found in other patients presenting to the ED with TIA/stroke like symptoms. We also had one scan that was indeterminate due to inability to visualize the entire carotid. This scan was excluded as this is how POCUS is used clinically. With any indeterminate scan the clinician should disregard the results and act based on the clinical information they have; these patients should be transferred for more comprehensive imaging.

The event rate was also low and, therefore, further study is required prior to carotid POCUS being used to rule out 50% or

greater carotid stenosis. It is also important to note that the inter-rater reliability of interpreting the scans was moderate, which may limit its external application. Finally, if further research is positive, this tool may be limited by its real-life applicability. Despite the generalizability, rural emergency physicians may not feel confident in a high-risk diagnosis using their own POCUS. This would have to be a target for educational interventions and continuing training/credentialing. Additionally, in a,higher resource medical system outpatient access to carotid imaging may not be delayed so as to affect surgical timeline. This likely limits the applicability of the scan to lower resource settings.

Because POCUS is available in most EDs.[41] it is a potential tool for a common presentation in TIA/stroke patients, which includes risk-stratification and triaging transfers of these patients as well as rapid identification of stroke etiology. It likely would play less of a role in a tertiary care center with 24-hour access to CTA. Unfortunately, these sites are less likely to have access to POCUS and operators are likely less experienced, which would limit the generalizability of the tool. Additionally, there are other reasons for performing a CTA other than to determine carotid stenosis including identification of proximal thrombi amenable to thrombectomy.[39]

Additionally, CTA can predict patients at risk of clinical deterioration.[40] Of course, because POCUS can only interrogate extracranial vessels, despite a normal scan these clinical questions would still require CTA or transfer to tertiary care. Unfortunately, due to the underpowering of our study the confidence intervals are quite wide and the test characteristics of the study may not be reliable. While our study demonstrates an intriguing new use of POCUS, it will require more study with more robust methodology until applied clinically.

CONCLUSION

In our study, carotid POCUS had a low to moderate association with CTA for the detection of carotid stenosis greater than or equal to 50%. Further research and investigation is needed prior to widespread use of carotid POCUS in patients with acute cerebral ischemia.

Address for Correspondence: Jeffrey J. Perry, MD, MSc, 1053 Carling Ave., Ottawa, ON K1Y 1J8, Canada. Email: jperry@ohri.ca.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. The study was funded through the CAEP Resident Research Grant 2018. There are no conflicts of interest or other sources of funding to declare.

REFERENCES

1. Giles M, Rothwell P. Risk of stroke early after transient ischaemic attack: a systematic review and meta-analysis. *Lancet Neurol.* 2007;6(12):1063-72.
2. Gladstone D, Oh J, Fang J, et al. Urgency of carotid endarterectomy for secondary stroke prevention: results from the Registry of the Canadian Stroke Network. *Stroke.* 2009;40(8):2776-82.
3. Qureshi M, Davies A. Carotid intervention following transient ischaemic attack: What are we waiting for? *Vascular.* 2016;24(5):556-8.
4. Chambers B, Norris J. Outcome in patients with asymptomatic neck bruits. *N Engl J Med*. 1986;315(14):860-865.
5. Jetty P, Husereau D, Kubelik D, et al. Wait times among patients with symptomatic carotid artery stenosis requiring carotid endarterectomy for stroke prevention. *J Vasc Surg.* 2012;56(3):661-7.e1-2.
6. Charbonneau P, Bonaventure PL, Drudi LM, et al. An institutional study of time delays for symptomatic carotid endarterectomy. *J Vasc Surg.* 2016;64(6):1726-33.
7. Johansson E, Wester P. Delay from symptoms to carotid endarterectomy. *J Intern Med.* 2008;263(4):404-11.
8. Dellagrammaticas D, Lewis S, Colam B, et al. Carotid endarterectomy in the UK: acceptable risks but unacceptable delays. *Clin Med (Lond).* 2007;7(6):589-92.
9. den Hartog AG, Moll FL, van der Worp HB, et al. (2014). Delay to carotid endarterectomy in patients with symptomatic carotid artery stenosis. *Eur J Vasc Endovasc Surg.* 2014;47(3):233-9.
10. Gocan S, Bourgoin A, Blacquiere D, et al. Fast-track systems improve timely carotid endarterectomy in stroke prevention outpatients. *Can J Neurol Sci.* 2016;43(5):648-54.
11. Boulanger JM, Lindsay MP, Gubits G, et al. Canadian Stroke Best Practice Recommendations for Acute Stroke Management: Prehospital, Emergency Department, and Acute Inpatient Stroke Care, 6th Edition, Update 2018. *Int J Stroke.* 2018;13(9):949-84.
12. Bergeron C, Fleet R, Tounkara F, et al. (2017). Lack of CT scanner in a rural emergency department increases inter-facility transfers: a pilot study. *BMC Res Notes*. 2017;10(1):772.
13. Léger P, Fleet R, Giguère J, et al. A majority of rural emergency departments in the province of Quebec use point-of-care ultrasound: a cross-sectional survey. *BMC Emerg Med*. 2015;15:36.
14. Adams H, Davis P, Leira E, et al. Baseline NIH Stroke Scale score strongly predicts outcome after stroke: a report of the Trial of Org 10172 in Acute Stroke Treatment (TOAST). *Neurology*. 1999;53(1:126-312.
15. Hill M, Yiannakoulias N, Jeerakathil T, et al. The high risk of stroke immediately after transient ischemic attack: a population-based study. *Neurology*. 2004;62(11):2015-20.
16. Mohr J, Mast H. Carotid artery disease. *Stroke*. 2011;334-61.
17. Lal B, Adelman M, Indes J, et al. 2018. *Carotid Artery Stenosis - BMJ Best Practice*. Available at: https://bestpractice.bmj.com/. Accessed September 4, 2019.
18. Flaherty M, Kissela B, Khoury J, et al. (2012). Carotid artery stenosis as a cause of stroke. *Neuroepidemiology*. 2012;40(1):36-41.
19. Al-Khaled M, Scheef B. Symptomatic carotid stenosis and stroke risk

in patients with transient ischemic attack according to the tissue-based definition. *Int J Neurosci*. 2015;126(10:888-92.

20. Sheehan O, Kyne L, Kelly L, et al. Population-based study of ABCD2 score, carotid stenosis, and atrial fibrillation for Early stroke prediction after transient ischemic attack: the North Dublin TIA Study. *Stroke*. 2010;41(5):844-50.
21. Tsivgoulis G, Spengos K, Manta P, et al. Validation of the ABCD score in identifying individuals at high early risk of stroke after a transient ischemic attack: a hospital-based case series study. *Stroke*. 2006;37(12):2892-7.
22. Henry J, Kiser D, Satiani B. A critical evaluation of carotid duplex scanning in the diagnosis of significant carotid artery occlusive disease. *Advances in Vascular Medicine*. 2015:1-6.
23. Jahromi A, Cinà C, Liu Y. Sensitivity and specificity of color duplex ultrasound measurement in the estimation of internal carotid artery stenosis: A systematic review and meta-analysis. *J Vasc Surg*. 41(6):962-72.
24. Arger PH, De Bari Iyoob S. *Complete Guide To Vascular Ultrasound*. Philadelphia: Wolters Kluwer; 2015.
25. Bhandari T, Socransky SJ. Is B-mode ultrasound alone a sufficient screening tool for carotid stenosis? a pilot study. *Crit Ultrasound J*. 2014;6(1):17.
26. Bluth E, Benson C, Ralls P, et al. *Ultrasonography In Vascular Diseases: A Practical Approach*. 1st ed. New York: Thieme; 2008.
27. Carroll BA. Carotid sonography. *Radiology*. 1991;178(2):303–13.
28. Lee W. General principles of carotid Doppler ultrasonography. *Ultrasonography*. 2013;33(1):11-17.
29. Luengo-Fernandez R, Gray A, Rothwell P. Effect of urgent treatment for transient ischaemic attack and minor stroke on disability and hospital costs (EXPRESS study): a prospective population-based sequential comparison. *Lancet Neurol*. 2009;8(3):235-43.
30. McGahan J., Goldberg B. *Diagnostic Ultrasound*. 1st ed. New York: Informa Healthcare; 2008.
31. Myers K, Clough A. *Practical Vascular Ultrasound*. 1st ed. Boca Raton; London [u.a.]: CRC Press, Taylor et Francis; 2014.
32. Nicolaides A. *Ultrasound And Carotid Bifurcation Atherosclerosis*. 1st ed. London: Springer; 2012.
33. Polak J. *Peripheral Vascular Sonography*. 1st ed. Philadelphia: Wolters Kluwer Health; 2004.
34. Rerkasem K, Rothwell P. A systematic review of randomized controlled trials of carotid endarterectomy for symptomatic carotid stenosis. *Stroke*. 2011;42(9):e543-4.
35. Rothwell PM, Giles MF, Chandratheva E, et al. Effect of urgent treatment of transient ischaemic attack and minor stroke on early recurrent stroke (EXPRESS study): a prospective population-based sequential comparison. *Lancet. 2007;*370(9596):1432-42.
36. Thomas K, Lewis N, Hill B, et al. Technical recommendations for the use of carotid duplex ultrasound for the assessment of extracranial blood flow. *Am J Physiol Regul Integr Comp Physiol*. 2015;309(7):R707-20.
37. Wardlaw J, Stevenson M, Chappell F et al. Carotid artery imaging for secondary stroke prevention. *Stroke*. 2009;40(11):3511-7.
38. Ricotta J, AbuRahma A, Ascher E, et al. Updated Society for Vascular Surgery guidelines for management of extracranial carotid disease: Executive summary. *J Vasc Surg*. 2011;54(3):832-6.
39. Nogueira R, Jadhav A, Haussen D, et al. Thrombectomy 6 to 24 hours after stroke with a mismatch between deficit and infarct. *N Engl J Med.* 2018;378(1):11-21.
40. Coutts SB, Modi J, Patel SK, et al. What causes disability after transient ischemic attack and minor stroke? Results from the CT and MRI in the Triage of TIA and minor Cerebrovascular Events to Identify High Risk Patients (CATCH) Study. *Stroke*. 2012;43(11):3018-22.
41. Mengarelli M, Nepusz A, Kondrashova T. A comparison of point-of-care ultrasonography use in rural versus urban emergency departments throughout Missouri. *Mo Med*. 2018;115(1):56-60.
42. Ginde A, Foianini A, Renner D, et al. Availability and quality of computed tomography and magnetic resonance imaging equipment in U.S. emergency departments. *Acad Emerg Med*. 2008;15(8):780-3.
43. Brott T, Halperin J, Abbara S, et al. Guideline on the management of patients with extracranial carotid and vertebral artery disease. *J Am Coll Cardiol*. 2011;57(8):e16-e94.

Appropriateness of Antibiotic Prescriptions for Urinary Tract Infections

Paige C. Chardavoyne, BA* *Pennsylvania State College of Medicine, Hershey, Pennsylvania
Kathryn E. Kasmire, MD, MS*† †Penn State Health Milton S. Hershey Medical Center, Division of Emergency Medicine, Hershey, Pennsylvania

Section Editor: Stephen Y. Liang, MD, MPHS
Submission history: Submitted November 20, 2019; Revision received January 27, 2020; Accepted January 31, 2020
Electronically published April 13, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.1.45944

Introduction: Urinary tract infections (UTI) are a common indication for antibiotic use in the emergency department (ED). With antibiotic resistance on the rise, it is essential that antibiotics be prescribed appropriately for UTIs. Our objective was to evaluate the appropriateness of antibiotic prescriptions by ED providers for uncomplicated cystitis and pyelonephritis.

Methods: We conducted a retrospective study of females ages 2-50 years seen in an academic ED from January 2017 to April 2018 diagnosed with UTI. We assessed the appropriateness of discharge antibiotic prescriptions, as determined by adherence to clinical practice guidelines, best evidence for the particular indication (cystitis vs pyelonephritis for children and adults), and the local antibiogram.

Results: A total of 421 patients were included in this study. Of these, 60 children and 198 adults were diagnosed with cystitis, and 47 children and 116 adults were diagnosed with pyelonephritis. Treatment in the absence of true infection was common, with culture-confirmed UTI occurring in only 17/50 (34%) of children and 60/129 (47%) of adults diagnosed with cystitis, and 23/40 (58%) of children and 58/87 (67%) of adults diagnosed with pyelonephritis, among patients who had urine cultures. The type of antibiotic prescribed was appropriate in 53/60 (88%) of children and 135/198 (68%) of adults with cystitis, and 38/47 (81%) of children and 53/116 (46%) of adults with pyelonephritis. The most common inappropriate antibiotic types were beta-lactams in adults (n = 92), nitrofurantoin for pyelonephritis (n = 16), and amoxicillin (n = 15). Dosing and duration errors were also common, occurring in 122/279 (44%) of prescriptions of an appropriate antibiotic type. The frequency of errors in the type of antibiotic prescribed was similar among provider types (attending physician, resident physician, and advanced practice clinician; p = 0.926).

Conclusion: This study reveals room for improvement in antibiotic prescription practices across provider cohorts in the ED for the management of uncomplicated cystitis and pyelonephritis in females. [West J Emerg Med. 2020;21(3)633-639.]

INTRODUCTION

Urinary tract infections (UTI) are common among females, accounting for upward of 10.5 million visits to physician offices and emergency departments (ED) per year.[1] While it is important to promptly treat UTIs with antibiotics to prevent complications such as septic shock and renal scarring in children,[2,3] it is also prudent to use antibiotics only when needed in an effort to reduce adverse medication effects and antibiotic resistance. With common UTI pathogens, resistance to fluoroquinolones and trimethoprim-sulfamethoxazole (TMP-SMX) has been on the rise. Additionally, there has been increasing prevalence of extended-spectrum β-lactamase and other multi-drug resistant organisms.[4-6]

Given the implications of inappropriate antibiotic prescription practices to individuals and populations, it is essential that providers appropriately select antibiotic treatment for the management of suspected UTIs. Guidelines from sources such as the Infectious Diseases Society of America (IDSA)

and the American Academy of Pediatrics (AAP) can provide guidance.[7,8] However, local factors, such as site-specific antibiotic resistance, also must be taken into account. Most organizations now publish hospital-wide antibiograms, which were present in 98% of United States hospitals in 2014.[9] Although hospital antibiograms exist, it remains unknown whether providers are using this tool, in conjunction with guidelines, such as those from the IDSA, to tailor their prescription practices to their particular location. In a recent survey of pediatric providers, 70% reported access to local antibiograms and, of these, only 50% reported using the antibiogram "always" or "most of the time" when empirically prescribing antibiotics for UTIs.[10] Prescribing practices for UTIs are variable and problems exist, including the use of overly broad antibiotics and treatment in the absence of true infection.[11,12]

To investigate antibiotic prescribing practices for suspected UTIs, we primarily sought to determine whether empiric antibiotic selection was appropriate for suspected UTIs in children and adults. Secondarily, we set out to analyze frequency of antibiotic prescription in the absence of true infection and whether variation in appropriate antibiotic selection existed between specific provider groups, including attending physicians, resident physicians, physician assistants, and nurse practitioners. We hypothesized that inappropriate antibiotics were frequently prescribed, that patients were frequently treated with antibiotics in the absence of true infection, and that variation existed between provider groups.

Population Health Research Capsule

What do we already know about this issue?
Previous studies have found overuse of antibiotics for urinary tract infections (UTI).

What was the research question?
To evaluate the appropriateness of antibiotic prescriptions for UTIs.

What was the major finding of the study?
Antibiotics were overused and inappropriate antibiotics were commonly prescribed for suspected UTIs.

How does this improve population health?
This study identified antibiotic misuse including overly broad antibiotics and overdiagnosis of UTIs, which can promote antimicrobial resistance.

METHODS

Study Design

The study was a retrospective analysis of females ages 2 to 50 years diagnosed with a UTI who were treated and discharged between January 1, 2017 – April 16, 2018, from an academic medical center ED. Females age 18 years or older were categorized as adults, while females under the age of 18 years were categorized as children. Institutional review board approval was obtained. We identified patients via an ED diagnosis of one or more of the following *International Classification of Diseases* (ICD-10) codes for UTI: ICD-10 CM: N39.0 (UTI, site not specified); N30.00 (acute cystitis without hematuria); N30.91 (cystitis, unspecified with hematuria); N30.80 (other cystitis without hematuria); N30.0 (acute cystitis); N30.01 (acute cystitis with hematuria); N30.90 (cystitis, unspecified without hematuria); N30 (cystitis); N30.8 (other cystitis); N30.9 (cystitis, unspecified); N30.81 (other cystitis with hematuria); N10 (acute pyelonephritis); and N12 (pyelonephritis). All data collection was conducted by PC after receiving training from KK. Approximately 5% of charts were reviewed by both authors independently to assess for congruency, including random charts and any cases in which there was uncertainty.

We excluded patients from this study if they had UTI complications (including renal abscess, septic shock, concurrent nephrolithiasis, or required hospital admission or observation); had pre-existing renal or urologic disease (including vesicoureteral reflux or other functional abnormality; obstructive uropathy, permanent or intermittent catheter, history of urinary tract surgery); were pregnant or up to six-weeks post-partum; were prisoners; had diabetes mellitus; or were immunocompromised. This included patients taking medications such as steroids, biologics, and chemotherapeutic drugs. We also excluded patients with recurrent UTI (had a UTI with or without antibiotic treatment within the prior month) and patients who were already prescribed an antibiotic for the current UTI prior to the ED visit.

Patients were categorized as having uncomplicated cystitis or pyelonephritis based on their ICD-10 code. In cases where the ICD-10 code CM N39.0 for "urinary tract infection, site not specified" was used, the authors categorized patients as having either cystitis or pyelonephritis based on medical chart documentation of symptoms, vital signs, physical exam, and provider impression. Patients were assigned to the pyelonephritis cohort if they had fever, flank pain, or costovertebral angle tenderness.[13]

Outcomes and Data Analysis

The primary outcome was the appropriateness of the antibiotic prescription for UTI, including the antibiotic type, dose, and duration. We determined a list of appropriate discharge antibiotics (Table 1, Appendix Tables 1 and 2) using guidelines from the IDSA, the AAP, UpToDate, and our hospital's 2016 outpatient antibiogram (Appendix Figure 1).[7,8,13-15] These references were selected as they represent current and reputable sources used by providers in our ED. For children, there are many potential antibiotic options with limited evidence for superiority of a particular antibiotic or regimen.[16] Thus, any antibioitcs

recommended by expert sources[7,14,15] with favorable susceptibility at our institution (> 80% of *E. coli* isolates susceptible) were included. For adults, antibiotics recommended by IDSA guidelines were used.[8] Based on our local susceptibilities (Appendix Figure 1), all of the antibiotic options had favorable resistance patterns to *E. coli* (more than 80% of isolates susceptible) and were included as appropriate.

We did not include beta-lactams as appropriate options for adults in accordance with the IDSA guidelines, which recommend against routine use for UTI due to inferior efficacy, as there are numerous other antibiotic options for adults with favorable local susceptibilities. Allergies were reviewed during chart review, and no patients were allergic to all appropriate first-line options. There are no standardardized antibiotic recommendations in place in our ED. Our hospital antibiogram is available on the hospital infonet, and pocket cards are distributed periodically. It provides susceptibilities for various organisms for inpatients and outpatients, but does not provide empiric treatment recommendations for infection types, such as UTI.

The secondary outcomes were the frequency of positive urine culture (when obtained) and the appropriateness of discharge antibiotic prescriptions between provider types (resident physician, advanced practice clinician, and attending physician). UTI was defined as growth of greater than or equal to 100,000 colonies of a single uropathogen via clean catch, growth of greater than or equal to 50,000 colonies of a single uropathogen via direct catheterization, or growth of greater than or equal to 50,000 colonies of a single uropathogen via clean catch in the presence of a positive urinalysis.[13,14] We performed data analysis using descriptive statistics and chi-squared tests where applicable.

RESULTS

During the study period, 421 patients met inclusion criteria (Figure 1). Common reasons for exclusion in adults included diabetes mellitus, presence of nephrolithiasis, and current treatment with antibiotics or immunosuppressing medications. Common reasons for exclusion in children included vesicoureteral reflux and current antibiotic treatment. Of the total 421 patients, 258 (61.3%) were classified as having cystitis and 163 were classified as having pyelonephritis (38.7%) (Figure 1). The median age for children was nine years and the median age for adults was 27 years.

Urine cultures were performed in 73% of patients (306/421), with higher utilization of urine culture in patients with pyelonephritis (127/163, 78%) than in patients with cystitis (179/258, 69%) (Figure 1). The presence of UTI was not confirmed for a substantial proportion of patients diagnosed with cystitis, whereas more patients diagnosed with pyelonephritis had a culture-proven UTI (Figure 1). A vast majority of the true positive urine cultures grew *E. coli* (80%).

The appropriateness of discharge antibiotic prescriptions (Appendix Figure 2) is shown in Table 2. The majority of patients received an appropriate antibiotic type, except for adults with pyelonephritis (46%). Figures 2 and 3 detail the reasons for lack of accordance with clinical guidelines for antibiotic type in children and adults, respectively. Errors in dosing and duration were common, with only 157 (56%) of those with appropriate antibiotic type having correct dosing and duration when compared to our established criteria (Appendix Tables 1 and 2). Duration was more frequently incorrect than dosing. Antibiotics were commonly prescribed for a longer, rather than shorter, duration than is specified in the Appendix Tables 1 and 2. Of the 104 patients with incorrect duration, 73 patients (70%) received antibiotics for a longer duration and 31 patients (30%) received antibiotics for a shorter duration.

A total of 130 unique prescribers treated the 421 patients included in the study. We assessed the frequency of appropriate discharge medication prescription type, independent of dosage and duration, for cystitis and pyelonephritis combined across the following three cohorts: attending physician (18/27, 67%); resident physician (168/249, 67%); and advanced practice clinician (93/145, 64%). No difference was found between the groups ($p = 0.926$).

Table 1. List of appropriate antibiotic types for the management of uncomplicated cystitis and pyelonephritis.

Age group	Infection type	Appropriate medications
Children[14,15]	Uncomplicated cystitis	Amoxicillin / clavulanic acid (immediate release formulations) 1st-3rd generation cephalosporin Nitrofurantoin Trimethoprim-sulfamethoxazole
	Pyelonephritis	Amoxicillin / clavulanic acid (immediate release formulations) 1st-3rd generation cephalosporin Trimethoprim-sulfamethoxazole
Adults[8,13]	Uncomplicated cystitis	Fosfomycin Nitrofurantoin Trimethoprim-sulfamethoxazole
	Pyelonephritis	Ciprofloxacin Levofloxacin Trimethoprim-sulfamethoxazole

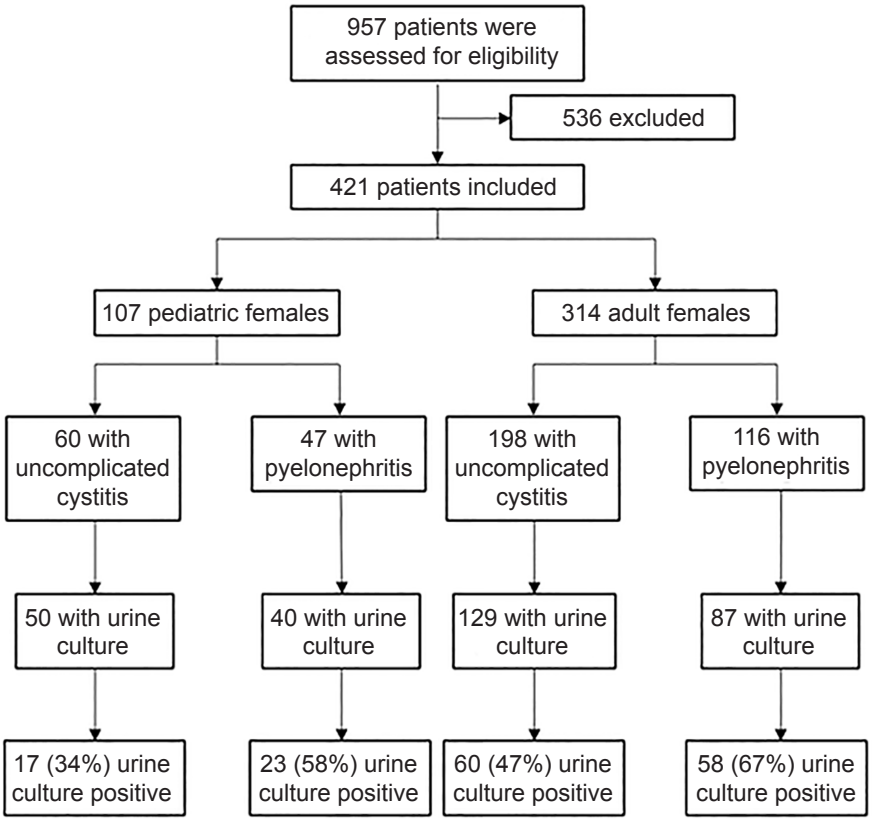


Figure 1. Flow diagram of study participants diagnosed with urinary tract infections.

DISCUSSION

In this study we found a number of areas for improvement in the initial management of female UTIs in an academic ED. Furthermore, we demonstrated that opportunity for improvement exists across all provider cohorts studied. These findings can guide improvement efforts for judicious use of antibiotics. Overtreatment of UTI was common, in particular for cystitis. As many as two-thirds of children who were treated for cystitis had a negative urine culture. Strategies to improve diagnostic accuracy and/or decrease unnecessary antibiotic treatment include the use of a decision aid, such as that by McIsaac et al for females with suspected cystitis.[17] This simple decision aid using three variables (dysuria, leukocytes greater than a trace amount, and positive nitrites) was statistically associated with a positive urine culture result.

Strategies to reduce antibiotic overuse include delaying antibiotic prescription if infection is uncertain and discontinuing antibiotics if the urine culture results as negative. In a study by Knottnerus et al, many women were willing to delay antibiotic initiation for cystitis while awaiting urine culture result. More than half of these women experienced resolution of symptoms within a week without antibiotic therapy.[18] In the pediatric and adult settings, nurse, clinician, and pharmacist follow-up after urine culture result has led to decreased total antibiotic days.[19,20] A common theme is the need for improved, ED-based antimicrobial stewardship strategies, as the ED is unique and may require its own specific interventions. [21]

Overtreatment of UTIs was also found in the form of excessive antibiotic duration (Table 2), particularly for cystitis. The variation in length of antibiotic courses could be due in part to limited evidence for superiority of particular regimens, especially for children.[16,22] However, longer than recommended antibiotic courses can contribute to antibiotic resistance.[23] Potential strategies for improving dosing and duration include interventions to the electronic health record, which have been demonstrated to improve appropriate antibiotic delivery.[24,25]

Finally, we investigated the utilization of appropriate antibiotic types given the local antibiogram and evidence-based guidelines. Adherence to the IDSA recommendations can increase narrow spectrum antibiotic use and decrease unnecessary antibiotic days.[26,27] In our study, we found overuse of fluoroquinolones for cystitis (albeit at lower rates than in other reported studies).[26,27] This antibiotic class can cause serious advserse events, promote antibiotic resistance, and predispose to *Clostridum difficile* infections.[28-31] Other deviations from the guidelines included the use of potentially ineffective antimicrobials, such as amoxicillin and nitrofurantoin for pyelonephritis. While clinical outcomes were not tracked, the liklihood of treatment failure is high with these agents, with *E. coli* resistance to amoxicillin being widespread.[8]

The most common deviation from IDSA guidelines in adults was treatment with beta-lactams (Figure 3). The significance of this is unclear despite how common this practice is at our institution. These antibiotics are likely prescribed because

Table 2. Appropriateness of antibiotic prescriptions for urinary tract infection.

Age group	Children, n (%)		Adult, n (%)	
Diagnosis	Cystitis	Pyelonephritis	Cystitis	Pyelonephritis
Total	60 (14%)	47 (11%)	198 (47%)	116 (28%)
Appropriate discharge antibiotic type	53/60 (88%)	38/47 (81%)	135/198 (68%)	53/116 (46%)
+ Appropriate dose[a]	48/60 (80%)	36/47 (77%)	128/198 (65%)	49/116 (42%)
+ Appropriate dose and duration[b]	41/60 (68%)	22/47 (47%)	68/198 (34%)	26/116 (22%)

[a] Appropriate antibiotic type and correct dose.
[b] Appropriate antibiotic type and correct dose and duration.

local susceptibilities are favorable for 1st- and 2nd-generation cephalosporins. Furthermore, additional studies have been published since the IDSA guidelines in 2011 supporting efficacy of beta-lactams for the treatment of UTIs in adults.[32-35] The use of beta-lactams could be studied further to provide more potential treatment options, especially given that antibiotic resistance to many other antibiotic classes is on the rise.

LIMITATIONS

This study analyzed adherence to clinical guidelines and expert recommendations, assuming that these promote optimal care. Additional limitations of this study are associated with its retrospective design. The determination of antibiotic appropriateness relied on diagnosis of either cystitis or pyelonephritis; however, some patients had a non-specific diagnosis of "urinary tract infection, site not specified." In this case, they were assigned to either the cystitis or pyelonephritis group based on the study team's interpretation of the patient's signs and symptoms. Errors in this designation by the study team would have affected the assessment of the appropriateness of antibiotics received. In an effort to check cohort assignment, we performed statistical analysis and found no significant difference in the appropriateness of discharge antibiotic type between patients whom the study team assigned to cystitis vs pyelonephritis and patients who had an ED diagnosis code for cystitis or pyelonephritis specifically ($p > 0.05$). Additionally, we did not assess why providers chose antibiotics that deviated from the recommendations, such as resistance in past urine cultures or lack of awareness of the guidelines. Furthermore, urine culture was used to assess presence of true infection; however, not all patients received cultures, which could affect our conclusions about the prevalence of true UTI in our study.

CONCLUSION

This study reveals gaps in the management of children and adults with urinary tract infections, including administration of antibiotics in the absence of true infection and inappropriate choice of discharge antibiotic type, dose, or duration. These shortcomings occurred across all three provider types studied and represent areas for further education and quality improvement to promote antimicrobial stewardship.

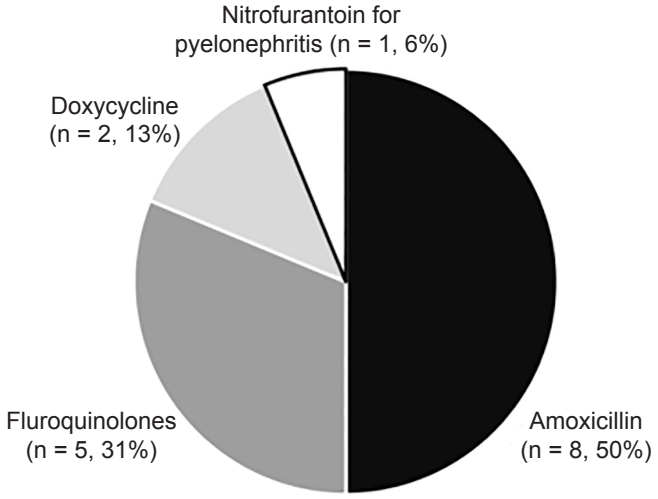


Figure 2. Inappropriate antibiotic types prescribed for children with urinary tract infections.

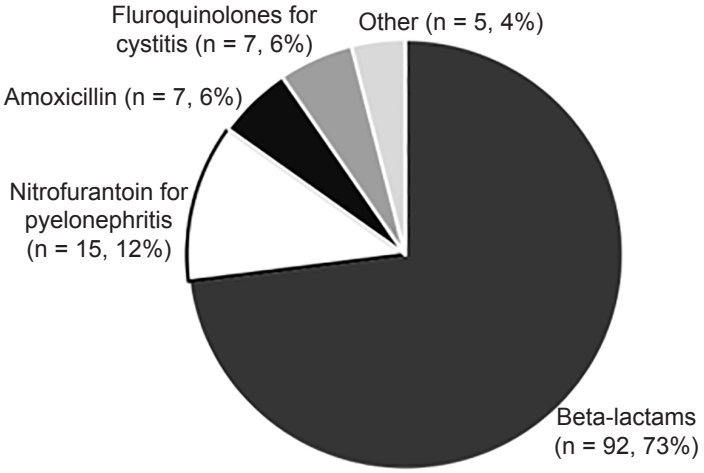


Figure 3. Inappropriate antibiotic types prescribed for adult women with urinary tract infections.

Address for Correspondence: Kathryn Kasmire, MD, Penn State Milton S. Hershey Medical Center, Emergency Medicine, 500 University Drive, H043, Hershey, PA 17033. Email: kkasmire@pennstatehealth.psu.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Schappert S, Rechtsteiner E. Ambulatory medical care utilization estimates for 2007. *Vital Health Stat 13.* 2007(169):1-38.
2. Johnson J, Russo T. Acute pyelonephritis in adults. *N Engl J Med.* 2018;378(1):48-59.
3. Karavanaki KA, Soldatou A, Koufadaki AM, et al. Delayed treatment of the first febrile urinary tract infection in early childhood increased the risk of renal scarring. *Acta Paediatr.* 2017;106(1):149-54.
4. Dancer SJ, Kirkpatrick P, Corcoran DS, et al. Approaching zero: temporal effects of a restrictive antibiotic policy on hospital-acquired Clostridium difficile, extended-spectrum beta-lactamase-producing coliforms and meticillin-resistant Staphylococcus aureus. *Int J Antimicrob Agents.* 2013;41(2):137-42.
5. Sanchez GV, Babiker A, Master RN, et al. Antibiotic resistance among urinary isolates from female outpatients in the United States in 2003 and 2012. *Antimicrob Agents Chemother.* 2016;60(5):2680-3.
6. Bidell MR, Palchak M, Mohr J, et al. Fluoroquinolone and third-generation-cephalosporin resistance among hospitalized patients with urinary tract infections due to *Escherichia coli*: Do rates vary by hospital characteristics and geographic region? *Antimicrob Agents Chemother.* 2016;60(5):3170-3.
7. Urinary tract infection: clinical practice guideline for the diagnosis and management of the initial UTI in febrile infants and children 2 to 24 months. *Pediatrics.* 2011;128(3):595-610.
8. Gupta K, Hooton TM, Naber KG, et al. International clinical practice guidelines for the treatment of acute uncomplicated cystitis and pyelonephritis in women: A 2010 update by the Infectious Diseases Society of America and the European Society for Microbiology and Infectious Diseases. *Clinl infect dis.* 2011;52(5),103-120.
9. Fridkin S, Baggs J, Fagan R, et al. Vital signs: improving antibiotic use among hospitalized patients. *MMWR Morb Mortal Wkly Rep.* 2014;63(9):194-200.
10. Selekman RE, Allen IE, Copp HL. Determinants of practice patterns in pediatric UTI management. *J Pediatr Urol.* 2016;12(5):308.
11. Al-Sayyed B, Le J, Al-Tabbaa MM, et al. Uncomplicated urinary tract infection in ambulatory primary care pediatrics: Are we using antibiotics appropriately? *J Pediatr Pharmacol Ther.* 2019;24(1):39-44.
12. O'Brien K, Hillier S, Simpson S, et al. An observational study of empirical antibiotics for adult women with uncomplicated UTI in general practice. *J Antimicrob Chemother.* 2007;59(6):1200-3.
13. Hooton TM, Gupta K. Acute simple cystitis in women. Post TW, ed. UpToDate. Waltham, MA: UpToDate Inc. Available at: https://www.uptodate.com. Accessed April 14, 2018.
14. Shaikh N, Hoberman A. Urinary tract infections in infants older than one month and young children: acute management, imaging, and prognosis. Post TW, ed. UpToDate. Waltham, MA: UpToDate Inc. Available at: https://www.uptodate.com. Accessed on April 14, 2018.
15. Palazzi, DL, Campbell, JR. Acute infectious cystitis: management and prognosis in children older than two years and adolescents. Post, TW (Ed). UpToDate. Waltham, MA: UpToDate Inc. Available at: https://www.uptodate.com. Accessed on Jan 2, 2020.
16. Fitzgerald A, Mori R, Lakhanpaul M, et al. Antibiotics for treating lower urinary tract infection in children. *Cochrane Database Syst Rev.* 2012;(8):CD006857.
17. McIsaac WJ, Moineddin R, Ross S. Validation of a decision aid to assist physicians in reducing unnecessary antibiotic drug use for acute cystitis. *Arch Intern Med.* 2007;167(20):2201-6.
18. Knottnerus BJ, Geerlings SE, Mol van Charante EP, et al. Women with symptoms of uncomplicated urinary tract infection are often willing to delay antibiotic treatment: a prospective cohort study. *BMC Fam Pract.* 2013;14:71.
19. Zhang X, Rowan N, Pflugeisen BM., et al. Urine culture guided antibiotic interventions: a pharmacist driven antimicrobial stewardship effort in the ED. *Am J Emerg Med.* 2017;35(4):594-8.
20. Saha D, Patel J, Buckingham D, et al. (2017). Urine culture follow-up and antimicrobial stewardship in a pediatric urgent care network. *Pediatrics.* 2017;139(4): e20162103.
21. May L, Cosgrove S, L'Archeveque M, et al. A call to action for antimicrobial stewardship in the emergency department: approaches and strategies. *Ann Emerg Med.* 2013;62(1):69-77.
22. Kyriakidou KG, Rafailidis P, Matthaiou DK, et al. Short- versus long-course antibiotic therapy for acute pyelonephritis in adolescents and adults: a meta-analysis of randomized controlled trials. *Clin Ther.* 2008;30(10):1859-68.
23. Spellberg B. The new antibiotic mantra: "Shorter is better". *JAMA Intern Med.* 2016;176(9):1254-5.
24. Hincker A, Ben Abdallah A, Avidan M, et al. Electronic medical record interventions and recurrent perioperative antibiotic administration: a before-and-after study. *Can J Anaesth.* 2017;64(7):716-23.
25. Kaushal R, Barker KN, Bates DW. How can information technology improve patient safety and reduce medication errors in children's health care? *JAMA Pediatrics.* 2001;155(9):1002-7.
26. Percival KM, Valenti KM, Schmittling SE, et al. Impact of an antimicrobial stewardship intervention on urinary tract infection treatment in the ED. *Am J Emerg Med.* 2015;33(9):1129-33.
27. Hecker MT, Fox CJ, Son AH, et al. Effect of a stewardship intervention

on adherence to uncomplicated cystitis and pyelonephritis guidelines in an emergency department setting. *PLoS One*. 2014;9(2):e87899.

28. Weber SG, Gold HS, Hooper DC, et al. Fluoroquinolones and the risk for methicillin-resistant *Staphylococcus aureus* in hospitalized patients. *Emerg Infect Dis*. 2003;9(11):1415-22.
29. McCusker ME, Harris AD, Perencevich E, et al. Fluoroquinolone use and *Clostridium difficile*-associated diarrhea. Emerg Infect Dis. 2003;9(6):730-3.
30. Hsu DI, Okamoto MP, Murthy R, et al. Fluoroquinolone-resistant *Pseudomonas aeruginosa*: risk factors for acquisition and impact on outcomes. *J Antimicrob Chemother*. 2005;55(4):535–41.
31. Food and Drug Administration. Fluoroquinolone antimicrobial drugs information. Available at: https://www.fda.gov/Drugs/DrugSafety/InformationbyDrugClass.htm. Accessed January 14, 2020.
32. Vogler S, Pavich E. Pyelonephritis treatment in the community emergency department: cephalosporins vs. first-line agents. *Am J Emerg Med*. 2018;36(11):2054-7.
33. Sanchez M, Collvinent B, Miro O, et al. Short-term effectiveness of ceftriaxone single dose in the initial treatment of acute uncomplicated pyelonephritis in women. A randomised controlled trial. *Emerg Med J*. 2002;19(1):19-22.
34. Monmaturapoj T, Montakantikul P, Mootsikapun P, et al. A prospective, randomized, double dummy, placebo-controlled trial of oral cefditoren pivoxil 400mg once daily as switch therapy after intravenous ceftriaxone in the treatment of acute pyelonephritis. *Int J Infect Dis*. 2012;16(12):843-9.
35. Jernelius H, Zbornik J, Bauer CA. One or three weeks' treatment of acute pyelonephritis? A double-blind comparison, using a fixed combination of pivampicillin plus pivmecillinam. *Acta Med Scand*. 1988;223(5):469-77.

Adolescents' Acceptance of Long-Acting Reversible Contraception After an Educational Intervention in the Emergency Department: A Randomized Controlled Trial

Tatyana Vayngortin, MD*
Lela Bachrach, MD, MS†
Sima Patel, MD‡
Kathleen Tebb, PhD§

*Rady Children's Hospital, University of California San Diego, Division of Emergency Medicine, San Diego, California
†University of California San Francisco Benioff Children's Hospital Oakland, Department of Adolescent Medicine, Oakland, California
‡University of California San Francisco Benioff Children's Hospital Oakland, Department of Emergency Medicine, Oakland, California
§University of California San Francisco, Department of Adolescent Medicine, San Francisco, California

Section Editor: Donna Mendez, MD
Submission history: Submitted October 4, 2019; Revision received January 6, 2020; Accepted February 17, 2020
Electronically published April 21, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.2.45433

Introduction: Adolescents who seek care in the emergency department (ED) are a cohort at increased risk of unintended pregnancy. Although adolescents are interested in learning about pregnancy prevention in the ED, there is a lack of effective educational interventions in this setting. Long-acting reversible contraceptives (LARC) are highly effective and safe in teens, yet are underutilized. This study assessed contraception use among adolescents in the ED and evaluated the impact of an educational video on their interest in and uptake of LARCs.

Methods: We conducted a two-arm randomized controlled trial on a convenience sample of sexually active females 14 to 21 years old in an urban pediatric ED. Participants were randomized to an educational video or standard care. All participants completed a survey and were given an informational card about affiliated teen clinics with the option to schedule an appointment. We assessed pre-post mean differences between control and intervention participants and pre-post differences among intervention participants. Participants were followed three months after their ED visit to examine use of contraception.

Results: A total of 79 females were enrolled (42 control and 37 intervention). The mean age was 17 years, and most were youth of color. The proportion of participants with a prior pregnancy was 18%. Almost all participants reported wanting to avoid pregnancy, yet 18% reported not using contraception at last intercourse. At baseline, 17.7% of participants were somewhat or very interested in the intrauterine device (IUD) or implant. After watching the video, 42.3% were somewhat or very interested in the IUD and 35.7% in the implant. Among those who watched the video, there were significant increases in interest in using an IUD or implant ($p<.001$). Compared to controls, adolescents who watched the video were also significantly more likely to report wanting an IUD ($p<0.001$) or implant ($p=0.002$). A total of 46% were reached for follow-up. Of these, 16% had initiated a LARC method after their ED visit (p=NS).

Conclusion: Most adolescent females in the ED want to avoid pregnancy, but are using ineffective methods of contraception. A brief educational video on LARCs was acceptable to adolescents and feasible to implement in a busy urban ED setting. Adolescents who watched the video had significantly greater interest in using LARCs, but no demonstrated change in actual adoption of contraception. [West J Emerg Med. 2020;21(3)640–646.]

INTRODUCTION

While teen pregnancy rates have been declining, the United States continues to have a higher teen pregnancy rate than all other developed nations.[1] Most (88%) teen pregnancies are unintended[2]; about half of these are due to contraceptive failure resulting from inconsistent or incorrect use, while the rest are due to contraception non-use.[3] The 2006-2010 National Survey of Family Growth found that less than one-third of females aged 15-19 years consistently used contraception at their last intercourse.[3,4] Condoms continue to be the most common contraceptive method used by adolescents.[4] While condoms are effective at preventing sexually transmitted infections, they have a high failure rate in preventing pregnancy (18%) based on typical use.[5] In addition, adolescents were twice as likely to have an unintended pregnancy when using short-acting methods such as oral contraceptive pills (OCP), patch, or ring, compared to adults.[6]

Long-acting reversible contraceptive methods (LARC), such as intrauterine devices (IUD) and contraceptive implants, are highly effective with <1% failure rate and have an excellent safety profile in all age groups, including adolescents.[6,7] They do not require daily adherence or follow-up appointments, and are easy to keep confidential. Therefore, multiple medical organizations recommend including LARCs in contraceptive counseling for adolescents and enhancing access to these methods.[7-10] Despite evidence of the safety and efficacy of LARCs for adolescents, use of these methods remains low among this population (about 3-5% nationally).[11,12]

Barriers to adolescents' use of LARCs include patient-related barriers such as access, cost, and misconceptions, as well as provider-related barriers such as knowledge, attitudes, and clinical competencies.[7,8] There are also disparities in adolescents' knowledge and access to LARCs based on race/ethnicity, income, and geographic location.[13] A growing body of evidence indicates that when adolescents have education and access to all of the contraceptive methods, many select LARCs.[14-16] Therefore, increasing education and access to LARCs may increase adolescents' interest in and use of these methods.

The emergency department (ED) is a potentially valuable setting to provide adolescents with education on pregnancy prevention. Adolescents are less likely to have a primary care provider compared to younger children, and thus may miss opportunities to receive anticipatory guidance on important topics such as reproductive health.[17] Many adolescents rely on the ED, and those who use it as their primary source of care tend to engage in riskier behaviors, including sex with multiple partners, unprotected sex, and substance use.[17,18] For example, Miller et al surveyed adolescents ages 14-19 in the ED, and found that 45% were sexually active, and of those, 63% reported high-risk behaviors and only one-fourth reported having received contraception counseling.[18] Multiple studies have found that adolescents are interested in learning about pregnancy prevention during ED visits.[15, 19-23] Hoehn et al evaluated in-person, contraceptive counseling in the ED, and found an increase in interest in initiating contraception, especially LARC.[15] No prior studies have evaluated the use of an educational on contraception in the ED.

Population Health Research Capsule

What do we already know about this issue?
Adolescents seeking care in the emergency department (ED) are at increased risk of unintended pregnancy, and are interested in learning about pregnancy prevention in the ED.

What was the research question?
Among sexually active adolescents in the ED, will watching an educational video increase their interest in and use of long-acting reversible contraceptives (LARC)?

What was the major finding of the study?
The study found that an educational video on LARCs was acceptable to adolescents and increased their interest in using LARCs. With 46% followup, we did not demonstrate a change in actual adoption of contraception.

How does this improve population health?
ED-based pregnancy prevention education may increase adolescents' use of contraception, thereby decreasing unintended pregnancy in this high-risk population.

The objectives of this study were to describe current contraception use among adolescents in the ED, and to evaluate whether showing them a brief educational video about LARCs in the ED would increase their awareness and uptake of LARCs. By improving education and access to contraception when adolescents are already in a healthcare setting, we aim to remove knowledge and access barriers so that high-risk patients can make informed decisions about which contraceptive method is best for them.

METHODS

Study Design

We conducted a two-arm, prospective, randomized controlled trial to evaluate the impact of an educational video intervention on adolescents' attitudes toward and uptake of LARC. The study was approved by the institutional review board of the University of California San Francisco (UCSF) Children's Hospital Oakland Research Institute, with waived parental and written informed consent.

Study Setting and Population

The study was conducted at an urban pediatric ED at a freestanding children's hospital from June 2016–December 2017. This ED has approximately 45,000 annual visits, about 9,000 (20%) of which are adolescents. Among all ED patients, 95% are insured, with 76% of these with government-issued insurance.

Subject Enrollment

Female patients 14 to 21 years old reporting prior sexual activity were eligible to participate. We excluded patients if they were critically ill, seeking care for a psychiatric chief complaint or sexual assault, not proficient in English, and/or currently using a LARC method. Eligible participants were identified from the ED electronic tracking board. Trained research assistants (RA) approached patients in their ED patient rooms and asked their parent/guardian to step out of the room during study participation. This is standard of care for patients over the age of about 12 years to have the opportunity to speak to a provider without a parent/guardian present.[24] The RAs explained the study and obtained verbal assent from participants. Participants who agreed to participate were randomized using an online randomization tool (https://www.randomizer.org) to either the control (standard care) or intervention group (video intervention).

Measures

All participants (control and intervention) completed a baseline paper survey that included questions on demographics, sexual activity, contraception use, pregnancy intention, and interest in using a LARC method (Survey 1). A multidisciplinary team of authors developed the survey tool based on the objectives of the study and previously published, adolescent-survey studies. We pilot tested the survey with 10 adolescent patients, and no significant issues were identified. Interest in LARCs was assessed with a five-point Likert scale (ranging from 1 = not at all interested to 5 = very interested). The survey was self-administered and took approximately five minutes to complete.

The intervention group then watched an eight-minute educational video on LARCs, which was shown on a computer on wheels in the patient's exam room. This video is publicly available and was created by the UCSF Bixby Center for Global Reproductive Health (https://vimeo.com/123257511). It features adolescents discussing their family planning goals, experiences with LARC methods, and provides information about how each LARC method works, efficacy, and cost. Participants who watched the video also filled out a post-video survey to gather feedback on the video and to assess any change in interest in using LARC, again with a five-point Likert scale (Survey 2). They were asked to rate the video on a five-point Likert scale. Participants were also asked whether they were would be interested in same-day initiation of LARC if it were to be available.

At the end of the survey, participants were asked whether they could be contacted for follow-up and their preferred contact method. All participants were given an informational card about our hospital-affiliated adolescent clinics with an option to have an appointment scheduled by the ED provider. Participants were compensated with a $5 gift card for study completion. If recruitment occurred during business hours, the principal investigator (PI) or RA called the adolescent clinic to schedule the appointment. If recruitment occurred after hours, the PI or RA sent the participant's contact information to the adolescent clinic scheduler to schedule follow-up the following day.

The PI reviewed the medical records of participants three months after their ED visit to assess whether they had initiated contraception. Participants were also contacted by the PI or RAs via phone, text, or e-mail as per their preference. In the follow-up interview, they were asked about current pregnancy intentions and contraceptive use with a scripted interview tool created by the authors. If they hoped to avoid pregnancy, they were asked if they had initiated a new contraceptive method since their ED visit. If they stated they were not using any contraception, they were asked about barriers to contraception use. The chart abstractors were not blinded to the group allocation.

Data Analysis

We summarized demographic characteristics of the study population using descriptive statistics. To assess the equivalence of intervention and control participants at baseline, we used t-tests to assess mean differences in age, and chi-square tests to assess differences for race/ethnicity, desire to avoid pregnancy, prior pregnancy, and method used at last intercourse. We analyzed differences in baseline LARC interest (IUD and implant) using the Mann-Whitney U test (nonparametric equivalent of independent sample t-test). To assess the effectiveness of the brief video intervention on LARC interest, Wilcoxon test for paired samples (the nonparametric equivalent of the paired sample t-test) was used to compare pre- and post-video differences in LARC interest. To compare the mean change in LARC interest between intervention and controls, we used the Mann-Whitney U test. We conducted power analyses assuming equal group allocation of 50 participants per group; the difference between means would have to achieve 0.6 standard deviations (SD) to be statistically significant. Data was analyzed using SPSS v25 (IBM SPSS Statistics, Chicago, IL).

RESULTS

Out of 228 potential subjects, 79 were enrolled. We excluded participants for the following reasons: 49% were not sexually active; 25% of sexually active girls were already using a LARC method; 4% declined to participate; and one parent declined to leave the room, so her child was excluded. Of the 79 participants, 42 were randomized to the intervention group, and 37 to the control group, as demonstrated in the Consolidated Standards of Reporting Trials (CONSORT) diagram (Figure 1). This is reported as per CONSORT guidelines.[25] There were no significant differences in demographics or key variables that

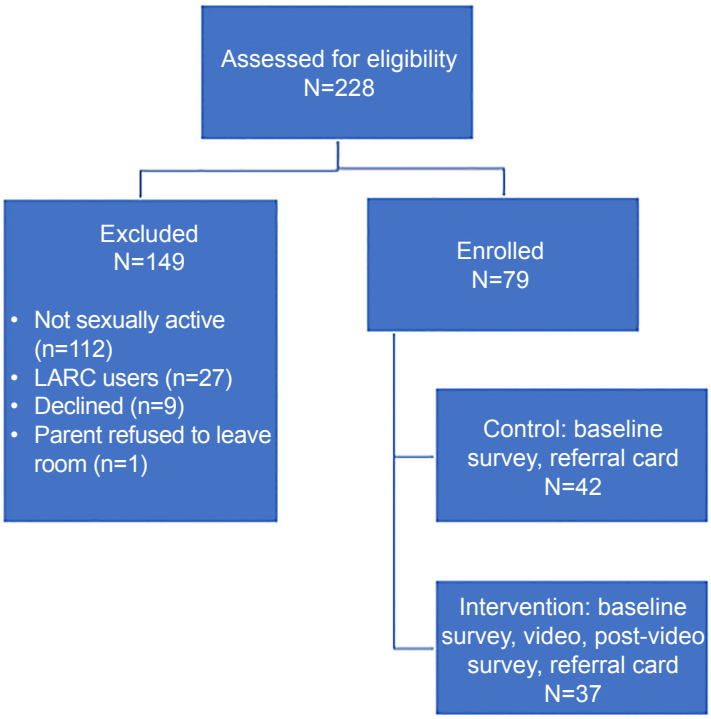


Figure 1. Consolidated Standards of Reporting Trials (CONSORT) diagram demonstrating selection and randomization of subjects in study of adolescent girls' response to education on pregnancy prevention options in the emergency department.
LARC, long-acting reversible contraceptive.

could impact outcomes between the control and intervention groups (see Tables 1 and 2). The majority of patients (94%) did not have a gynecologic chief complaint and were seeking care for non-reproductive related problems. Subject characteristics and contraceptive usage by method are described in Table 1. As noted in Table 1, the most frequently used method was a condom and 18% of patients did not use any method at last intercourse, 19% used withdrawal, and 6% used emergency contraception. A total of 18% of patients had a prior pregnancy. A total of 90.14% of participants reported that it was either very or somewhat important to avoid becoming pregnant, and there were no significant differences between intervention and controls ($X^2 = 2.25$, p = .325). When patients were asked their preferred method with the question "if you could get any method today, which would it be?" answers were variable, as shown in Table 2. There were no significant differences between the control and intervention group in desired contraception method at baseline. The most frequently desired method was condoms (33%), and 15% of patients did not want any method.

At baseline, there was no significant difference between the control and intervention groups in LARC interest. Of the control participants, 29.7% said they were somewhat or very interested in the IUD compared to 21.4% of intervention participants (p = .42). For the implant the baseline difference approached but did not achieve significance with 16.2% of controls expressing interest in an implant compared to 19.0% in the intervention group (p = .07). After watching the video, 42.3% were somewhat or very interested in the IUD and 35.7% in the implant. The pre-post increase was significant for both IUD and implant (p=.001). Compared to controls, the increase in LARC interest was significantly greater for those who watched the video (p<0.001 for IUD, p = 0.002 for implant) (see Table 3). When asked about interest in same-day initiation of LARC if it were available, participants had low interest among all groups. Of the controls, 9.5% and 14.3% would want same-day IUD and implant, respectively. Of the intervention subjects, 14.3% and 13.5% would want same-day IUD and implant respectively, at baseline. After the video, 18.9% and 13.5% would want same-day IUD and implant, respectively. Reasons for not wanting LARC included "not ready," "not sure," concerns about pain, and satisfaction with current contraceptive method. We also calculated the mean rating for the following statements: "I learned a lot from the video" – 4.2; "I liked watching the video in the emergency department" – 3.9, and "I would prefer to watch a video like this in another setting other than the emergency department" – 2.9. Subjects also had the opportunity to write subjective comments about the video. Sample comments include the following: "very informative"; "I would recommend other teens watch this"; and "you should do more videos like this so people can learn."

About half (45.6%) of patients were reached for follow-up, either by direct contact or electronic chart review. Electronic chart review could only capture patients followed in our hospital system, which included 19 patients with

documentation on contraception use. Fourteen patients were reached by phone call or text message, and three were reached by e-mail. On phone follow-up, when asked about barriers to using contraception, multiple patients had concerns about side effects such as "it will make me fat." We had offered to schedule adolescent clinic appointments at the time of the ED visit, but only six participants accepted appointments and only one actually attended. Six patients initiated LARC after their ED visit: two in the control group, and four in the intervention group. Two patients got an IUD, and four got an implant. Of patients who were followed up, 21.6% were using the same hormonal method as during their ED visit (OCP or medroxyprogesterone acetate), 30% were using condoms only, and 30% were not using any method.

DISCUSSION

This is the first study, to our knowledge, that demonstrated that a brief, video-based educational intervention on contraception shown to patients in a pediatric ED can increase interest in using LARC. Our study found that about half of adolescent females presenting to the ED are sexually active, and a large proportion of them are at risk of unintended pregnancy and in need of contraception. We found a higher rate of LARC use in our population than that reported in the general adolescent population (25% vs 5%, respectively), which is likely due to our adolescent clinic's efforts to enhance access to LARCs around the same time this study was initiated. Similar to prior literature, our study found that adolescents are interested in ED-based pregnancy prevention education. One advantage of a video-based intervention is that it may be more feasible to implement in a busy ED if a provider does not have sufficient time to engage in comprehensive contraceptive counseling. The study took 10-15 minutes to complete, and most eligible teens agreed to participate. Study participants were highly satisfied with the video and enjoyed watching it.

Our study focused on education on LARC because while these methods are the most effective, they are the least frequently used by adolescents. It is important that adolescents are aware of all contraceptive methods so that they can make an informed decision regarding which method will work best for them. When we asked adolescents their preferred contraceptive method, we found a variety of responses, further demonstrating that patients have various needs and preferences in selecting their contraceptive method. Thus, patient-centered counseling

Table 1. Demographics of adolescent girls who responded to survey regarding baseline contraception.

Variables	Control (N=42)	Intervention (N=37)	P-value
Mean age	17.3	16.8	p = .853
Ethnicity	n (%)	n (%)	p = .805
African-American	20 (47.6)	17 (45.9)	
Hispanic	14 (33.3)	14 (37.8)	
Multi-ethnic	5 (11.9)	2 (5.4)	
Caucasian	3 (7.1)	3 (8.1)	
Asian/Pacific-Islander	0 (0)	1 (2.7)	
Have a primary care doctor	31 (73.8)	33 (89.2)	p = .084
Prior pregnancy*	7 (16.7)	7 (18.9)	p = .789
>1 pregnancy	1 (14.3)	2 (28.6)	
Therapeutic abortion	4 (57.1)	6 (85.7)	
Spontaneous abortion	2 (28.6)	3 (42.9)	
Birth	1 (14.3)	2 (28.6)	
Method used at last intercourse:			
Condoms	22 (52.4)	20 (54.1)	p = .537
Withdrawal or none	14 (33.3)	7 (18.9)	p = .352
Multiple methods	9 (21.4)	11 (29.7)	p = .540
Medroxyprogesterone acetate	6 (14.3)	7 (18.9)	p = .391
Oral contraceptive pill	5 (11.9)	4 (10.8)	p = .589
Emergency contraception	2 (4.8)	3 (8.1)	p = .434
NuvaRing	3 (7.1)	0 (0)	p = .147
Patch	0	0	n/a

*For patients who had a history of prior pregnancy, the values listed (ie, therapeutic abortion) refer to the proportion of prior pregnancies. Data was dichotomized as Yes/No.

Table 2. Desired contraceptive method at baseline.

Contraceptive method	n (%)	n (%)	P-value
Condoms	16 (38.1)	10 (27)	p = .420
OCP	10 (23.8)	8 (21.6)	p = .556
Medroxyprogesterone acetate	8 (19)	7 (18.9)	p = .368
None	6 (14.3)	5 (13.5)	p = .620
Implant	3 (7.1)	5 (13.5)	p = .265
NuvaRing	3 (7.1)	4 (10.8)	p = .580
Patch	5 (11.9)	2 (5.4)	p = .265
IUD	3 (7.1)	2 (5.4)	p = .434
Emergency contraception	1 (2.4)	0 (0)	p = .542

IUD, intrauterine device; *OCP*, oral contraceptive pills.

Table 3. Mean Difference in Interest in LARC use.

LARC Method	Control Mean Difference (SD)	Intervention Mean Difference (SD)	(95% CI, p-value)
IUD	0 (0.0)	0.686 (1.13)	(0.297, 1.07, p=.001)
Implant	0 (0.0)	0.514 (0.96)	(0.193, 0.83, p=.003)

CI, confidence interval; *IUD,* intrauterine device; *LARC,* long-acting reversible contraceptive; *SD,* standard deviation.

is paramount. Despite significant increases in the desire to use LARC among our study participants, attitudes transitioned from negative to neutral and there was not a significant increase in the actual uptake of LARC. Of subjects who completed follow-up, 16% initiated LARC after their ED visit. However, the majority of patients at follow-up were still using either no method or less effective methods. On follow-up, several patients reported misconceptions about contraceptive side effects.

Chernick et al interviewed adolescent females in the ED about barriers to contraception use, and participants reported concerns of effects on menstruation, weight, fertility, and overall mistrust of contraceptives.[20] Therefore, providers should strive to address patients' concerns and misconceptions during contraceptive counseling. ED-based studies involving adolescents frequently demonstrate low follow-up rates, as was seen in our study as well. Chernick et al evaluated referrals with wallet cards for adolescents in the ED to family planning clinics and found no significant difference in follow-up compared to standard discharge instructions.[26] Hoehn et al offered adolescent females in the ED a scheduled follow-up appointment and found that about half of participants scheduled an appointment, and 40% of those actually attended.[15]

Poor follow-up among adolescents raises the question whether contraception should be initiated in the ED, as this may be their primary healthcare setting. In our study survey, we assessed potential interest in same-day LARC initiation, and one-third of our participants were interested. Miller et al found that two-thirds of adolescents surveyed in the ED were interested in same-day contraception initiation, including one-third interested in LARC.[21] Hoehn et al also asked adolescents who had missed their appointments whether they would have started contraception during their ED visit if it had been offered, and 77% said yes.[15] Offering same-day contraception in the ED may decrease unintended pregnancy, but further research is needed to assess the feasibility and acceptance of this. Moreover, offering contraception counseling in the ED is provider-dependent, and may face provider-level barriers including time, training, and motivation.

LIMITATIONS

The study has several limitations. While our sample size was small, it was sufficient to identify significant differences between our control and intervention groups in interest in using LARC. However, the study was not powered to detect differences in actual uptake of LARC. The study was conducted at a single site, an urban children's hospital, so our results may not be generalizable to all settings. RAs were only available for limited time periods (ie, a summer research internship), and recruited patients during afternoon-early evening hours on weekdays. The PI also recruited patients at various times when available. The PI and RAs were not blinded to group allocation when conducting follow-up calls and chart review. The survey and video were only available in English, which excluded non-English speaking patients.

Additionally, survey studies are subject to social desirability bias. About half of our patients were lost to follow-up, so our results may have been different if we had follow-up data on all initial participants. Since most adolescent ED visits occurred in the evenings after school, patients had to be contacted the following day to schedule the appointment. This may have been one reason contributing to less follow-up if patients could not be reached. Also, some patients may have followed up with their primary care provider or at another clinic rather than our adolescent clinic. There were concomitant LARC initiatives in our hospital around the time of this study, for example availability of LARC in our adolescent clinic.

CONCLUSION

Most adolescent females in the pediatric ED want to avoid pregnancy, yet many are using ineffective or no contraception. They are interested in a wide range of family planning methods; therefore, it is important to provide them with comprehensive, patient-centered, contraceptive counseling. We found that a brief educational video on LARCs was acceptable to adolescents and successfully implemented in a busy ED setting. Adolescents who watched the video were significantly more interested in using LARCs; however, LARC initiation remained low. Future studies are needed to determine the most effective method of providing contraception education to adolescents to improve contraception uptake and access.

Address for Correspondence: Tatyana Vayngortin, MD, Rady Children's Hospital, University of California San Diego, Division of Emergency Medicine, 3020 Children's Way, San Diego, CA 92123, Mailcode 5075. Email: tvayngortin@rchsd.org.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Sedgh G, Finer LB, Bankole A, et al. Adolescent pregnancy, birth, and abortion rates across countries: levels and recent trends. *J Adolesc Health*. 2015;56(2):223-30.
2. Finer LB, Zolna MR. Unintended pregnancy in the United States: incidence and disparities, 2006. *Contraception.* 2011; 84(5):478-85.
3. Kost K, Singh S, Vaughan B, et al. Estimates of contraceptive failure from the 2002 National Survey of Family Growth. *Contraception.* 2008;77(1):10-21.
4. Centers for Disease Control and Prevention, National Center for Health Statistics. Teenagers in the United States: sexual activity, contraceptive use and childbearing. 2006-2010 National Survey of Family Growth. *Natl Vital Health Stat.* 2011;23(31):1-35.
5. Trussel J. Contraceptive failure in the United States. *Contraception.* 2011;83(5):397–404.
6. Winner B, Peipert JF, Zhao Q, et al. Effectiveness of long-acting reversible contraception. *N Engl J Med.* 2012;366(21):1998-2007.
7. Committee on Adolescence. Policy Statement: Contraception for Adolescents. *Pediatrics.* 2014;134(4):1244-56.
8. Society for Adolescent Health and Medicine. Improving Knowledge About, Access to, and Utilization of Long-Acting Reversible Contraception Among Adolescents and Young Adults. *J Adolesc Health.* 2017;60(4):472-4.
9. Pathfinder International; Evidence 2 action; PSI; Marie Stopes International; FHI 360. Global Consensus Statement: Expanding contraceptive choice for adolescents and youth to include long-acting reversible contraception; 2015. Available at: https://www.familyplanning2020.org/sites/default/files/Global%20Consensus%20Statement%20-%20Expanding%20Contraceptive%20Choice.pdf. Accessed November 19, 2019.
10. ACOG Committee Opinion No. 735 Summary: Adolescents and Long-Acting ReversibleContraception: Implants and Intrauterine devices. *Obstet Gynecol.* 2018;131(5):947-8.
11. Mosher WD, Jones J. Use of contraception in the United States: 1982–2008. *Vital Health Stat 23.* 2010;(29):1–44.
12. Pazol K, Daniels K, Romero L, et al. Trends in long-acting reversible contraception use in adolescents and young Adults: New estimates accounting for sexual experience. *J Adolesc Health.* 2016;59(4):438-42.
13. Hall K, Moreau C, Trussell J. Continuing social disparities despite upward trends in sexual and reproductive health service use among young women in the United States. *Contraception.* 2012;86(6):681-6.
14. Mestad R, Secura G, Allsworth JE, et al. Acceptance of long-acting reversible contraceptive methods by adolescent participants in the Contraceptive CHOICE Project. *Contraception.* 2011;84(5):493–8.
15. Hoehn E, Hoefgen H, Chernick L, et al. A Pediatric emergency department intervention to increase contraception initiation among adolescents. *Acad Emerg Med.* 2019;26(7):761-9.
16. Ricketts S, Klingler G, Schwalberg R. Game change in Colorado: widespread use of long-acting reversible contraceptives and rapid decline in births among young, low-income women. *Perspect Sex Reprod Health.* 2014;46(3):125-32.
17. Wilson KM, Klein JD. Adolescents who use the emergency department as their usual source of care. *Arch Pediatric Adolesc Med.* 2000;154(4):361-5.
18. Miller MK, Pickett M, Leisner K, et al. Sexual health behaviors, preferences of care, and use of health services among adolescents in pediatric emergency departments. *Pediatr Emerg Care.* 2013;29(8):907-11.
19. Fine LC, Mollen CJ. A pilot study to assess candidacy for emergency contraception and interest in sexual health education in a pediatric emergency department population. *Pediatr Emerg Care.* 2010;26(6):413-6.
20. Chernick LS, Schnall R, Higgins T, et al. Barriers to and enablers of contraceptive use among adolescent females and their interest in an emergency department-based intervention. *Contraception.* 2015;91(3):217-25.
21. Miller M, Randell K, Barral R, et al. Factors associated with interest in same-day contraception initiation among females in the pediatric emergency department. *J Adolesc Health.* 2016;58(2):154-9.
22. Vayngortin T, Tanaka D, Liu D, et al. Exploring adolescents' current sources and learning preferences about contraception in a US pediatric emergency department. *BMJ Sex Reprod Health.* 2018;44(2):148-9.
23. Chernick L, Kharbanda EO, Santelli J, et al. Identifying adolescent females at high risk of pregnancy in a pediatric emergency department. *J Adolesc Health.* 2012;51(2):171-8.
24. Hagan J, Shaw J, Duncan P. 2008. Bright Futures: Guidelines for Health Supervision of Infants, Children, and Adolescents. (3rd ed). Elk Grove Village, IL: American Academy of Pediatrics.
25. Begg C, Cho M, Eastwood S, et al. Improving the quality of reporting of randomized controlled trials. The CONSORT statement. *JAMA.* 1996;276(8):637-9.
26. Chernick L, Westhoff C, Ray M, et al. Enhancing referral of sexually active adolescent females from the emergency department to family planning. *J Womens Health.* 2015;24(4): 324-8.

Boarding is Associated with Reduced Emergency Department Efficiency that is not Mitigated by a Provider in Triage

Anthony M. Napoli, MD
Shihab Ali, MD
Alexis Lawrence, MD
Janette Baird, PhD

Warren Alpert Medical School of Brown University, Department of Emergency Medicine, Providence, Rhode Island

Section Editor: David Thompson, MD
Submission history: Submitted October 29, 2019; Revision received December 13, 2019; Accepted February 3, 2020
Electronically published April 21, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.2.45728

Introduction: Boarding of patients in the emergency department (ED) is associated with decreased ED efficiency. The provider-in-triage (PIT) model has been shown to improve ED throughput, but it is unclear how these improvements are affected by boarding. We sought to assess the effects of boarding on ED throughput and whether implementation of a PIT model mitigated those effects.

Methods: We performed a multi-site retrospective review of 955 days of ED operations data at a tertiary care academic ED (AED) and a high-volume community ED (CED) before and after implementation of PIT. Key outcome variables were door to provider time (D2P), total length of stay of discharged patients (LOSD), and boarding time (admit request to ED departure [A2D]).

Results: Implementation of PIT was associated with a decrease in median D2P by 22 minutes or 43% at the AED ($p < 0.01$), and 18 minutes (31%) at the CED ($p < 0.01$). LOSD also decreased by 19 minutes (5.9%) at the AED and 8 minutes (3.3%) at the CED ($p<0.01$). After adjusting for variations in daily census, the effect of boarding (A2D) on D2P and LOSD was unchanged, despite the implementation of PIT. At the AED, 7.7 minutes of boarding increased median D2P by one additional minute ($p < 0.01$), and every four minutes of boarding increased median LOSD by one minute ($p < 0.01$). At the CED, 7.1 minutes of boarding added one additional minute to D2P ($p < 0.01$), and 4.8 minutes of boarding added one minute to median LOSD ($p < 0.01$).

Conclusion: In this retrospective, observational multicenter study, ED operational efficiency was improved with the implementation of a PIT model but worsened with boarding. The PIT model was unable to mitigate any of the effects of boarding. This suggests that PIT is associated with increased efficiency of ED intake and throughput, but boarding continues to have the same effect on ED efficiency regardless of upstream efficiency measures that may be designed to minimize its impact. [West J Emerg Med. 2020;21(3)647–652.]

INTRODUCTION

Emergency department (ED) visits have steadily increased over the last decade, outpacing population growth.[1,2] As ED utilization has increased, boarding of admitted patients in the ED while they await inpatient bed assignment has become a nationally ubiquitous issue.[3-5] In 2014, Pitts *et al.* found the national median boarding time was 79 minutes with 32% of admitted patients waiting greater than two hours for bed assignment.[6] Among other adverse effects, boarded patients are less likely to have inpatient care initiated and boarding is associated with increased mortality.[3,4,7]

The physician-in-triage (PIT) intake model has been shown to improve ED operational efficiency in both community EDs and tertiary referral centers.[8-12] Specifically, PIT is associated with improved intake (shorter door to provider times and lower left without being seen rates) and throughput (shorter lengths-of-stay), as well as other ED measures of efficiency (fewer days of ambulance diversion and shorter radiologic turnaround times).[8-13]

PIT models are designed to improve ED intake and throughput. The effect of boarding on availability of ED beds is one of many reasons cited for why EDs move to a PIT model. Despite this, there is little research quantifying the effect that boarding has on upstream efficiency measures with or without a PIT model in place. White *et al.* in a single-center study at a high-volume, academic, tertiary referral center found that increased boarding was associated with increased length of stay of discharged patients.[5] However, this study was a single center study in an ED that was not staffed with a PIT operational model. The primary aim of this study was to assess the effect ED boarding has on ED intake and throughput metrics and whether implementation of a PIT model mitigated those effects. Specifically, we hypothesized the PIT model would not attenuate the effects of boarding on important ED throughput metrics, in particular door to provider time (D2P) and length of stay for discharged (LOSD) patients.

Population Health Research Capsule

What do we already know about this issue?
Boarding of admitted patients in the emergency department (ED) is known to reduce the quality and efficiency of care of both boarded patients and other ED patients.

What was the research question?
Would a provider-in-triage (PIT) model reduce the effect that boarding has on other ED patients?

What was the major finding of the study?
Every 4-5 minutes of boarding increased the length of stay of other patients by one minute. PIT did not mitigate this effect.

How does this improve population health?
PIT improves the efficiency of ED care but does not attenuate the effect of hospital boarding. Improved hospital throughput is needed to reduce the consequences of boarding.

METHODS

This was a multi-site retrospective observational cohort study of ED operations at two sites. In total, 955 days of ED operations at a tertiary care academic ED (AED) and a high-volume community ED (CED) were analyzed before and after the implementation of a PIT protocol. The institutional review boards associated with each ED approved the study.

We reported descriptive statistics on the key outcome variables using median values with interquartile ranges (IQR) and proportions calculated with 95% confidence interval (CI). Unadjusted analysis of the differences in the median values of outcome variables was conducted using Wilcoxon exact test. We conducted a series of quartile regressions, adjusting for differences in daily ED census centered at the overall ED median volume by time period (before or after PIT), to determine the effects of PIT implementation and boarding time on operational metrics as measured by the key outcome variables. These key outcome variables included the following: LOSD – the total time spent in the ED from arrival to discharge of non-admitted ED patients; D2P time – the time from arrival to provider evaluation; median active-care time – the time spent managing and dispositioning a patient, defined as LOSD less D2P; and boarding time (A2D) – the time between the admission bed request to ED departure. In these quartile regression models we examined the interaction of patient boarding time with PIT before and after its implementation to determine the effects of boarding on LOSD and D2P. Additionally, we examined the median number of patients leaving without being seen (LWBS). Statistical analyses were conducted using SAS version 9.4 (SAS Institute, Cary, NC).

RESULTS

Census Measures Before and After Implementation of the PIT

Across the 955 days of ED operations that data were collected, there were 250 days pre- and 705 days post-PIT implementation at the AED and 552 days pre- and 443 days post-PIT implementation at the CED. During that time, there were a total 275,981 patient visits at the AED and 190,039 visits at the CED. The median daily census at both sites significantly increased pre- to post-PIT implementation, with a median increase of 8 patients/day at the AED, a 2.8% increase in daily volume (95% CI, 0.8-4.7), and a median increase of 14 patients/day or 7.6% volume increase at the CED (95% CI, 3.8-11.4) (Table 1). The percentage of patient admissions significantly increased pre- to post-PIT implementation in both EDs ($p < 0.01$); however, the LWBS rate did not significantly change at either site.

Operational Metrics Before and After Implementation of the PIT

Implementation of PIT was associated with significantly shorter median LOSD at both EDs (Table 2), with a decrease of 5.9% (19 minutes) at the AED and 3.3% (8 minutes at CED). After implementation of the PIT model, we found a statistically significant decrease in D2P time at both sites, and a statistically significant increase in boarding time. D2P times demonstrated the largest shift after implementation of PIT. The median D2P time decreased by 22 minutes or 43%. The D2P was 51 minutes (IQR 37-68) pre-PIT as compared with 29 minutes post-PIT (IQR 21-41) at the AED ($p < 0.01$). At the CED, the D2P went from 58 minutes (IQR 38-77) to 40 (IQR 26-59), a 31% decrease ($p<0.01$). Post-PIT implementation median active-care time increased by 5 minutes or 1.8% at the AED (pre-PIT median time = 264 [IQR 249-282] post-PIT = 269 [IQR 251-290], $p = 0.01$), and 9 minutes or 5% at the CED (pre-PIT median time = 180 [IQR 170-192] post-PIT = 189 [IQR 175-205], $p < 0.01$). For

Table 1. Patient census data pre- to post-implementation of a physician in triage.

Outcome	ED type	Pre-PIT	Post-PIT	P-value
Median Daily Census (IQR)	AED	284 (271, 300)	292 (275, 306)	0.01
	CED	185 (174, 196)	199 (186, 210)	<0.01
Median daily admissions (IQR)	AED	80 (74, 87)	84 (76, 91)	<0.01
	CED	50 (45, 56)	55 (49, 61)	<0.01
Mean annual percent admit (SD)	AED	28.2 (±2.8)	29.3 (±2.8)	<0.01
	CED	26.7 % (±3.5)	27.6 % (± 3.7)	<0.01
Median daily LWBS (IQR)	AED	11 (6, 19)	11 (6, 17)	0.13
	CED	5 (2, 8)	4 (2, 9)	0.29
Mean annual percent LWBS (SD)	AED	4.6 % (± 2.3)	4.1 % (± 2.3)	0.15
	CED	3.2 % (±1.3)	2.9 % (± 1.2)	0.24

ED, emergency department; *AED,* tertiary care academic emergency department; *CED,* community emergency department; *LWBS,* left without being seen; *PIT,* physician in triage; *IQR,* interquartile range; *SD,* standard deviation.

both EDs, median A2D significantly increased (AED Δ = 13.5 minutes [95% CI: 8.1, 18.01]), $p < 0.01$; CED Δ = 29 minutes [95% CI: 24.2, 34.8], $p < 0.01$), with the increase in median A2D significantly larger at the CED ($p < 0.01$).

A series of quartile regressions were performed to determine the effects of PIT implementation and boarding time on operational metrics at both sites, as can be seen in Table 3. In both EDs, after adjusting for variability in overall median ED census (centered on the median patient volume relevant to pre- and post-PIT), implementation of PIT at both sites was shown to be associated with shorter median D2P (AED and CED: $p < 0.01$) and median LOSD (AED and CED: $p < 0.01$), confirming the unadjusted analyses. At the AED, the implementation of PIT was associated with a 21.1-minute reduction in D2P and a 29.8-minute reduction in LOSD, after adjusting for the effects of census and boarding. This reduction was also found in the CED with a reduction of 18.5 minutes in median D2P and 11.5 minutes in median LOSD.

Table 2. Operational metrics pre- to post-implementation of a physician in triage.

Metric (min)	ED type	Pre-PIT Median (IQR)	Post-PIT Median (IQR)	P-value
Discharged patients				
D2P	AED	51 (37, 68)	29 (21, 41)	<0.01
	CED	58 (38, 77)	40 (26, 59)	<0.01
LOSD	AED	289 (257, 320)	261 (238, 297)	<0.01
	CED	241 (219, 264)	232.5 (209, 265)	0.01
Admitted patients				
A2D	AED	97.5 (84.5, 116)	111.0 (93, 144.5)	<0.01
	CED	77 (66,92)	106 (80,140)	<0.01

ED, emergency department; *AED,* tertiary care academic emergency department; *CED,* community emergency department; *D2P,* arrival to being seen by physician; *LOSD,* total length of stay for discharged patients; *A2D,* admit request to departure for boarded patients awaiting hospital admission; *PIT*, physician in triage.

Association of Boarding with Upstream Inefficiency of ED Care

After adjusting for median census at each site, the effect of boarding (A2D) on upstream efficiency metrics of D2P and LOSD is constant and unchanged despite the implementation of PIT. Every 7.7 minutes of boarding is associated with an additional one minute of median D2P ($p < 0.01$), and every four minutes of boarding is associated with an additional one minute to the median LOSD ($p < 0.01$) at the AED (Table 3 and Figure 1). Every 7.1 minutes of boarding is associated with an additional minute to the D2P time ($p < 0.01$) and every 4.8 minutes of boarding with an additional minute to the median LOSD ($p < 0.01$) at the CED. Even with a significant reduction in D2P and LOS after PIT implementation, with median A2D of 111 post-PIT implementation at the AED, 14.4 minutes are added to the median D2P, and 27.75 minutes are added to the median LOSD (assuming that the ED census is at the median).

The effects on the CED after PIT implementation, with a median A2D of 106 minutes, are an additional 14.84 minutes for the median patient's D2P and 22.26 minutes on the median LOSD. Two additional analyses that we conducted (not shown in Table 2) support these results; regression slopes for A2P on D2P and LOSD were significant for both pre- and post-PIT implementation for both the AED (D2P pre-PIT $p < 0.01$, post $p < 0.01$; LOSD pre-PIT $p = 0.03$, post $p < 0.01$), and for the CED (D2P pre-PIT $p = 0.02$, post $p < 0.01$; LOSD pre-PIT $p = 0<0.01$, post $p < 0.01$). Additionally an interaction term for PIT * A2P added to the analysis shown in Table 3 for both ED sites and for the two outcomes (D2P and LOSD) were not significant (interaction A2D * PIT for AED; D2P = 0.06, LOSD = 0.17; CED D2P =0.52, LOS p = 0.44), indicating that the effect of A2P on the efficiency outcomes was not attenuated with the introduction of PIT.

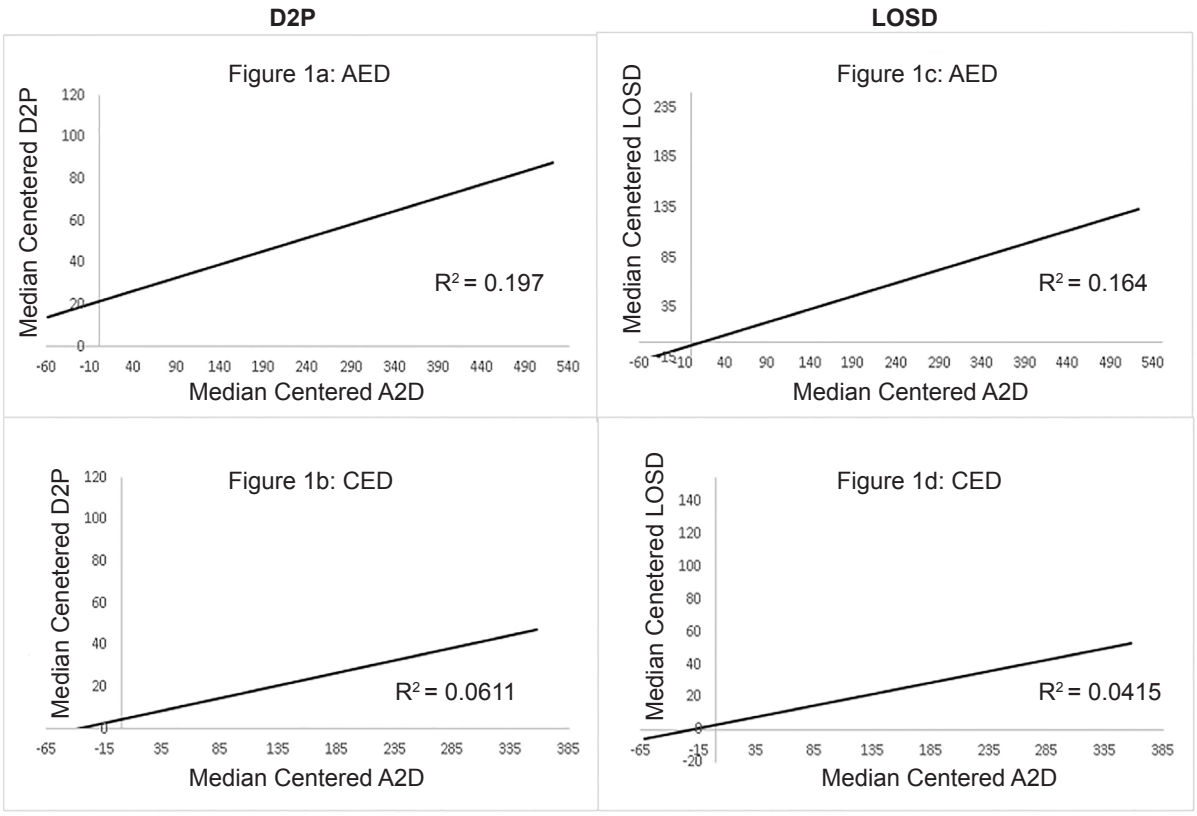


Figure 1a-1d. Effects of Patient Boarding on Median Centered Door to Physician and Length of Stay of Discharged Patients. In all four panels, X and Y axes in minutes.
AED, tertiary care academic emergency department; *A2D,* admit request to departure for boarded patients awaiting hospital admission; *CED,* community emergency department; *D2P,* arrival to being seen by physician; *LOSD*, total length of stay for discharged patients;

DISCUSSION

The effects of boarding have been well classified in the ED literature and national quality guidelines. The PIT model is one clear way in which ED administrative leadership has been able to improve the efficiency of intake and throughput, often in the face of worsening boarding. However, boarding continues to be a problem for EDs across the country. The output constraints of poor hospital throughput that boarding puts on EDs reduce the efficiency of ED intake and throughput.

This study showed that implementation of a PIT model was not associated with an ability to mitigate the operational inefficiencies created by boarding. PIT was associated with decreases in D2P and LOS for discharged patients at two EDs that concurrently experienced increases in ED volume and boarding. Increased boarding of admitted patients was positively associated with increased D2P and LOS for discharged patients; this relationship was unchanged despite the implementation of PIT. This suggests that increased boarding of admitted patients has systemic effects on overall ED efficiency, even affecting the care of discharged (non-boarded) patients. Improvements in ED throughput using the PIT model is largely independent of hospital throughput and could not mitigate the effects of boarding.

In 2003 Asplin *et al.* presented a conceptual framework that examined ED crowding as a combination of input, throughput, and output stressors.[14] Input, or the demand for ED care, reflects the extent to which there is patient demand for ED services and is largely beyond the immediate control of ED leadership. Output factors, including inpatient hospital capacity and access to appropriate outpatient services are likewise outside the scope of ED administrative control. Throughput focuses on time spent within the ED and is largely comprised of active patient-care time. Interventions designed to impact throughput time include process improvements during patient intake, disease-specific protocols designed to reduce provider variability, and the implementation of clinical decision units. The PIT model is one way in which EDs can innovate to improve ED throughput efficiency. This study demonstrated the efficacy of PIT implementation on improving intake and throughput in two large, urban EDs. We were also able to quantify the negative effect that boarding has on the upstream efficiency of both EDs before and after implementation of PIT and also demonstrate that PIT was unable to mitigate this negative correlation.

Improving ED operational efficiency in the current environment of increasing ED boarding will likely require hospital-wide policy changes that address the downstream bottlenecks in care. EDs can improve operational efficiency using innovative models of care such as PIT, but outflow of patients remains a significant contributor to ED inefficiency. Viccellio et

Table 3. Quartile regression models examining the effect of boarding on median door-to-provider time and median discharged patient length of stay (in minutes).

	AED			CED		
Parameter	Estimate Minutes (95%CI)	SE	t-value, p-value	Estimate Minutes (95%CI)	SE	t-value, p-value
			D2P			
Intercept	36.84 (33.18, 40.50)	1.87	19.74, < 0.01	45.11 (42.1, 50.19)	2.08	22.18, < 0.01
Census median centered	0.32 (0.28, 0.36)	0.02	15.62, < 0.01	0.82 (0.73, 0.82)	0.04	19.88, < 0.01
A2D	0.13 (0.10, 0.16)	0.02	8.08, < 0.01	0.14 (0.10, 0.18)	0.02	6.65, < 0.01
PIT (post vs pre)	-21.61 (-23.78, -19.44)	1.11	19.44, < 0.01	-18.45 (-21.37, -15.52)	1.50	12.36, < 0.01
			LOSD			
Intercept	260.7 (251.27, 270.13)	4.81	54.23, < 0.01	223.47 (216.42, 230.52)	3.59	62.2, < 0.01
Census median centered	0.66 (0.53, 0.78)	0.06	10.67, < 0.01	0.90 (0.80, 1.01)	0.05	16.91, < 0.01
A2D	0.25 (0.19, 0.31)	0.03	8.52, < 0.01	0.21 (0.13, 0.28)	0.04	5.08, < 0.01
PIT (post vs pre)	-29.83 (-38.03, -21.68)	4.17	7.16, < 0.01	-11.45 (-16.16, -4.77)	2.40	4.77, < 0.01

ED, emergency department; *AED,* tertiary care academic emergency department; *CED,* community emergency department; *D2P,* arrival to being seen by physician; *LOSD*, total length of stay for discharged patients; *A2D,* admit request to departure for boarded patients awaiting hospital admission; *PIT*, physician in triage; *95% CI*, 95% confidence interval; *SE*, standard error.

al suggested that transfer of boarding patients to inpatient hallway beds may mitigate the impact of boarding but did not directly examine the impact of a full-capacity protocol on operational metrics.[15] Several studies have documented that there is no increased in-hospital mortality or intensive care unit transfer rate among patients in inpatient-ward hallway beds, suggesting that boarding of patients in inpatient hallway beds is not associated with increased patient harm.[15,16]

To the contrary, there are a number of studies that demonstrate the adverse quality of care associated with boarding patients in the ED.[4,17] Surveyed patients strongly prefer waiting in inpatient wards rather than the ED.[16,18] Despite these data, Pitts et al in 2014 found that only 19% of EDs used a strategy of moving admitted boarding patients to alternate sites in the hospital.[6] One prior study was able to quantify the throughput inefficiency introduced by higher levels of boarding; however, this single-center study was at a center where a PIT model had yet to be introduced.[5] Modern innovative models such as PIT are often a reactive process designed to improve ED throughput in the face of poor hospital throughput. However, as this study demonstrates, these models are unable to substantially mitigate the effect that boarding has on ED intake and throughput.

LIMITATIONS

This study has several limitations. One important limitation is that these effects were quantified in daily intervals. EDs often have variable arrival and admission rates. Consequently, boarding follows a similar but often-delayed pattern.[19,20] Daily data intervals likely underestimate the effects of boarding as the effects of boarding are spread over all patients. Many patients, particularly during periods of low ED census, may not be subjected to the inefficiencies introduced by boarding. Consequently, a shorter interval study would more accurately assess the effects of boarding during times of peak ED crowding.

Second, this study took place in two separate institutions under the same umbrella and leadership of one healthcare system. Thus, the system and ED leadership were largely familiar with each other's systems of care and followed similar care pathways and surge protocols. This includes implementation of a very similar PIT model. While a similar PIT model may improve the interval validity of the study, it may limit the conclusions one may draw given the diversity of expected changes in the way healthcare systems address the issue of boarding.

Workflow changes that occurred during the implementation of the PIT model may have also confounded these results. These include expedited admission protocols, expansion of a clinical decision unit, and innovations in efficiency of core processes such as lab and radiology turnaround time. While each of these could reduce the overall LOS and overestimate the departmental efficiencies associated with the PIT model they are also likely to have a positive impact on boarding, thus underestimating our findings. Lastly, one system implemented its PIT model after learning from the operational challenges of the first.

CONCLUSION

This study showed that implementation of a PIT model was associated with improved intake and throughput at two EDs during a time of increasing ED volume and boarding. However, the PIT model was not able to mitigate any of the upstream inefficiencies introduced by boarding. Increased boarding of admitted patients was positively associated with increased D2D and LOS for discharged patients despite the implementation of

PIT. This suggests that increased boarding of admitted patients has systemic effects on overall ED efficiency affecting care of discharged (non-boarded) patients. While PIT may improve ED throughput, it cannot mitigate the negative effects of poor hospital throughput introduced by boarding.

Address for Correspondence: Anthony M. Napoli, MD, Warren Alpert Medical School of Brown University, Department of Emergency Medicine, 55 Claverick Street, Providence, RI 02903. Email: anapoli@lifespan.org.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Pitts S., Pines JM, Handrigan MT, et al. National trends in emergency department occupancy, 2001 to 2008: effect of inpatient admissions versus emergency department practice intensity. *Ann Emerg Med*. 2012;60(6):679-86.e3.
2. Tang N, Stein J, Hsia RY, et al. Trends and characteristics of US emergency department visits, 1997-2007. *JAMA*. 2010;304(6):664-70.
3. Coil CJ, Flood JD, Belyeu BM, et al. The effect of emergency department boarding on order completion. *Ann Emerg Med*. 2016;67(6):730-6.e2.
4. Singer AJ, Thode Jr HC, Viccellio P, et al. The association between length of emergency department boarding and mortality. *Acad Emerg Med*. 2011;18(12):1324-9.
5. White BA, Biddinger PD, Chang Y, et al. Boarding inpatients in the emergency department increases discharged patient length of stay. *J Emerg Med*. 2013;44(1):230-5.
6. Pitts SR, Vaughns FL, Gautreau MA, et al. A cross-sectional study of emergency department boarding practices in the United States. *Acad Emerg Med*. 2014;21(5):497-503.
7. Sprivulis PC, Da Silva JA, Jacobs IG, et al. The association between hospital overcrowding and mortality among patients admitted via Western Australian emergency departments. *Med J Aust*. 2006;184(5):208-12.
8. Holroyd BR, Bullard MJ, Latoszek K, et al. Impact of a triage liaison physician on emergency department overcrowding and throughput: a randomized controlled trial. *Acad Emerg Med*. 2007;14(8):702-8.
9. Imperato J, Morris DS, Binder D, et al. Physician in triage improves emergency department patient throughput. *Intern Emerg Med*. 2012;7(5):457-62.
10. Choi YF, Wong TW, Lau CC. Triage rapid initial assessment by doctor (TRIAD) improves waiting time and processing time of the emergency department. *Emerg Med J*. 2006;23(4):262-5.
11. Partovi SN, Nelson BK, Bryan ED, et al. Faculty triage shortens emergency department length of stay. *Acad Emerg Med*. 2001;8(10):990-5.
12. Subash F, Dunn F, McNicholl B, et al. Team triage improves emergency department efficiency. *Emerg Med J*. 2004;21(5):542-4.
13. Rowe BH, Guo X, Villa-Roel C, et al. The role of triage liaison physicians on mitigating overcrowding in emergency departments: a systematic review. *Acad Emerg Med*. 2011;18(2):111-20.
14. Asplin BR, Magid DJ, Rhodes KV, et al. A conceptual model of emergency department crowding. *Ann Emerg Med*. 2003;42(2):173-80.
15. Viccellio A, Santora C, Singer AJ, et al. The association between transfer of emergency department boarders to inpatient hallways and mortality: a 4-year experience. *Ann Emerg Med*. 2009;54(4):487-91.
16. Viccellio P, Zito JA, Sayage V, et al. Patients overwhelmingly prefer inpatient boarding to emergency department boarding. *J Emerg Med*. 2013;45(6):942-6.
17. Carr BG, Hollander JE, Baxt WG, et al. Trends in boarding of admitted patients in US emergency departments 2003-2005. *J Emerg Med*. 2010;39(4):506-11.
18. McGowan H, Gopeesingh K, O'Kelly P, et al. Emergency department overcrowding and the full capacity protocol cross over study: what patients who have experienced both think about being an extra patient in the emergency department or on a ward. *Ir Med J*. 2018;111(7):788.
19. Gorski JK, Batt RJ, Otles E, et al. The Impact of emergency department census on the decision to admit. *Acad Emerg Med*. 2017;24(1):13-21.
20. McCarthy ML, Aronsky D, Jones ID, et al. The emergency department occupancy rate: a simple measure of emergency department crowding? *Ann Emerg Med*. 2008;51(1):15-24.e1-2.

Impact of Scribes with Flow Coordination Duties on Throughput in an Academic Emergency Department

Keith Thomas, BS*
Joshua Marcum, BS*
Alexei Wagner, MD, MBA†
Michael A. Kohn, MD, MPP†

*Stanford Hospital and Clinics, Department of Emergency Medicine, Stanford, California
†Stanford University School of Medicine, Department of Emergency Medicine, Stanford, California

Section Editor: Eric Snoey, MD
Submission history: Submitted December 7, 2019; Revision received February 19, 2020; Accepted March 7, 2020
Electronically published April 24, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.2.46110

Introduction: With the increasing influence of electronic health records in emergency medicine came concerns of decreasing operational efficiencies. Particularly worrisome was increasing patient length of stay (LOS). Medical scribes were identified to be in a good position to quickly address barriers to treatment delivery and patient flow. The objective of this study was to investigate patient LOS in the mid- and low-acuity zones of an academic emergency department (ED) with and without medical scribes.

Methods: A retrospective cohort study compared patient volume and average LOS between a cohort without scribes and a cohort after the implementation of a scribe-flow coordinator program. Patients were triaged to the mid-acuity Vertical Zone (primarily Emergency Severity Index [ESI] 3) or low-acuity Fast Track (primarily ESI 4 and 5) at a tertiary academic ED. Patients were stratified by treatment zone, acuity level, and disposition.

Results: The pre-intervention and post-intervention periods included 8900 patients and 9935 patients, respectively. LOS for patients discharged from the Vertical Zone decreased by 12 minutes from 235 to 223 minutes (p<0.0001, 95% confidence interval [CI], -17,-7) despite a 10% increase in patient volume. For patients admitted from the Vertical Zone, volume increased 13% and LOS remained almost the same, increasing from 225 to 228 minutes (p=0.532, 95% CI, -6,12). For patients discharged from the Fast Track, volume increased 14% and LOS increased six minutes, from 89 to 95 minutes (p<0.0001, 95% CI, 4,9). Predictably, only 1% of Fast Track patients were admitted.

Conclusion: Despite substantially increased volume, the use of scribes as patient flow facilitators in the mid-acuity zone was associated with decreased LOS. In the low-acuity zone, scribes were not shown to be as effective, perhaps because rapid patient turnover required them to focus on documentation. [West J Emerg Med. 2020;21(3)653–659.]

INTRODUCTION

Background

The advent of electronic health records promised an improvement in healthcare quality, safety, outcomes, and clinic-related efficiencies.[1–3] Evidence suggests electronic health records have important structural- and process-related benefits.[4–8] However, over the short term, they may reduce productivity, potentially increasing provider documentation time and patient length of stay (LOS).[9–16] To help address these increasing concerns about physician efficiency and rapid patient throughput[17,18], as well as the issue of worsening emergency department (ED) crowding[19–23], the use of medical scribes increased nationwide.[24–26]

Importance

Strategies that reduce LOS and improve patient flow are critical to the efficient and humane delivery of emergency medical care.[27] Implementation of traditional scribe programs

has been shown to be beneficial.[1,28,29] At various institutions, scribes have been tasked with ancillary responsibilities to facilitate patient throughput[30,31] since they may be in a good position to quickly address potential barriers to treatment delivery and patient flow (Figure 1). However, the full effectiveness of these programs remains unknown.

Population Health Research Capsule

What do we already know about this issue?
By alleviating a physician's documentation burden, medical scribes can help address concerns about physician efficiency and patient throughput.

What was the research question?
If scribes were also tasked with facilitating throughput, what effect can they have on patient length of stay (LOS)?

What was the major finding of the study?
Using scribes as patient flow facilitators in the mid-acuity zone was associated with decreased LOS of 12 minutes per patient. In the low-acuity zone, scribes were less effective (no change), perhaps because rapid patient turnover required focus on documentation.

How does this improve population health?
Tasking medical scribes with additional flow coordination responsibilities can be a solution for departments looking to improve patient LOS.

Goals of this Investigation

In addition to the traditional documentation role, scribes were tasked with facilitating throughput in mid- and low-acuity treatment zones of an academic ED. This study assessed the impact of scribe-flow coordinators on patient throughput by comparing LOS between a pre-implementation period without any scribes and a post-implementation period with scribe-flow coordinators in both treatment zones.

METHODS

Study Design

The study used a retrospective cohort design and was approved by our institutional review board (IRB) with waiver of informed consent.

Study Setting and Population

The setting for the study was the ED of a level I trauma and tertiary care center. The ED has seen a 5-8% annual increase in patient volume over the past several years and had 71,500 patient visits in 2016.

Emergency Severity Index (ESI) 3 patients aged 14 years and older who were capable of sitting in reclining chairs were seen in a mid-acuity Vertical Zone. It was operational 13 hours per day and staffed by one attending physician, one senior resident, one first-year resident, four to one nursing staff plus a throughput nurse, one ED technician, and one clerk. The Vertical Zone had the baseline capacity to treat 12 patients and could flex to 16 patients if needed. ESI 4 and 5 patients aged six months and older were seen in a low-acuity Fast Track. This zone was operational 12 hours per day and staffed by one attending, one to two nurses, and one ED technician. The Fast Track was capable of treating up to 10 patients at a time. These zones were established prior to the development of the scribe-flow coordinator program and were not part of this study. Prior to this cohort, there was no scribe utilization in any area within this ED.

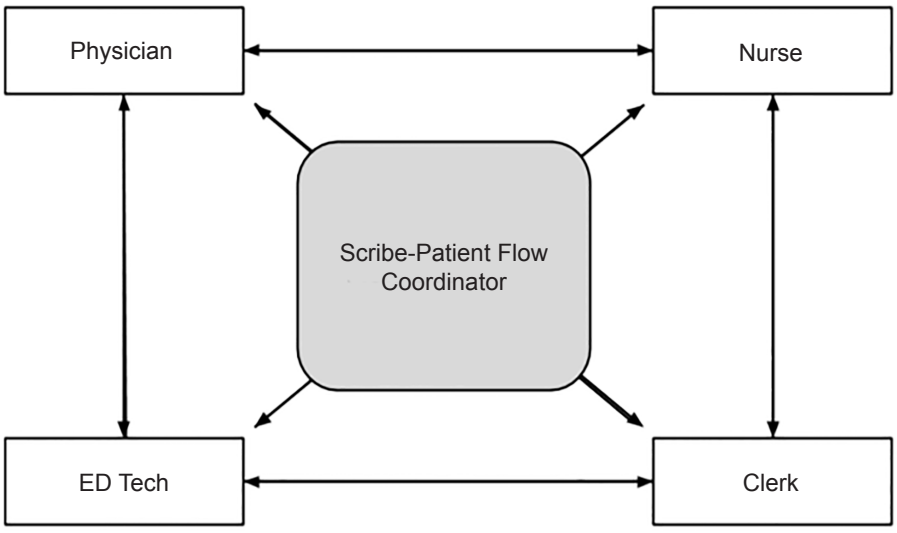


Figure 1. Representation of emergency department (ED) staff communication associations using a scribe as a patient flow coordinator.

Study Protocol

Patients were triaged to either the Vertical Zone or Fast Track if they arrived during operational hours and met the appropriate clinical criteria. We evaluated all patient encounters in the Vertical Zone and Fast Track during two six-month periods before any scribe implementation and after scribe-flow coordinator implementation for study inclusion. The pre-intervention period without scribes was July 1–December 31, 2014, and the post-intervention period with scribes was July 1–December 31, 2015. July through December of both years were used to control for seasonal variations.

Patients were excluded if their LOS could not be determined because of missing or incomplete data. Intradepartmental room transfers did not allow a full complement of the scribe-flow coordinator's intervention so these patients were excluded from the data set. We also excluded conspicuously erroneous data (eg, LOS values less than 0 minutes or greater than 13 hours). After removing patient charts with any such data, a total of 10,929 Vertical Zone encounters and 7,906 Fast Track encounters were examined in this study (Figure 2).

A group of scribe-flow coordinators with a wide variety of medical backgrounds (eg, emergency medical service, foreign medical school graduation) was interviewed from outside applications and hired in April 2015 and trained over a two-month period using an in-house curriculum developed by emergency medicine faculty and nursing supervisors to ensure competency and uniformity of desired performance. A customized curriculum was necessary in order to outline institutional flow coordinating protocol (eg, how often to check for lab updates, how to address consultant delays, etc). Their schedules were developed separately from those of attending physicians.

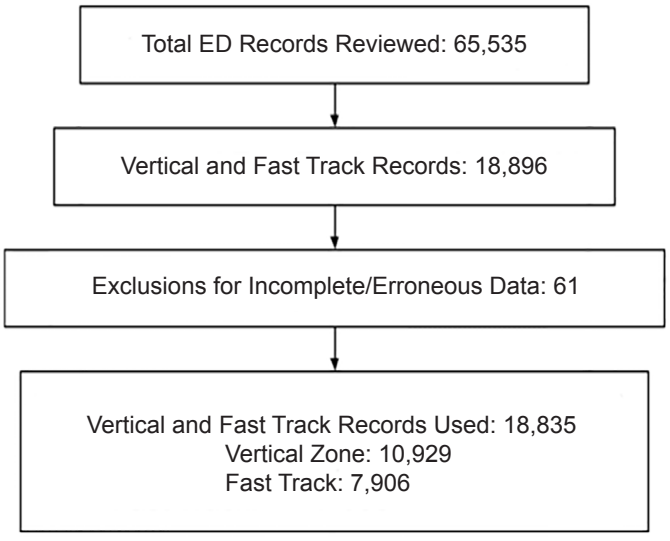


Figure 2. Process of emergency department (ED) record selection for 2014 and 2015.

Since institutional policy prohibited first-year residents from using documentation assistance, not all patient encounters were documented by the scribe-flow coordinator in the Vertical Zone. However, the scribe-flow coordinator was still responsible for facilitating throughput for all active patients within the Vertical Zone. Specific functions included ensuring closed-loop communication between staff, mitigating consultant delays, taking a proactive role in tracking lab and imaging results, updating patients, and completing non-clinical discharge tasks (Figure 3). These tasks were completed as expected by every scribe-flow coordinator on each shift. The intent was to have the scribe-flow coordinator share a holistic view of all patients so that treatment and disposition would be maximally efficient.

Measures

Data on ED patients triaged to the Vertical Zone and the Fast Track during the two study periods were extracted from the hospital's electronic database and managed in accordance with IRB protocol. We examined throughput metrics for each patient encounter.

The outcome variable was LOS in minutes. For admitted patients, LOS was arrival time to admit order time. For discharged patients, LOS was arrival time to discharge order time. When compared to after visit summary print time or nursing discharge timestamps, the discharge order time metric reflected the scribes' contributions most accurately because it was the least dependent on variable nursing workload and constraints.We also measured daily patient volume and the patient demographics of age and gender.

Data Analysis

We compared patient demographics of age and gender. The comparison of LOS between periods was stratified by treatment zone, ESI acuity level, and disposition. We compared categorical variables using the chi-square test. Continuous variables, including LOS, were compared using the t-test and reporting 95% confidence intervals (CI). We performed statistical analysis using Stata 13 (Statacorp, College Station, TX).

RESULTS

Characteristics of Study Subjects

In the Vertical Zone, 5201 patients with complete data were seen in 2014 without a scribe-flow coordinator present and 5728 were seen in 2015 with scribe-flow coordinators. The Fast Track saw 3699 in 2014 without scribe-flow coordinators and 4207 in 2015 with scribe-flow coordinators.

In the Fast Track, the proportion of patients aged 18-64 years decreased significantly by 3.3% (95% confidence interval [CI], 0.02-0.08). Otherwise the demographic characteristics did not differ between the two time periods (Table 1).

Main Results–Vertical Zone

In the pre-intervention cohort (2014), the Vertical Zone volume was 28.3 patients per day (2.2 patients per hour). In

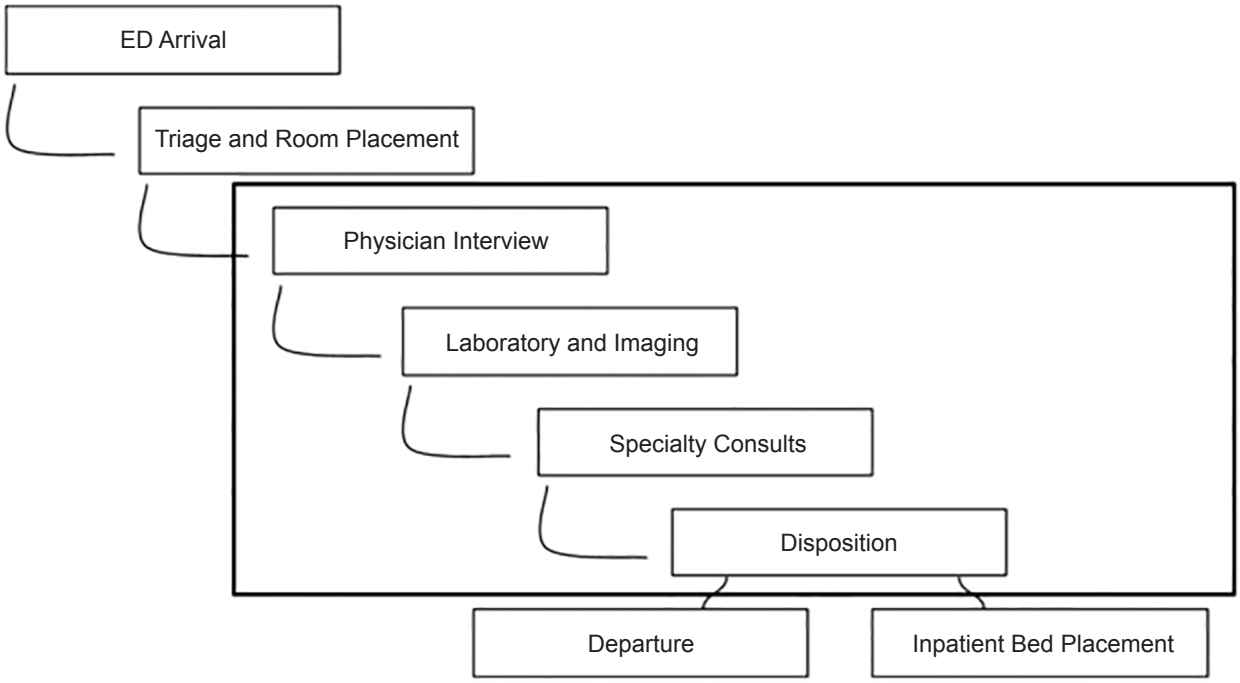


Figure 3. Representation of a scribe-patient flow coordinator intervention in emergency department (ED) flow.

the post-intervention cohort (2015), daily volume increased by 2.9 to 31.1 patients per day and hourly volume increased to 2.4 patients per hour. LOS for patients treated and discharged decreased by 12 minutes from 235 minutes to 223 minutes ($p<0.0001$, 95% CI, -17,-7) despite the 10% increase in volume. For patients admitted from the Vertical Zone, volume increased by 13% and LOS remained almost the same, increasing by three minutes from 225 minutes to 228 minutes, which was not statistically significant ($p = 0.532$, 95% CI, 6,12) (Table 2).

Main Results–Fast Track

In the pre-intervention cohort, the Fast Track volume was 20.1 patients per day (1.7 patients per hour). In the post-intervention cohort, the Fast Track daily volume increased by 2.9 to 23 patients per day (1.9 patients per hour) in 2015. For patients discharged, patient volume increased by 14% with a corresponding increase in LOS of 6 minutes, from 89 minutes to 95 minutes ($p<0.0001$, 95% CI, 4,9). Predictably, only 1% of Fast Track patients were admitted, 30 in the pre-intervention period and 54 in the post-intervention period with an insignificant 27-minute increase in LOS.

DISCUSSION

In the medium-acuity Vertical Zone, scribe-flow coordinators helped enable clinical providers to treat 9.7% more discharged patients while decreasing LOS by 5% and to treat 13% more admitted patients with no change in total LOS. In the low-acuity Fast Track, volume increased by 13.6%, but LOS also increased by 7%.

Our literature review failed to identify any published studies that stratified throughput metrics on ESI-specific treatment zones. Studies by Allen et al and Bastani et al also showed improvements in throughput times after implementation of a scribe program.[28,32] However, other studies have shown no significant improvement in LOS with most, including a meta-analysis by Heaton et al, also citing an increase in patient volume.[29,33–36] Therefore, implementation expectations and details are of great consequence.[36] By the end of 2015, the Vertical Zone and Fast Track accounted for approximately one-third of the total ED census. Patient volume growths of 10% in the Vertical Zone and 14% in the Fast Track were significantly higher than the 5% annual increase for the entire ED. As with nurse-flow coordinators who decreased LOS by maintaining open communication with inpatient units,[20] scribe-flow coordinators appear to have decreased LOS in the Vertical Zone by facilitating communication between ED staff and patients.

Since patients generally require a more involved medical workup in the Vertical Zone than in the Fast Track, scribe-flow coordinators have more opportunities to decrease LOS for patients seen in the Vertical Zone. Ensuring optimal staff communication, mitigating consultant delays, and taking a proactive role in tracking lab and imaging results are a few such possible interventions. In contrast, the typical Fast Track patient's ED stay often involves immediate disposition with no need for laboratory or imaging studies, so the impact of the scribe's flow coordination duties on throughput in this low-acuity zone may be minimal.

LIMITATIONS

Concurrent to this study, various protocol changes and new

Table 1. Patient volume, demographics, and acuity in the Vertical Zone and Fast Track.

	Vertical Zone				Fast Track			
Variables	Pre-implementation (2014)	Post-implementation (2015)	Change (%)	P-value	Pre-implementation (2014)	Post-implementation (2015)	Change (%)	P-value
Total visits, N (%)								
Discharged	3834 (73.7%)	4204 (73.4)	9.7%		3639 (98.4%)	4133 (98.2%)	13.6%	
Admitted	1266 (24.3%)	1436 (25.1)	13.4%		30 (0.8%)	54 (1.3%)	80.0%	
Total†	5201	5728	10.1%		3699	4207	13.7%	
Volume visits/day [/hour]								
Discharged	20.8 [1.6]	22.9 [1.8]	10.1%		19.8 [1.7]	22.6 [1.9]	14.1%	
Admitted	6.9 [0.5]	7.8 [0.6]	13.0%		0.1 [0]	0.3 [0]	-	
Total†	28.3 [2.2]	31.1 [2.4]	9.9%		20.1 [1.7]	23 [1.9]	14.4%	
Gender, N (%)				0.06				0.984
Male	2217 (42.6%)	2327 (40.6%)	-2.0%		1828 (49.4%)	2080 (49.4)	0%	
Age (years), N (%)				0.48				0.003
<18	70 (1.3%)	48 (0.8%)	-0.5%		1108 (30.0%)	1377 (32.7%)	2.7%	
18-64	3835 (73.7%)	4257 (74.3%)	0.6%		2386 (64.5%)	2576 (61.2%)	-3.3%	
65+	1296 (24.9%)	1423 (24.8%)	-0.1%		205 (5.5%)	254 (6.0%)	0.5%	
ESI level-discharged, N (%)								
ESI 2	144 (3.8%)	92 (2.2%)	-36.1%		-	-	-	
ESI 3	3279 (85.5%)	3665 (87.2%)	11.8%		559 (15.4%)	455 (11.0%)	-18.6%	
ESI 4	396 (10.3%)	432 (10.3%)	0%		2755 (75.7%)	3272 (79.2%)	18.8%	
ESI 5	-	-	-		324 (8.9%)	405 (9.8%)	25.0%	
ESI level-admitted, N (%)								
ESI 2	271 (21.4%)	308 (21.4%)	13.7%		-	-	-	
ESI 3	980 (77.4%)	1108 (77.2%)	13.1%		22 (73.3%)	34 (63.0%)	54.5%	
ESI 4	11 (0.9%)	16 (1.1%)	45.5%		4 (13.3%)	19 (35.2%)	375.0%	
ESI 5	-	-	-		-	-	-	

†Includes encounters without triage Emergency Severity Index (ESI) labels.

Table 2. Length of stay (LOS) for the Vertical Zone and Fast Track patients.

	Vertical Zone							Fast Track						
	Pre-implementation (2014)		Post-implementation (2015)					Pre-implementation (2014)		Post-implementation (2015)				
Patient disposition	LOS (min)	SD	LOS (min)	SD	Δ (min)	95% CI	P-value	LOS (min)	SD	LOS (min)	SD	Δ (min)	95% CI	P-value
Discharged	235	110	223	108	-12	-17,-7	<0.0001	89	55	95	60	6	4,9	<0.0001
Admitted	225	120	228	122	3	-6,12	0.5324	226	114	253	136	27	-29,85	0.3351
Total	233	-	224	-	-8	-	<0.0001	90	-	97	-	7	-	<0.0001

CI, confidence interval; *LOS,* length of stay; *min,* minutes; *SD,* standard deviation.

initiatives had been implemented in the ED. The benefit of improving triage protocols was exemplified by the 4% decrease in ESI 2 patients in the Vertical Zone and the 16% decrease in ESI 3 patients in the Fast Track.

Initially strict triage criteria resulted in intermittent periods where there were no Fast Track patients, contributing to the low 1.7 patients per hour in 2014. In 2015, Fast Track exclusion criteria were eased and hourly volume increased to 1.9, although there were still lulls in patient volume. The physical spaces of both the Vertical Zone and the Fast Track were changed multiple times over the study period due to surge protocols. The result was recurrent updates to workflows. Despite these changes, the core patient care delivery model remained constant in both treatment zones.

CONCLUSION

The use of medical scribes to facilitate patient flow appears to be beneficial to patient throughput in a mid-acuity setting. In low-acuity zones, medical scribes were not shown to be effective at improving patient throughput likely due to faster patient turnover that requires the scribes to focus on documentation.

ACKNOWLEDGMENTS

The authors acknowledge the contribution of Ian Brown, MD, for his acquisition of the datasets; Jamie Stone, RN, MBA, for his mentorship through the process of compiling this article; and Sam Shen, MD, MBA, for his efforts in developing the scribe-flow coordinator program.

Address for Correspondence: Keith Thomas, BS, Stanford Hospital and Clinics, Department of Emergency Medicine, 900 Welch Road, Suite 350, Palo Alto, CA 94304. Email: kgt8xn@gmail.com.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Shultz CG, Holmstrom HL. The use of medical scribes in health care settings: a systematic review and future directions. *J Am Board Fam Med.* 2015;28(3):371–81.
2. Institute of Medicine. *Key Capabilities of an Electronic Health Record System: Letter Report*. Washington, DC: The National Academies Press; 2003.
3. Chou D. Health IT and patient safety: building safer systems for better care. *JAMA.* 2012;308(21):2282–2282.
4. Baumlin KM, Shapiro JS, Weiner C, et a. Clinical information system and process redesign improves emergency department efficiency. *Jt Comm J Qual Patient Saf.* 2010;36(4):179–AP1.
5. Zikos D, Diomidous M, Mpletsa V. The effect of an electronic documentation system on the trauma patient's length of stay in an emergency department. *J Emerg Nurs.* 2014;40(5):469–75.
6. Boger E. Electronic tracking board reduces ED patient length of stay at Indiana Hospital. *J Emerg Nurs.* 2003;29(1):39–43.
7. Daniel GW, Ewen E, Willey VJ, et al. Efficiency and economic benefits of a payer-based electronic health record in an emergency department: payer-based EHR evaluation in an ED. *Acad Emerg Med.* 2010;17(8):824–33.
8. Spalding SC, Mayer PH, Ginde AA, et al. Impact of computerized physician order entry on ED patient length of stay. *Am J Emerg Med.* 2011;29(2):207–11.
9. Mohan MK, Bishop RO, Mallows JL. Effect of an electronic medical record information system on emergency department performance. *Med J Aust.* 2013;198(4):201–4.
10. Ward MJ, Froehle CM, Hart KW, et al. Transient and sustained changes in operational performance, patient evaluation, and medication administration during electronic health record implementation in the emergency department. *Ann Emerg Med.* 2014;63(3):320–8.
11. Ward MJ, Landman AB, Case K, et al. The Effect of Electronic Health Record Implementation on Community Emergency Department Operational Measures of Performance. *Ann Emerg Med.* 2014;63(6):723–30.
12. Perry JJ, Sutherland J, Symington C, et al. Assessment of the impact on time to complete medical record using an electronic medical record versus a paper record on emergency department patients: a study. *Emerg Med J.* 2014;31(12):980–5.
13. Kennebeck SS, Timm N, Farrell MK, et al. Impact of electronic health record implementation on patient flow metrics in a pediatric emergency department. *J Am Med Inform Assoc.* 2012;19(3):443–7.
14. Park SY, Lee SY, Chen Y. The effects of EMR deployment on doctors' work practices: A qualitative study in the emergency department of a teaching hospital. *Int J Med Inform.* 2012;81(3):204–17.
15. Feblowitz J, Takhar SS, Ward MJ, et al. A Custom-Developed Emergency Department Provider Electronic Documentation System Reduces Operational Efficiency. *Ann Emerg Med.* 2017;70(5):674–82.
16. Fleming NS, Becker ER, Culler SD, et al. The impact of electronic health records on workflow and financial measures in primary care practices. *Health Serv Res.* 2014;49(1 Pt 2):405–20.
17. Cooke MW, Wilson S, Halsall J, et al. Total time in English accident and emergency departments is related to bed occupancy. *Emerg Med J.* 2004;21(5):575–6.
18. Sax DR, Shesser R. Ten common misconceptions about emergency care. In: Pines JM, Abualenain J, Scott J, et al. *Emergency Care and the Public's Health*. Chichester, UK: John Wiley & Sons, Ltd; 2014. p.11–20.
19. Li G, Lau JT, McCarthy ML, et al. Emergency department utilization in the United States and Ontario, Canada. *Acad Emerg Med.*

2007;14(6):582–4.

20. Murphy SO, Barth BE, Carlton EF, et al. Does an ED flow coordinator improve patient throughput? *J Emerg Nurs.* 2014;40(6):605–12.
21. Schafermeyer RW, Asplin BR. Hospital and emergency department crowding in the United States. *Emerg Med.* 2003;15(1):22–7.
22. Afilal M, Yalaoui F, Dugardin F, et al. Forecasting the emergency department patients flow. *J Med Syst.* 2016;40(7):175.
23. Rui P KK. National Hospital Ambulatory Medical Care Survey: 2014 Emergency Department Summary Tables. CDC; 2014. Available at: https://www.cdc.gov/nchs/data/nhamcs/web_tables/2014_ed_web_tables.pdf. Accessed February 22, 2017.
24. William J, Wiler JL, Barry WS, et al. Use of scribes: an information paper. American College of Emergency Physicians; 2011. Available at: https://www.acep.org/globalassets/uploads/uploaded-files/acep/clinical-and-practice-management/resources/administration/use-of-scribes-in-the-ed-june2011-2.pdf. Accessed February 22, 2017.
25. Butler M. Fixing a broken EHR: HIM working in the spotlight to solve common EHR issues. *J AHIMA* 2015;86(3):18–23.
26. Gellert GA, Ramirez R, Webster SL. The rise of the medical scribe industry: implications for the advancement of electronic health records. *JAMA.* 2015;313(13):1315–6.
27. Rodi SW, Grau MV, Orsini CM. Evaluation of a fast track unit: alignment of resources and demand results in improved satisfaction and decreased length of stay for emergency department patients. *Qual Manag Health Care.* 2006;15(3):163–70.
28. Allen B, Banapoor B, Weeks EC, et al. An assessment of emergency department throughput and provider satisfaction after the implementation of a scribe program. *Advances in Emergency Medicine*. 2014. Available at: https://www.hindawi.com/archive/2014/517319/abs/. Accessed May 8, 2017.
29. Hess JJ, Wallenstein J, Ackerman JD, et al. Scribe impacts on provider experience, operations, and teaching in an academic emergency medicine practice. *West J Emerg Med.* 2015;16(5):602–10.
30. Allred RJ, Ewer S. Improved emergency department patient flow: five years of experience with a scribe system. *Ann Emerg Med.* 1983;12(3):162–3.
31. Shuaib W, Hilmi J, Caballero J, et al. Impact of a scribe program on patient throughput, physician productivity, and patient satisfaction in a community-based emergency department. *Health Informatics J.* 2019;25(1):216-224.
32. Bastani A, Shaqiri B, Palomba K, et al. An ED scribe program is able to improve throughput time and patient satisfaction. *Am J Emerg Med.* 2014;32(5):399–402.
33. Heaton HA, Nestler DM, Lohse CM, et al. Impact of scribes on emergency department patient throughput one year after implementation. *Am J Emerg Med.* 2017;35(2):311–4.
34. Arya R, Salovich DM, Ohman-Strickland P, et al. Impact of scribes on performance indicators in the emergency department. *Acad Emerg Med.* 2010;17(5):490–4.
35. Heaton HA, Nestler DM, Jones DD, et al. Impact of scribes on patient throughput in adult and pediatric academic EDs. *Am J Emerg Med.* 2016;34(10):1982–5.
36. Heaton HA, Castaneda-Guarderas A, Trotter ER, et al. Effect of scribes on patient throughput, revenue, and patient and provider satisfaction: a systematic review and meta-analysis. *Am J Emerg Med.* 2016;34(10):2018–28.

What is a Freestanding Emergency Department? Definitions Differ Across Major United States Data Sources

Darya M. Herscovici, BS
Krislyn M. Boggs, MPH
Ashley F. Sullivan, MS, MPH
Carlos A. Camargo Jr., MD, DrPH

Massachusetts General Hospital, Department of Emergency Medicine, Boston, Massachusetts

Section Editor: Bryan J. Yun, MD, MBA, MPH
Submission history: Submitted November 26, 2019; Revision received February 18, 2020; Accepted March 9, 2020
Electronically published April 16, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.3.46001

Introduction: Despite the growing number of freestanding emergency departments (FSED) in the United States (US), FSED definitions differ across major US data sources of healthcare facilities and use. We compare these sources and propose a universal definition of FSED (and its two major types) to improve communications regarding these facilities and their patients.

Methods: We collected definitions of FSEDs from 11 national data sources using their websites, email, and telephone communications. For each source, we asked how they define FSEDs, whether being open 24/7 is a requirement to be called an ED, and whether they maintain a dataset of FSEDs.

Results: Definitions varied across the data sources. All sources recognize FSEDs in their definitions, regardless of type; only one (the National Health Intervew Survey) does not differentiate them from other EDs. Five of the 11 sources (45%) omit autonomous FSEDs from their definitions and do not separately identify satellite FSEDs from their affiliated hospitals. One source does separately identify satellite FSEDs from their affiliated hospitals, but also omits autonomous FSEDs. Furthermore, three of the 11 sources (27%) do not require being open 24/7, while all others (73%) employ this criterion. Six of the 11 (55%) maintain datasets of FSEDs using their definition.

Conclusion: As FSEDs continue to change the landscape of emergency care, it is important that they also be represented in national ED data sources. The current differences in the definition of an FSED make it difficult to provide accurate and longitudinal analysis for these facilities and patients who receive services at these facilities. We propose a universal definition of FSEDs as described by both the American College of Emergency Physicians and the National Emergency Department Inventory. Implementing a standard definition would facilitate a more accurate representation of FSEDs in national data sources and enhance ongoing efforts to improve the quality of emergency care delivered in FSEDs. [West J Emerg Med. 2020;21(3)660–664.]

INTRODUCTION

The American College of Emergency Physicians (ACEP) defines a freestanding emergency department (FSED) as an emergency facility that is not physically connected to inpatient services.[1] In recent years, the number of FSEDs in the United States (US) has grown exponentially.[2] According to the National Emergency Department Inventory (NEDI)-USA, a database containing all 24/7/365 non-federal EDs, in 2001 1% (50/4,884) of all US EDs were FSEDs.[3] In 2016, however, the Medicare Payment Advisory Commission (MedPAC) reported that FSEDs accounted for 11% (566/5,200) of all EDs nationwide.[4]

This increase in FSEDs is in part a result of a 2004 Medicare reimbursement policy change that allowed payment for services provided in FSEDs.[4] However, this policy only applies to hospital-affiliated (satellite) FSEDs and does not include non-hospital-affiliated (autonomous)

FSEDs. The introduction of this policy presented an important difference between the two major types of FSEDs. Differences between these two types are not always indicated in major US data sources, which can lead to inaccurate representation of the ED landscape.

To characterize the magnitude of this data gap, we compared how US data sources define FSEDs and propose a universal definition of these facilities that allows for clear distinctions between two major FSED types. Adoption of this terminology would facilitate a more accurate representation of FSEDs in national data sources, communication about FSEDs, and efforts to improve the quality of emergency care delivered in FSEDs.

METHODS

We compiled information from the seven sources presented in the 2010 profile of national ED sources by Owens et al.[5] Data from the Hospital Market Profiling Solution, originally supported by Service Management Group, has since been integrated into the IQVIA OneKey Hospital Database following ownership transitions. Additional FSED definitions from four sources – ACEP; the Drug Abuse Warning Network (DAWN); the Emergency Department Benchmarking Alliance (EDBA); and the Centers for Medicare & Medicaid Services (CMS) – were obtained from a May 2019 online search using the criteria "national emergency department databases."

We collected information from each source using website, email, and telephone communication. When we collected information from only one representative from an organization, we contacted these organizations a second time six months later to confirm the definition. For each source, we determined whether a facility must be open 24/7 to be classified as an FSED and whether the source maintains an ED dataset. We also determined whether they separately identify each type of FSED, and we extracted unique terminology used to identify the major types of FSED (eg, satellite vs autonomous). We employed the term satellite FSED to encompass all hospital-affiliated FSEDs, and autonomous FSED to encompass all non-hospital-affiliated FSEDs as outlined by Sullivan et al.[2] We investigated the number of FSEDs of each type and their visit volumes in 2017 using data from NEDI-USA.[6] Data are presented as proportions and medians with interquartile ranges (IQR) from Stata version 14.1 (StataCorp. College Station, TX).

Data Sources

ACEP is a professional organization of US-based emergency physicians with >38,000 members. We obtained the organization's FSED definition from the September 2019 Policy Compendium on its website.[1] The American Hospital Association Annual Survey Database uses data from its annual survey that asks hospitals about facility characteristics.[7] We obtained its FSED definition in a conversation with Vice President of Policy Research, Analytics, and Strategy A. Weslowski and Director of Health Analytics and Policy C. Vaz (March 2018).

CMS maintains multiple datasets, including a Provider of Services file where data on characteristics of healthcare facilities are kept.[8] We obtained their FSED definition using the June 2018 MedPAC Report. DAWN is a nationwide public health surveillance system that tracks drug-related ED visits in a representative sample of US EDs.[10] We obtained its FSED definition on the DAWN website under its glossary of terms. EDBA maintains a database of performance metrics from over 2,500 hospitals.[11] We obtained its FSED definition in a conversation with Vice President J. Augustine (January 2020).

IQVIA maintains a dataset of hospitals and outpatient centers.[12] We obtained its FSED definition in a conversation with the sales solution specialist DE Franz (January 2020). NEDI-USA is maintained by the Emergency Medicine Network at Massachusetts General Hospital. It contains an inventory of all US EDs that includes facility characteristics.[3] We obtained the FSED definition using the 2007 profile of FSEDs by Sullivan et al.[2]

The Nationwide Emergency Department Sample (NEDS) is sponsored by the Agency for Healthcare Research and Quality. It includes data on hospital and patient characteristics for a representative sample of EDs.[13] We obtained its FSED definition using the 2017 NEDS Introduction and a conversation with lead technical advisor M. Barrett (January 2020).[14] The National Electronic Injury Surveillance System is run by the National Center for Injury Prevention and tracks injury-related ED visits in a representative sample of hospitals within the US.[15] We obtained its FSED definitions during a telephone conversation with the director T Schroeder (February 2020).

The National Hospital Ambulatory Medical Care Survey (NHAMCS) is an annual survey conducted by the National Center for Health Statistics of the US Centers for Disease Control and Prevention. This survey collects information on hospital departments and ambulatory surgery centers.[16] The FSED definition was obtained using the 2017 NHAMCS micro-data file documentation.[17] The National Health Interview Survey is a household-based survey of the US population that collects information on healthcare utilization, status, and coverage for members of the selected household.[18] FSED definitions were obtained through a telephone call with statistician M. Martinez (January 2020).

RESULTS

Overall, FSED definitions vary across the 11 major US data sources (Table 1). Among the 11 sources, all recognize FSEDs within their definition. Three (27%) do not require that FSEDs are open 24/7. Five sources (45%) omit autonomous FSEDs and do not separately identify satellite FSEDs as part of their FSED definitions. Furthermore, multiple terms are used across different datasets when describing FSEDs. Across the 11 sources, four different names are used to describe

Table 1. Comparison of freestanding emergency department definitions among major US data sources.

Type of ED source	24/7 operation requirement	Maintains ED dataset	Separately identifies autonomous FSEDs (ie, unaffiliated with hospital)	Separately identifies satellite FSEDs (ie. affiliated with hospital)	Unique terminology	Notes
American College of Emergency Physicians (ACEP)[1]	Yes	No	Yes	Yes	Hospital Outpatient Department (HOPD): Satellite FSED Independent Freestanding Emergency Center (IEFC): Autonomous FSED	
American Hospital Association (AHA) Annual Survey Database[7]	Yes	Yes	No	No	Satellite Off Campus ED (OCED): Satellite FSED	Groups information from satellite FSEDs with its affiliated parent hospital
The Centers for Medicare & Medicaid Services (CMS)[8]	No	Yes	No	No		FSED needs to be owned and operated by a Medicare participating hospital, or meet requirements to seek participation in Medicare as a "hospital specializing in emergency services." These facilities do not have a 24/7 requirement.
Drug Abuse Warning Network (DAWN)[10]	Yes	No	No	No	OCED: Satellite FSED	Uses AHA criteria
Emergency Department Benchmarking Alliance (EDBA)[11]	Yes	Yes	No	Yes		
IQVIA OneKey Hospital Database[12]	No	Yes	Yes	Yes		"FSED" includes any outpatient center with a site specialty of Emergency Medicine
National Emergency Department Inventory (NEDI)[3]	Yes	Yes	Yes	Yes		
Nationwide Emergency Department Sample (NEDS)[13]	Yes	No	No	No		Uses AHA criteria
National Electronic Injury Surveillance System (NEISS)[15]	Yes	No	No	No	HOPD: Satellite FSED	Uses AHA criteria
National Hospital Ambulatory Medical Care Survey (NHAMCS)[16]	Yes	No	No	No		Only considers FSEDs as EDs unaffiliated with a hospital
National Health Interview Survey (NHIS)[18]	No	No	Yes	Yes		No differentiation between FSEDs and hospital-based EDs, all classified under ED

ED, emergency department; *FSED,* freestanding emergency department; *US,* United States.

satellite FSEDs and two different names are used to describe autonomous FSEDs. Figure 1 shows the relation between satellite and autonomous FSEDs, with respect to hospital-based EDs. Upon comparison, only NEDI-USA maintains an ED dataset that requires FSEDs to be open 24/7, separates satellite and autonomous FSEDs, and maintains annual ED visit volumes for these centers.

FSED Types and Visit Volume

Since NEDI-USA is the only data source that separates FSEDs by type and includes facility-specific visit volumes, we present results from this dataset. In 2017, NEDI-USA reported that out of 5,455 EDs, 669 (12%) are FSEDs. Among FSEDs, 408 (61%) are satellite FSEDs and 261 (39%) are autonomous FSEDs. The three states with the most FSEDs are Texas (373 FSEDs), Ohio (45), and Colorado (44). In Texas, 246 (66%) of FSEDs are autonomous, while 127 (34%) are satellites. Most FSEDs in Ohio and Colorado are satellites (98% and 77%, respectively). Of 159,531,391 ED visits nationwide in 2017, 7,387,966 (5%) were from satellite FSEDs while 1,587,371 (1%) were from autonomous FSEDs. The median visit volume for satellite FSEDs in 2017 was 17,250 (IQR = 9,348–21,900), while the median visit volume for autonomous FSEDs was 4,530 (IQR = 2,920–8,433).

DISCUSSION

We found important definitional differences for FSEDs among 11 major US data sources. Specifically, datasets differ in whether or not they separate hospital-affiliated (satellite) FSEDs from non-hospital-affiliated (autonomous) FSEDs. These distinctions complicate efforts to obtain accurate and representative national ED data and suggest that one should use caution when interpreting FSED data, depending on the source. Accurate information about FSEDs is essential to both research efforts and legislation related to this rapidly growing part of the emergency care landscape. There is also statewide variation in policies regarding FSEDs. A 2016 study determined that 29 states have no regulations about FSEDs (either to encourage or limit them).[19] There are only four states where autonomous FSEDs are legal. The diversity of state FSED policies is a reflection of the diversity of FSED definitions.

In 2014, ACEP published essential criteria for FSED facilities.[1] These requirements included 24/7 availability (as is typically required for any ED) and distinctions for "hospital-affiliated" and "non-hospital-affiliated" FSEDs. Despite the publication of these criteria, the ACEP definition has not yet been adopted by several national organizations (Table 1). Most often, FSEDs are not identified separately within datasets. Rather, they are imbedded within the hospitals they are affiliated with, or are excluded from their sampling frame.

Based on our analysis, NEDI-USA is the only source that maintains an up-to-date inventory that abides by the guidelines published by ACEP and has been doing so since the mid-2000s.[3] Additionally, the NEDI-USA FSED definition allows for all FSED locations to be included within datasets and for differentiation among satellite vs autonomous FSEDs. Without this differentiation, essential ED information is lost, and datasets may no longer accurately reflect the facilities that deliver emergency care.

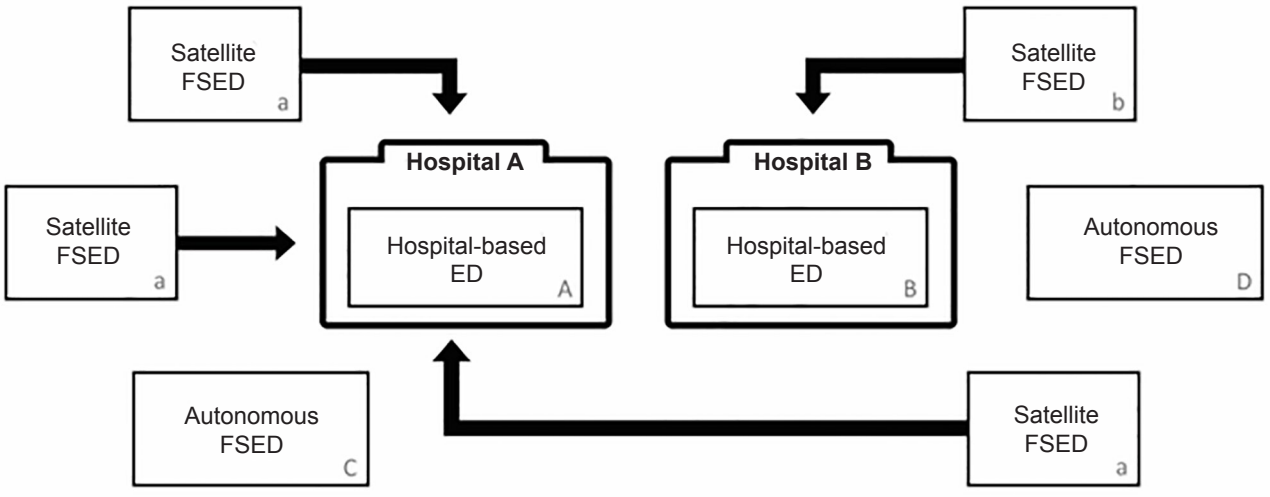


Figure 1. Example of the relation between hospital-based emergency departments, satellite freestanding emergency departments, and autonomous freestanding emergency departments.
This schematic contains eight total EDs: two hospital-based EDs (located within "Hospital A" and "Hospital B"), and six FSEDs. The three satellite FSEDs "a" are affiliated with "Hospital A", and satellite FSED "b" is affiliated with "Hospital B." The two autonomous FSEDs, "Autonomous C" and "Autonomous D," operate independently of any hospital affiliation.
ED, emergency department; *FSED,* freestanding emergency department

LIMITATIONS

Despite identifying 11 major US data sources, there may be additional sources that classify FSEDs. We are not aware of such sources, nor are the multiple individuals we contacted at the identified organizations. Regardless, among the identified datasets, there exist major differences that merit discussion and support adoption of standard terms (ie, ACEP/NEDI-USA definition) to improve clarity. Additionally, the amount and nature of information accessible for each organization and their corresponding dataset varied. However, whenever information was not clearly available online, we collected additional data from the organization by phone or email and collected the names and positions of the individuals we spoke to.

Lastly, because of the heterogeneity of the 11 sources, direct comparisons were not possible. Instead, we compared sources that keep inventories versus sources that conduct patient interviews versus sources that only maintain FSED definitions. However, we were able to identify comparable criteria despite the fundamental differences in sources and we demonstrated important differences.

CONCLUSION

Currently, there are discrepant definitions for FSEDs among major US data sources. Universally employing the ACEP/NEDI-USA definition would allow FSEDs to be individually identified and listed in national ED datasets. This would allow for future research to more accurately characterize all of US ED care and facilitate ongoing efforts to improve the quality of emergency care, including that provided in the growing number of FSEDs.

Address for Correspondence: Carlos A. Camargo, Jr, MD, DrPH, Department of Emergency Medicine,125 Nashua Street, Suite 920, Boston, MA 02114. Email: ccamargo@partners.org.

Conflicts of Interest: By the WestJEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. This study was funded by a grant from R Baby Foundation (New York, NY). There are no conflicts of interest or other sources of funding to declare.

REFERENCES

1. Freestanding Emergency Departments. American College of Emergency Physicians. Available at: https://acep.org/patient-care/policy-statements/freestanding-emergency-departments/. Accessed August 1, 2019.
2. Sullivan AF, Bachireddy C, Steptoe AP, et al. A profile of freestanding emergency departments in the United States, 2007. *J Emerg Med*. 2012;43(6):1175-80.
3. Sullivan AF, Richman IB, Ahn CJ, et al. A profile of US emergency departments in 2001. *Ann Emerg Med*. 2006;48(6):694-701.
4. Medicare Payment Advisory Commission (MEDPAC). *Report To The Congress: Medicare And The Health Care Delivery System*. Washington, D.C.; 2017:245-260. Available at: http://www.medpac.gov/docs/default-source/reports/jun17_ch8.pdf. Accessed August 1, 2019.
5. Owens PL, Barrett ML, Gibson TB, et al. Emergency department care in the United States: a profile of national data sources. *Ann Emerg Med*. 2010;56(2):150-65.
6. Freestanding EDs. Emergency Medicine Network. Available at: http://www.emnet-usa.org/research/studies/nedi/nedi2016/freestanding-eds/. Accessed: November 12, 2019.
7. Glossary. AHA Dataviewer. Available at: https://www.ahadataviewer.com/glossary/. Accessed August 1, 2019.
8. Data. Center for Medicare & Medicaid Services. Available at: https://www.cms.gov/newsroom/data. Accessed August 1, 2019.
9. Medicare Payment Advisory Commission (MEDPAC). *Report to the Congress: Medicare and the Health Care Delivery System*. Washington, D.C.; 2018:35-58. Available at: http://medpac.gov/docs/default-source/reports/jun18_medpacreporttocongress_sec.pdf. Accessed October 4, 2019.
10. DAWN Glossary, 2011 Update. Substance Abuse and Mental Health Services Administration (SAMHSA). Available at: https://www.samhsa.gov/data/report/glossary-dawn-terms-2011-update. Accessed August 1, 2019.
11. About Us. Emergency Department Benchmarking Alliance. Available at: https://www.edbenchmarking.org/about-us. Accessed January 24th, 2020.
12. Hospital Data List. OneKey by IQVIA. Available at: https://www.onekeydata.com/databases/hospital-data. Accessed August 1, 2019.
13. NEDS Overview. Healthcare Cost and Utilization Project. Available at: https://www.hcup-us.ahrq.gov/nedsoverview.jsp#about. Updated June 19, 2019. Accessed August 1, 2019.
14. Introduction to the HCUP Nationwide Emergency Department Sample (NEDS) 2017. Healthcare Cost and Utilization Project. Available at: https://www.hcup-us.ahrq.gov/db/nation/neds/NEDS2017Introduction.pdf. Accessed January 24, 2020.
15. National Electronic Injury Surveillance System (NEISS). United States Consumer Product Safety Commission. Available at: https://www.cpsc.gov/Research--Statistics/NEISS-Injury-Data. Accessed August 3, 2019.
16. NAMCS/NHAMCS - Ambulatory Health Care Data. Centers for Disease Control and Prevention. Available at: https://www.cdc.gov/nchs/ahcd/index.htm. Updated July 3, 2019. Accessed August 3, 2019.
17. 2017 NHAMCS Micro-Date File Documentation. Available at: ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHAMCS/doc17_ed-508.pdf. Accessed January 29, 2020.
18. National Health Interview Survey. Centers for Disease Control and Prevention. Available at: https://www.cdc.gov/nchs/nhis/index.htm. Updated July 29, 2019. Accessed August 1, 2019.
19. Gutierrez C, Lindor RA, Baker O, et al. State regulation of freestanding emergency departments varies widely, affecting location, growth, and services provided. *Health Affairs.* 2016;35(10):1857-866.

Retrospective Analysis of Emergency Medical Services (EMS) Physician Medical Control Calls

Balaj Rai, MD*
Joseph Tennyson, MD†
R. Trevor Marshall, MD‡

*The Christ Hospital, Department of Internal Medicine, Cincinnati, Ohio
†University of Massachusetts Medical School, Department of Emergency Medicine, Worcester, Massachusetts
‡Stony Brook University, Department of Emergency Medicine, Stony Brook, New York

Section Editor: Mark I. Langdorf, MD, MHPE
Submission history: Submitted August 22, 2019; Revision received January 23, 2020; Accepted January 31, 2020
Electronically published April 22, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.1.44943

Introduction: Although emergency medical services (EMS) standing-order protocols provide more efficient and accurate on-scene management by paramedics, online medical direction (OLMD) has not been eliminated from practice. In this modern era of OLMD, no studies exist to describe the prevalence of reasons for contacting OLMD.

Objectives: The primary goal of this study was to describe the quantity of and reasons for calls for medical direction. We also sought to determine time diverted from emergency physicians due to OLMD. Finally, we hoped to identify any areas for potential improvement or additional training opportunities for EMS providers.

Methods: This was a descriptive study with retrospective data analysis of recorded OLMD calls from January 1, 2016, to December 31, 2016. Data were extracted by research personnel listening to audio recordings and were entered into a database for descriptive analysis. We abstracted the date and length of call, patient demographic information (age and gender), category of call (trauma, medical, cardiac, or obstetrics), reason for call, and origin of call (prehospital, interhospital, nursing home, or discharge).

Results: The total number of recordings analyzed was 519. Calls were divided into four categories pertaining to their nature: 353 (68.5%) medical; 70 (13.6%) trauma; 83 (16.1%) cardiac; and 9 (8%) were obstetrics related. Repeat calls regarding the same patient encounter comprised 48 (9.4%) of the calls. Patient refusal of transport was the most common reason for a call medical direction (32.3% of calls). The total time for medical direction calls for the year was 26.6 hours. The maximum number of calls in a single day was seven, with a mean of 2.04 calls per day (standard deviation [SD] ± 1.18). The mean call length was 3.06 minutes (SD ± 2.51).

Conclusion: Our analysis shows that the use of OLMD frequently involves complex decision-making such as determination of the medical decision-making capacity of patients to refuse treatment and transport, and evaluation of the appropriate level of care for interfacility transfers. Further investigation into the effect of EMS physician-driven medical direction on both the quality and time required for OLMD could allow for better identification of areas of potential improvement and training. [West J Emerg Med. 2020;21(3)665-670.]

INTRODUCTION

Emergency medical services (EMS) systems often require online medical direction (OLMD) by trained physicians to supplement protocol-based management of patients in the field.[1,2] Over the past few decades the EMS system has evolved to employ standing-order protocols through offline medical direction, providing more efficient and accurate on-scene management by paramedics without the need for OLMD.[3] Protocol-based care has been shown to be at least equivalent to OLMD-based care in urban EMS systems.[4] On average a call to OLMD takes approximately four minutes of physician time per call and results in increased on-scene time and delay in arrival to

the hospital.[5,6]

OLMD is designed to provide EMS personnel with access to a physician to address more complicated clinical issues such as interfacility transfer authorization and guidance of care, ventilator and advanced medication management, patient refusals, and evaluation of a patient's medical decision-making capacity. These calls are often related to OLMD contact for refusal of medical aid due to provider concerns about a patient's medical decision-making capacity or in the case of high-risk diagnoses. Previous studies have demonstrated a benefit to physician involvement.[7-9]

A few studies have explored the efficacy of using an OLMD vs protocol-based hospital care. Erder et al determined that paramedic discretion to correctly triage OLMD use would result in shorter on-scene times for most patients. In one study, 86% of patient-care interventions were provided based on standing orders with an overall paramedic error rate of 0.6%.

The primary goal of this study was to determine the most common causes for contact of medical control. Additionally, we aimed to determine the time diverted from emergency physicians due to OLMD. In reviewing these data we hoped to identify possible areas for improvement and additional training opportunities for EMS respondents. We hypothesized that given the success of standing-orders protocols, the remaining needs for medical control would be more complex and require longer online times.

Population Health Research Capsule

What do we already know about this issue?
Prior studies have shown improved scene times and equal quality with reduction of online medical direction (OLMD) in favor of standing order protocols. Refusal of care is a common reason for an OLMD call.

What was the research question?
In a large diverse multi-department medical direction system, what are the reasons for calls to OLMD?

What was the major finding of the study?
The most common reason for calls to OLMD was refusal of medical aid. OLMD was able to effect a change in the patient's decision in 10% of the cases they spoke to.

How does this improve population health?
This study helps to build knowledge about the use of OLMD by EMS services, so system designers can plan appropriate staffing and infrastructure.

METHODS

State regulations require that all OLMD be performed by licensed, credentialed physicians and be recorded. In our system, EMS providers can contact OLMD through one of two means. Providers may contact the destination emergency department via a central two-way radio-based system referred to as central medical emergency direction (CMED) or providers affiliated with our medical center may contact an EMS physician via a dedicated voice over Internet protocol (VOIP) toll-free telephone number when seeking medical control. Calls through the VOIP system are routed to the EMS physician on call using an Internet-based call forwarding software (RingCentral, Belmont, CA). All recordings are stored on a secure, password-protected server.

Institutional review board approval was obtained to review 12 months of this existing VOIP call data. Researchers reviewed all recorded calls within the study period of January 1, 2016, to December 31, 2016. Data were extracted by research personnel listening to audio recordings and were entered into a secure database for descriptive analysis. The research protocol called for exclusion of any call whose audio quality was insufficient for extraction. No other exclusion criteria were included in the protocol.[10,11]

Our group provides medical oversight for services, responding to over 120,000 calls per year. The OLMD system is covered 24 hours per day by either an EMS fellow with available faculty backup or by EMS faculty. OLMD is provided to a variety of different prehospital and interfacility services including private services providing both emergency response and interfacility transfer, helicopter emergency medical services (HEMS), and both hospital-owned-and-operated and fire-based services providing emergency response.

Many of the calls in this system are for OLMD for interfacility transport. Massachusetts Statewide Treatment Protocols state:

> "In cases where the patient's care during the transfer exceeds the standing-order scope of practice as defined by the current version of the Statewide Treatment Protocols for an EMT-Paramedic or the patient is unstable or is likely to become unstable as defined previously (see "Scope of Practice" above) will provide a concise, complete and accurate patient report to an On-Line Medical Control physician…"[12]

As a result, many calls are placed to OLMD for interfacility transfers. While EMS providers are permitted to obtain refusals of medical aid independently, they are required to call in cases of refusal in the context of established invasive care (ie, refusal following dextrose administration in hypoglycemia). Crews are also encouraged to call for cases where there is a concern for the medical decision-making capacity of the refusing party or in cases considered to be high risk for patient morbidity.

We collected and managed study data using REDCap electronic data capture tools hosted at the University of

Massachusetts Medical School.[13] We abstracted the date, time and length of call, patient demographic information (age and gender), category of call (trauma, medical, cardiac, or obstetrics), reason for call, and origin of call (prehospital, interhospital, nursing home, or discharge). Call categories were defined prior to review based on expected call categories and experience in provision of OLMD in this area. Consideration was given to the difference in nature of prehospital and interfacility calls of a general medical as opposed to cardiac nature, as well as the separation of these categories in the statewide treatment protocols. Because of this, cardiac calls, although arguably a subset of medical calls, were given their own category. The category of "reason for call" was meant to determine the specific support requested of the OLMD from the field providers. Level of care in this context refers to OLMD assistance in determining the appropriate level of the transporting EMS service; Basic Life Support, Advanced Life Support, or critical care.

Paramedic-level ambulances performing interfacility transfers are required to have transport ventilators and may continue established ventilator settings. These calls also require OLMD. Ventilator sedation referred to requests for orders to manage the sedation of patients being transported on the ventilator. Ventilator management requests involved the request for orders regarding settings for the ventilator. Termination of resuscitation calls were for the order to terminate resuscitative efforts for cardiac arrests in the field. This order from OLMD is required by state protocol when the termination protocol is employed. In contrast to this, confirmation of death/do no resuscitate (DNR) was a category applied to calls where OLMD was notified in cases where a valid DNR order was in place. This is not required by state protocol. The other category also lists several calls from the HEMS service to provide policy-based approval to perform missions by ground when the aircraft could otherwise be available (often due to local weather conditions). This is a policy of our specific service and was a source of enough calls to warrant breaking them out into a separate category. The categories of "reason for call" were determined a priori, but the subcategories of "other" were determined during the review process.

We also abstracted the time of day calls were placed and their durations. The database was created by the principal investigator. We conducted analyses using JMP Pro 13 (SAS Institute Inc., Cary, NC).

RESULTS

Based on estimates of annual volume of the EMS services included in our analysis, OLMD was sought in less than one percent of responses. The total number of recordings available in the study period was 519. No calls were excluded. Calls were received from 17 distinct services. Private services placed the most calls at 60%; HEMS 18%, hospital-based 13%; and fire-based 9%. The four services calling the most frequently composed 84.4% of the calls.

The distribution of age and gender of the patients is shown in Table 1. Calls were divided into four categories pertaining to their nature: 353 (68.5%) medical; 70 (13.6%) trauma; 83 (16.1%) cardiac; and 9 (8%) obstetrics. Repeat calls regarding the same patient encounter comprised 48 (9.4%) of the calls.

The reasons for the call for medical direction are displayed in Figure 1. Refusal of medical aid was the most common reason for calling OLMD with 167 (32.3%) of the 519 reviewed calls categorized in this manner. Of the 167 calls, the OLMD physician spoke directly to the patient in 48 (30%) of cases and effected a change in the patient's decision to refuse in 5 (10.5%) cases. Some of these calls involved OLMD assessment of the patient's medical decision-making capacity, though a quantitative analysis of this is not reported here. Reasons listed in the "other" category included administrative approval for the HEMS crew to perform ground critical care transportation, confirmation of death/DNR, and a change of destination as well as other, less frequent, reasons.

The total time for medical direction calls for the year was 26.6 hours. The maximum number of calls in a single day was seven, with a mean of 2.04 calls per day (standard deviation [SD] ± 1.18) (Figure 2). As may be seen from the box plot in Figure 2, the mean and median numbers of calls per day were very similar. The mean call length was 3.06 minutes (SD ± 2.51) (Figure 3). Calls to OLMD were placed between 1 AM -8 AM in 20.7% (107) of cases, between 8:01 AM-4 PM in 37.6% (194) of cases and between 4:01 PM-12 AM in the remaining 41.7% (215) of cases.

DISCUSSION

This descriptive analysis of one year of medical direction calls identifies that a significant need for OLMD continues in our age of protocolized standing orders. Past research has shown that standing orders as opposed to OLMD can speed care without weakening quality.[11] Our analysis shows that the use of OLMD frequently involves complex decision-making such as evaluation of the medical decision-making capacity of patients to refuse against medical advice, and evaluation of the appropriate level of care for interfacility transfers.

Our analysis further demonstrates the amount of time these calls to medical direction utilize. Our mean and median times are marginally shorter than previously reported data.[5]

Table 1. Patient characteristics in study to determine the most common reasons prehospital providers call for medical direction.

Variables	Frequency (n = 516)	Mean (SD)
Age in years		55.3 (24.9)
Gender		Proportion
Male	229	46.5%
Female	248	50.3%
Unknown	16	3.2%

SD, standard deviation.

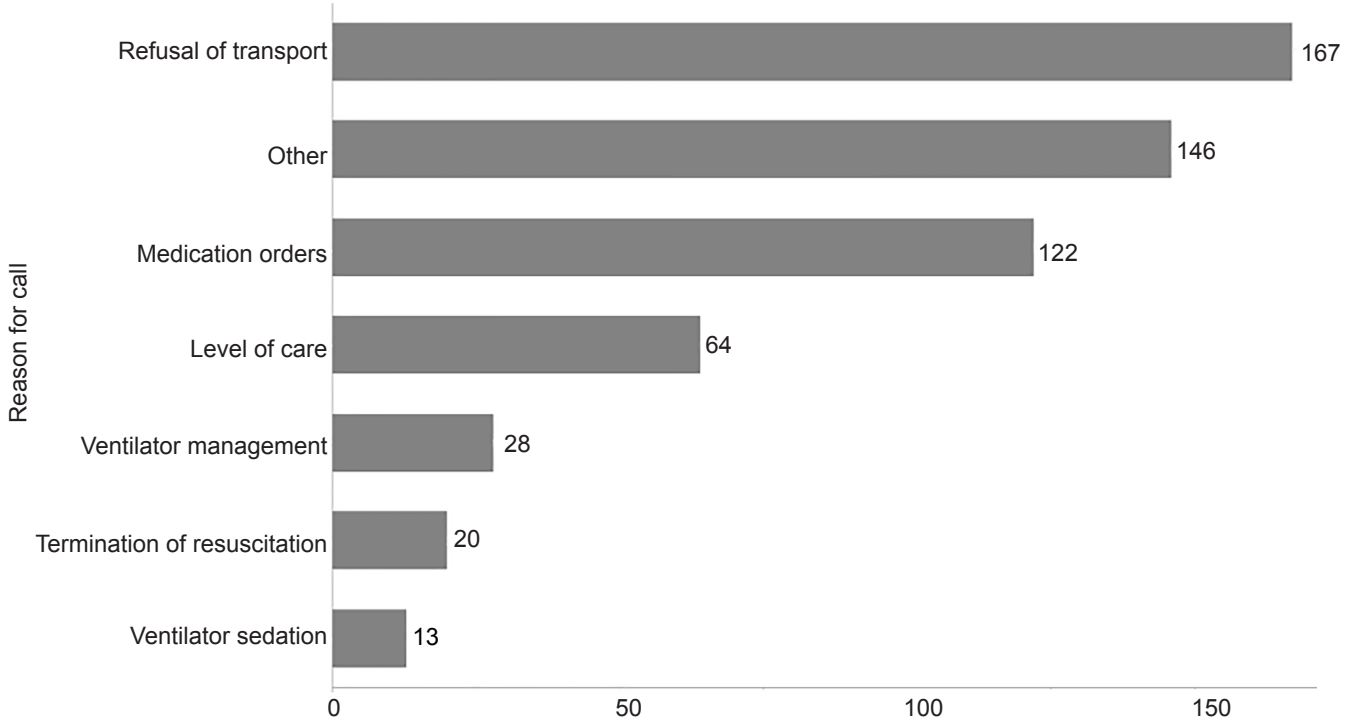


Figure 1. Reasons for calls for medical direction.

EMS physician-based medical control provides an opportunity for a significant time savings to emergency physicians who would otherwise be required to provide this service – in the case of our data, a total of 1594 minutes over the course of a year. Additionally, the shorter average time for call completion compared to previously reported data suggests that routing calls to EMS-specialist physicians might provide an increase in overall efficiency in the medical direction process.

The most common reason for the call to OLMD was a patient refusal of medical aid. Prior published data indicates that speaking to an OLMD physician can improve the rate of transport of these against-medical-advice patients.[8,9] Some of these calls involved assessment of the patient's medical decision-making capacity. There is a paucity of existing research on the ability of prehospital providers to perform this assessment.[9,14,15] A further evaluation of OLMD to determine the extent to which these calls involve capacity assessment may aid in future research as well as prehospital curriculum development.

In addition to prehospital decision-making, a large portion of calls pertained to interfacility transfers. Determination of appropriate level of care for interhospital transfers was 12.4% of calls, often complicated decisions requiring knowledge of system capabilities, prehospital protocols, and scope of practice beyond the knowledge base of the average emergency physician. Further, 7.9% of calls concerned ventilator management or sedation of patients prior to or during transfer. These calls often involve multiple aspects of out-of-hospital care, which can represent a significant burden for the emergency physician, especially as they may not be receiving this patient.

Previous studies have addressed the role of OLMD from the standpoint of prehospital providers, but no studies were identified examining the effect on the emergency physician of providing OLMD. The implementation of an EMS physician medical direction system may allow the diversion of some high-risk and high-complexity medical direction calls such as refusal of medical aid and other calls involving complex medical decision-making from EDs. This has the potential to decrease distractions and interruptions to EPs during clinical shifts.

LIMITATIONS

Limitations of the study most prominently include a potential analytical bias due to subjective categorization of medical record calls based on the interpretations of one researcher. Furthermore, this study was conducted at a single, academic medical center with an academic EMS physician group, resources that are not available at many institutions.

CONCLUSION

Most calls for OLMD involve complex decision-making such as refusal of medical aid and level of care determination for interfacility transfers. The implementation of an EMS-physician based OLMD model provided for the opportunity to decrease the time diverted from emergency physicians in order to provide OLMD to out-of-hospital providers as well as reducing the overall time required to provide OLMD. Further investigation into the effect of EMS physician-driven OLMD on both the quality and time required for OLMD could allow for better identification of areas of potential improvement and training.

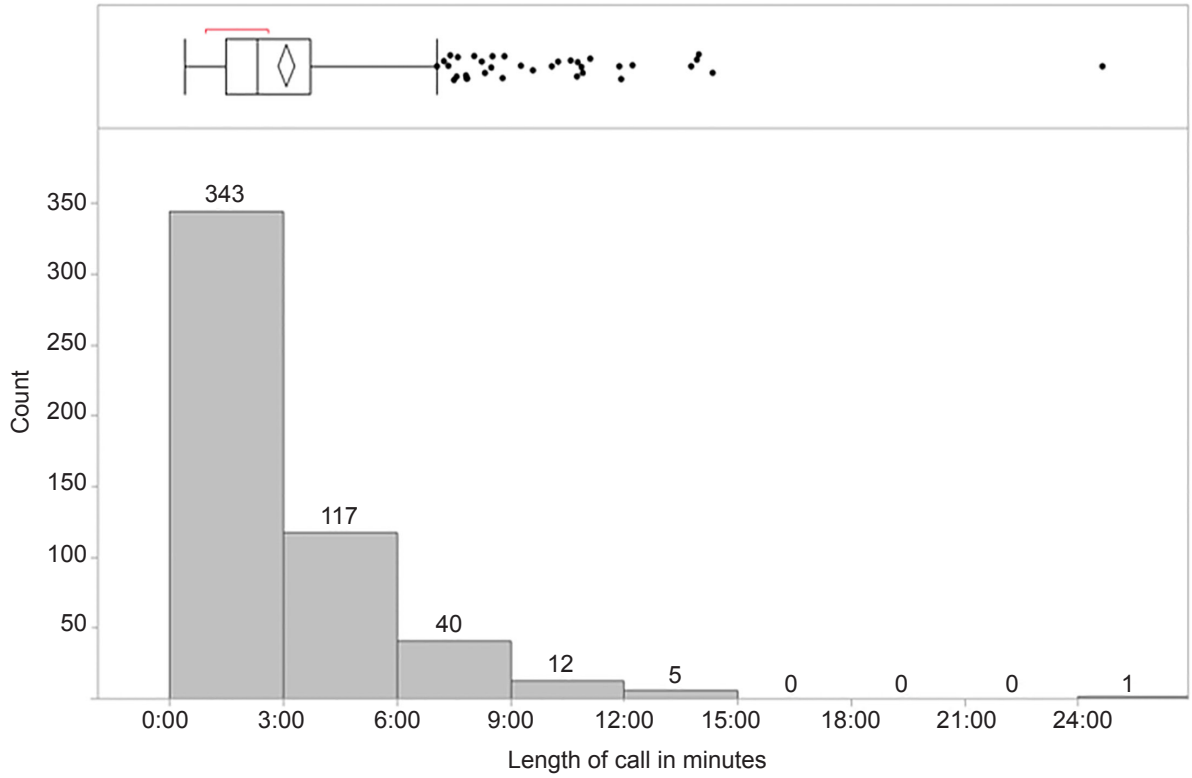


Figure 2. Distribution of call duration in minutes when prehospital providers call for medical direction.
Figure is displayed as histogram of call duration with accompanying box plot (above) of median and interquartile ranges of the distribution, with dots representing outliers and diamond denoting the mean value.

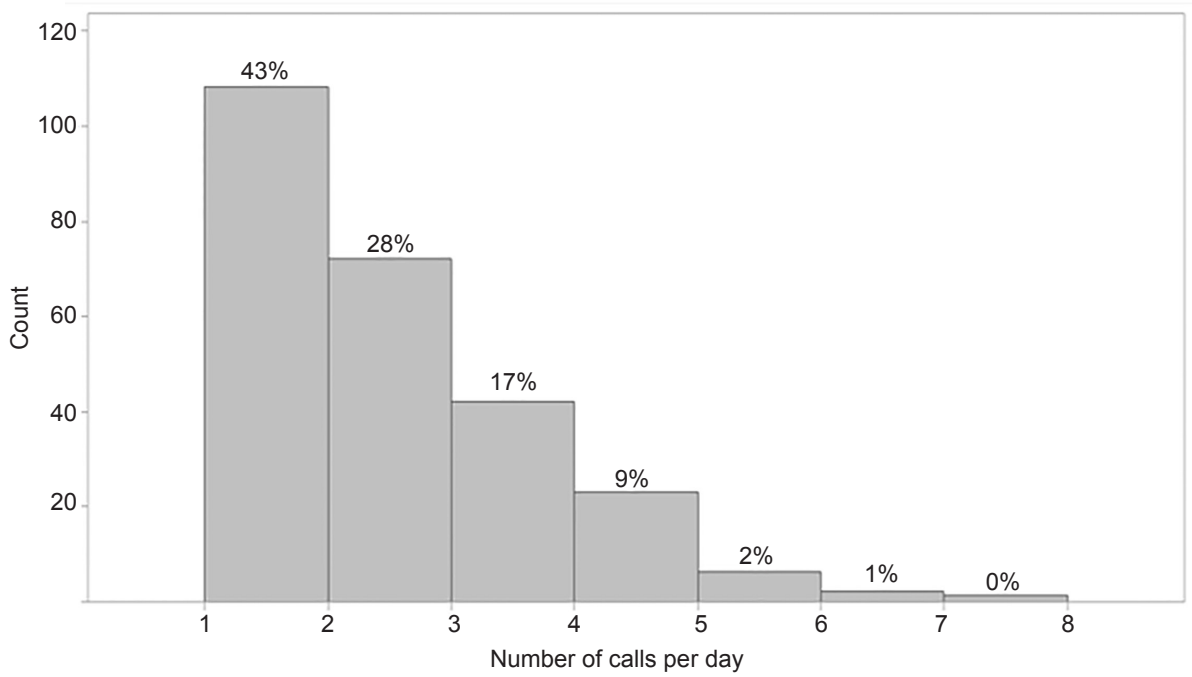


Figure 3. Distribution of number of calls per day placed by prehospital providers to base physician.
Figure is displayed as a histogram of the number of calls to the medical direction service per day over the reviewed 12 months.

Address for Correspondence: Joseph Tennyson, MD, University of Massachusetts, Department of Emergency Medicine, 55 Lake Ave North, Worcester, MA 01655. Email: joseph.tennyson@umassmemorial.org.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Alonso-Serra H, Blanton D, and O'Connor RE. Physician medical direction in EMS. *Prehosp Emerg Care*. 1998;2(2):153-7.
2. Clawson JJ. Emergency medical dispatching. *Prehospital Disaster Med*. 1989;4(2):163-6.
3. McSwain NE. Medical control: What is it? *J Am Coll Emerg Physicians*. 1978;7(3):114-6.
4. Rottman SJ, Schriger DL, Charlop G, et al. On-line medical control versus protocol-based prehospital care. *Ann Emerg Med.* 1997;30(1):62-8.
5. Wuerz RC, Swope GE, Holliman CJ, et al. On-line medical direction: a prospective study. *Prehospital Disaster Med.* 1995;10(3):174-7.
6. Erder MH, Davidson SJ, and Cheney RA. On-line medical command in theory and practice. *Ann Emerg Med*. 1989;18(3):261-8.
7. Cone DC, Kim DT, and Davidson SJ. Patient-Initiated refusals of prehospital care: ambulance call report documentation, patient outcome, and on-line medical command. *Prehospital Disaster Med*. 1995;10(1):3-9.
8. Hoyt BT and Norton RL. Online medical control and initial refusal of care: Does it help to talk with the patient? *Acad Emerg Med*. 2001;8(7):725-30.
9. Burstein JL, Hollander JE, Delagi R, et al. Refusal of out-of-hospital medical care: effect of medical-control physician assertiveness on transport rate. *Acad Emerg Med*. 1998;5(1):4-8.
10. Holliman CJ, Wuerz RC, Miguel GV, et al. Comparison of interventions in prehospital care by standing orders versus interventions rrdered by direct [on-line] medical command. *Prehospital Disaster Med.* 1994;9(4):202-9.
11. Holliman CJ, Wuerz RC, and Meador SA. Decrease in medical command errors with use of a "standing orders" protocol system. *Am J Emerg Med*. 1994;12(3):279-83.
12. Emergency Medical Services Statewide Treatment Protocols. Available at: https://www.mass.gov/lists/emergency-medical-services-statewide-treatment-protocols. Accessed December 4, 2019.
13. Harris PA, Taylor R, Thielke R, et al. Research electronic data capture (REDCap)—A metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. 2009;42(2):377-81.
14. Riley J, Burgess R, and Schwartz B. Evaluating the impact of an educational intervention on documentation of decision-making capacity in an emergency medical services system. *Acad Emerg Med.* 2004;11(7):790-3.
15. Stuhlmiller DEE, Cudnik MT, Sundheim SM, et al. Adequacy of online medical command communication and emergency medical services documentation of informed refusals. *Acad Emerg Med.* 2005;12(10):970-7.

Variations in the California Emergency Medical Services Response to Opioid Use Disorder

Nancy K. Glober, MD* *Indiana University, Department of Emergency Medicine, Indianapolis, Indiana
Gene Hern, MD, MS† †Alameda Health System-Highland Hospital, Department of Emergency Medicine, Oakland, California
Owen McBride, MD†
Mary P. Mercer, MD, MPH‡ ‡University of California, San Francisco, Department of Emergency Medicine, San Francisco, California

Section Editor: Erik Anderson, MD
Submission history: Submitted September 12, 2019; Revision received November 19, 2019; Accepted December 8, 2019
Electronically published April 16, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2019.12.45189

Introduction: Opioids contributed to over 300,000 deaths in the United States in the past 10 years. Most research on drug use occurs in clinics or hospitals; few studies have evaluated the impact of opioid use on emergency medical services (EMS) or the EMS response to opioid use disorder (OUD). This study describes the perceived burden of disease, data collection, and interventions in California local EMS agencies (LEMSA).

Methods: We surveyed medical directors of all 33 California LEMSAs with 25 multiple-choice and free-answer questions. Results were collected in RedCap and downloaded into Excel (Microsoft Corporation, Redmond WA). This study was exempt from review by the Alameda Health System - Highland Hospital Institutional Review Board.

Results: Of the 33 California LEMSAs, 100% responded, all indicating that OUD significantly affects their patients. Most (91%) had specific protocols directing care of those patients and repeat naloxone dosing. After naloxone administration, none permitted release to law enforcement custody, 6% permitted patient refusal of care, and 45% directed base hospital contact for refusal of care. Few protocols directed screening or treatment of OUD or withdrawal symptoms. Regular data collection occurred in 76% of LEMSAs, with only 48% linking EMS data with hospital or coroner outcomes. In only 30% did the medical director oversee regular quality improvement meetings. Of respondents, 64% were aware of public health agency-based outreach programs and 42% were aware of emergency department BRIDGE programs (Medication Assisted Treatment and immediate referral). Only 9% oversaw naloxone kit distribution (all under the medical director), and 6% had EMS-based outreach programs. In almost all (94%), law enforcement officers carried naloxone and administered it anywhere from a few times a year to greater than 200 in one LEMSA.

Conclusion: This study represents an important description of EMS medical directors' approaches to the impact of OUD as well as trends in protocols and interventions to treat and prevent overdoses. Through this study, we can better understand the variable response to patients with OUD across California. [West J Emerg Med. 2020;21(3)671-676.]

INTRODUCTION

Drug overdoses have led to more than half a million deaths in the United States in the last 10 years, two-thirds of which were opioid-related.[1] Opioid-related deaths increased fivefold from 1999 to 2016,[2] and became the leading cause of accidental death in the US in 2015.[3] While heroin and other illicit opioids contributed to the epidemic, prescription opioids constituted the bulk of the drugs leading to overdose.[4-6] Although poorly characterized, the impact to the emergency medical services (EMS) system is significant. Naloxone administration was

documented in nearly half a million EMS runs nationally from 2014 to 2016, as presented by the National EMS Information System (NEMSIS).[7]

In response, institutions and governments rolled out programs to curb the epidemic at every level of healthcare delivery. Broadly, the Centers for Disease Control and Prevention (CDC) recommended a five-pronged response: perform surveillance and research; empower consumers to make safe choices; build state, local, and tribal capacity; partner with public safety; and support providers, health systems, and payers.[8] Specifically, the CDC recommended that states emphasize surveillance, policies, and funding to reduce prescription size and number, increase access to medication assisted therapy (MAT), and expand first responder access to naloxone.[8] As a result, local, regional, and national governments implemented laws to reduce supply, monitor use, and enhance response to overdoses.[9]

Across the country, legal immunity has been granted to clinicians prescribing naloxone to third parties and bystanders aiding overdose patients in possession of illicit drugs.[10,11] Naloxone is now widely available at pharmacies through physician standing orders.[10,11] Community groups designed kits with naloxone and educational programs to teach laypersons how to correctly identify and treat opioid overdose.[12-14] Many EMS medical directors expanded the scope of practice for naloxone administration to include law enforcement personnel and other non-paramedic first responders.[15-18]

Most research and data collection has focused on patients who use opioids in hospital and clinic settings. Little research explores the burden of disease and scope of response in the prehospital setting. In the state of California, oversight of EMS and coordination of care are accomplished through medical directors in 33 local emergency medical system agencies (LEMSA). According to the US Census Bureau, LEMSAs provide care to a population greater than 39 million that is spread across an area of nearly 156 thousand square miles, diverse in urbanicity and demographics. Each LEMSA regulates prehospital care with independent protocols that can vary widely from one region to the next. In this paper, we surveyed medical directors in all 33 LEMSAs within California to describe local approaches to opioid use disorder (OUD), access to data on patients who overdose from opioids, and community harm-reduction programs to prevent opioid overdoses.

Population Health Research Capsule

What do we already know about this issue?
The Centers for Disease Control declared opioid overdoses to be a national health crisis.

What was the research question?
We surveyed the medical directors of all 33 California Local Emergency Medical Services (EMS) Agencies to define perception and response to opioid use disorder.

What was the major finding of the study?
While all Local EMS Agencies perceived the burden of opioid use disorder to be significant, few had built EMS-based outreach programs in response.

How does this improve population health?
We provide EMS agencies with information about variation in perception and response to opioid use disorder.

METHODS

In March 2019, we sent a survey via electronic mail to the medical directors of the 33 LEMSAs in California. One survey was to be completed for each LEMSA by either the medical director for that LEMSA or a representative. After six weeks, we sent reminder emails to medical directors who had not completed the survey. Incomplete or conflicting data was resolved with a follow-up phone call or electronic mail to the medical director.

We developed the survey by committee consensus. The survey highlighted three main outcomes: local perception of burden of OUD and protocols to respond to opioid overdoses; access to data on patients who overdosed from opioids; and community harm-reduction programs to prevent further opioid overdoses. Within those three areas, we asked 25 questions, in a combination of multiple-choice and free-answer formats (Appendix A). Results were collected in RedCap and downloaded into Excel (Microsoft Corporation, Redmond WA) for data analysis. We present a descriptive analysis of the results.

RESULTS

Local Perception And Protocols

All 33 LEMSAs responded to the survey and all indicated that OUD significantly affects patients in their areas. Most (91%) had specific protocols directing care of those patients as well as directing repeat dosing of naloxone. When they existed, those protocols specified a range from one re-dose to unlimited, titrating to effect. Few LEMSAs had policies for patient refusal of care after naloxone administration, but nearly half had policies directing base hospital physician contact when a patient refused transport after naloxone administration. No LEMSA had a protocol to release a patient to law enforcement custody after naloxone administration, screen patients for withdrawal symptoms, or distribute naloxone to patients in the field. However, after base hospital physician contact was made, some LEMSAs (36%) permitted patients to be released to law enforcement custody after naloxone administration, and a few LEMSAs (9%) permitted treatment of patients with opioid withdrawal syndrome (Table 1 and Figure 1).

Table 1. Percentage (number) of local emergency medical services agencies (LEMSA) with protocols to understand and regulate a response to patients with opioid use disorder.

Survey question	Affirmative response
Does your LEMSA have a specific protocol directing care for patients with suspected opioid overdose?	91% (30)
Does your LEMSA have a protocol for repeated dosing of naloxone?	91% (30)
Does your LEMSA have a specific protocol for patient refusal and release from care following administration of naloxone or suspected overdose?	6% (2)
Does your refusal policy require base hospital physician contact for refusals following naloxone administration?	45% (15)
Does your LEMSA have a specific protocol for treating a patient with naloxone and releasing the patient to law enforcement custody?	0% (0)
Does your LEMSA have a specific protocol for screening patients for opioid use disorder?	3% (1)
Does your LEMSA have a specific protocol for distributing a naloxone kit to patients?	0% (0)
Does your LEMSA have a specific protocol for screening patients for opioid withdrawal syndrome?	0% (0)
Does your LEMSA have a specific protocol for treating patients with opioid withdrawal syndrome?	3% (1)

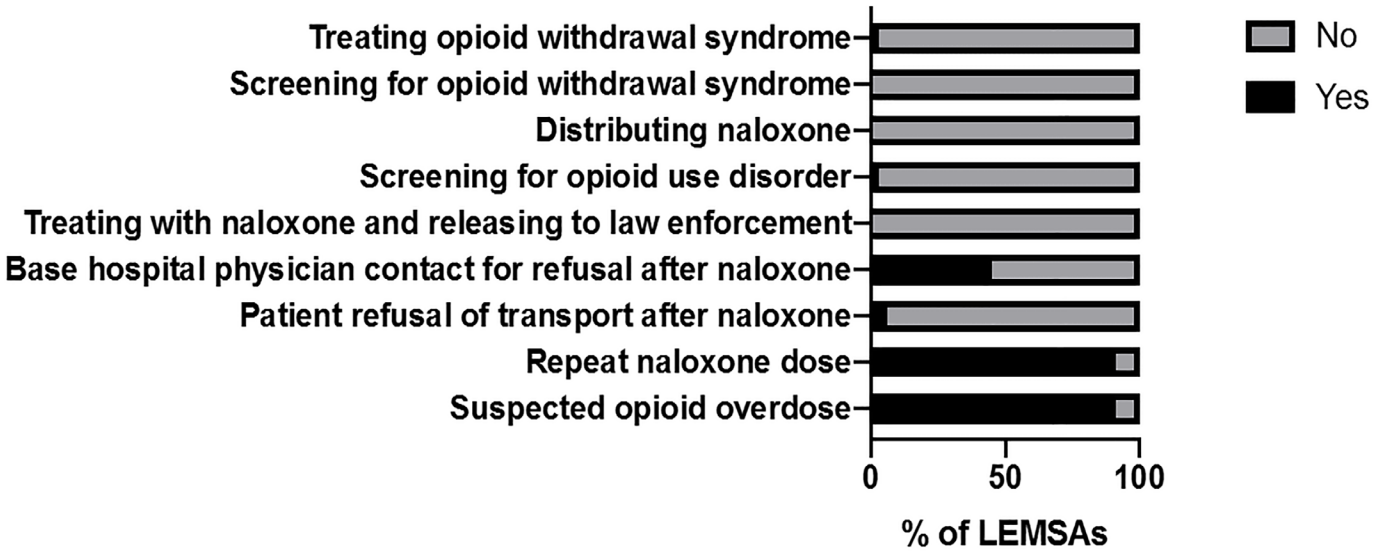


Figure 1. Percentage of emergency medical services agencies (LEMSA) that did or did not have protocols to understand and regulate a response to patients with opioid use disorder.

Access to Data on Patients Who Overdose from Opioids

Of all LEMSAs, 76% collected data on opioid overdoses, but only 48% linked data with hospital and coroner outcomes. In only 30% did the medical director regularly oversee quality improvement (QI) meetings to review the data. The QI meetings varied from review of law enforcement naloxone administration to review of cases in which naloxone was administered, to review of presumed opioid overdoses by an epidemiologist. Of those with a regular QI process, 38% examined the geographic distribution of naloxone administration within their LEMSA.

Community Programs to Prevent Opioid Overdoses

More than half of respondents were aware of public health agency-based outreach programs for harm reduction or emergency department (ED) BRIDGE programs – ED-based buprenorphine prescribing with rapid access to outpatient follow-up. When they existed, those programs varied widely and included law enforcement distribution of naloxone, public health outreach, multidisciplinary committees, ED referral to outpatient BRIDGE programs, and sheriff department distribution of naloxone to recently released inmates. In one LEMSA, the respondent replied that there was no such program, and in the rest (33%), the respondents indicated uncertainty as to whether such a program existed. Few LEMSAs oversaw naloxone kit distribution or had EMS-based outreach programs. In almost all (94%), law enforcement officers carried naloxone.

Most started within the past two years, and one started four years ago. Use of law enforcement naloxone varied from a few uses a year to greater than 200 in one LEMSA (Table 2 and Figure 2).

DISCUSSION

This study highlighted the variable EMS response to OUD across California. Prehospital administration of naloxone for patients with suspected opioid overdose has proven safe and effective for 30 years,[19] and is now standard practice in the US.[20] Our results suggest that California medical directors are uniformly aware of the impact of the opioid epidemic. Accordingly, LEMSAs widely adopted protocols for naloxone administration, re-dosing, and use by law enforcement, consistent with the national standard of practice.

Few LEMSAs implemented specific protocols allowing patients to refuse transport after naloxone. While emerging data from the prehospital setting indicates patients who sign out against medical advice following naloxone reversal have low mortality as a result of rebound toxicity,[21-24] these studies were mostly limited to heroin and morphine overdose Little to no data exists on high-potency opioids (fentanyl and its analogs) or long-acting opioids. Current literature suggests an observation period of at least one hour following reversal of opioid overdose with naloxone in the ED.[25,26] Given the rise in overdose deaths from high-potency opioids,[27,28] some groups have recommended longer observation periods, up to six hours.[29]

The question of how to safely and ethically care for these patients is a complex one. Medically, further studies are needed to continue to evaluate the safety of patient release after naloxone administration in the setting of increasing use of high-potency synthetic opioids. Ethically, we must balance the medical prerogative of autonomy with that of non-malfeasance. We must allow those patients to determine their own medical care, while simultaneously evaluating whether or not administration of naloxone and subsequent release is consistent with the medical principle "first, do no harm." Furthermore, non-transport of patients after naloxone administration could

Table 2. Percentage (number) of emergency medical services agencies (LEMSA) with programs to prevent opioid overdoses.

Survey question	Affirmative response
Are there any public health agency-based outreach or harm reduction programs for patients with opioid use disorder within the county(ies) served by your LEMSA?	64% (21)
Does your LEMSA oversee a naloxone kit distribution program?	9% (3)
Do law enforcement officers carry naloxone within the counties served by your LEMSA?	94% (31)
Are you aware of any emergency department BRIDGE programs within the counties served by your LEMSA? (Patients treated and discharged with buprenorphine-naloxone and referral)	42% (14)
Within your LEMSA, do you have any EMS-based outreach programs? (eg, paramedics distributing information to at-risk patients and family members, prehospital distribution of buprenorphine-naloxone, referrals by prehospital providers to treatment programs)	9% (3)

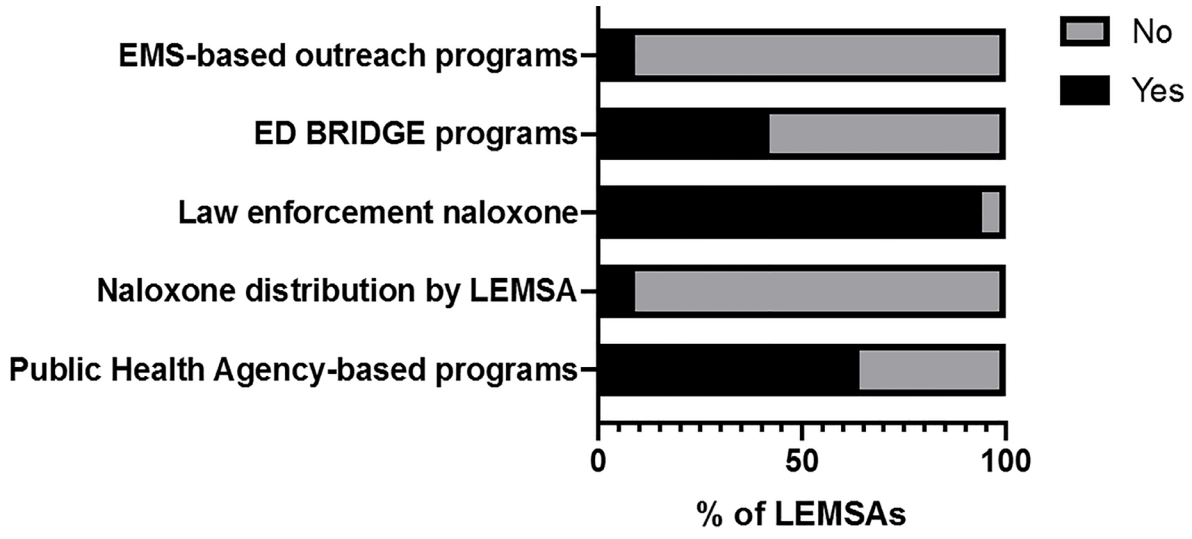


Figure 2. Percentage of emergency medical services agencies (LEMSA) that did or did not have programs to prevent opioid overdoses.

represent a lost opportunity to provide therapy and counseling in the ED.

Available data suggests that efforts aimed at increasing community access to naloxone decrease mortality from opioid overdose.[30-34] In their guidelines on community management of opioid overdose, the World Health Organization issued a strong recommendation to distribute naloxone to individuals likely to witness an opioid overdose.[35] Across the country, naloxone distribution programs are expanding in number and scope.[36] EMS providers frequently encounter individuals at high risk for repeat overdose and individuals who are likely to witness an overdose.[20,37] Despite this, only 9% of California LEMSAs oversee a naloxone distribution program. Further, only 64% were aware of public health outreach or harm reduction programs within their jurisdictions, and less than half of the LEMSA medical directors surveyed were aware of BRIDGE programs to connect patients with MAT centers. This demonstrates the disconnect between awareness and action and shows a potential growth area for LEMSAs to more fully address the public health burden. The development of EMS "leave behind" naloxone programs is an emerging strategy[38-40] for stakeholders seeking to exploit this previously missed opportunity to intervene at the site of an overdose.

LIMITATIONS

This study is limited in scope to examining EMS system protocols in only one state, California. Therefore, its findings may not be generalizable to trends or experiences in addressing opioid-related issues in other geographic settings. Additionally, as a survey based-study, the findings are limited to exploring approaches of EMS medical directors and protocols rather than examining outcome data for opioid-related EMS calls between LEMSAs. This study does not attempt to compare prehospital practices or outcomes with those described in hospital and clinic settings.

CONCLUSION

Significant variation exists throughout the state in prehospital response to patients with opioid use disorder. The responses indicate an awareness of some harm-reduction principles for acute overdose (such as law enforcement naloxone), but little initiation of EMS-led programs such as naloxone distribution to the community sites or linkage with MAT programs. We hope that this study will prove useful to medical directors in California and throughout the US as they continue their efforts to respond appropriately and effectively to opioid use disorder.

ACKNOWLEDGMENTS

The authors would like to express our appreciation to the EMS medical directors of California (EMDAC), EMS administrators and staff at California LEMSAs, and the California EMS Authority for supporting and participating in this survey to improve understanding of regional differences in the burden of opioid overdoses and regional variations.

Address for Correspondence: Nancy K. Glober, MD, Indiana University, Department of Emergency Medicine, 720 Eskenazi Ave, Indianapolis, Indiana, 46202. Email: nglober@iu.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Opioid overdose: understanding the epidemic. 2017. Available at: https://www.cdc.gov/drugoverdose/epidemic/?utm_source=EWSE+July+2017+Newsletter&utm_campaign=EWSE+Jul+2017&utm_medium=email. Accessed June 29, 2018.
2. Drug overdose death data. 2017. Available at: https://www.cdc.gov/drugoverdose/data/statedeaths.html. Accessed June 29, 2018.
3. Opioid addiction 2016 facts and figures. 2017. Available at: https://www.asam.org/docs/default-source/advocacy/opioid-addiction-disease-facts-figures.pdf. Accessed June 29, 2018.
4. Paulozzi LJ, Weisler RH, Patkar AA. A national epidemic of unintentional prescription opioid overdose deaths: how physicians can help control it. *J Clin Psychiatry.* 2011;72(5):589-92.
5. Doyon S, Aks SE, Schaeffer S, et al. Expanding access to naloxone in the United States. *Clin Toxicol (Phila).* 2014;52(10):989-92.
6. Jones CM, Mack KA, Paulozzi LJ. Pharmaceutical overdose deaths, United States, 2010. *JAMA.* 2013;309(7):657-9.
7. NK Glober KN, and Prasanthi Govindarajan. Population-based estimates of ambulance utilization and treatment patterns for opioid-related overdose in a national sample. *Prehosp Emerg Care.* 2018:21(10):97-152.
8. Centers for Disease Control and Prevention. Opioid overdose: Information for providers. Available at: https://www.cdc.gov/drugoverdose/providers/index.html. Accessed September 11, 2018.
9. Beheshti A, Lucas L, Dunz T, et al. An evaluation of naloxone use for opioid overdoses in West Virginia: a literature review. *Am Med J.* 2015;6(1):9-13.
10. Gupta R, Shah ND, Ross JS. The rising price of naloxone: risks to efforts to stem overdose deaths. *N Engl J Med.* 2016;375(23):2213-5.
11. Reynolds V, Causey H, McKee J, et al. The role of pharmacists in the opioid epidemic: an examination of pharmacist-focused initiatives across the United States and North Carolina. *N C Med J.* 2017;78(3):202-5.
12. Behar E, Santos GM, Wheeler E, et al. Brief overdose education is sufficient for naloxone distribution to opioid users. *Drug Alcohol*

Depend. 2015;148:209-12.
13. Winstanley EL, Clark A, Judith Feinberg, et al. Barriers to implementation of opioid overdose prevention programs in Ohio. *Subst Abus.* 2015;37(1):42-6.
14. Clark AK, Wilder CM, Winstanley EL. A systematic review of community opioid overdose prevention and naloxone distribution programs. *J Addict Med.* 2014;8(3):153-63.
15. Fisher R, O'Donnell D, Ray B, et al. Police officers can safely and effectively administer intranasal naloxone. *Prehosp Emerg Care.* 2016;20(6):675-80.
16. Rando J, Broering D, Olson JE, Marco C, Evans SB. Intranasal naloxone administration by police first responders is associated with decreased opioid overdose deaths. *Am J Emerg Med.* 2015;33(9):1201-4.
17. Davis CS, Ruiz S, Glynn P, et al. Expanded access to naloxone among firefighters, police officers, and emergency medical technicians in Massachusetts. *Am J Public Health.* 2014;104(8):e7-9.
18. Weiner SG, Mitchell PM, Temin ES, et al. Use of intranasal naloxone by Basic Life Support providers. *Prehosp Emerg Care* 2017;21(3):322-6.
19. Yealy DM, Paris PM, Kaplan RM, et al. The safety of prehospital naloxone administration by paramedics. *Ann Emerg Med.* 1990;19(8):902-5.
20. Olfson M, Wall M, Wang S, et al. Risks of fatal opioid overdose during the first year following nonfatal overdose. *Drug Alcohol Depend.* 2018;190:112-9.
21. Greene JA, Deveau BJ, Dol JS, et al. Incidence of mortality due to rebound toxicity after 'treat and release' practices in prehospital opioid overdose care: a systematic review. *Emerg Med J.* 2019;36(4):219-24.
22. Kolinsky D, Keim SM, Cohn BG, et al. Is a prehospital treat and release protocol for opioid overdose safe? *J Emerg Med.* 2017;52(1):52-8.
23. Rudolph SS, Jehu G, Nielsen SL, et al. Prehospital treatment of opioid overdose in Copenhagen: Is it safe to discharge on-scene? *Resuscitation.* 2011;82(11):1414-8.
24. Wampler DA, Molina DK, McManus J, et al. No deaths associated with patient refusal of transport after naloxone-reversed opioid overdose. *Prehosp Emerg Care.* 2011;15(3):320-4.
25. Willman MW, Liss DB, Schwarz ES, et al. Do heroin overdose patients require observation after receiving naloxone? *Clin Toxicol (Phila).* 2017;55(2):81-7.
26. Clemency BM, Eggleston W, Shaw EW, et al. Hospital Observation Upon Reversal (HOUR) with naloxone: a prospective clinical prediction rule validation study. *Acad Emerg Med.* 2019;26(1):7-15.
27. Centers for DIsease Control and Prevention. Opioid overdose: synthetic opioid overdose data. Available at https://www.cdc.gov/drugoverdose/data/fentanyl.html. Accessed July 22, 2019.
28. O'Donnell JK, Gladden RM, Seth P. Trends in deaths involving heroin and synthetic opioids excluding methadone, and law enforcement drug product reports, by census region - United States, 2006-2015. *MMWR Morb Mortal Wkly Rep.* 2017;66(34):897-903.
29. Boyer EW. Management of opioid analgesic overdose. *N Engl J Med.* 2012;367(2):146-55.
30. Keane C, Egan JE, Hawk M. Effects of naloxone distribution to likely bystanders: Results of an agent-based model. *Int J Drug Policy.* 2018;55:61-9.
31. Walley AY, Xuan Z, Hackman HH, et al. Opioid overdose rates and implementation of overdose education and nasal naloxone distribution in Massachusetts: interrupted time series analysis. *BMJ.* 2013;346:f174.
32. McClellan C, Lambdin BH, Ali MM, et al. Opioid-overdose laws association with opioid use and overdose mortality. *Addict Behav.* 2018;86:90-5.
33. Rees D, Sabia, JJ, Argys, LM, et al. With a little help from my friends: the effects of naloxone access and good samaritan laws on opioid-related deaths. 2017. Available at: https://www.nber.org/papers/w23171. Accessed [June 29, 2018].
34. Abouk R, Pacula RL, Powell D. Association between state laws facilitating pharmacy distribution of naloxone and risk of fatal overdose. *JAMA Intern Med.* 2019;179(6):805-11.
35. Geneva: World Health Organization. Community management of opioid overdose. 2014. Available at https://www.ncbi.nlm.nih.gov/books/NBK264311/. Accessed July 22, 2019.
36. Wheeler E, Jones TS, Gilbert MK, et al. Opioid overdose prevention programs providing naloxone to laypersons - United States, 2014. *MMWR Morb Mortal Wkly Rep.* 2015;64(23):631-5.
37. Martins SS, Sampson L, Cerda M, et al. Worldwide prevalence and trends in unintentional drug overdose: a systematic review of the literature. *Am J Public Health.* 2015;105(11):e29-49.
38. NYC Fire Department. Fire Commissioner Nigro announces Leave Behind Naloxone Program. Available at https://www1.nyc.gov/site/fdny/news/fa7218/fire-commissi. Accessed July 22, 2019.
39. Pittsburgh EMS Implements program to leave naloxone with overdose patients. Available at: https://www.ems1.com/addiction/articles/pittsburgh-ems-leaving-naloxone-with-overdose-patients-who-refuse-treatment-c8ggpbbJkvKkJd5D/. Accessed July 22, 2019.
40. Arias J. Md. EMS to leave narcan with overdose patients. Available at https://www.emsworld.com/news/220553/md-ems-leave-narcan-overdose-patients. Accessed July 22, 2019.

Retrospective Study of Midazolam Protocol for Prehospital Behavioral Emergencies

Ryan M. Huebinger, MD*
Hashim Q. Zaidi, MD†‡
Katie L. Tataris, MD, MPH†‡
Joseph M. Weber, MD‡§
Kenneth S. Pearlman, MD‡¶
Eddie Markul, MD‡‖
Leslee Stein-Spencer, RN, MS‡#
Christopher T. Richards, MD, MS‡¶**††

*McGovern Medical School at The University of Texas Health Science Center at Houston (UT Health), Department of Emergency Medicine, Houston, Texas
†University of Chicago Pritzker School of Medicine, Section of Emergency Medicine, Chicago, Illinois
‡Chicago Emergency Medical Services System, Chicago, Illinois
§John H. Stroger, Jr., Hospital of Cook County, Department of Emergency Medicine, Chicago, Illinois
¶Northwestern University Feinberg School of Medicine, Department of Emergency Medicine, Chicago, Illinois
‖Advocate Illinois Masonic Medical Center, Department of Emergency Medicine, Chicago, Illinois
#Illinois Department of Public Health, Springfield, Illinois
**Northwestern Feinberg School of Medicine Center for Healthcare Studies, Institute for Public Health and Medicine, Chicago, Illinois
††University of Cincinnati School of Medicine, Division of EMS, Department of Emergency Medicine, Cincinnati, Ohio

Section Editor: Shira A. Schlesinger, MD
Submission history: Submitted October 14, 2019; Revision received January 6, 2020; Accepted March 8, 2020
Electronically published April 21, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.3.45552

Introduction: Agitated patients in the prehospital setting pose challenges for both patient care and emergency medical services (EMS) provider safety. Midazolam is frequently used to control agitation in the emergency department setting; however, limited data exist in the prehospital setting. We describe our experience treating patients with midazolam for behavioral emergencies in a large urban EMS system. We hypothesized that using midazolam for acute agitation leads to improved clinical conditions without causing significant clinical deterioration.

Methods: We performed a retrospective review of EMS patient care reports following implementation of a behavioral emergencies protocol in a large urban EMS system from February 2014–June 2016. For acute agitation, paramedics administered midazolam 1 milligram (mg) intravenous (IV), 5 mg intramuscular (IM), or 5 mg intranasal (IN). Results were analyzed using descriptive statistics, Levene's test for assessing variance among study groups, and t-test to evaluate effectiveness based on route.

Results: In total, midazolam was administered 294 times to 257 patients. Median age was 30 (interquartile range 24–42) years, and 66.5% were male. Doses administered were 1 mg (7.1%) and 5 mg (92.9%). Routes were IM (52.0%), IN (40.8%), and IV (7.1%). A second dose was administered to 37 patients. In the majority of administrations, midazolam improved the patient's condition (73.5%) with infrequent adverse events (3.4%). There was no significant difference between the effectiveness of IM and IN midazolam (71.0% vs 75.4%; p = 0.24).

Conclusion: A midazolam protocol for prehospital agitation was associated with reduced agitation and a low rate of adverse events. [West J Emerg Med. 2020;21(3)677–683.]

INTRODUCTION

Agitated patients pose challenges for both patient care and emergency medical services (EMS) provider safety, but there is no consensus regarding the optimal medication to manage prehospital agitation.[1] Behavioral emergencies are complex with numerous etiologies, including neurologic, traumatic, intoxication, acute psychiatric, infectious, and metabolic.[2] While EMS providers can use de-escalation techniques and physical restraints, pharmacologic intervention may be required when non-pharmacologic methods fail to effectively control agitation.[3,4]

Previous studies in the emergency department (ED) setting demonstrate that benzodiazepines and antipsychotics can be effective agents todecrease patient's level of agitation.[5–7] When given alone, benzodiazepines have a well-established safety profile, a rapid onset of action, and are effective in treating agitation.[8,9] Specifically, midazolam provides a quicker onset when compared to lorazepam and haloperidol while maintaining equivalent sedative potency.[6,10,11] Additionally, midazolam can be administered via the intranasal (IN) route as well as the intravenous (IV) and intramuscular (IM) routes.[12] The IN route offers a needle-less option for EMS providers, thus decreasing the risk of blood-borne pathogen exposure.[13,14] While IN midazolam has been proven to be safe and effective when administered to control seizures and for procedural sedation, there is limited research regarding its use for prehospital behavioral emergencies.[15,16] Prior studies have described the IM and IV routes for chemical sedation, but IN administration remains under-studied.[4,7]

In this study, we report the rate of clinical improvement, need for repeat dosing, and rate of adverse events for a prehospital behavioral emergencies protocol using midazolam. Secondarily, we compare the effectiveness and safety of IN midazolam to IM midazolam for treating behavioral emergencies.

Population Health Research Capsule

What do we already know about this issue?
While prehospital agitation poses a significant challenge to emergency medical services providers, medications can help improve safety of care and transport.

What was the research question?
Is a prehospital protocol using midazolam for agitation safe and effective?

What was the major finding of the study?
Use of this protocol was associated with decreased agitation and had a low rate of complications.

How does this improve population health?
Most of the agitated patients in our study were from racial minorities. Identifying the optimal treatment for agitation is important for this at-risk population.

METHODS

Study Design, Population, and Setting

We performed a retrospective chart review of patients who were administered midazolam by EMS for behavioral emergencies from February 2014 through June 2016. We conducted this study in the Chicago EMS System, which serves an estimated 2.7 million residents and covers 237 square miles. The Chicago EMS System is a regional collaborative of hospital-based, EMS physicians and nurses who provide medical oversight for EMS provider agencies within the system, including the Chicago Fire Department (CFD), which provides emergency response to all 9-1-1 calls. CFD is an urban, fire-based EMS agency with over 280,000 annual transports, of which approximately 3% are for behavioral or psychiatric emergencies and related complaints.

In 2014, the Chicago EMS system implemented a new protocol for management of patients with behavioral emergencies using midazolam. Paramedics had previous training on the use of IN medications and on the use of IV midazolam for other indications. They underwent additional training for the use of midazolam for behavioral emergencies including IN delivery. Per protocol, paramedics attempted verbal de-escalation techniques and physical restraint, but if a patient remained combative and physically dangerous to themselves and others, paramedics could administer midazolam. Midazolam dosing was 1 milligram (mg) IV or 5 mg either IM or IN (repeating once as needed), guided by prior studies.[7,10,11,20,21] EMS providers then documented the dose and route of midazolam administration in addition to the patient's response to therapy with one of the following options: a) clinical deterioration; b) no change; c) slight improvement; or d) significant improvement. Paramedics also documented the indication for midazolam administration as either "behavioral emergency" or "seizures" in the electronic patient care report.

Using SafetyPAD software (ESO Solutions Inc, Austin, TX), we extracted all EMS patient care reports from February 2014 through June 2016 of patients for whom 9-1-1 was called and in which midazolam was administered. We included all cases in which midazolam was administered to adult patients for behavioral emergency via the IM, IN, or IV route. We excluded all cases in which midazolam was given for indications other than behavioral emergency, cases in which midazolam was administered other than via IM, IN, or IV routes, and cases with dosages outside the range prescribed in the protocol. Per EMS patient care protocol, we excluded patients less than 18 years of age or greater than 60 years of age. Additionally, we excluded cases if key data elements were missing, such as dose, route, or patient response.

Patient demographic information including age, gender,

and race was collected and included in analysis. Additionally, an unblinded abstractor (RH) reviewed all charts for complications, predefined as systolic blood pressure < 100, oxygen saturation < 95%, use of airway intervention, and mention of provider injury. RH was trained in chart abstraction by another author (CTR). Meetings were held weekly during chart abstraction to answer questions and review results.

Outcomes and Analytical Methods

We evaluated the dose, route, need for repeat dosing, and clinical effect of midazolam administrations, and we performed descriptive statistics for administrations of midazolam for behavioral emergencies. Levene's test was used to assess variance between aggregate groups of "any improvement" (significant and slight improvement) and "no improvement." Using t-tests, we compared effectiveness between the routes and rate of adverse events for IN and IM administrations. We used Stata 15 (StataCorp, College Station, TX) to create descriptive statistics, calculate confidence intervals (CI), and perform the t-tests.

Human Subjects Committee Review

Northwestern University's institutional review board approved the study.

RESULTS

During the study period, 478 patients received midazolam. We excluded 221 cases for indications other than behavioral emergency, deviations from dosing protocol, or missing data (Figure 1). After exclusions, we included 294 administrations to 257 patients. Patient characteristics are reported in Table 1.

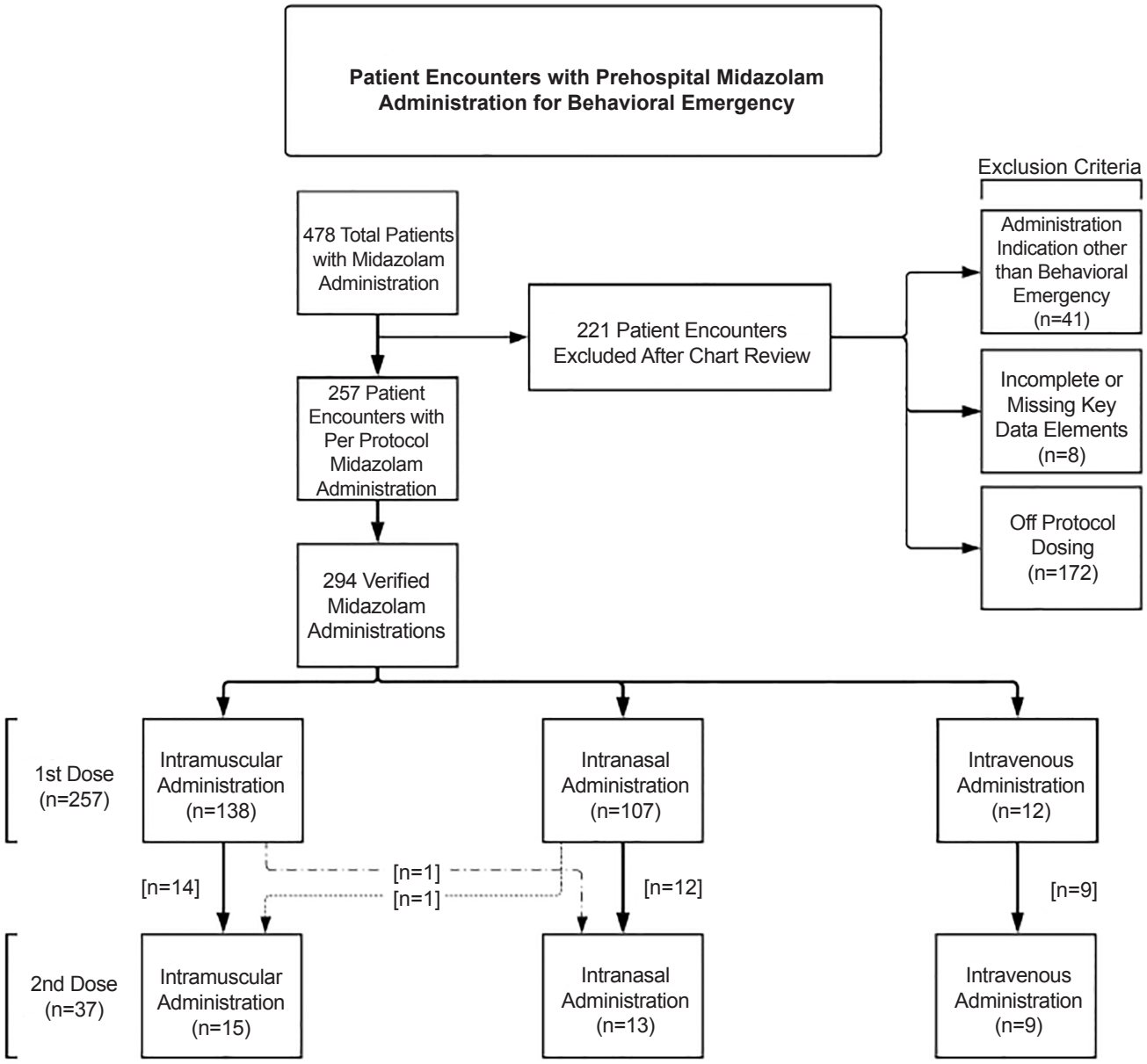


Figure 1. Patient encounters reviewed for midazolam administration in prehospital.

Including all administrations of midazolam (n = 294), paramedics noted improvement in 73.5% of cases, 34.5% (95% CI, 29.6-39.8%) of which had substantial improvement in level of agitation and 39.3% (95% CI, 34.2-44.7%) had slight improvement. No improvement was noted in 25.5% (95% CI, 21.1-30.5%) of cases, and 0.6% (95% CI, 0.1-2.4%) had clinical deterioration. Of all administrations, 52.0% were IM, 40.8% were IN, and 7.1% were IV. The doses administered were 1 mg (7.1%) and 5 mg (92.9%).

In the subset of first-dose midazolam administrations (n = 257), paramedics reported substantial improvement in 32.7% (95% CI, 27.2-38.7%), slight improvement in 39.3% (95% CI, 33.5-45.4%), no change in 27.2% (95% CI, 22.1-33.0%), and deterioration in 0.8% (95% CI, 0.1-3.1%) (Figure 2). The routes were IM (53.7%), IN (41.6%), and IV (4.7%). The majority of first doses were 5 mg. (Table 2). Response rates to specific routes are shown in Figure 2.

In those patients requiring a repeat dosage (n = 37), paramedics reported improvement in 83.7% of cases, with substantial improvement noted in 43.2% (95% CI, 28.0-59.9%) of patients, and slight improvement documented for 40.5% (95% CI, 25.7.0-57.3%) of patients. No change was noted in 16.2% (95% CI, 7.3-32.4%) of patients (Figure 3). The routes of the second dose were IV (24.3%), IM (40.5%), and IN (35.1%) (Table 2). Of those receiving a second dose, their responses to the first dose were as follows: no response (75.7%, 95% CI, 58.9-87.1%); slight improvement (18.9%, 95% CI, 9.1-35.3%); substantial improvement (2.7%, 95% CI, 0.4-17.9%); and clinical deterioration (2.7%, 95% CI, .4-17.9%).

IM and IN routes of midazolam administration were compared for effectiveness after applying Levene's test to compare "any improvement" ("slight improvement" + "substantial improvement") to "no improvement" ("no improvement" + "clinical deterioration"). The datasets were found to be homogenous (p = 0.18). Using a t-test, we found no significant difference between "any improvement" after IN midazolam (71.0%) and IM (75.4%, p = 0.24). There was also no significant difference found between the documented adverse events of IM midazolam (3.9%) and IN (3.3%, p = .79). Additionally, we found no significant difference between the rates of reported EMS provider injury for IM (3.9%) and IN (1.7%, p=.27) doses. The majority of these injuries were kicks or bites by the patient, with no needlestick injuries reported.

Paramedics reported six adverse events thought to be due to midazolam administration, and an additional three adverse events were identified upon chart review. Adverse events included hypotension (systolic blood pressure < 100 millimeters of mercury [mmHg]) (n = 3); hypoxia with airway intervention required (n = 1); hypoxia without airway intervention (n = 1); unresponsiveness (n = 2); traumatic cardiac arrest (n =1); and worsening agitation (n = 2). For the nine cases, all happened after a single 5 mg dose administered via IM (n = 6) or IN (n = 3) routes. The patient who received an airway intervention had an oropharyngeal airway placed and bag-valve-mask ventilation performed. In the two cases of hypotension with systolic pressures less than 100 mmHg, none of the cases had a systolic blood pressure less than 90 mmHg systolic. Of patients experiencing unresponsiveness, two were given midazolam for agitation after naloxone was administered for suspected opioid overdose. The patient who experienced traumatic cardiac arrest sustained blunt trauma injuries after a four-story fall. This patient received 5 mg of midazolam IM to facilitate safe and timely transport in the setting of severe trauma and experienced cardiac arrest during transport.

Table 1. Characteristics of patients receiving midazolam for behavioral emergencies.

Characteristic	Total patients (n = 257)
Age – median years (IQR)	30 (24-42)
Male gender	171 (66.5%)
Race	
African American	138 (53.7%)
White	65 (25.3%)
Hispanic	43 (16.7%)
Asian	6 (2.3%)
Other	2 (0.8%)
Unknown	3 (1.2%)

IQR, interquartile range.

Table 2. Characteristics of midazolam administrations for behavioral emergencies.

Administration Characteristic	Initial Dose (n = 257)	Repeat Dose (n = 37)
Dose administerd, n (%)		
1mg	12 (4.7%)	9 (24.3%)
5 mg	245 (95.3%)	28 (75.7%)
Administration route, n (%)		
IM	138 (53.7%)	15 (40.5%)
IN	107 (41.6%)	13 (35.1%)
IV	12 (4.7%)	9 (24.3%)

IM, intramuscular; *IN,* intranasal; *IV,* intravenous, *mg,* milligrams.

DISCUSSION

To our knowledge, this study represents the largest cohort of prehospital patients administered midazolam as a single agent for behavioral emergency. Paramedics reported clinical improvement in a majority of patients following midazolam administration. Only 14.4% of patients required a second dose, after which, the majority were assessed by paramedics to have a clinical improvement. Over 294 administrations, adverse events were noted in 3.1%, all with IM or IN dosing. Based on

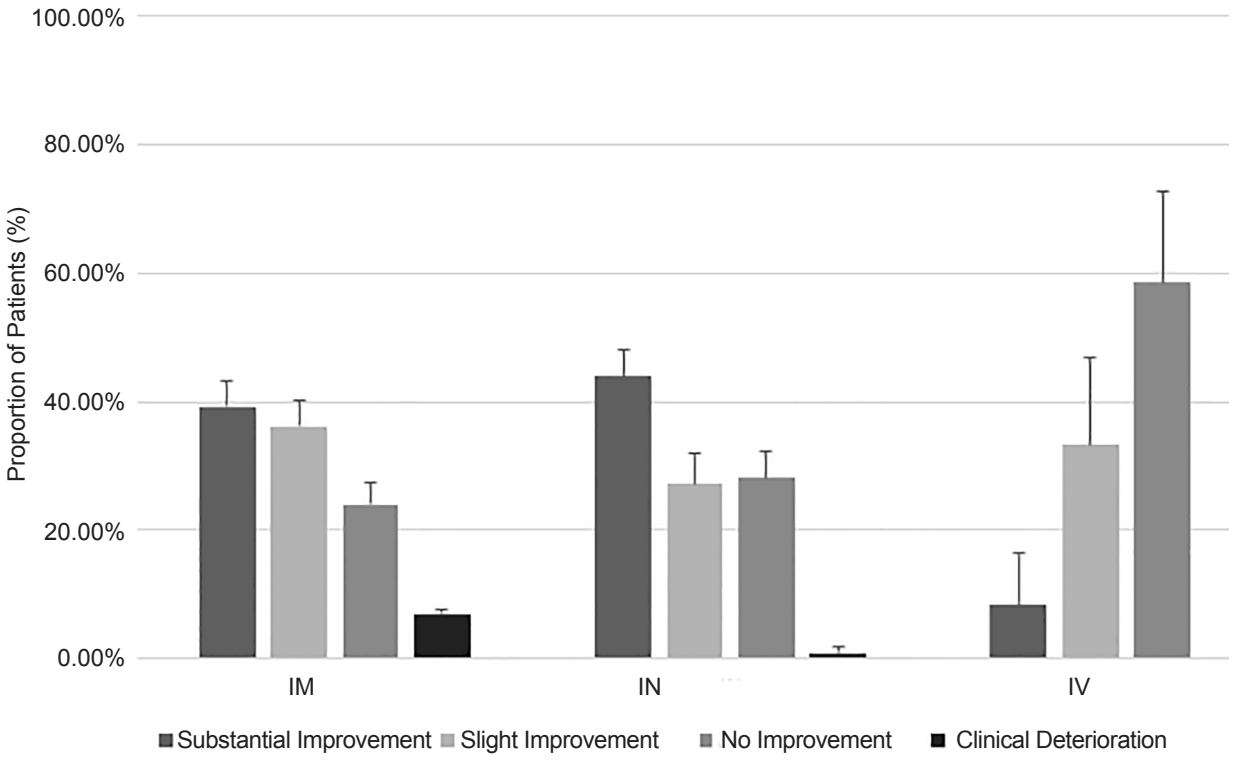


Figure 2. Subjective clinical change after initial midazolam administration for behavioral emergencies as reported by paramedics. *IM,* intramuscular; *IN,* intranasal; *IV,* intravenous.

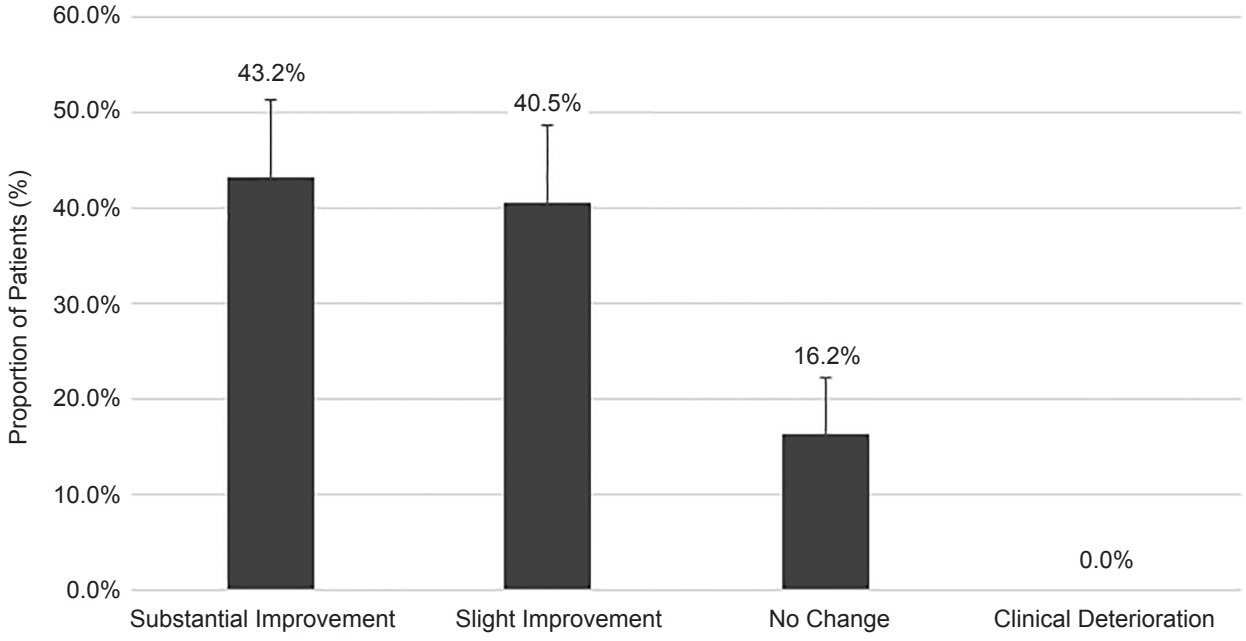


Figure 3. Subjective clinical change after repeat midazolam administration for behavioral emergencies as reported by paramedics.

this improvement rate and low complication rate, a prehospital behavioral emergencies protocols using midazolam to control agitation may be considered for use in EMS systems.

One notable advantage of midazolam over alternative agents is the possibility for IN administration. In this study, IN administration represented 40.8% of the midazolam administrations, suggesting a preference of IN route by EMS providers. Additionally, we found IN midazolam to be no less effective than IM midazolam. These results suggest that IN administration may represent a preferable route of delivering midazolam, particularly as the IN route eliminates the risk of needlestick provider injury.

Adverse events after midazolam use for behavioral emergency were rare in this study, with only 3.1% of patients experiencing an adverse event, all after initial administration of midazolam. Hypoxia and apnea were also rare, with only one patient requiring any airway intervention and no patients requiring intubation in the field. For the patient administered midazolam in order to facilitate transport in the setting of blunt trauma, they likely experienced cardiac arrest due to injuries rather than midazolam administration. Further studies are needed to investigate the safety of midazolam administration in the setting of known or suspected opioid use as prior studies have demonstrated that concurrent benzodiazepine and opioid administration increases the risk of respiratory depression.[17–19]

Prehospital providers are frequently exposed to agitated patients, and improved strategies are needed to safely care for these patients.[3,14] The optimal agent for safely managing agitation in the prehospital setting after de-escalation techniques have failed remains to be determined. Benzodiazepines are one of the most frequently used classes of drugs for acute agitation due to their safety profile and sedating effects. IM doses of short-acting benzodiazepines like midazolam have shown rapid onset of action and more rapid effect when compared to antipsychotics alone.[6,7,10,20] However, sedating effects from benzodiazepines have raised concerns about potential respiratory depression and their use may lead to an increase in respiratory adverse events.[6,7,20,21]

An alternate agent for prehospital agitation that has attracted attention over the last decade is ketamine. Despite being used since the 1960s, ketamine has only recently been evaluated for use in treating agitation in the prehospital and ED settings and has been shown to be effective in controlling agitated patients in several studies.[22–24] However, research on the use of ketamine in the prehospital setting has demonstrated hypoxia, increased secretions, and laryngospasm requiring intubation following ketamine administration.[22–25] In one of the largest studies to date evaluating ketamine for prehospital agitation, ketamine performed well in comparison to haloperidol in controlling agitation but with an intubation rate of 39%.[23] While further studies are needed to clarify the use of ketamine for prehospital agitation, alternatives such as benzodiazepines may be preferable given the low frequency of complications requiring advanced airway as shown in this and other studies.[6,10]

LIMITATIONS

Using paramedic impression as an outcome limits the results of this study. While paramedic impression is certainly important for prehospital treatments and has been used in prior studies, using a standardized aggression scoring systems may more accurately measure effectiveness of midazolam in treating agitation and improve external validity.[24,26] A large portion of patients receiving 1 mg of IV midazolam required a second dose. This likely represents an under-dosing by the protocol, and the study EMS system has subsequently implemented a change to 2 mg for IV doses. We did not investigate the need for additional sedation in the ED, and we look forward to future studies linking prehospital and ED data.

We did not limit midazolam administration to excited delirium, so these results may not accurately represent the effects of midazolam on excited delirium. Excited delirium represents a small portion of agitated patients though, and protocols are necessary for control of agitation in a variety of clinical scenarios. Additionally, despite 3% of transports being for behavioral complaints, less than 0.1% of patients received midazolam during the study period. This likely suggests that non-pharmacological approaches may be adequate to address the majority of behavioral emergencies.

Adverse events were limited to paramedic documentation and chart review, which may not capture all adverse events, particularly paramedic injuries. We excluded more than a third of cases for dosing deviations, the large portion of which were due to online medical control. Excluding these deviations might bias the results by missing adverse events, but on analysis of all midazolam administrations, the adverse rate was similar at 2.9% for all administrations compared to 3.1% for per protocol. Lastly, this study was performed in a single EMS system, and further studies could verify effectiveness in other settings.

CONCLUSION

In a large urban EMS system, we found that a prehospital behavioral emergencies protocol using midazolam was associated with improved agitation and a limited number of adverse events. Additionally, we demonstrate the effective use of IN midazolam for use in a prehospital behavioral emergencies protocol. Further studies will be needed to validate these findings in other EMS systems and to compare midazolam to other pharmacological options to help determine the ideal agent for the agitated prehospital patient.

Address for Correspondence: Ryan Huebinger, Department of Emergency Medicine, McGovern Medical School at The University of Texas Health Science Center at Houston, 6431 Fannin St, JJL 451, Houston, TX 77030. Email: Ryan.M.Huebinger@uth.tmc.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Brice JH, Pirrallo RG, Racht E, et al. Management of the violent patient. *Prehosp Emerg Care*. 2003;7(1):48-55.
2. Deal N, Hong M, Matorin A, et al. Stabilization and management of the acutely agitated or psychotic patient. *Emerg Med Clin North Am*. 2015;33(4):739-52.
3. Kupas DF,Wydro GC. Patient restraint in emergency medical services systems. *Prehosp Emerg Care*. 2002;6(3):340-5.
4. Weiss S, Peterson K, Cheney P, et al. The use of chemical restraints reduces agitation in patients transported by emergency medical services. *J Emerg Med*. 2012;43(5):820-8.
5. Rund DA, Ewing JD, Mitzel K, et al. The use of intramuscular benzodiazepines and antipsychotic agents in the treatment of acute agitation or violence in the emergency department. *J Emerg Med*. 2006;31(3):317-24.
6. Klein LR, Driver BE, Miner JR, et al. Intramuscular midazolam, olanzapine, ziprasidone, or haloperidol for treating acute agitation in the emergency department. *Ann Emerg Med*. 2018;72(4):374-85.
7. Isbister GK, Calver LA, Page CB, et al. Randomized controlled trial of intramuscular droperidol versus midazolam for violence and acute behavioral disturbance: the DORM study. *Ann Emerg Med*. 2010;56(4):392-401.e1.
8. Wright SW, Chudnofsky CR, Dronen SC, et al. Midazolam use in the emergency department. *Am J Emerg Med*. 1990;8(2):97-100.
9. Nordt SP, Clark RF. Midazolam: a review of therapeutic uses and toxicity. *J Emerg Med*. 1997;15(3):357-65.
10. Nobay F, Simon BC, Levitt MA, et al. A prospective, double-blind, randomized trial of midazolam versus haloperidol versus lorazepam in the chemical restraint of violent and severely agitated patients. *Acad Emerg Med*. 2004;11(7):744-9.
11. TREC Collaborative Group. Rapid tranquillisation for agitated patients in emergency psychiatric rooms: a randomised trial of midazolam versus haloperidol plus promethazine. *BMJ*. 2003;327(7417):708-13.
12. Nordstrom K, Allen MH. Alternative delivery systems for agents to treat acute agitation: progress to date. *Drugs*. 2013;73(16):1783-92.
13. Leiss JK. Management practices and risk of occupational blood exposure in U.S. paramedics: Needlesticks. *Am J Ind Med*. 2010;53(9):866-74.
14. Bigham BL, Jensen JL, Tavares W, et al. Paramedic self-reported exposure to violence in the emergency medical services (EMS) workplace: a mixed-methods cross-sectional survey. *Prehosp Emerg Care*. 2014;18(4):489-94.
15. Holsti M, Sill BL, Firth SD, et al. Prehospital intranasal midazolam for the treatment of pediatric seizures. *Pediatr Emerg Care*. 2007;23(3):148-53.
16. Hosseini Jahromi SA, Hosseini Valami SM, Adeli N, et al. Comparison of the effects of intranasal midazolam versus different doses of intranasal ketamine on reducing preoperative pediatric anxiety: a prospective randomized clinical trial. *J Anesth*. 2012;26(6):878-82.
17. Jann M, Kennedy WK, Lopez G. Benzodiazepines: a major component in unintentional prescription drug overdoses with opioid analgesics. *J Pharm Pract*. 2014;27(1):5-16.
18. Gomes T, Mamdani MM, Dhalla IA, et al. Opioid dose and drug-related mortality in patients with nonmalignant pain. *Arch Intern Med*. 2011;171(7):686-91.
19. Lee SC, Klein-Schwartz W, Doyon S, et al. Comparison of toxicity associated with nonmedical use of benzodiazepines with buprenorphine or methadone. *Drug Alcohol Depend*. 2014;138:118-23.
20. Knott JC, Taylor DM, Castle DJ. Randomized clinical trial comparing intravenous midazolam and droperidol for sedation of the acutely agitated patient in the emergency department. *Ann Emerg Med*. 2006;47(1):61-7.
21. Martel M, Sterzinger A, Miner J, et al. Management of acute undifferentiated agitation in the emergency department: a randomized double-blind trial of droperidol, ziprasidone, and midazolam. *Acad Emerg Med*. 2005;12(12):1167-72.
22. Burnett AM, Salzman JG, Griffith KR, et al. The emergency department experience with prehospital ketamine: a case series of 13 patients. *Prehosp Emerg Care*. 2012;16(4):553-9.
23. Cole JB, Moore JC, Nystrom PC, et al. A prospective study of ketamine versus haloperidol for severe prehospital agitation. *Clin Toxicol (Phila)*. 2016;54(7):556-62.
24. Keseg D, Cortez E, Rund D, et al. The use of prehospital ketamine for control of agitation in a metropolitan rirefighter-based EMS system. *Prehosp Emerg Care*. 2015;19(1):110-15.
25. Burnett AM, Peterson BK, Stellpflug SJ, et al. The association between ketamine given for prehospital chemical restraint with intubation and hospital admission. *Am J Emerg Med*. 2015;33(1):76-9.
26. Weber JM, Tataris KL, Hoffman JD, et al. Can nebulized naloxone be used safely and effectively by emergency medical services for suspected opioid overdose? *Prehosp Emerg Care*. 2012;16(2):289-92.

Males Receive Low-Tidal Volume Component of Lung Protective Ventilation More Frequently than Females in the Emergency Department

Derek L. Isenberg, MD
Benjamin Bloom, MD
Nina Gentile, MD
Hannah Reimer, BSN
Owen D. Glaze, BS
Paige Palumbo, BS
Rachel Fenstermacher, BS

Lewis Katz School of Medicine, Department of Emergency Medicine, Philadelphia, Pennsylvania

Section Editor: Matthew Prekker, MD, MPH
Submission history: Submitted September 13, 2019; Revision received January 30, 2020; Accepted February 6, 2020
Electronically published April 16, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.2.45191

Introduction: Mechanical ventilation is a commonly performed procedure in the emergency department (ED). Approximately 240,000 patients per year receive mechanical ventilation in the ED representing 0.23% of ED visits. An ED-based trial published in 2017 showed that a bundle of interventions in mechanically ventilated patients, including low tidal volume ventilation, reduced the development of acute respiratory distress syndrome by nearly 50%. Prior literature has shown that as many as 40% of ED patients do not receive lung protective ventilation. Our goal was to determine whether differences exist between the percent of males vs females who are ventilated at ≥ 8 milliliters per kilogram (mL/kg) of predicted body weight.

Methods: We conducted this study at Temple University Hospital, a tertiary care center located in Philadelphia, Pennsylvania. This was a planned subgroup analysis of study looking at interventions to improve adherence to recommended tidal volume settings. We used a convenience sample of mechanically ventilated patients in our ED between September 1, 2017, and September 30, 2018. All adult patient > 18 years old were eligible for inclusion in the study. Our primary outcome measure was the number of patients who had initial tidal volumes set at > 8 mL/kg of predicted body weight. Our secondary outcome was the number of patients who had tidal volumes set at ≥ 8 mL/kg at 60 minutes after initiation of mechanical ventilation.

Results: A total of 130 patients were included in the final analysis. We found that significantly more females were initially ventilated with tidal volumes ≥ 8 mL/kg compared to men: 56% of females vs 9% of males (p=<0.001). Data was available for 107 patients (82%) who were in the ED at 60 minutes after initiation of mechanical ventilation. Again, a significantly larger percentage of females were ventilated with tidal volumes ≥ 8 mL/kg at 60 minutes: 56% of females vs 10% of males (p<0.001).

Conclusion: The vast majority of tidal volumes ≥ 8 mL/kg during mechanical ventilation occurs in females. We suggest that objective measurements, such as a tape measure and tidal volume card, be used when setting tidal volumes for all patients, especially females. [West J Emerg Med. 2020;21(3)684-687.]

INTRODUCTION

Mechanical ventilation is a commonly performed procedure in the emergency department (ED). Approximately 240,000 patients per year receive mechanical ventilation in the ED, representing 0.23% of ED visits.[1] The landmark LOV-ED trial published in 2017 showed that a bundle of interventions in the ED for mechanically ventilated patients reduced the development of acute respiratory distress syndrome (ARDS) and related complications by nearly 50%.[2] One item in the bundle was low tidal volume ventilation defined as 6-8 milliliters per kilogram (mL/kg) of predicted body weight (PBW). An earlier 2012 meta-analysis by Neto et al showed that an early low tidal volume ventilation strategy in patients without ARDS/acute lung injury resulted in lower rates of development of ARDS, decreased rates of pulmonary infection, and decreased mortality rates.[3] Prior literature has shown that as many as 40% of ED patients do not receive lung protective ventilation.[4] Risks of ventilating patients with larger tidal volume include barotrauma, pneumothorax, and damage to surfactant in the lungs.[5,6]

Our goal was to determine whether differences exist between the percent of males vs females who are ventilated at ≥ 8mL/kg of PBW at the time of initial ventilator settings and at 60 minutes after the initiation of mechanical ventilation.

Population Health Research Capsule

What do we already know about this issue?
Lung protective ventilation reduces complications from acute respiratory distress syndrome, but it is infrequently practiced in the emergency department (ED).

What was the research question?
Do male and female patients receive lung protective ventilation at the same frequency in the ED?

What was the major finding of the study?
Males received initial lung protective ventilation at significantly higher rates than females: 91% vs 44%.

How does this improve population health?
Objective measurements, such as a tape measure and tidal volume card, should be used when setting ventilators for all patients, especially females.

METHODS

This study took place at Temple University Hospital (TUH), a tertiary care center located in Philadelphia, Pennsylvania. TUH is a 599-bed tertiary care center with 84,433 annual ED visits. TUH has a postgraduate year (PGY) 1-3 emergency medicine (EM) residency with 38 residents. The majority of intubations are performed by the PGY-2 and PGY-3 residents in the ED.

This was a planned subgroup analysis of study looking at interventions to improve adherence to recommended tidal volume settings. This study used a convenience sample of mechanically ventilated patients in our ED between September 1, 2017 – September 30, 2018. Our ED has research associates (RA) in the department for 12 hours per day, seven days a week during academic semesters. These RAs are responsible for screening patients for various ED-based studies as well as recording study data in real time. Mechanically ventilated patients were only enrolled when the RAs were physically in the department to collect data.

All adult patient ≥18 years old were eligible for inclusion in the study. Exclusion criteria included patients younger than 18 years of age, prisoners, pregnant women, and trauma patients (as the ventilators are set by the trauma surgery service rather than the emergency physicians). Patients who were intubated by or had their intubations supervised by one of the investigators were also excluded.

In our ED, emergency physicians (faculty and residents) are responsible for setting the tidal volumes for mechanically ventilated patients. Nurses will enter a patient's height and weight into the electronic health record, but these values are typically estimated rather than measured. Physicians had access to a measuring tape and tidal volume chart but were not required to measure the patients' heights. After the ventilator had been set and routine, post-intubation care was completed, one of the RAs measured the patient with the tape measure and calculated the PBW of the patient. PBW was calculated using the same formulas that were used in prior ARDS studies.[7,8] All emergency physicians were blinded as to the hypothesis and purpose of this study.

Our primary outcome measure was the number of patients stratified by gender who had initial tidal volumes set ≥8 mL/kg of PBW. Our secondary outcome was the number of patients stratified by gender who had tidal volumes set ≥8 mL/kg by 60 minutes post-intubation. We hypothesized tidal volume settings might be titrated within the first hour of mechanical ventilation. In our ED, all ventilator changes within the first hour are made by the treating emergency physicians.

We performed data analysis using descriptive statistics and compared the groups using the chi-squared method to determine p values. This study was approved by the institutional review board at Temple University.

RESULTS

We included 130 patients in the final analysis, and 107 patients had data available at 60 minutes. Twenty-three patients left the ED prior to one hour, either admitted to an intensive care unit or operating room; 38% of the patients were female.

The mean age was 57 years with a range of 21-89 years. The patients' demographic information is listed in Table 1.

We found that significantly more females were initially ventilated at tidal volumes ≥ 8mL/kg compared to men: 56% of females vs 9% of males (p=<0.001) (Table 2). Data was available for 107 patients (82%) who were still in the ED at 60 minutes after initiation of mechanical ventilation. Again, a significantly larger percentage of females were ventilated at tidal volumes ≥ 8mL/kg at 60 minutes: 56% of females vs 10% of males (p<0.001).

DISCUSSION

In the analysis of our data, we found that females were more frequently ventilated at tidal volumes ≥ 8mL/kg compared to males. This has been reported before in intensive care and operating room literature, but not in the EM literature. Han et al found, in their multivariate analysis, that the high tidal volumes for women during mechanical ventilation were related to their height rather than their gender.[9] Lellouche et al studied mechanical ventilation in patients after cardiac surgery.[10] His group found that women and obese patients (≥ 30kg per meter squared) were less likely to receive lung protective ventilation.

We suspect that clinicians may not appreciate the difference in PBW between males and females of the same height. (Calculations available at http://www.ardsnet.org/files/pbwtables_2005-02-02.pdf). For example, at 152 centimeters (cm) (60 inches), 8 mL/kg of PBW is 368 mL for female and 400 mL for men. At 168 cm (66 inches), 8 mL/kg of PBW is 475 ml for females and 512 mL for males. It is also possible that physicians do not feel comfortable setting a ventilator at or below 400 mL. Because of the discrepancy between the tidal volumes between males and females, clinicians should be encouraged to use an objective measure of PBW when setting a ventilator.

Table 1. Demographics of patients in study examining lung protective ventilation by gender in the emergency department.

	Men, n (%)	Women, n (%)	P-value
Patients initially ventilated at tidal volumes ≥ 8mL/kg	7 (9)	28 (56)	p<0.001
Patients ventilated at tidal volumes ≥ 8mL/kg at 60 minutes	6 (10)	23 (56)	p<0.0001

ml/kg, milliliters per kilogram.

LIMITATIONS

This study focused on ventilator settings and did not evaluate mortality or duration of mechanical ventilation. It is possible that tidal volumes over 8 mL/kg did not adversely affect patient-oriented outcomes. In addition, this was a convenience sample of patients and may not reflect the entirety of patients who received mechanical ventilation in the ED. Finally, this is a single, tertiary care center and thus results may not apply to all centers.

Table 2. Results of study comparing tidal volume settings by gender.

Variables	Male	Female	All patients
Age, years (range)	59.0 (21-87)	62.6 (26-98)	57.3 (21-98)
Mean height, cm (range)	175.5 (143-194)	161.4 (145-175)	170.1 (143-191)
Number of patients with initial ventilator settings, n (%)	80 (62)	50 (38)	130 (100)
Number of patients with ventilator settings at 60 minutes, n (%)	62 (58)	45 (43)	107 (82)
Mean initial tidal volume, mL/kg PBW (range)	6.2 (5.3-9.1)	8.2 (7.4-9.3)	
Mean initial tidal volume, mL (range)	481 (375-600)	440 (300-550)	465 (300-600)
Mean tidal volume at 60 minutes, mL(range)	477 (375-600)	447 (350-550)	504 (375-600)
Indications for mechanical ventilation, n (%)			
Respiratory failure	15 (19)	25 (50)	40 (31)
Cardiac arrest	20 (25)	6 (12)	26 (20)
Altered mental status/Overdose	21 (26)	9 (18)	30 (23)
Seizure/Status epilepticus	10 (13)	3 (6)	13 (10)
Angioedema/Airway infection	5 (6)	4 (8)	9 (8)
Stroke	4 (5)	2 (4)	6 (5)
Gastrointestinal bleeding	2 (3)	0 (0)	2 (1)
DKA	1 (1)	1 (2)	2 (1)
Burns/Smoke inhalation	2 (3)	0 (0)	2 (1)

Cm, centimeters; *ml/kg,* milliliters per kilogram; *PBW,* predicted body weight; *DKA,* diabetic ketoacidosis.

CONCLUSION

The vast majority of patients with tidal volumes ≥ 8mL/kg of PBW during mechanical ventilation are females. This difference did not improve after 60 minutes, although clinicians had time to adjust the ventilator. We suggest that objective measurements, such as a tape measure and tidal volume card, be used when setting ventilators for all patients, especially females.

Address for Correspondence: Derek Isenberg, MD, Department of Emergency Medicine, Lewis Katz School of Medicine, 1314 West Ontario Street, Philadelphia, Pennsylvania. Email: derek.isenberg@tuhs.temple.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Easter BD, Fischer C, Fisher J. The use of mechanical ventilation in the ED. *Am J Emerg Med.* 2012;30(7):1183-8.
2. Fuller BM, Ferguson IT, Mohr NM, et al. Lung-Protective Ventilation Initiated in the Emergency Department (LOV-ED): A Quasi-Experimental, Before-After Trial. *Ann Emerg Med.* 2017;70(3):406-18.e404.
3. Neto AS, Simonis FD, Barbas CS, et al. Lung-protective ventilation with low tidal volumes and the occurrence of pulmonary complications in patients without acute respiratory distress syndrome: a systematic review and individual patient data analysis. *Crit Care Med.* 2015;43(10):2155-63.
4. Wilcox SR, Richards JB, Fisher DF, et al. Initial mechanical ventilator settings and lung protective ventilation in the ED. *Am J Emerg Med.* 2016;34(8):1446-51.
5. Tobin MJ. *Principles and Practice of Mechanical Ventilation.* 3rd ed. New York: McGraw-Hill Medical; 2013.
6. Briel M, Meade M, Mercat A, et al. Higher vs lower positive end-expiratory pressure in patients with acute lung injury and acute respiratory distress syndrome: systematic review and meta-analysis. *JAMA.* 2010;303(9):865-73.
7. Crapo RO, Morris AH, Gardner RM. Reference spirometric values using techniques and equipment that meet ATS recommendations. *Am Rev Respir Dis.* 1981;123(6):659-64.
8. Crapo RO, Morris AH, Clayton PD, et al. Lung volumes in healthy nonsmoking adults. *Bull Eur Physiopathol Respir.* 1982;18(3):419-25.
9. Han S, Martin GS, Maloney JP, et al. Short women with severe sepsis-related acute lung injury receive lung protective ventilation less frequently: an observational cohort study. *Crit Care.* 2011;15(6):R262.
10. Lellouche F, Dionne S, Simard S, et al. High tidal volumes in mechanically ventilated patients increase organ dysfunction after cardiac surgery. *Anesthesiology.* 2012;116(5):1072-82.

Efficacy of Laryngeal Tube versus Bag Mask Ventilation by Inexperienced Providers

Danielle Hart, MD, MACM
Brian Driver, MD
Gautham Kartha, MD
Robert Reardon, MD
James Miner, MD

Hennepin Healthcare, Department of Emergency Medicine, Minneapolis, Minnesota

Section Editor: Juan F. Acosta, DO, MS
Submission history: Submitted November 10, 2019; Revision received February 28, 2020; Accepted March 8, 2020
Electronically published April 16, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.3.45844

Introduction: Bag mask ventilation (BMV) and extraglottic devices (EGDs) are two common methods of providing rescue ventilation. BMV can be difficult to perform effectively, especially for inexperienced providers and in patients with difficult airway characteristics. There is some evidence that the laryngeal tube (LT) can be successfully placed by inexperienced providers to provide effective ventilation. However, it is unclear whether ventilation provided by LT is superior to that of BMV, especially in the hands of inexperienced airway providers. Therefore, we aimed to compare ventilation efficacy of inexperienced airway providers with BMV versus LT by primarily measuring tidal volumes and secondarily measuring peak pressures on a simulated model.

Methods: We performed a crossover study first year emergency medicine residents and third and fourth year medical students. After a brief instructional video followed by hands on practice, participants performed both techniques in random order on a simulated model for two minutes each. Returned tidal volumes and peak pressures were measured.

Results: Twenty participants were enrolled and 1200 breaths were measured, 600 per technique. The median ventilation volumes were 194 milliliters (mL) for BMV, and 387 mL for the laryngeal tube, with a median absolute difference of 170 mL (95% confidence interval [CI] 157-182 mL) (mean difference 148 mL [95% CI, 138-158 mL], p<0.001). The median ventilation peak pressures were 23 centimeters of water (cm H_2O) for BMV, and 30 cm H_2O for the laryngeal tube, with a median absolute difference of 7 cm H_2O (95% CI, 6-8 cm H2O) (mean difference 8 cm H_2O [95% CI, 7-9 cm H_2O], p<0.001).

Conclusion: Inexperienced airway providers were able to provide higher ventilation volumes and peak pressures with the LT when compared to BMV in a manikin model. Inexperienced providers should consider using an LT when providing rescue ventilations in obtunded or hypoventilating patients without intact airway reflexes. Further study is required to understand whether these findings are generalizable to live patients. [West J Emerg Med. 2020;21(3)688–693.]

INTRODUCTION

Rescue ventilation, performed for apneic or hypoventilating patients and after failed intubation attempts, is an important skill for emergency airway management. Bag mask ventilation (BMV) and the use of extraglottic devices (EGDs) are two common methods of providing rescue ventilation.

BMV, long the gold standard, can be difficult to perform effectively and requires proper technique to ensure sufficient ventilation.[1–5] In a study of first-year anesthesia residents, only 17% were able to provide effective BMV on anesthetized patients following a traditional 36-hour BMV and endotracheal intubation (ETI) course.[2] BMV can prove to be especially

difficult in patients with older age, obesity, lack of teeth, a beard, a higher Mallampati class, or history of snoring.[6,7]

EGDs provide similar ventilation to endotracheal tubes,[8–10] are easy to place, and are often used for emergency ventilation. The laryngeal tube (LT), a type of EGD, can be successfully placed by inexperienced providers to provide effective ventilation.[3,11–13] However, there is conflicting evidence on whether ventilation provided by LT is superior to that of BMV, and it is unknown whether an efficacy difference exists in the hands of inexperienced airway providers or those who infrequently perform emergency ventilation, a group that requires an easy and effective method to maintain oxygenation. Proper BMV may require skill acquisition and maintenance that would be difficult for providers that rarely perform the procedure; however, training and skill acquisition for both BMV and EGD placement is important. Studies examining minute ventilation as well as those using a subjective outcome of "adequate ventilation" as judged by the care provider have yielded conflicting results when examining the efficacy of LT versus BMV.[3,8,14,15]

We therefore aimed to compare ventilation efficacy of inexperienced airway providers with BMV versus LT on a simulated model. Our primary outcome was measured tidal volume, and our secondary outcome was peak pressure. We hypothesized that LT would produce higher tidal volumes and peak pressures than BMV.

METHODS

We performed a crossover study, including first year emergency medicine (EM) residents and third and fourth year medical students. Twenty participants were enrolled, all inexperienced in airway management: 12 medical students, seven first year EM residents, and one paramedic student. We chose these participants because they were largely inexperienced in basic airway management. The local institutional review board declared this study exempt from review; all participation was voluntary.

To teach the basics of BMV and LT insertion, participants listened to a brief introductory lecture discussing basic airway management and watched a standardized, four-minute video that described best practices for BMV and LT insertion and use. The two-handed thenar eminence (TE) BMV technique was taught due the superiority of this technique when compared to the one-handed or two-handed E-C technique;[16,17] in this technique, the thenar eminences rest on the mask, and the fingers lift the ramus of the mandible upward into the mask to create a seal (Appendix). For LT insertion, participants were instructed to perform a jaw lift, insert the LT deeply, then withdraw the tube slowly during ventilation, until adequate ventilation was achieved.

After a period of unstructured hands-on practice (which included the same length of time, manikins, airway equipment, and instructor availability for all participants), participants performed both techniques in random order. They were given a standard adult size facemask and a #4 King LT. We used a manikin to compare the effectiveness of each technique (TruCorp AirSim Combo X; Belfast, Ireland); the esophagus and cricothyroid membrane apertures were taped closed; a 3 liter reservoir bag (Intersurgical; East Syracuse, NY) was used to simulate inflation and deflation of a lung. The manikin was inspected for any tears or disruptions prior to data collection to ensure there were no detectable areas that would result in an air leak. A mechanical ventilator, connected with standard ventilator tubing to the facemask or laryngeal tube, (Viasys LTV 1200; Vyaire Medical, Mettawa, IL), delivered a tidal volume of 500 milliliters (mL) at 15 breaths per minute, and measured peak pressure and returned tidal volumes. We used a ventilator rather than manual bagging in order to standardize the volume delivered, allowing comparisons between devices

After LT insertion or establishing a facemask seal, five breaths were administered to inflate the reservoir bag; then, the participants performed each technique for two minutes. The LT or mask position could be adjusted at any time to maintain the best possible ventilation. Participants were able to see the reservoir bag inflating and deflating during the ventilation; no other real-time feedback or assistance was provided. We recorded the tidal volume and peak pressure for each ventilation. This essentially compared the ability of subjects to achieve an airway seal with a two-hand thenar eminence technique on a mask compared to placement of the LT.

The primary outcome was returned tidal volume; the secondary outcome was peak pressure. These parameters are indicative of the effectiveness of the airway technique and have been used in prior research.[17] Assuming delivered volumes of about 400 mL (with a standard deviation of approximately 75 mL), we estimated 20 subjects would be required to detect a 50 mL difference in volumes delivered by the two techniques. Using the Shapiro-Wilk normality test, we determined that neither tidal volume and peak pressure values were normally distributed. Therefore, we compared the volumes and pressures for the two techniques by calculating the median difference between groups. The mean values are also presented. We used Stata (version 15.1, College Station, TX) for all data analysis.

RESULTS

All participants performed both techniques; 1200 breaths were measured, 600 per technique. The median ventilation volumes were 194 mL for BMV, and 387 mL for the laryngeal tube, with a median absolute difference of 170 mL (95% confidence interval [CI], 157-182 mL) (mean difference 148 mL [95% CI, 138-158 mL], $p<0.001$). The median ventilation peak pressures were 23 centimeters of water (cm H_2O) for BMV, and 30 cm H_2O for the laryngeal tube, with a median absolute difference of 7 cm H_2O (95% CI, 6-8 cm H_2O) (mean difference 8 cm H_2O [95% CI, 7-9 cm H_2O], $p<0.001$). Volumes and pressures achieved by training level are displayed in the Table. Performance of each participant in each technique is presented in Figure 1.

Table. Median and mean volume delivered, by training level and technique.

Training level	Laryngeal tube	Bag-mask ventilation
	Volume (mL)	
First year resident	398 (318 to 402); 367 (54)	194 (161 to 232); 194 (53)
Medical student	382 (370 to 405); 382 (26)	227 (143 to 347); 243 (109)
	Pressure delivered (cm H_2O)	
First year resident	29 (26 to 31); 29 (3)	23 (22 to 25); 23 (1.6)
Medical student	36 (28 to 42); 35 (8)	25 (17 to 35); 26 (9)

mL, milliliters; *cm H_2O*, centimeters of water.
All values are median (interquartile range); mean (standard deviation).

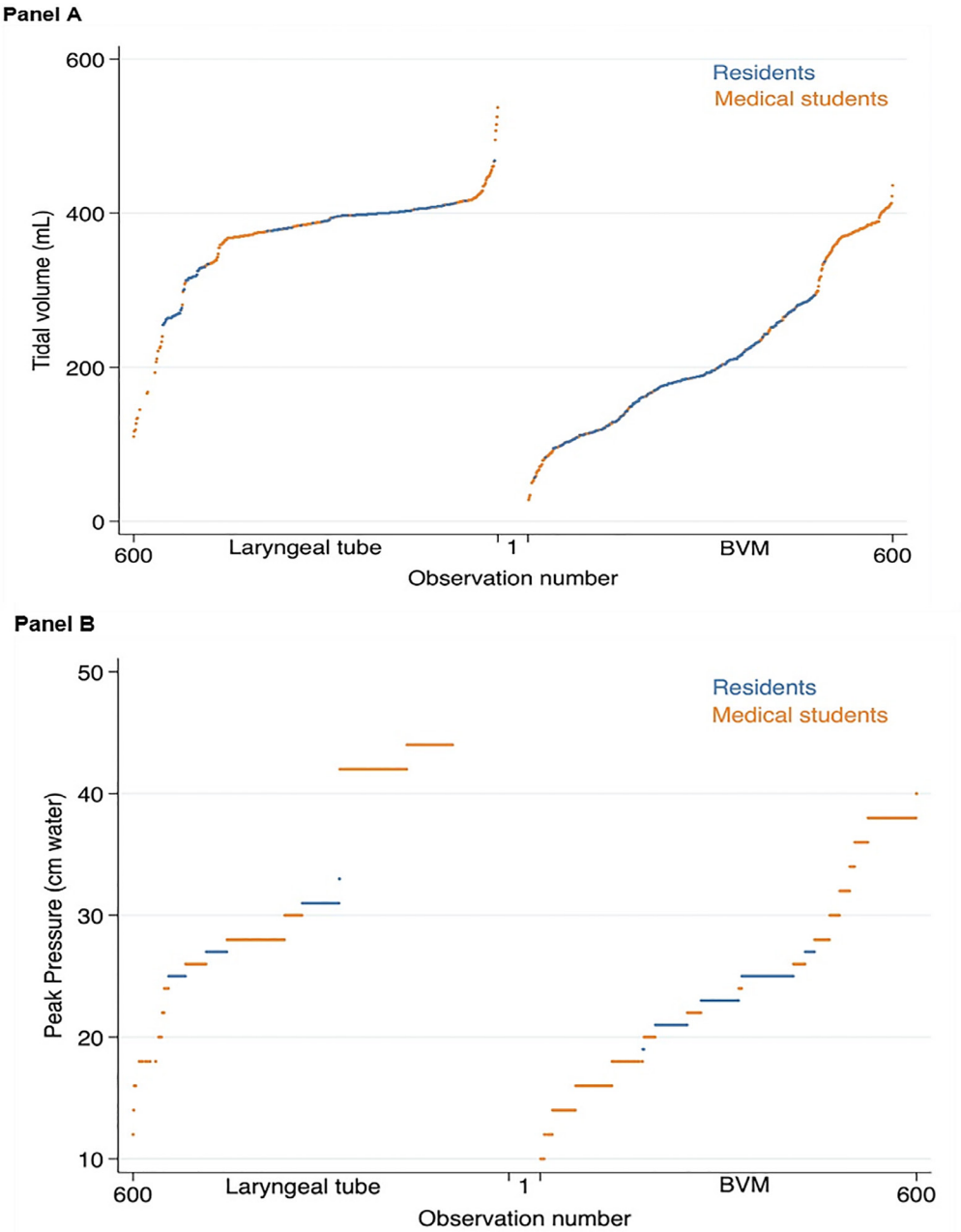


Figure 1. Tidal volume and peak pressure. This figure displays each tidal volume (panel A) and peak pressure (panel B) measurement for the 1,200 breaths administered, sorted in ascending order and by group.
mL, milliliters; *cm*, centimeters; *BVM*, bag mask ventilation.

DISCUSSION

Although BMV is often the first-line method of emergency ventilation, there is growing evidence supporting the use of LTs and other EGDs in airway management, including those with out of hospital cardiac arrest (OHCA), and those requiring advanced airway management in the out-of-hospital setting, ED, or during general anesthesia. Prior literature suggests that the LT has a high rate of successful placement and adequate ventilation. [3,18–21] What is less clear is how the LT compares to BMV in the hands of inexperienced providers.

In our study, we found significantly higher ventilation volumes and peak pressures when using the LT compared to BMV for medical students and first year EM residents. This supports previous work of Kurola, who found significantly higher minute ventilation with LT compared to BMV in a simulation model with emergency medical technician (EMT) students, and of Roth, who found that the LT was subjectively more effective than BMV in OHCA patients managed by volunteer EMTs.[3,8] There are, however, a few studies that have not found differences in ventilation provided by LT versus BMV. Kurola later found that both LT and BMV were equally effective in ventilating and oxygenating anesthetized patients in the controlled setting of the operating room (OR) in the same study population as his simulation-based study. In addition, Fiala et al found no difference between BMV and the LT for ventilating OHCA patients in a multicenter randomized study of EMT-led airway management.[14,15]

Considering other EGDs, our findings are also consistent with multiple prior studies of inexperienced providers using laryngeal mask airways (LMA), all of which concluded that inexperienced airway providers (including nurses, nursing students, dental students, and other volunteers with no prior experience) can provide better ventilation with the LMA than with BMV (with or without a concomitant oropharyngeal airway).[5,22–26] One study looking specifically at obese patients found that medical students were able to establish effective ventilation more quickly with the LMA than with BMV.[27] A few studies that contradict these findings used more experienced providers, highlighting the need for experience and practice in order to ventilate with BMV effectively.[2,28–30]

EGDs are essential for emergency ventilation in patients who are known to have difficult mask ventilation, such as those with beards, morbid obesity, or a history of snoring.[6,7,27] In cardiac arrest patients, EGDs result in a lower incidence of gastric insufflation and regurgitation than BMV.[3,5,26,31] With prior conflicting results regarding the efficacy of LT versus BMV in providing superior ventilation, our results add support to the assertion that the LT may be a better choice than BMV in obtunded or hypoventilating patients without intact airway reflexes for inexperienced providers who have not developed effective BMV techniques.[1–5] Knowing that LMAs have also shown to result in superior ventilation to BMV in the hands of inexperienced providers, it is possible that when an inexperienced provider encounters a patient who requires emergency ventilation, an EGD may be preferred to BMV, because this device requires less practice and skill, and likely allows higher tidal volume and peak pressure, enabling better overall ventilation. Further study is required to determine whether the findings in our study of LT being superior to BMV for inexperienced providers is generalizable to live patients.

LIMITATIONS

Our study included a convenience sample of subjects, who may have volunteered for our study due to their perceived increased or decreased skill compared to their overall cohort. There are also inherent differences between manikins and actual patients, including a taped-off esophagus. While this differs from human anatomy, closing off the esophagus was necessary to accurately measure delivered and returned tidal volumes and pressures for this study. While a human model would be preferred, unfortunately there is no practical way to compare BMV with LT insertion for inexperienced providers during actual emergency airway management. Therefore, these data should serve as a surrogate that reflects the increased difficulty in obtaining a mask seal compared to inserting an EGD in the clinical environment. Although further human study in emergency airway management may not be feasible in an emergency setting, further study of inexperienced medical students and residents could be performed in the more controlled environment of the operating room. This could then account for additional variables that may occur in live patients, such as variations in human anatomy and differences in lung compliance. Similarly, use of a ventilator rather than a resuscitation bag does not mirror real-world practice, but enabled standardization of tidal volumes between groups, so that differences in measured volume and pressure were due to differences in laryngeal tube or BMV technique rather than differences in bag squeezing. We did not measure skill retention, which could be an area of future exploration. Finally, we had a small sample size of 20 participants; although this sample size provided power to detect a 50 mL difference, a larger sample size would provide further mitigation of type 2 error.

CONCLUSION

Inexperienced airway providers were able to provide higher ventilation volumes and peak pressures with the LT when compared to BMV in a manikin model. Inexperienced providers should consider using an LT when providing rescue ventilations in obtunded or hypoventilating patients without intact airway reflexes. Further study is required to understand whether these findings are generalizable to live patients.

Address for Correspondence: Danielle Hart, MD, MACM, Hennepin Healthcare, Department of Emergency Medicine, 701 Park Ave, Minneapolis, MN 55415. Email: danielle.hart@hcmed.org.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Soleimanpour H, Sarahrudi K, Hadju S, et al. How to overcome difficult-bag-mask-ventilation: Recents approaches. *Emerg Med.* 2012;2:e116.
2. Soleimanpour H, Gholipouri C, Panahi JR, et al. Role of anesthesiology curriculum in improving bag-mask ventilation and intubation success rates of emergency medicine residents: a prospective descriptive study. *BMC Emerg Med.* 2011;11(1):8.
3. Roth D, Hafner C, Aufmesser W, et al. Safety and feasibility of the laryngeal tube when used by EMTs during out-of-hospital cardiac arrest. *Am J Emerg Med.* 2015;33(8):1050-5.
4. Walsh K, Cummins F, Keogh J, et al. Effectiveness of mask ventilation performed by hospital doctors in an Irish tertiary referral teaching hospital. *Ir Med J.* 2000;93(2):55-7.
5. Ocker H, Wenzel V, Schmucker P, et al. Effectiveness of various airway management techniques in a bench model simulating a cardiac arrest patient. *J Emerg Med.* 2001;20(1):7-12.
6. Yildiz TS, Solak M, Toker K. The incidence and risk factors of difficult mask ventilation. *J Anesth.* 2005;19(1):7-11.
7. El-Orbany M, Woehlck HJ. Difficult mask ventilation. *Anesth Analg.* 2009;109(6):1870-80.
8. Kurola J, Harve H, Kettunen T, et al. Airway management in cardiac arrest--comparison of the laryngeal tube, tracheal intubation and bag-valve mask ventilation in emergency medical training. *Resuscitation.* 2004;61(2):149-153.
9. Benger JR, Kirby K, Black S, et al. Effect of a Strategy of a Supraglottic Airway Device vs Tracheal Intubation During Out-of-Hospital Cardiac Arrest on Functional Outcome: The AIRWAYS-2 Randomized Clinical Trial. *JAMA*. 2018;320(8):779-91.
10. Wang HE, Schmicker RH, Daya MR, et al. Effect of a Strategy of Initial Laryngeal Tube Insertion vs Endotracheal Intubation on 72-Hour Survival in Adults With Out-of-Hospital Cardiac Arrest: A Randomized Clinical Trial. *JAMA*. 2018;320(8):769-78.
11. Schalk R, Byhahn C, Fausel F, et al. Out-of-hospital airway management by paramedics and emergency physicians using laryngeal tubes. *Resuscitation.* 2010;81(3):323-6.
12. Gahan K, Studnek JR, Vandeventer S. King LT-D use by urban basic life support first responders as the primary airway device for out-of-hospital cardiac arrest. *Resuscitation.* 2011;82(12):1525-8.
13. Kette F, Reffo I, Giordani G, et al. The use of laryngeal tube by nurses in out-of-hospital emergencies: preliminary experience. *Resuscitation.* 2005;66(1):21-5.
14. Kurola JO, Turunen MJ, Laakso J-P, et al. A comparison of the laryngeal tube and bag-valve mask ventilation by emergency medical technicians: a feasibility study in anesthetized patients. *Anesth Analg.* 2005;101(5):1477-81.
15. Fiala A, Lederer W, Neumayr A, et al. EMT-led laryngeal tube vs. face-mask ventilation during cardiopulmonary resuscitation - a multicenter prospective randomized trial. *Scand J Trauma Resusc Emerg Med.* 2017;25(1):104.
16. Gerstein NS, Carey MC, Braude DA, et al. Efficacy of facemask ventilation techniques in novice providers. *J Clin Anesth.* 2013;25(3):193-7.
17. Hart D, Reardon R, Ward C, et al. Face mask ventilation: a comparison of three techniques. *J Emerg Med.* 2013;44(5):1028-33.
18. Heuer JF, Barwing J, Eich C, et al. Initial ventilation through laryngeal tube instead of face mask in out-of-hospital cardiopulmonary arrest is effective and safe. *Eur J Emerg Med.* 2010;17(1):10-5.
19. Länkimäki S, Alahuhta S, Kurola J. Feasibility of a laryngeal tube for airway management during cardiac arrest by first responders. *Resuscitation.* 2013;84(4):446-9.
20. Hagberg C, Bogomolny Y, Gilmore C, et al. An evaluation of the insertion and function of a new supraglottic airway device, the King LTTM, during spontaneous ventilation. *Anesthesia & Analgesia.* 2006;102(2):621-5.
21. Frascone RJ, Wewerka SS, Griffith KR, et al. Use of the King LTS-D during medication-assisted airway management. *Prehosp Emerg Care.* 2009;13(4):541-5.
22. Gruber E, Oberhammer R, Balkenhol K, et al. Basic life support trained nurses ventilate more efficiently with laryngeal mask supreme than with facemask or laryngeal tube suction-disposable—A prospective, randomized clinical trial. *Resuscitation.* 2014;85(4):499-502.
23. Martin PD, Cyna AM, Hunter WA, et al. Training nursing staff in airway management for resuscitation. A clinical comparison of the facemask and laryngeal mask. *Anaesthesia.* 1993;48(1):33-7.
24. Morse Z, Sano K, Kageyama I, et al. The relationship of placement accuracy and insertion times for the laryngeal mask airway to the training of inexperienced dental students. *Anesth Prog.* 2002;49(1):9-13.
25. Alexander R, Hodgson P, Lomax D, et al. A comparison of the laryngeal mask airway and Guedel airway, bag and facemask for manual ventilation following formal training. *Anaesthesia.* 1993;48(3):231-4.
26. Doerges V, Sauer C, Ocker H, et al. Airway management during cardiopulmonary resuscitation—a comparative study of bag–valve–mask, laryngeal mask airway and combitube in a bench model. *Resuscitation.* 1999;41(1):63-9.
27. Abdi W, Dhonneur G, Amathieu R, et al. LMA SupremeTM Versus

Facemask Ventilation Performed by Novices: A Comparative Study in Morbidly Obese Patients Showing Difficult Ventilation Predictors. *Obes Surg*. 2009;19(12):1624-30.

28. Garcia-Guasch R, Ferrà M, et al. Ease of ventilation through the cuffed oropharyngeal airway (COPA), the laryngeal mask airway and the face mask in a cardiopulmonary resuscitation training manikin. *Resuscitation.* 2001;50(2):173-7.
29. SOS-KANTO study group. Comparison of Arterial Blood Gases of Laryngeal Mask Airway and Bag-Valve-Mask Ventilation in Out-of-Hospital Cardiac Arrests. *Circ J.* 2009;73(3):490-6.
30. Dörges V, Wenzel V, Knacke P, et al. Comparison of different airway management strategies to ventilate apneic, nonpreoxygenated patients. *Crit Care Med.* 2003;31(3):800-4.
31. Stone BJ, Chantler PJ, Baskett PJ. The incidence of regurgitation during cardiopulmonary resuscitation: a comparison between the bag valve mask and laryngeal mask airway. *Resuscitation.* 1998;38(1):3-6.

Assessment of Vessel Density on Non-Contrast Computed Tomography to Detect Basilar Artery Occlusion

Andrew W. Asimos, MD*
D. Richard Sassano, BA†
Stephen C. Jackson, MD*
Jonathan D. Clemente, MD‡
Jeremy B. Rhoten, RN, BSN§
Brenda Chang, MS, MPH¶
Michael S. Runyon, MD, MPH*

*Atrium Health's Carolinas Medical Center, Department of Emergency Medicine, Charlotte, North Carolina
†Brody School of Medicine at East Carolina University, Greenville, North Carolina
‡Atrium Health's Carolinas Medical Center, Department of Radiology, Charlotte, North Carolina
§Atrium Health's Carolinas Medical Center, Department of Neurosciences, Charlotte, North Carolina
¶Atrium Health, Information and Analytics Services, Charlotte, North Carolina

Section Editor: Edward Sloan, MD
Submission history: Submitted September 16, 2019; Revision received November 20, 2019; Accepted December 6, 2019
Electronically published April 13, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2019.12.45247

Introduction: Basilar artery occlusion (BAO) may be clinically occult due to variable and non-specific symptomatology. We evaluated the qualitative and quantitative determination of a hyperdense basilar artery (HDBA) on non-contrast computed tomography (NCCT) brain for the diagnosis of BAO.

Methods: We conducted a case control study of patients with confirmed acute BAO vs a control group of suspected acute stroke patients without BAO. Two EM attending physicians, one third-year EM resident, and one medical student performed qualitative and quantitative assessments for the presence of a HDBA on axial NCCT images. Our primary outcome measures were sensitivity and specificity for BAO. Our secondary outcomes were inter-rater and intra-rater reliability of the qualitative and quantitative assessments.

Results: We included 60 BAO and 65 control patients in our analysis. Qualitative assessment of the hyperdense basilar artery sign was poorly sensitive (54%–72%) and specific (55%–89%). Quantitative measurement improved the specificity of hyperdense basilar artery assessment for diagnosing BAO, with a threshold of 61.0–63.8 Hounsfield units demonstrating relatively high specificity of 85%–94%. There was moderate inter-rater agreement for the qualitative assessment of HDBA (Fleiss' kappa statistic 0.508, 95% confidence interval: 0.435–0.581). Agreement improved for quantitative assessments, but still fell in the moderate range (Shrout-Fleiss intraclass correlation coefficient: 0.635). Intra-rater reliability for the quantitative assessments of the two attending physician reviewers demonstrated substantial consistency.

Conclusion: Our results highlight the importance of carefully examining basilar artery density when interpreting the NCCT of patients with altered consciousness or other signs and symptoms concerning for an acute basilar artery occlusion. If the Hounsfield unit density of the basilar artery exceeds 61 Hounsfield units, BAO should be highly suspected. [West J Emerg Med. 2020;21(3)694-702.]

INTRODUCTION

For emergency physicians (EP), acute basilar artery occlusion (BAO) is an easily missed, devastating type of ischemic stroke. Since BAO results in brainstem, cerebellar, or thalamic compromise, patients can initially present with a broad range of signs and symptoms, including headache, neck pain, visual symptoms, vertigo, nausea, vomiting, altered consciousness, and impaired gait.[1-4] Frequently, this progresses to serious sequelae, including seizures, tetraplegia, locked-in syndrome, or death.[5] BAO has the highest mortality rate of all

types of ischemic stroke,[6] with a morbidity and mortality rate of acute BAO of 80%–90% without active intervention.[7] The era of mechanical thrombectomy has considerably elevated the importance of early identification of acute BAO.[8] A recent meta-analysis examining the relationship between recanalization of acute BAO and clinical outcomes from 45 studies (n = 2056), reported a twofold and 1.5-fold reduction in mortality and risk of death or dependency, respectively.[9] Furthermore, outcome after BAO is largely dependent on early recanalization, highlighting the importance of early detection.[10-13]

While computed tomography angiography (CTA) is increasingly being performed as part of the initial imaging of patients suspected to have acute ischemic strokes involving the anterior circulation of the brain, due to the varied presentation of BAO, non-contrast computed tomography (NCCT) of the brain is often the only initial imaging modality obtained for these patients. Additionally, the interpreting radiologist is often not provided enough clinical information to consider and carefully evaluate for a BAO, so scrutiny is rarely applied by radiologists in assessing the basilar artery. While the hyperdense middle cerebral artery (MCA) sign has been studied extensively and may be identified in 35-67% of patients with clinical MCA stroke,[14-17] a "hyperdense basilar artery sign" (HDBA) is considerably less established. Reasons for this include concerns that posterior fossa artifact may alter the vessel density and the lack of a comparable (paired) artery to evaluate for asymmetry. Furthermore, the ability of EPs to assess the presence of a HDBA has never been reported. If EPs can reliably assess for a BAO by identifying an HDBA with sufficient accuracy to help guide immediate performance of a confirmatory CTA, this could lead to earlier identification of BAO, especially when the initial interpreting radiologist overlooks an HDBA. This has the potential to dramatically affect the outcome for some patients eligible for mechanical thrombectomy.

We aimed to do the following: 1) investigate the diagnostic accuracy and agreement of qualitative assessment of the HDBA sign on NCCT by EPs and a novice reader in patients with a CTA or digital subtraction angiography (DSA)-proven BAO; and 2) determine whether the quantitative Hounsfield unit (HU) BA density measured by EPs could increase accuracy and reliability over the qualitative assessment.

Population Health Research Capsule

What do we already know about this issue?
In patients with basilar artery occlusions, qualitative and quantitative assessment by radiologists of basilar artery density on computed tomography has been previously reported.

What was the research question?
To investigate the accuracy and agreement of these measurements by emergency physicians and a novice reader.

What was the major finding of the study?
A measurement above 61 Hounsfield units is highly specific for a basilar artery occlusion.

How does this improve population health?
These findings have the potential to improve the health of patients with basilar artery occlusion through earlier detection and treatment.

METHODS

Study Design

We conducted a case control study of patients with confirmed acute BAO vs a control group of acute stroke patients without BAO. Our institutional review board reviewed this study and determined it met criteria for waiver of authorization and expedited review.

Study Setting and Population

We identified patients admitted to our comprehensive stroke center with a BAO by conducting a query of our institutional database (Premier Inc., Charlotte, NC) for the following *International Classification of Diseases*-9/10 codes during 2015–2017: I65.1, 433.00, 433.01, 433.20, 433.21, 433.30, 433.31, 433.90, I63.02, and I63.12. Additionally, we queried our stroke center's database of suspected acute stroke patients to identify patients diagnosed with a stroke caused by an acute BAO. Patients identified in these queries were excluded if they did not have a BAO identified in a board-certified neuroradiologist's imaging report of a CTA or DSA. Additionally, all CTA and DSA studies of BAOs were re-interpreted by a neuroradiologist (JDC) to confirm the presence of a total vs partial BAO. Occlusions were further classified as to whether they were limited to the basilar artery apex.

We excluded patients without an initial NCCT and confirmatory BAO identified on a CTA or DSA performed within 12 hours of the initial NCCT. Additionally, we excluded patients treated with systemic thrombolytics or mechanical thrombectomy between performance of the NCCT and CTA, MRA or DSA. This yielded 60 confirmed BAO patients. Our control patients consisted of 65 emergency department (ED)-suspected acute stroke patients randomly selected from our stroke center's database (REDCap) who met the following criteria: performance of brain NCCT and CTA studies of both the head and neck within the time specifications described above and without an arterial occlusion or dissection identified on any CTA.

Measurements

We randomly loaded the 4–5 millimeter (mm) NCCT axial imaging slice series of all patients into an imaging

database. To assess intra-rater reliability, a subset of the BAO and control CTs were loaded twice. Four reviewers, consisting of two attending EPs, a third-year emergency medicine (EM) resident, and a medical student, performed the measurements described below. The two attending physician investigators have 26 and 16 years of experience as emergency practitioners. A medical student was chosen to participate to determine if a novice clinician could perform the measurements after the instruction described below. The medical student's qualitative assessments were performed on all scans. His quantitative assessments were limited to only 38 BAO and 49 control patients, since he did not have access to the picture archiving and communication system (PACS) Hounsfield unit (HU) measurement software for all measurements, as some cases were added to the study sample after completion of the student's summer research externship. All reviewers were blinded to the CTA/DSA images, the neuroradiologist's CTA/DSA interpretation, and each other's measurements. Reviewers were not provided with any patient history or exam findings.

Development and delivery of investigator instruction on assessing basilar artery density on NCCT was performed by AWA. At the outset of the trial, all clinicians performing measurements received a 30-minute tutorial of basilar artery anatomy, its identification on axial NCCT images, qualitative assessment for a segment of hyperdensity, and the quantitative measurement described below. In the authors' opinions, once the relevant anatomy is understood, the basilar artery is readily identified as a midline vessel ventral to the medulla and pons on axial NCCT slices of those regions.

First, each reviewer made a qualitative "yes/no" determination regarding the subjective presence of an HDBA based on scrolling through the axial slices covering the levels from the medulla to the midbrain. Next, on the axial slice in which the BA was determined to be most dense, the HU measurement of what was judged to be the BA artery was measured as follows: we zoomed the image to 400% and a circular region of interest measurement was obtained of the basilar artery density using Intellispace PACS, Enterprise Version 4.4.532.11 (Philips, N.V. Amsterdam, Netherlands). Each reviewer was instructed to exclude from the boundaries of the region of interest (ROI) any areas deemed to be beyond the margins of the artery and to limit the ROI circle circumference to the most homogeneously dense portion of the vessel possible (Figure 1). Additionally, we specifically asked each reviewer to document their qualitative assessment first to avoid any bias associated with the subsequent HU measurement.

All study measurements were entered directly by each reviewer into a REDCap database. Additionally, stroke program data abstractors, who were blinded to the basilar artery density measurements, extracted demographic and clinical characteristics for each patient from a prospectively maintained institutional database of patients who present to the ED with suspected acute stroke symptoms.

Outcome Measures

Our primary outcome measures were sensitivity and specificity for BAO, based on the qualitative determination of the HDBA, with the aim to determine whether the quantitative HU BA density measured by EPs could increase accuracy over the qualitative assessment. Our secondary outcomes were intra-rater and inter-rater reliability of the qualitative and quantitative assessments.

Data Analysis

Our reference standard for calculation of sensitivity and specificity was a CTA or DSA confirming partial or total BAO based on interpretation by a board-certified neuroradiologist. We used Fleiss' kappa statistic to evaluate inter- and intra-rater reliability for the presence of HDBA as referenced against the interpretation of a neuroradiologist. The Shrout-Fleiss intraclass correlation coefficient (ICC 2,1) was used to evaluate single measures inter- and intra-rater reliability with absolute agreement and consistency of scores, respectively.[18] We interpreted the categorical variable agreement according to the method of Landis and Koch.[19] For the intraclass correlation coefficient (ICC) classifications, we used the categorization recommended by Koo and Li.[20] We performed receiver operating characteristic (ROC) curve analysis to identify the optimal cut point of the HU BA lumen attenuation measurement associated with BAO presence. The optimal cut point was determined by maximizing sensitivity and specificity (Youden's index).

RESULTS

Our analysis included 60 BAO patients and 65 control patients (Table 1). There were no statistically significant differences in demographic, clinical, or imaging characteristics between the two groups, other than the initial National Institutes of Health (NIH) Stroke Scale score. Among BAO patients, qualitative assessment for the HDBA sign performed inadequately to be of diagnostic utility in determining presence or absence of BAO on NCCT (Table 2). ROC curves for the quantitative measurements of each reviewer are shown in Figure 2. The data in Table 3 demonstrate that quantitative assessment improves the specificity of HDBA assessment for diagnosing BAO over subjective assessment. There was moderate inter-rater agreement for the qualitative assessment of HDBA presence (Fleiss' kappa statistic 0.508, 95% confidence interval [CI], 0.435–0.581). Agreement improved for the quantitative assessments, but still fell in the moderate range (Shrout-Fleiss ICC 0.635, 95% CI, 0.624–0.982). Intra-rater consistency ranged from moderate to substantial among the four readers and improved to substantial for the two attending physician reviewers for the quantitative assessments (Table 4).

DISCUSSION

Our study represents the first published assessment of HDBA by EPs and includes the largest number of

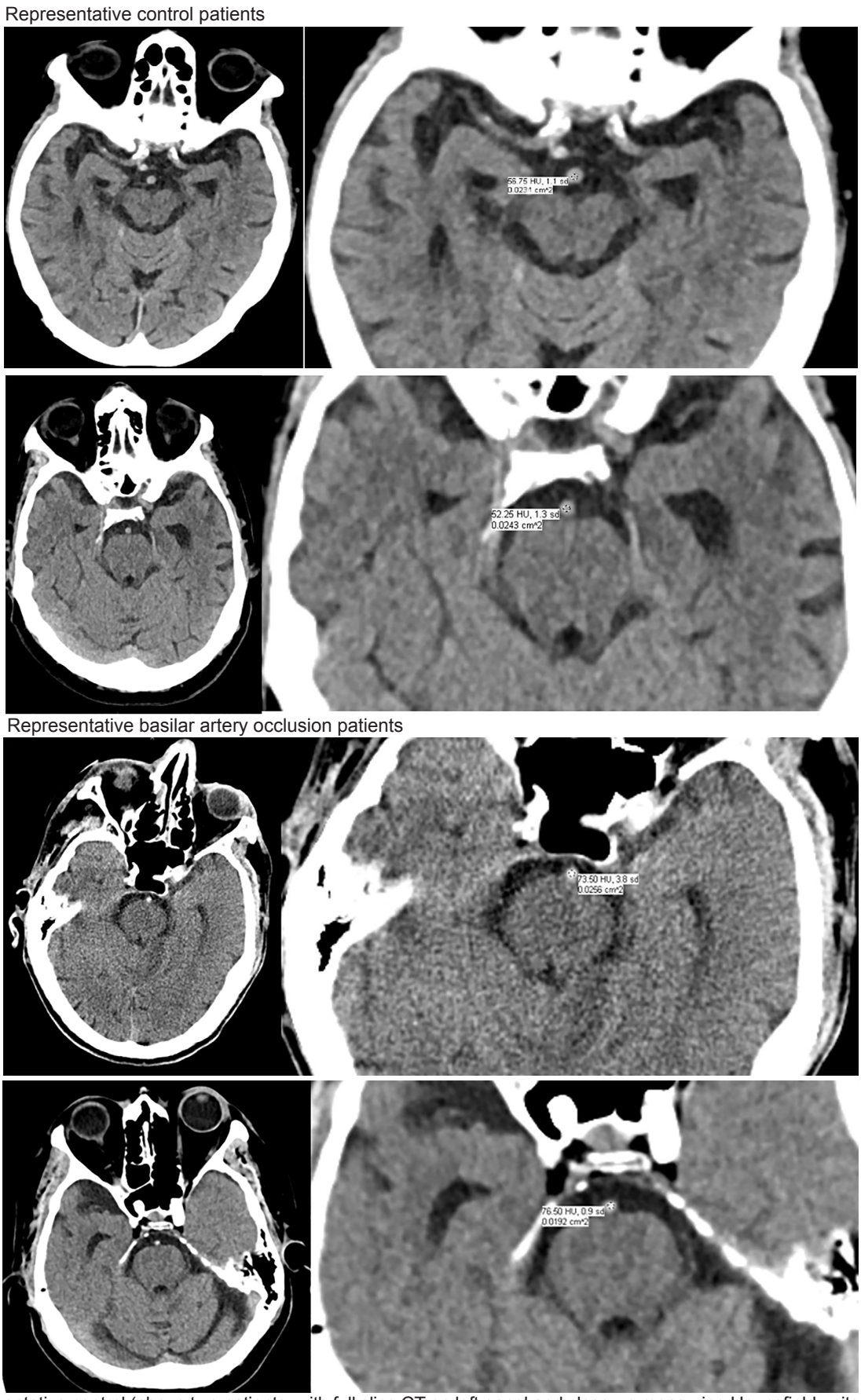


Figure 1. Representative control (above two patients, with full slice CT on left panel and close-up measuring Hounsfield units of basilar artery on right panel) vs basilar artery occlusion (bottom two patients).

Table 1. Demographic, clinical, and computed tomography (CT) characteristics.

	Occlusion (n=60)				Control (n=65)				
	N	%	Mean	Std Dev	N	%	Mean	Std Dev	P-value
Demographic characteristics									
Age	60	100	66.6	14.7	65	100	64.4	16.6	0.429
Median (IQR)			68	(57-78)			66	(51-77)	
Gender									0.061
Male	35	58.3			27	41.5			
Female	25	41.7			38	58.5			
Race									0.760
Caucasian	43	71.7			43	66.2			
African American	13	21.7			17	26.2			
Asian	2	3.3			1	1.5			
Missing	2	3.3			3	4.6			
Ethnicity									0.236
Hispanic	1	1.7			1	1.5			
Non-Hispanic	33	55.0			47	72.3			
Missing	26	43.3			17	26.2			
Clinical characteristics									
Initial NIHSS	41	68.3	13.2	10.3	62	95.4	2.7	4.1	<0.001
Median (IQR)			10.5	(4-22)			1	(0-4)	
Hypertension	50	83.3			49	75.4			0.274
Diabetes	16	26.7			25	38.5			0.161
Hyperlipidemia	29	48.3			36	55.4			0.677
Atrial fibrillation	14	23.3			10	15.4			0.260
Smoking	17	28.3			17	26.2			0.784
Hematocrit	60	100	42.2	5.1	65	100	40.5	6.6	0.199
Median (IQR)			211	(173-257)			229	(186-264)	
Platelet count	60	100	226	77	65	100	237	73	0.444
Median (IQR)			211	(173-257)			229	(186-264)	
Type of basilar occlusion									
Total	24	40.0			0	0			
Partial	19	31.7			0	0			
Total (Apex)	10	16.7			0	0			
Partial (Apex)	7	11.7			0	0			
CT scanning specifications									
Number of detectors									0.057
≥64 detectors	40	66.7			53	81.5			
<64 detectors	20	33.3			12	18.5			
Voltage (kilovoltage peak [kVp])									0.633
80	3	5.0			3	4.6			
100	1	1.7			0	0.0			
120	56	93.3			62	95.4			
Current (millampere-seconds [mAs])	60	100	261	111	65	100	284	57	0.133
Median (IQR)			263	(168-322)			280	(264-314)	

Std Dev, standard deviation; *IQR*, interquartile range; *NIHSS*, National Institutes of Health Stroke Scale. Comparisons between the occlusion and control group for categorical variables (gender, race, ethnicity, comorbidities, etc.) and continuous variables were made using chi-square tests and two-sample independent t-tests, respectively. Comparisons for voltage were made using the Kruskal-Wallis test.

Table 2. Subjective assessment of hyperdense basilar artery (HDBA) presence with basilar artery occlusion.

Reviewer	Sensitivity (95% CI)	Specificity (95% CI)
Attending EP 1	0.54 (0.41–0.67)	0.89 (0.79–0.96)
Attending EP 2	0.63 (0.50–0.75)	0.60 (0.47–0.72)
Resident EP	0.63 (0.49–0.75)	0.55 (0.43–0.68)
Medical Student	0.72 (0.59–0.83)	0.69 (0.57–0.80)

CI, confidence interval; *EP*, emergency physician.

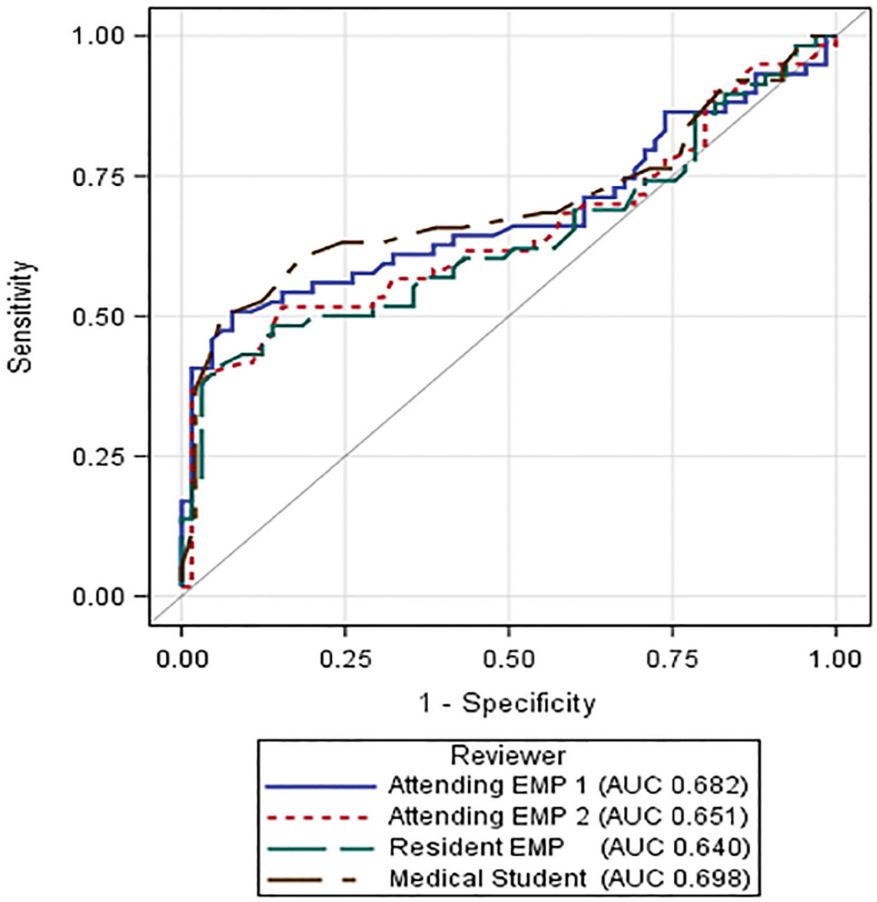


Figure 2. Receiver operating characteristics curve by reviewer for basilar artery density quantitative measurements . *EMP*, emergency physician; *AUC*, area under the curve.

Table 3. Optimal cut points for basilar artery density measurement (HU) of basilar artery occlusion.

Reviewer	Cut point	Sensitivity (95% CI)	Specificity (95% CI)	Area under the curve (95% CI)*
Attending EP 1	61.8	0.51 (0.37–0.64)	0.92 (0.85–0.98)	0.68 (0.58–0.78)
Attending EP 2	61.3	0.52 (0.38–0.63)	0.85 (0.75–0.94)	0.65 (0.55–0.75)
Resident EP	63.8	0.41 (0.29–0.55)	0.94 (0.88–0.98)	0.64 (0.54–0.74)
Medical Student	61.0	0.50 (0.34–0.66)	0.94 (0.65–1.00)	0.70 (0.58–0.82)

HU, Hounsfield unit; *EP*, emergency physician; *CI*, confidence interval
*95% confidence intervals for the sensitivity and specificity at optimal cut points were bootstrapped with 2000 replicates, while the 95% confidence intervals for the area under the curve were obtained using DeLong's method.

Table 4. Intra-rater consistency of qualitative and quantitative assessments.*

	Qualitative assessment of HDBA presence: Fleiss' kappa statistic (95% CI)	Quantitative Measurement of Basilar Artery Density (HU): Shrout-Fleiss ICC – Consistency (95% CI)
Attending EP 1	0.85 (0.69-1.02)	0.90 (0.84-0.94)
Attending EP 2	0.67 (0.43-0.91)	0.85 (0.76-0.91)
Resident EP	0.71 (0.48-0.93)	0.38 (0.15-0.58)
Medical Student	0.67 (0.44-0.90)	

EP, emergency physician; *HDBA*, hyperdense basilar artery; *HU*, Hounsfield unit; *ICC*, interclass correlation coefficient.
*The number of duplicate reads was 43, except for the resident who lacked one duplicate read for the quantitative measurements. The medical student performed 43 duplicate reads on only the qualitative assessments.

BAO patients ever studied to evaluate HDBA. Since EPs routinely have greater knowledge of the clinical context prompting NCCT performance, and radiologists rarely comment qualitatively or quantitatively on the BA density, it is important to understand the proficiency, reliability, and accuracy of emergency medicine (EM) providers in assessing for an HDBA. Furthermore, understanding the performance of qualitative assessment alone vs quantitative assessment is essential. Our results indicate that subjective determination of HDBA by EM providers is insufficiently reliable and accurate.

However, quantitative HU measurement, which is a consistent capability of any digital imaging and communications in medicine reading software, at a consistent cutoff value above 61.0–63.8 greatly improved the specificity for identifying BAO. Moreover, our data suggest in a clinical scenario potentially consistent with a BAO, an HDBA with a HU measurement above 61 is highly specific for a BAO. This should prompt immediate consideration of this important and time-sensitive diagnosis. Nonetheless, despite the improved specificity, our results indicate that quantitative assessment of BA density on NCCT is insensitive for identifying a BAO.

Our findings differ somewhat from those found in other studies, which evaluated assessment of the HDBA by neuroradiologists and other experienced readers. In a study of three radiologists with varying degrees of neuroradiology expertise and overall experience, Connell et al reported similar sensitivities and specificities to ours for qualitative determinations for an HDBA.[21] Alternatively, in two studies of neuroradiologist readers, the sensitivity of visual detection of the HDBA on NCCT was higher (81% and 71%[22-23]), as was the specificity (91% and 98%).[22-23] Importantly, in both studies the image readers were aware that all patients were imaged for a possible BAO or other posterior circulation stroke, which most likely elevated pretest probability compared with our study.

Additionally, the studies performed by Ernst et al, Connell et al, and a much earlier and smaller study by Vonofakos et al,[24] found the highest accuracy cutoff value for detection of BAO to be lower than that found in our study (40.0–46.5 HU and 61.0–63.8, respectively). Differing scanning parameters, newer generation scanning technology, or software differences in obtaining the HU measurements may explain the difference in the higher cutoff found in our study. Also, we relied on a more standard routine head CT slice thickness of 4-5 mm, while the other three studies used thicknesses down to 2 mm.

Despite the improved diagnostic specificity that quantitative measurements of a perceived HDBA may provide, NCCT is still a method that delivers an unacceptable percentage of false negative results in the diagnostic work-up of BAO. Furthermore, because of the high morbidity and mortality of untreated BAO, and because of its variable and fluctuating clinical presentation, obtaining a CTA, MRA, or DSA is essential when BAO is in the differential diagnosis. Nonetheless, we recognize that frequently only NCCT will be initially performed on many BAO patients.

BAO patients include those who present with the so-called "five Ds" of posterior circulation stroke, which include dizziness, diplopia, dysarthria, dysphagia, and dystaxia. Additionally, we recognize that in many of the most compelling presentations of BAO, such as altered consciousness, NCCT may only initially be performed, since intracerebral, subarachnoid, or intraventricular hemorrhage is frequently suspected. Our results suggest when those are not found, performing a HU measurement of the BA is a worthwhile undertaking by the EP. If he or she lacks this ability, the radiologist can assist in measuring the BA density at its most dense axial slice. Furthermore, if the density is above 61 HU in a clinical scenario concerning for a BAO, this devastating diagnosis should be considered and immediately pursued by performing a CTA in most cases.

Over 20 years ago, Perron and Kline introduced the "Blood Can Be Very Bad" mnemonic as a standardized method of cranial CT interpretation for EPs.[25] "Blood" reminds the examiner to search for blood; "Can" prompts the examiner to identify four key cisterns; "Be" denotes the need to examine the brain; "Very" prompts a review of the four ventricles; and "Bad" reminds the examiner to evaluate the bones of the cranium. We propose that mnemonic be expanded to "Blood Can Be Very, Very Bad" to additionally remind EM practitioners to assess the density of "vessels," not only qualitatively but also quantitatively in the appropriate scenarios. Additionally, our reliability data suggest that in the context of teaching this structured approach to reviewing a

cranial CT, EM trainees may benefit from modest education in locating and assessing the basilar artery on CT.

LIMITATIONS

CT scanners used were produced by several different manufacturers with inconsistent machine characteristics, which may have impacted the consistency of basilar artery density and HU measurements obtained for both BAO and control patients.[26] However, as demonstrated in Table 1, CT scanner characteristics were similar between both patient groups, and the majority of all patients had a voltage of 120 kilovoltage peak and similar mean and median tube currents. Control patients were randomly selected based on the criteria described in the methods, but were not matched based on clinical or imaging characteristics. Nonetheless, as detailed in Table 1, BAO and control patients had similar demographic, clinical, and imaging characteristics.

The interpreting EPs and student were unaware of the patients' symptoms and signs. However, we purposefully chose this study design, as the clinical presentation of patients with BAO can be broad. This correlates to an initial assessment of many BAO patients that only includes a NCCT with thick slices reported, rather than performance of an NCCT with thin slices and inclusion of an intracranial CTA. Especially since some of our patients had only partial BAOs, or had occlusions limited to the apex of the basilar artery, we recognize that CTs with thinner slices may be more likely to demonstrate an HDBA in the setting of a BAO. However, we believe that our methodology of including all patients with any degree of BAO and examining for HDBA on 4–5 mm NCCT slices represents a relatively conservative, "real-world" investigation of the clinical utility of qualitative and quantitative assessment of the HDBA sign.

Finally, none of the CT interpreters in our study received formal neuroradiological training. It is unclear what amount of training would be needed by average EM practitioners to identify and measure basilar artery density reliably, but our data suggest that at least some minimal training would be required by EM trainees to perform the assessments described in this work.

CONCLUSION

Our results highlight the importance of carefully examining basilar artery density when the NCCT does not show a hemorrhage or other obvious intracranial abnormality to explain altered consciousness or other signs and symptoms potentially referable to the posterior cranial circulation. Furthermore, if the HU density of the BA exceeds 61 HU, BAO should be highly considered. With the rapid progress of artificial intelligence and machine learning in CT interpretation, we anticipate the presence of an HDBA may be identified by a computer in the future. Until such an advancement is integrated into clinical practice, EM practitioners should consider quantitatively assessing the basilar artery in the appropriate clinical scenarios.

Address for Correspondence: Andrew W. Asimos, MD, Atrium Health's Carolinas Medical Center, Department of Emergency Medicine, 1000 Blythe Blvd., Charlotte, NC 28203. Email: andrew.asimos@atriumhealth.org.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Mahawish K. Hyperdense basilar artery sign. *BMJ Case Rep*. 2015. Available at: http://dx.doi.org/10.1136/bcr-2015-209317. Accessed September 16, 2019.
2. Goto H, Tanaka T, Yoshida M, et al. Hyperdense basilar artery sign. *Intern Med.* 2015;54(8):991-2.
3. Voetsch B, DeWitt LD, Pessin MS, et al. Basilar artery occlusive disease in the New England Medical Center Posterior Circulation Registry. *Arch Neurol.* 2004;61(4):496-504.
4. Demel SL, Broderick JP. Basilar occlusion syndromes: an update. *Neurohospitalist.* 2015;5(3):142-50.
5. Ferbert A, Brückmann H, Drummen R. Clinical features of proven basilar artery occlusion. *Stroke.* 1990;21(8):1135-42.
6. Mortimer AM, Bradley M, Renowden SA. Endovascular therapy for acute basilar artery occlusion: a review of the literature. *J Neurointerv Surg.* 2012;4(4):266-73.
7. Yeung JT, Matouk CC, Bulsara KR, et al. Endovascular revascularization for basilar artery occlusion. *Interv Neurol.* 2015;3(1):31-40.
8. Nagel S, Kellert L, Möhlenbruch M, et al. Improved clinical outcome after acute basilar artery occlusion since the introduction of endovascular thrombectomy devices. *Cerebrovasc Dis.* 2013;36(5-6):394-400.
9. Kumar G, Shahripour RB, Alexandrov AV. Recanalization of acute basilar artery occlusion improves outcomes: a meta-analysis. *J Neurointerv Surg.* 2015;7(12):868-74.
10. Smith WS. Intra-arterial thrombolytic therapy for acute basilar occlusion: pro. *Stroke.* 2007;38(2 Suppl):701-3.
11. Hacke W, Zeumer H, Ferbert A, et al. Intra-arterial thrombolytic therapy improves outcome in patients with acute vertebrobasilar occlusive disease. *Stroke.* 1988;19(10):1216-22.
12. Brandt T, von Kummer R, Muller-Kuppers M, et al. Thrombolytic therapy of acute basilar aretry occlusion: variables affecting recanalization and outcome. *Stroke.* 1996;27(5):875-81.
13. Vergouwen MDI, Algra A, Pfefferkorn T, et al. Time is brain(stem) in

basilar artery occlusion. *Stroke.* 2012;43(11):3003-6.
14. Tomsick T, Brott T, Barsan W, et al. Thrombus localization with emergency cerebral CT. *AJNR Am J Neuroradiol.* 1992;13(1):257-63.
15. Bastianello S, Pierallini A, Colonnese C, et al. Hyperdense middle cerebral artery CT sign. Comparison with angiography in the acute phase of ischemic supratentorial infarction. *Neuroradiology.* 1991;33(3):207-11.
16. Lövblad K-O, Baird AE. Computed tomography in acute ischemic stroke. *Neuroradiology.* 2010;52(3):175-87.
17. von Kummer R, Meyding-Lamadé U, Forsting M, et al. Sensitivity and prognostic value of early CT in occlusion of the middle cerebral artery trunk. *AJNR Am J Neuroradiol.* 1994;15(1):9-15; discussion 16-8.
18. Shrout PE, Fleiss JL. Intraclass correlations: uses in assessing rater reliability. *Psychol Bull.* 1979;86(2):420-8.
19. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics.* 1977;33(1):159-74.
20. Koo TK, Li MY. A guideline of selecting and reporting intraclass correlation coefficients for reliability research. *J Chiropr Med.* 2016;15(2):155-63.
21. Connell L, Koerte IK, Laubender RP, et al. Hyperdense basilar artery sign-a reliable sign of basilar artery occlusion. *Neuroradiology.* 2012;54(4):321-7.
22. Ernst M, Romero JM, Buhk J-H, et al. Sensitivity of hyperdense basilar artery sign on non-enhanced computed tomography. *PLoS One.* 2015;10(10):e0141096.
23. Goldmakher GV, Camargo ECS, Furie KL, et al. Hyperdense basilar artery sign on unenhanced CT predicts thrombus and outcome in acute posterior circulation stroke. *Stroke.* 2009;40(1):134-9.
24. Vonofakos D, Marcu H, Hacker H. CT diagnosis of basilar artery occlusion. *AJNR Am J Neuroradiol.* 1983;4(3):525-8.
25. Perron AD, Huff JS, Ullrich CG, et al. A multicenter study to improve emergency medicine residents' recognition of intracranial emergencies on computed tomography. *Ann Emerg Med.* 1998;32(5):554-62.
26. Zatz LM, Alvarez RE. An inaccuracy in computed tomography: the energy dependence of CT values. *Radiology.* 1977;124(1):91-7.

Presyncope Is Associated with Intensive Care Unit Admission in Emergency Department Patients with Acute Pulmonary Embolism

David R. Vinson, MD*†‡
Darcy C. Engelhart, MS§
Disha Bahl, BS¶
Alisha A. Othieno, BA‖
Ashley S. Abraham, BS‖
Jie Huang, PhD†
Mary E. Reed, DrPH†
William P. Swanson, MD‖#
Victoria A. Clague, MD, MPH*,**
Dale M. Cotton, MD*,††
William C. Krauss, MD#
Dustin G. Mark, MD*†,‡‡

*The Permanente Medical Group, Oakland, California
†Kaiser Permanente Division of Research, Oakland, California
‡Kaiser Permanente Sacramento Medical Center, Department of Emergency Medicine, Sacramento, California
§University of California, San Diego, La Jolla, California
¶St. George's University, School of Medicine, Grenada, West Indies
‖University of California, Davis, School of Medicine, Sacramento, California
#Kaiser Permanente San Diego Medical Center, Department of Emergency Medicine, San Diego, California
**Kaiser Permanente San Rafael Medical Center, Department of Radiology, San Rafael, California
††Kaiser Permanente South Sacramento Medical Center, Department of Emergency Medicine, Sacramento, California
‡‡Kaiser Permanente Oakland Medical Center, Department of Emergency Medicine, Oakland, California

Section Editor: Gabriel Wardi, MD
Submission history: Submitted August 30, 2019; Revision received January 4, 2020; Accepted February 12, 2020
Electronically published April 13, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.2.45028

Introduction: Syncope is common among emergency department (ED) patients with acute pulmonary embolism (PE) and indicates a higher acuity and worse prognosis than in patients without syncope. Whether presyncope carries the same prognostic implications has not been established. We compared incidence of intensive care unit (ICU) admission in three groups of ED PE patients: those with presyncope; syncope; and neither.

Methods: This retrospective cohort study included all adults with acute, objectively confirmed PE in 21 community EDs from January 2013–April 2015. We combined electronic health record extraction with manual chart abstraction. We used chi-square test for univariate comparisons and performed multivariate analysis to evaluate associations between presyncope or syncope and ICU admission from the ED, reported as adjusted odds ratios (aOR) with 95% confidence intervals (CI).

Results: Among 2996 PE patients, 82 (2.7%) had presyncope and 109 (3.6%) had syncope. ICU admission was similar between groups (presyncope 18.3% vs syncope 25.7%) and different than their non-syncope counterparts (either 22.5% vs neither 4.7%; p<0.0001). On multivariate analysis, both presyncope and syncope were independently associated with ICU admission, controlling for demographics, higher-risk PE Severity Index (PESI) class, ventilatory support, proximal clot location, and submassive and massive PE classification: presyncope, aOR 2.79 (95% CI, 1.40, 5.56); syncope, aOR 4.44 (95% CI 2.52, 7.80). These associations were only minimally affected when excluding massive PE from the model. There was no significant interaction between either syncope or presyncope and PESI, submassive or massive classification in predicting ICU admission.

Conclusion: Presyncope appears to carry similar strength of association with ICU admission as syncope in ED patients with acute PE. If this is confirmed, clinicians evaluating patients with acute PE may benefit from including presyncope in their calculus of risk assessment and site-of-care decision-making. [West J Emerg Med. 2020;21(3)703-713.]

INTRODUCTION

Patients with acute pulmonary embolism (PE) who present to the emergency department (ED) cross a wide severity spectrum: low-risk patients may be safe for expedited discharge and outpatient management;[1,2] intermediate-risk patients may require more prolonged cardiopulmonary monitoring and inpatient treatment; while high-risk patients may have or develop life-threatening hemodynamic instability and need aggressive care.[3] Initiating treatments that are tailored to patient needs requires reliable risk stratification,[4,5] a practice that is endorsed by international society guidelines.[6,7]

Syncope, a brief, fully reversible transient loss of consciousness and postural tone, is a common symptom among ED patients with acute PE, found in a large systematic review of nearly 22,000 cases to occur in approximately 17% of cases.[8] The true prevalence of syncope in ED patients with acute PE is unknown, however, and has varied widely by study, ranging from 6.8% to 29.9%.[8] That review found that unselected acute PE patients with syncope have more severe disease and worse prognosis than their non-syncopal counterparts.[8] Syncope is associated with higher prevalence of hemodynamic instability, echocardiographic signs of right ventricular dysfunction, as well as a higher risk of 30-day PE-related adverse outcomes and in-hospital or 30-day all-cause mortality. What marginal role syncope plays in assigning PE patients to escalating risk strata is unclear, and only a few prognostic instruments include syncope among their prediction variables.[5]

Presyncope, also known as near-syncope, is the sensation of imminent syncope, but absent a complete loss of consciousness. The prevalence of presyncope in patients with acute PE is unclear. Whether presyncope carries the same implications as syncope in PE patients is unknown, as presyncope has been less commonly studied. Few studies of acute PE identify presyncope in their population,[9,10] and often fail to distinguish presyncopal from syncopal patients in their analysis.[9] The aforementioned systematic review of syncope and PE makes no mention of presyncope.[8]

Of the 29 studies in the review, only one included presyncopal patients. The world's largest contemporary registry of PE, the RIETE (Registro Informatizado de Enfermedad TromboEmbólica), includes syncope in its dataset, but not presyncope, and the same is true with other registries.[11,12] The assumption, though, that presyncopal patients should be grouped with syncopal patients for analysis is not altogether unjustified. A large, 11-center prospective study of all-comers (not restricted to PE) with syncope and presyncope in 3581 ED adults ≥60 years of age found that presyncope confers similar risks as syncope for the composite outcome of death or serious clinical event.[13] Whether PE patients with presyncope and syncope also have similar outcomes has not been established – only 1% of this larger syncopal population was diagnosed with acute PE.

We undertook this secondary analysis of a multicenter, community-based cohort of United States ED patients with objectively confirmed PE to compare presyncopal with syncopal patients in terms of clinical and radiographic characteristics. We hypothesize that presyncope is as important an historical variable as syncope in the evaluation of ED patients with acute PE as both are associated with intensive care unit (ICU) admission, our primary outcome. If this hypothesis is confirmed, clinicians and researchers evaluating patients with acute PE may benefit from including presyncope in their calculus of risk assessment and site-of-care decision-making.

Population Health Research Capsule

What do we already know about this issue?
Syncope in patients with acute pulmonary embolism (PE) indicates a worse prognosis than in those without syncope.

What was the research question?
Is presyncope associated with intensive care unit (ICU) admission in emergency department (ED) patients with acute PE?

What was the major finding of the study?
Presyncope, like syncope, is associated with ICU admission in ED patients with PE, even when adjusted for high-risk variables.

How does this improve population health?
Asking patients with acute PE about presyncope and syncope may inform risk assessment and site-of-care decision-making, as these risk factors support hospitalization over home discharge.

METHODS

Study Design and Setting

We performed a planned secondary analysis of the MAPLE (Management of Acute PuLmonary Embolism) dataset.[14-16] MAPLE is a retrospective cohort study conducted from January 2013–April 2015 in all 21 community medical centers across Kaiser Permanente (KP) Northern California, a large integrated healthcare system that provides comprehensive medical care for more than four million members with approximately 1.2 million ED visits per year. KP members include at least 33% of the population in areas served and are representative of the demographic and socioeconomic diversity of the surrounding and statewide population.[17,18] Characteristics of the 21 medical centers at the time of the study are reported elsewhere.[14] This study was approved by the institutional review board of KP Northern California, which granted a waiver of informed consent due to the observational nature of the study.

Care for patients with PE was at the discretion of the treating physicians. The only structured guidance for PE management

occurred during the final eight months of the 28-month MAPLE study, during which an electronic clinical decision support tool was implemented at select sites to aid emergency physicians with site-of-care decision-making: home vs hospital. It did not address indications for ICU admission. The tool included presyncope and syncope in a list of relative contraindications to home management. Details of the eSPEED (electronic Support for Pulmonary Embolism Emergency Disposition) controlled pragmatic trial are reported elsewhere.[1]

Indications for ICU admission of PE patients in our EDs are not protocolized. The primary reasons for ICU admission of PE patients are current or anticipated hemodynamic instability or respiratory insufficiency. PE patients are admitted to the ICU also for close monitoring after receiving catheter-directed thrombolytics.

Selection of Participants, Data Collection and Processing

We included a consecutive series of adult ED patients ≥18 years of age with acute, objectively confirmed PE diagnosed in the ED or in the preceding 12 hours, as we have described previously.[14,15] We depict the cohort assembly in Figure 1.

We combined electronic health record (EHR) extraction with manual chart abstraction. Thirteen practicing emergency physicians abstracted variables from the EHRs after receiving standardized training on data collection methods and use of the electronic data collection instrument, which was modified to its final form after pilot testing.[14] A second reviewer abstracted specified variables on a randomly selected subset of 90 cases from the larger MAPLE study of 2996 patients to measure inter-rater reliability, the results of which have been reported elsewhere.[15] Any case of syncope or presyncope was confirmed by a second abstractor blinded to the initial review, and arbitrated by a third abstractor if necessary.

We defined syncope as an abrupt, transient, and complete loss of consciousness with loss of postural tone, followed by rapid, spontaneous recovery. We defined presyncope as the sensation of imminent syncope, that is, an abrupt, transient feeling of nearly fainting or losing consciousness, followed by

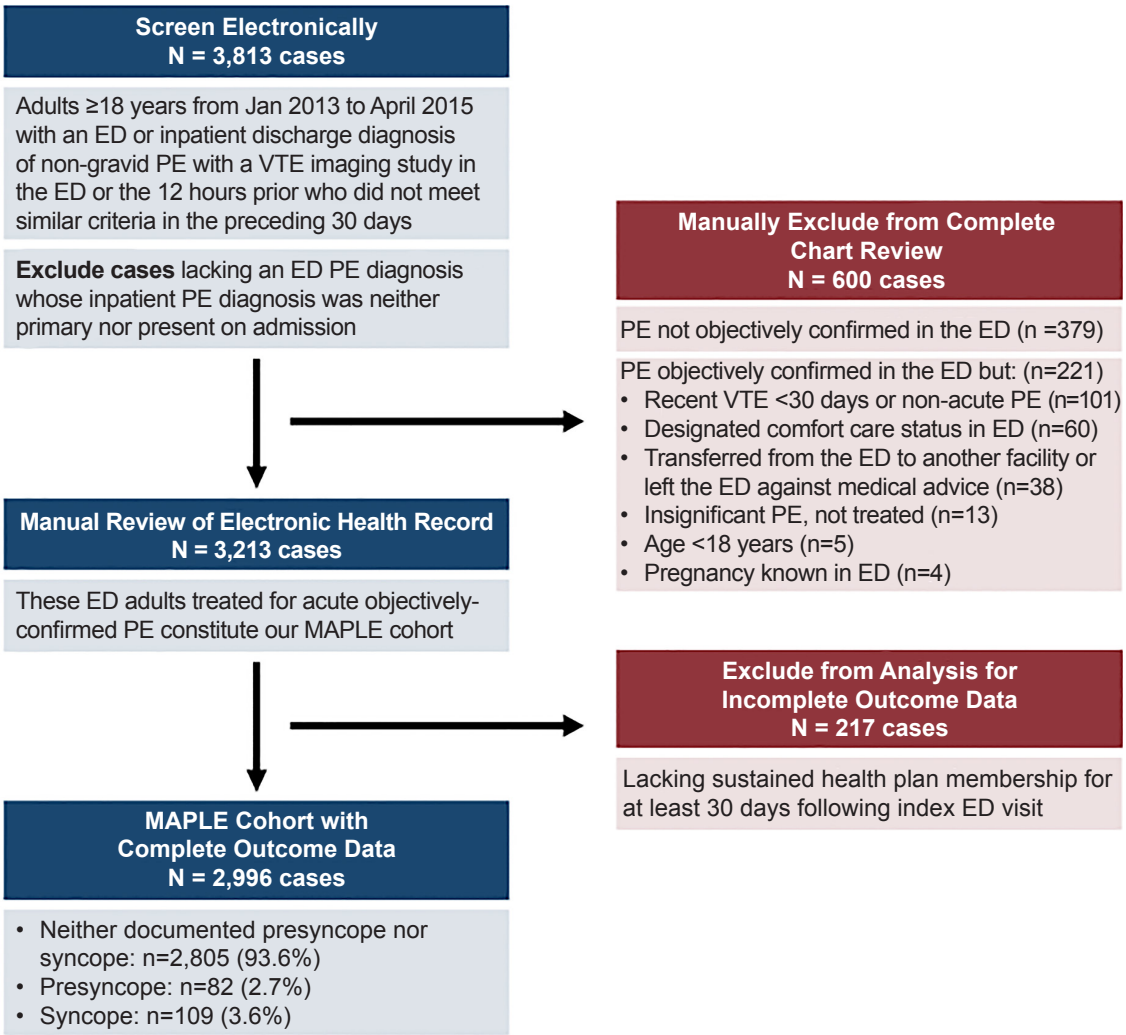


Figure 1. Cohort assembly of emergency department patients with acute pulmonary embolism.
ED, emergency department; *MAPLE,* Management of Acute PuLmonary Embolism study; *PE*, pulmonary embolism; *VTE*, venous thromboembolism.

rapid, spontaneous recovery as documented by the emergency physician or consultant physician. Non-specific dizziness and light-headedness were not sufficient to constitute presyncope. We provided hypothetical patient quotes to our abstractors to illustrate the study definition of presyncope: "I almost fainted"; "I had to lay down because I felt like I was going to pass out"; "My vision darkened, I got hot and sweaty and nearly lost consciousness."

We have previously described our calculation of the PE Severity Index (PESI).[19] Proximal clots involved lobar or main pulmonary arteries.[14] We classified ED patients as having massive PE who had systolic blood pressure <90 millimeters of mercury sustained over 15 minutes or more, received vasopressors or required cardiopulmonary resuscitation, not caused by new-onset arrhythmia, hypovolemia, or septic shock.[6,7,20] We classified ED patients as having submassive PE who did not meet massive PE criteria yet had an elevated ED troponin level (above the 99th percentile), an elevated B-type natriuretic peptide (>100 picograms per milliliter), or right ventricular dysfunction on echocardiogram. Findings of right ventricular enlargement on computed tomography pulmonary angiography (CTPA) were infrequently reported.[21] Nearly all of the patients with abnormal right ventricular findings on CTPA were also positive for right ventricular strain by the criteria listed above.

The interventions we measured were as follows: ED ventilatory support included non-rebreather mask; positive-pressure ventilation; and mechanical ventilation. Advanced clot treatment included systemic thrombolysis, catheter-directed thrombolysis, and embolectomy.

Primary and Secondary Outcomes

Our primary outcome was ICU admission from the ED. This included patients who en route from the ED to the ICU passed through the interventional radiology suite for catheter-directed thrombolysis, an infrequent occurrence during the study period. Secondary outcomes included 30-day major hemorrhage, recurrent venous thromboembolism, and all-cause mortality.[22-24] Major hemorrhage was defined by the International Society on Thrombosis and Haemostasis as bleeding at high-risk anatomic locations (intracranial, intraspinal, intraocular, retroperitoneal, intra-articular, pericardial, or intramuscular with compartment syndrome), or overt bleeding with either a reduction of hemoglobin ≥2 grams per deciliter or a transfusion of two or more units of red blood cells.[25] Recurrent venous thromboembolism was defined as a new or expanded abnormality on imaging. Deaths were identified using a health system mortality database that links to the Social Security Death Master File and the California State Department of Vital Statistics to identify deaths both within and outside of the healthcare delivery system. We also identified out-of-system medical encounters using a comprehensive claims database to improve capture of all healthcare visits related to our 30-day outcomes.

Data Analysis

We present continuous variables as medians with interquartile ranges (IQR) and categorical data as frequencies and proportions. We compare characteristics between groups (presyncope vs syncope vs neither) using chi-square tests for categorical variables and t-tests or Wilcoxon rank-sum tests for continuous variables. A two-tailed p value of less than 0.05 is considered significant. Covariates that are differentially distributed between the three groups of interest were candidates for inclusion in the predictive models.

We examined adjusted associations of syncope and presyncope with ICU admission using multivariable logistic regression, adjusting for demographics, PESI class, ventilatory support, submassive and massive PE classification with standard errors adjusted for clustering by medical center. We also tested interaction terms between either presyncope and syncope and submassive or massive PE and PESI class. We undertook sensitivity analyses by excluding massive PE from the predictors in the model since the association of sustained hypotension with ICU admission is not in question. We also examined adjusted associations of the above covariates of interest with the secondary outcome of 30-day, all-cause mortality. Adjusted associations are reported as odds ratios (aOR) with 95% confidence intervals (CI). All analyses were conducted using SAS statistical software, version 9.31 (SAS Institute, Cary, NC) and Stata, version 14.2 (StataCorp LP, College Station, TX).

RESULTS

Throughout the 28-month study, we identified 2996 eligible patient encounters (Figure 1). The median age of the entire cohort was 66 years (IQR 54-77), and 1485 (49.5%) were men. Overall, 82 (2.7%) had presyncope and 109 (3.6%) had syncope documented in the EHR. We report in Table 1 patient demographic, comorbid, and clinical characteristics stratified by the three groups: patients with presyncope; syncope; and neither. Table 2 highlights notable between-group differences in radiographic risk stratification, and management characteristics. The presyncope and syncope patients shared in common many characteristics distinct from their counterparts with neither documented complaint: they more commonly arrived by ambulance, had a proximal clot, and a higher PESI class, submassive, and massive PE classification. They more commonly required ventilatory support and thrombolytics. They were also more commonly hospitalized (Table 2). Overall, 175 patients (5.8%) were admitted to the ICU: 170 from the ED, five of whom passed through interventional radiology for catheter-directed thrombolysis (Table 2). The presyncope and syncope subgroups had similar prevalence of ICU admission: presyncope 18.3% vs syncope 25.7% (compared with 4.7% among those with neither condition).

We report in Table 3 the results of our univariate and multivariate analysis for the primary outcome, ICU admission. We found that presyncope and syncope were both independently associated with ICU admission, as were lower age, higher

Table 1. Demographic and comorbid characteristics of emergency department patients with acute pulmonary embolism stratified by documentation of presyncope and syncope (n = 2996).

Patient characteristics	Neither Presyncope nor Syncope n = 2805 (93.6%)		Presyncope n = 82 (2.7%)		Syncope n = 109 (3.6%)	
Demographics	n	%	n	%	n	%
Age median (IQR), years	66 (54-77)		67.5 (56-75)		68 (56-77)	
Gender male	1390	49.6	34	41.5	61	56.0
Race/ethnicity						
White	2002	71.4	66	80.5	74	67.9
African American	357	12.7	6	7.3	21	19.3
Hispanic or Latino	282	10.1	3	3.7	6	5.5
Asian or Pacific Islanders	127	4.5	2	2.4	8	7.3
Other	37	1.3	5	6.1	0	0.0
Comorbidities						
Obesity (body mass index >30 kg/m^2)	1267	45.2	46	56.1	46	42.2
Cancer (history of or active)	807	28.8	28	34.2	32	29.4
Chronic lung disease (includes asthma)	762	27.2	19	23.2	29	26.6
Documented history of prior venous thromboembolism	466	16.6	15	18.3	12	11.0
Coronary artery disease	404	14.4	12	14.6	19	17.4
Heart failure (diastolic or systolic)	281	10.0	9	11.0	10	9.2
Cerebrovascular disease	235	8.4	6	7.3	11	10.1
Smoking	167	6.0	7	8.5	4	3.7
Chronic severe renal failure	62	2.2	3	3.7	4	3.7
Charlson Comorbiditiy Index Score						
Mean (SD)	1.90 (2.39)		1.91 (2.36)		2.03 (2.51)	
Median (IQR)	1 (0-3)		1 (0-3)		1 (0-3)	
0	1056	37.7	31	37.8	37	33.9
1	535	19.1	11	13.4	28	25.7
≥2	1154	41.1	36	43.9	42	38.5
No measure (no visits in prior year)	60	2.1	4	4.9	2	1.8

IQR, interquartile range; *SD,* standard deviation.

PESI class, ventilatory support, proximal clot location, and submassive and massive classification. The association of both presyncope and syncope with ICU admission remained when massive PE patients were removed from the analysis and only normotensive patients remained (see the supplemental files, Table S1). There was no significant interaction between either syncope or presyncope and PESI, submassive classification or massive classification in predicting ICU admission (data not shown). Presyncope was thus associated with ICU admission even among normotensive patients and those without markers of right ventricular dysfunction.

Four patients (4.9%) in the presyncope group died of any cause within 30 days and 10 (9.2%) in the syncope group (p = 0.40). In adjusted analysis, higher-risk PESI class (Classes III-V; aOR 22.17; 95% CI, 7.91-62.14), ventilatory support (aOR 3.78; 95% CI 2.77-5.16) and massive PE (aOR 3.69; 95% CI, 1.42-9.59) were independently associated with 30-day all-cause mortality (Table 4). Restricting the analysis to normotensive patients did not meaningfully change these findings (see the supplemental files, Table S2).

DISCUSSION

In this multicenter, retrospective cohort study of community-based ED patients with acute PE we found a similar prevalence of ICU admission (approximately one in five) among patients with syncope and those with presyncope. Both groups had a four-fold or higher proportion of ICU admission than their counterparts with neither complaint. Presyncope and syncope were each associated with ICU admission, independent of patient demographics, PESI class, ventilatory support, clot location, and submassive and massive classification.

Our finding that both syncopal and presyncopal PE patients

are at higher and comparable risk for needing intensive care than non-syncopal patients is concordant with one of the few PE studies to have identified presyncope in their PE population and compared them to their syncopal and non-syncopal patients. Among 1716 patients with PE enrolled in the prospective Italian Pulmonary Embolism Registry, 239 patients (13.9%) reported presyncope and 219 (12.8%) reported syncope.[10] Their presyncopal patients were similar to the syncopal patients on most measures. Both groups had significantly higher 30-day, all-cause mortality than their non-syncopal counterparts: presyncope

Table 2. Clinical characteristics of emergency department patients with acute pulmonary embolism stratified by documentation of presyncope and syncope (n = 2996).

Patient characteristics	Neither Presyncope nor Syncope n = 2805 (93.6%)		Presyncope n = 82 (2.7%)		Syncope n = 109 (3.6%)		P-values comparing three groups
Arrival by ambulance	n	%	n	%	n	%	
No	2264	80.7	48	58.5	40	36.7	<0.0001
Yes	541	19.3	34	41.5	69	63.3	
PE Severity Index class							
I	503	17.9	10	12.2	14	12.8	0.0254
II	615	21.9	13	15.9	14	12.8	
III	547	19.5	19	23.2	22	20.2	
IV	492	17.5	19	23.2	20	18.4	
V	648	23.1	21	25.6	39	35.8	
Ventilatory support*	140	5.0	10	12.2	15	13.8	<0.001
Non-rebreather mask only	79	2.8	9	11.0	11	10.1	
Non-invasive or invasive ventilation	61	2.2	1	1.2	4	3.7	
Clot location on CTPA†							
Proximal	1349	48.1	50	61.0	68	62.4	0.0013
Distal	1195	42.6	21	25.6	33	30.3	
Unclear or not measured	261	9.3	11	13.4	8	7.3	
Massive classification‡							
Neither massive nor submassive	1958	69.8	31	37.8	52	47.7	<0.0001
Submassive	829	29.6	49	59.8	50	45.9	
Massive	18	0.6	2	2.4	7	6.4	
Hospitalization	2184	77.9	77	93.9	105	96.3	<0.0001
To hospital floor	2052	73.2	62	75.6	77	70.6	
To intensive care unit	132	4.7	15	18.3	28	25.7	
Thrombolytics (n=28)§	18	0.6	5	6.1	5	4.6	<0.0001
Intravenous (n=23)	14		4		5		
Catheter-directed (n=5)	4		1		0		
30-day adverse events							
Major hemorrhage	79	2.8	3	3.7	8	7.3	0.0236
Recurrent venous thromboembolism	20	0.7	0	0.0	1	0.9	0.7196
All-cause mortality	115	4.1	4	4.9	10	9.2	0.0364

CTPA, computed tomography pulmonary angiography; *ED,* emergency department; *PE,* pulmonary embolism.
*Includes non-rebreather mask, non-invasive ventilation, and endotracheal intubation with mechanical ventilation
†Proximal emboli were clearly lobar or more proximal, whereas distal emboli were "segmental or lobar" or more distal. Location was not measured in patients whose PE was diagnosed with ventilation/perfusion scan.
‡Massive PE required systolic blood pressure <90 mmHg sustained over 15 minutes or more, reception of vasopressors or cardiopulmonary resuscitation, not caused by new-onset arrhythmia, hypovolemia, or septic shock. Submassive PE did not meet massive PE criteria, yet had an elevated ED troponin level, an elevated B-type natriuretic peptide, or right ventricular dysfunction on echocardiogram.
§Thrombolytics were administered in the ED or upon arrival (<2h) to interventional radiology or the intensive care unit.

(47.2%); syncope (37.4%); neither (6.2%). Direct comparisons between the Italian registry and our own, however, are prevented because of the disparate populations and settings. Their overall 30-day, all-cause mortality was 15.9%, whereas ours was 4.4%, suggesting significant between-site differences in disease severity and management.[1]

Our results are also consistent with more general studies comparing presyncope with syncope patients across a broad spectrum of ED complaints. For example, a prospective, observational study in 3581 older adults (≥60 years) with presyncope or syncope in 11 EDs identified no between-group differences in the composite incidence of 30-day mortality or serious clinical events.[13] These events included cardiac arrhythmias, myocardial infarction, cardiac intervention, new diagnosis of structural heart disease, stroke, PE, aortic dissection, subarachnoid hemorrhage, cardiopulmonary resuscitation, internal hemorrhage or anemia, and recurrent fall or syncope resulting in major injury. Only 1% of their cohort was diagnosed

Table 3. Association between patient characteristics and intensive care unit admission among emergency department patients with acute pulmonary embolism (n = 2996).

	Univariate models		Multivariate model	
Patient characteristics	Odds ratio	95% CI	Adjusted odds ratio	95% CI
Age, per year	0.99	0.98-1.00	0.94	0.93-0.96
Gender				
Female	reference		reference	
Male	1.06	0.71-1.56	0.99	0.69-1.41
Race/ethnicity				
White	reference		reference	
Non-white	1.19	0.86-1.65	1.04	0.70-1.53
PE Severity Index class				
I	reference		reference	
II	1.74	0.75-4.05	4.27	1.97-9.26
III	1.83	0.78-4.25	3.67	1.64-8.22
IV	2.75	1.29-5.87	7.54	3.32-17.10
V	5.62	2.40-13.15	13.82	5.98-31.94
(Pre)syncope classification				
Neither	reference		reference	
Presyncope	4.53	2.30-8.95	2.79	1.40-5.56
Syncope	7.00	4.36-11.23	4.44	2.52-7.80
Ventilatory support*				
None	reference		reference	
Any	10.51	7.39-14.94	4.06	2.52-6.53
Clot location on CTPA†				
Distal	reference		reference	
Proximal	3.07	2.16-4.37	2.23	1.47-3.38
Unclear or not measured	0.94	0.34-2.58	0.67	0.28-1.58
(Sub)massive classification‡				
Neither	reference		reference	
Submassive	5.03	3.74-6.75	3.32	2.26-4.88
Massive	139.37	56.78-342.10	36.49	12.33-107.98

CI, confidence interval; *CTPA,* computed tomography pulmonary angiography; *PE,* pulmonary embolism.
*Includes non-rebreather mask, non-invasive ventilation, and endotracheal intubation with mechanical ventilation.
†Proximal emboli were clearly lobar or more proximal, whereas distal emboli were "segmental or lobar" or more distal. Location was not measured in patients whose PE was diagnosed with ventilation/perfusion scan.
‡Massive PE required systolic blood pressure <90 mmHg sustained over 15 minutes or more, reception of vasopressors or cardiopulmonary resuscitation, not caused by new-onset arrhythmia, hypovolemia, or septic shock. Submassive PE did not meet massive PE criteria, yet had an elevated ED troponin level, an elevated B-type natriuretic peptide, or right ventricular dysfunction on echocardiogram.

Table 4. Associations between patient characteristics and 30-day all-cause mortality among emergency department patients with acute pulmonary embolism (n = 2996).

	Univariate models		Multivariate model	
Patient characteristics	Odds ratio	95% CI	Adjusted odds ratio	95% CI
Age, per year	1.03	1.02-1.04	1.01	0.99-1.02
Gender				
Female	reference		reference	
Male	0.77	0.52-1.15	0.67	0.44-1.02
Race/ethnicity				
White	reference		reference	
Non-white	0.86	0.56-1.32	0.95	0.61-1.47
PE Severity Index class				
I-II	reference		reference	
III-V	10.17	2.61-16.81	22.17	7.91-62.14
(Pre)syncope classification				
Neither	reference		reference	
Presyncope	1.20	0.47-3.03	0.77	0.34-1.75
Syncope	2.36	1.03-5.44	1.41	0.45-4.37
Ventilatory support*				
None	reference		reference	
Any	6.78	5.07-9.07	3.78	2.77-5.16
Clot location on CTPA†				
Distal	reference		reference	
Proximal	1.12	0.82-1.53	0.97	0.69-1.36
Unclear or not measured	1.72	0.94-3.15	1.54	0.80-2.95
(Sub)massive classification‡				
Neither	reference		reference	
Submassive	1.51	1.15-2.00	0.88	0.64-1.23
Massive	16.32	7.46-35.72	3.69	1.42-9.59

CI, confidence interval; *CTPA*, computed tomography pulmonary angiography; *PE,* pulmonary embolism.
* Includes non-rebreather mask, non-invasive ventilation, and endotracheal intubation with mechanical ventilation
†Proximal emboli were clearly lobar or more proximal, whereas distal emboli were "segmental or lobar" or more distal. Location was not measured in patients whose PE was diagnosed with ventilation/perfusion scan.
‡ Massive PE required systolic blood pressure <90 millimeters mercury sustained over 15 minutes or more, reception of vasopressors or cardiopulmonary resuscitation, not caused by new-onset arrhythmia, hypovolemia, or septic shock. Submassive PE did not meet massive PE criteria yet had an elevated ED troponin level, an elevated B-type natriuretic peptide, or right ventricular dysfunction on echocardiogram.

with acute PE, however, so these investigators cannot speak directly to our particular study population. Nevertheless, their findings suggest that presyncopal ED patients carry similar short-term risks as syncopal ED patients and should be managed in a similar fashion.

Syncope is a known predictor of adverse events in unselected ED patients with acute PE, as it correlates with a higher prevalence of hemodynamic instability and right ventricular dysfunction at the time of PE presentation and confers a higher risk for adverse outcomes.[8,26] But the correlation between syncope and adverse outcomes has disappeared in some studies when patients presenting with hypotension were removed from the cohort, according to the results of a recent 29-study meta-analysis of nearly 22,000 patients with PE.[8] The authors suggest that hemodynamic instability (rather than syncope itself) may be driving the correlation. Presyncope was not included in the analysis given its near absence from the included studies. However, our study suggests that the increased risk imparted by presyncope or syncope is independent of hemodynamic instability, since our findings were insensitive to removal of patients with massive PE from the analysis. These results suggest that the effect of presyncope and syncope on PE outcomes is not mediated exclusively by hemodynamic instability and carries an independent prognostic role, even in normotensive patients and even when adjusted for other variables known to confer risk of adverse outcomes, such as right ventricular dysfunction.

Pulmonary emboli are thought to cause presyncope and syncope by mechanical, neurohumoral, and tachydysrhythmic mechanisms. Large, central PE can work at the mechanical level, creating direct right ventricle outflow obstruction, which can lead to a downstream reduction in left ventricular filling and cardiac output. Proximal clots are more prevalent among PE patients with presyncope or syncope than those without: we found this in our study (61.7% vs 48.1% [p = 0.001; Table 2]), as have others.[27-29] Nevertheless, about 40% of our presyncope/syncope cohort did not have proximal clots at the time of CTPA. PE, however, is a dynamic condition and some of these patients may have had larger, more central clots earlier that had subsequently undergone partial in vivo fibrinolysis and fragmentation by the time of imaging.[29] The increase in pulmonary hypertension can manifest with right ventricular dysfunction (and qualify patients for submassive classification). Right ventricular dysfunction was more prevalent in our presyncope/syncope patients compared with their non-syncopal counterparts: 51.8 % vs 29.6% (p<0.0001; Table 2), results that are also consistent with other studies.[8,9,28]

Smaller and more distal clots lack the mechanical effects of their larger, proximal counterparts, but can still impede cardiac function through biochemically-induced pulmonary vasoconstriction. PE may also cause presyncope and syncope by provoking paroxysmal tachydysrhythmias, as well as by transiently increasing vagal tone.[29,30] These various mechanisms of presyncope and syncope do not each carry the same implications. A transient vagal reaction in a patient with acute PE generally has less prognostic significance than a large, central clot with evidence of persistent right ventricular dysfunction. Given, however, that presyncope and syncope are independently associated with ICU admission, even after controlling for known prognostic factors, including clot location and right ventricular dysfunction, we think it wise to initially hospitalize this population of PE patients for monitoring.

We have already incorporated these results into our ED PE clinical pathway by denoting presyncope an indication for hospitalization. In an electronic clinical decision support application to assist emergency physicians in real-time, site-of-care decision-making, we provide two complementary risk-stratification tools. The first is the PESI, accurately auto-populated from the EHR.[1,19,31] The second tool is a memory-jogging list of relative contraindications to immediate outpatient care. Among the PE-related factors, we include presyncope alongside syncope.[1] The results of this current study, while only suggestive, nevertheless lend weight to considering presyncope a relative contraindication to immediate home discharge among ED patients with acute PE. Likewise, for patients diagnosed with PE in the primary care setting, presyncope and syncope may both be an indication for transfer to a higher level of care.[32]

LIMITATIONS

The major shortcoming of this study is its retrospective design, which likely underestimates the prevalence of presyncope and syncope. We were able to manually abstract presyncope and syncope from the EHR in a structured fashion and achieved the agreement of two physician abstractors. But not all presyncopal and syncopal events made it to the health record, as patient reporting, physician inquiry, and physician documentation were all subject to incompleteness. Physicians may have been more inclined to inquire and to document presyncope and syncope in patients with more severe manifestations of PE, but how this potential bias, if it exists, may have affected our results is unclear. Nevertheless, this limitation in design attenuates the claims we can make from our results.

Moreover, our primary outcome, ICU admission, was not protocolized, and may have been influenced by many patient-, physician-, and facility-level variables. When attempting to isolate the effect of presyncope and syncope upon ICU admission, we adjusted for multiple high-risk factors, but could not account for excluded and unmeasured variables. Additionally, the results we found reflect the study population and setting and may not be generalizable to other geographic locations, practice settings and case mixes. As expected, the number of patients in the presyncope and syncope subgroups who died was small. Although we found no significant adjusted association between presyncope or syncope and mortality, the low observed incidence and relatively small study cohort limit any conclusions about mortality effects.

While ICU admission as an outcome variable can be construed as too variable (eg, interfacility differences in admission criteria) and too subjective (based on physician judgment), these factors were minimized by the large number of centers (n = 21) and physicians involved. As such, ICU admission represents a valid proxy for tenuous clinical status. The increase in ICU admission among the presyncope/syncope population was not exclusively attributable to hemodynamic status (eg, massive classification), need for ventilatory support, clot location, right ventricular dysfunction, or predicted short-term mortality (PESI classification).

CONCLUSION

Little attention has been paid to the prognostic significance of presyncope in ambulatory adults with acute PE. This retrospective study suggests that presyncope carries similar risks as syncope in the PE population, an hypothesis supported by the Italian PE registry as well as the broader presyncope literature.[10,13] Prospective studies are needed to quantify the magnitude of the association between presyncope and high-risk clinical characteristics and short-term adverse outcomes, as well as to tease out more clearly the prognostic import of presyncope in the normotensive population and those without right ventricular dysfunction. Meanwhile, it may be sensible to add presyncope to the list of questions we ask of our PE patients when making site-of-care decisions and to consider it a prognostic factor comparable to syncope.

ACKNOWLEDGMENTS

We are grateful to our generous funders and to our brilliant and well-organized administrative team, led by Adina S. Rauchwerger, MPH, Kaiser Permanente Division of Research, Oakland, California.

Address for Correspondence: David R. Vinson, MD, Kaiser Permanente Sacramento Medical Center, Department of Emergency Medicine, 2025 Morse Avenue, Sacramento, CA 95825. Email: drvinson@ucdavis.edu.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. This work was supported by the Garfield Memorial Fund, the Permanente Medical Group Delivery Science and Physician Researcher Programs, and the Kaiser Permanente Northern California Community Benefit Program.

REFERENCES

1. Vinson DR, Mark DG, Chettipally UK, et al. Increasing safe outpatient management of emergency department patients with pulmonary embolism: a controlled pragmatic trial. *Ann Intern Med.* 2018;169(12):855-65.
2. Bledsoe JR, Woller SC, Stevens SM, et al. Management of low-risk pulmonary embolism patients without hospitalization: the Low-Risk Pulmonary Embolism Prospective Management Study. *Chest.* 2018;154(2):249-56.
3. Secemsky E, Chang Y, Jain CC, et al. Contemporary management and outcomes of patients with massive and submassive pulmonary embolism. *Am J Med*. 2018;131(12):1506-14.e0.
4. Barrios D, Morillo R, Yusen RD, et al. Pulmonary embolism severity assessment and prognostication. *Thromb Res.* 2018;163:246-51.
5. Elias A, Mallett S, Daoud-Elias M, et al. Prognostic models in acute pulmonary embolism: a systematic review and meta-analysis. *BMJ Open.* 2016;6(4):e010324.
6. Konstantinides SV, Meyer G, Becattini C, et al. 2019 ESC Guidelines for the diagnosis and management of acute pulmonary embolism developed in collaboration with the European Respiratory Society (ERS): the Task Force for the Diagnosis and Management of Acute Pulmonary Embolism of the European Society of Cardiology (ESC). *Eur Respir J*. 2020;41(4):543-603.
7. Kearon C, Akl EA, Ornelas J, et al. Antithrombotic therapy for VTE disease: CHEST guideline and expert panel report. *Chest*. 2016;149(2):315-52.
8. Barco S, Ende-Verhaar YM, Becattini C, et al. Differential impact of syncope on the prognosis of patients with acute pulmonary embolism: a systematic review and meta-analysis. *Eur Heart J.* 2018;39(47):4186-95.
9. Keller K, Beule J, Balzer JO, et al. Syncope and collapse in acute pulmonary embolism. *Am J Emerg Med*. 2016;34(7):1251-7.
10. Roncon L, Zuin M, Casazza F, et al. Impact of syncope and pre-syncope on short-term mortality in patients with acute pulmonary embolism. *Eur J Intern Med*. 2018;54:27-33.
11. Pollack CV, Schreiber D, Goldhaber SZ, et al. Clinical characteristics, management, and outcomes of patients diagnosed with acute pulmonary embolism in the emergency department: initial report of EMPEROR (Multicenter Emergency Medicine Pulmonary Embolism in the Real World Registry). *J Am Coll Cardiol.* 2011;57(6):700-6.
12. Seyyedi SR, Jenab Y, Tokaldany ML, et al. Syncope paradox in the outcome of patients with pulmonary thromboembolism: short-term and midterm outcome. *Clin Respir J.* 2016;10(1):90-7.
13. Bastani A, Su E, Adler DH, et al. Comparison of 30-day serious adverse clinical events for elderly patients presenting to the emergency department with near-syncope versus syncope. *Ann Emerg Med.* 2019;73(3):274-80.
14. Vinson DR, Ballard DW, Huang J, et al. Outpatient management of emergency department patients with acute pulmonary embolism: variation, patient characteristics, and outcomes. *Ann Emerg Med*. 2018;72(1):62-72.e3.
15. Vinson DR, Ballard DW, Mark DG, et al. Risk stratifying emergency department patients with acute pulmonary embolism: Does the simplified Pulmonary Embolism Severity Index perform as well as the original? *Thromb Res*. 2016;148:1-8.
16. Liu MY, Ballard DW, Huang J, et al. Acute pulmonary embolism in emergency department patients despite therapeutic anticoagulation. *West J Emerg Med.* 2018;19(3):510-6.
17. Krieger N. Overcoming the absence of socioeconomic data in medical records: validation and application of a census-based methodology. *Am J Public Health.* 1992;82(5):703-10.
18. Gordon N, Lin T. The Kaiser Permanente Northern California Adult Member Health Survey. *Perm J.* 2016;20(4):34-42.
19. Vinson DR, Morley JE, Huang J, et al. The accuracy of an electronic Pulmonary Embolism Severity Index auto-populated from the electronic health record: setting the stage for computerized clinical decision support. *Appl Clin Inform.* 2015;66(2):318-33.
20. Jaff MR, McMurtry MS, Archer SL, et al. Management of massive and submassive pulmonary embolism, iliofemoral deep vein thrombosis, and chronic thromboembolic pulmonary hypertension: a scientific statement from the American Heart Association. *Circulation*. 2011;123(16):1788-830.
21. Vinson DR, Arasu VA, Trujillo-Santos J. Detecting right ventricular dysfunction in patients diagnosed with low-risk pulmonary embolism: is routine computed tomographic pulmonary angiography sufficient? *Eur Heart J.* 2019;40(40):3356.
22. Aujesky D, Roy PM, Verschuren F, et al. Outpatient versus inpatient treatment for patients with acute pulmonary embolism: an international, open-label, randomised, non-inferiority trial. *Lancet.*

2011;378(9785):41-8.

23. Vinson DR, Zehtabchi S, Yealy DM. Can selected patients with newly diagnosed pulmonary embolism be safely treated without hospitalization? A systematic review. *Ann Emerg Med.* 2012;60(5):651-62 e4.
24. Vinson DR, Drenten CE, Huang J, et al. Impact of relative contraindications to home management in emergency department patients with low-risk pulmonary embolism. *Ann Am Thorac Soc.* 2015;12(5):666-73.
25. Schulman S, Kearon C, Subcommittee on Control of Anticoagulation of the Scientific and Standardization Committee of the International Society on Thrombosis and Haemostasis. Definition of major bleeding in clinical investigations of antihemostatic medicinal products in non-surgical patients. *J Thromb Haemost*. 2005;3(4):692-4.
26. Mohebali D, Heidinger BH, Feldman SA, et al. Right ventricular strain in patients with pulmonary embolism and syncope. *J Thromb Thrombolysis*. 2019 Oct 30. [Epub ahead of print].
27. Duplyakov D, Kurakina E, Pavlova T, et al. Value of syncope in patients with high-to-intermediate risk pulmonary artery embolism. *Eur Heart J Acute Cardiovasc Care.* 2015;4(4):353-8.
28. Jenab Y, Lotfi-Tokaldany M, Alemzadeh-Ansari MJ, et al. Correlates of syncope in patients with acute pulmonary thromboembolism. *Clin Appl Thromb Hemost*. 2015;21(8):772-6.
29. Castelli R, Tarsia P, Tantardini C, et al. Syncope in patients with pulmonary embolism: comparison between patients with syncope as the presenting symptom of pulmonary embolism and patients with pulmonary embolism without syncope. *Vasc Med.* 2003;8(4):257-61.
30. Simpson RJ, Jr., Podolak R, Mangano CA, Jr., et al. Vagal syncope during recurrent pulmonary embolism. *JAMA*. 1983;249(3):390-3.
31. Vinson DR, Mark DG, Ballard DW. Outpatient management of patients with pulmonary embolism. *Ann Intern Med.* 2019;171(3):228.
32. Vinson DR, Aujesky D, Geersing GJ, et al. Comprehensive outpatient management of low-risk pulmonary embolism: Can primary care do this? A narrative review. *Perm J*. 2020; 24:19.163.

Demographics and Outcomes of Pulmonary Hypertension Patients in United States Emergency Departments

Susan R. Wilcox, MD
M. Kamal Faridi, MPH
Carlos A. Camargo Jr., MD, DrPH

Massachusetts General Hospital, Department of Emergency Medicine, Boston, Massachusetts

Section Editor: Gary Johnson, MD
Submission history: Submitted September 12, 2019; Revision received February 21, 2020; Accepted February 27, 2020
Electronically published April 16, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.2.45187

Introduction: Pulmonary hypertension (PH) is a common, yet under-diagnosed, contributor to morbidity and mortality. Our objective was to characterize the prevalence of PH among adult patients presenting to United States (US) emergency departments (ED) and to identify demographic patterns and outcomes of PH patients in the ED.

Methods: We analyzed the Nationwide Emergency Department Sample (NEDS) database, with a focus on ED patients aged 18 years and older, with any International Classification of Diseases, Clinical Modification (ICD)-9-CM or ICD-10-CM diagnosis code for PH from 2011 to 2015. The primary outcome was inpatient, all-cause mortality. The secondary outcomes were hospital admission rates and hospital length of stay (LOS).

Results: From 2011 to 2015, in a sample of 121,503,743 ED visits, representing a weighted estimate of 545,500,486 US ED visits, patients with a diagnosis of PH accounted for 0.78% (95% confidence interval [CI], 0.75- 0.80%) of all US ED visits. Of the PH visits, 86.9% were admitted to the hospital, compared to 16.3% for all other ED visits (P <0.001). Likewise, hospital LOS and hospital-based mortality were higher in the PH group than for other ED patients (e.g., inpatient mortality 4.5% vs 2.6%, P < 0.001) with an adjusted odds ratio (aOR) of 1.34 (95% CI, 1.31–1.37). Age had the strongest association with mortality, with an aOR of 10.6 for PH patients over 80 years (95% CI, 10.06–11.22), compared to a reference of ages 18 to 30 years.

Conclusion: In this nationally representative sample, presentations by patients with PH were relatively common, accounting for nearly 0.8% of US ED visits. Patients with PH were significantly more likely to be admitted to the hospital than all other patients, had longer hospital LOS, and increased risk of inpatient mortality. [West J Emerg Med. 2020;21(3)714–721.]

INTRODUCTION

Pulmonary hypertension (PH) is defined as pressure elevation in the pulmonary circulation with a mean pulmonary artery pressure over 25 millimeters of mercury (mmHg)[1] and can arise from a multitude of physiologic insults resulting in increased pulmonary vascular resistance. This sustained elevation in pressure leads to strain on the right ventricle[2] and eventual heart failure if untreated.[3] In addition to resulting in chronic issues, PH impacts the approach to resuscitation, as common interventions such as volume administration or intubation can be deleterious in the setting of right heart failure.[2,4]

Despite having substantial clinical impact, PH remains under-diagnosed.[5] Over the last 30 years, clinicians outside the emergency department (ED) have increasingly recognized the risks of PH and right ventricular failure,[2,6] but this diagnosis has been underappreciated during emergency care.[4,7,8] Quantifying the burden of PH in the ED is difficult, as it is a heterogeneous condition, with five groups defined by the World Health Organization based upon the underlying etiology.[9] Data are sparse for the rates of patients with PH presenting to EDs, and

there are no studies of the diagnosis or management of PH in the ED. The only demographic study of all groups of PH in the ED was a single-center study, finding a 0.84% prevalence of PH in ED visits.[10] A large epidemiologic study of ED visits focused on Group 1 PH, or pulmonary arterial hypertension (PAH), a rare disease with estimates of 5-15 cases per one million adults.[11] Yet even this rare condition was responsible for approximately 0.01% of all ED visits.[12] The remaining literature on the assessment of PH in the ED is limited to case reports[13,14] and a small observational study.[15]

Improving the care of patients with PH in the ED begins with appropriate recognition of the condition. While it may seem evident that patients with PH have higher-acuity ED presentations as compared to other patients, the magnitude of this discrepancy is unknown. Quantifying the prevalence and acuity of patients with of PH in the ED is therefore integral to designing future studies of the emergency management of PH.

Our objective was to characterize the prevalence of PH among adult patients presenting to the ED, identify demographic patterns of these patients, and to evaluate admission rates, hospital length of stay (LOS), and inpatient mortality for these patients.

Population Health Research Capsule

What do we already know about this issue?
Pulmonary hypertension (PH) is an under-diagnosed condition with high morbidity and mortality.

What was the research question?
We analyzed the national database of ED visits to assess the inpatient, all-cause mortality of PH patients.

What was the major finding of the study?
Patients with a diagnosis of PH accounted for 0.78% of all United States ED visits, with an adjusted odds ratio for mortality of 1.34.

How does this improve population health?
PH is relatively common among ED visits, and is associated with increased rate of inpatient mortality.

METHODS

We analyzed the Nationwide Emergency Department Sample (NEDS) database, developed for the Healthcare Cost and Utilization Project (HCUP) sponsored by the Agency for Healthcare Research and Quality and constructed annually using records from state ED databases and state inpatient databases, to collect data on all ED visits, regardless of disposition. NEDS is the largest ED database in the US, yielding national estimates of hospital-based ED visits, and providing a snapshot of demographics for selected conditions. Unweighted, it contains data from approximately 30 million ED visits each year. Weighted, it estimates roughly 135 million ED visits per year.[16] This study was declared exempt from review by the institutional review board of Massachusetts General Hospital.

Patients included for analysis were those ages 18 years and older, with any ED visit, with a diagnosis that met the 9th or 10th revision of the *International Classification of Diseases, Clinical Modification* (ICD-9-CM or ICD-10-CM, respectively) codes for PH, including Groups 1-5 of PH in the first through 10th diagnosis field.[9] Patients were included if they had a code for PH as an ED diagnosis or hospital diagnosis. The list of included ICD-9-CM and ICD-10-CM codes are provided in the Supplemental File. In the HCUP outpatient databases, the first listed diagnosis is the condition considered to be chiefly responsible for the visit.

We collected data from NEDS from 2011–2015, including demographic characteristics of age, gender, and national quartile for median household income, as estimated by the patient's home ZIP code. Primary insurance types were categorized as public (Medicare and Medicaid), private, self-pay, and other. ED visit data were reviewed, including diagnoses, ED disposition, and hospital disposition. We also reviewed hospital characteristics, such as geographic region (Northeast, South, Midwest, and West) as defined by the US Census Bureau, and annual ED visit volume, trauma center designation, urban or rural status, and teaching status.

The primary outcome measure was inpatient, all-cause mortality. The secondary outcomes were hospital admission rates and hospital LOS. Of note, data on ED LOS, ED observation unit admission, and intensive care unit admission are not available in NEDS.

Statistical Analysis

All analyses included appropriate inflation using sampling weights, and we estimated variance using all observations in the database to account for domain-level variance. ED visits by patients with PH were compared to all ED visits. We reported weighted frequencies and proportions with corresponding 95% confidence intervals (CI) for patient and hospital characteristics, and used chi-square test to test statistical significance. Hospital-based mortality was computed by dividing the number of ED and inpatient, any-cause deaths by the number of PH-related ED visits. Because no unique patient identifiers were provided with ED records, the unit of analysis for the study was an ED visit. We ran bivariate analyses to explore associations of inpatient death, total ED visits, ED disposition, and hospital LOS with PH visits.

We ran a multivariable logistic-regression model to test the relationship between PH ED visits and inpatient mortality. Our goal was to assess the outcomes attributable to PH, while controlling for confounders. We selected variables a priori for possible inclusion in the model; the final model was chosen using lowest Akaike's information criterion with the following

predictors: age, gender, patient's primary health insurance, geographic location, trauma center status, and teaching status of the hospitals. To assess change over time in admission rates and inpatient mortality rates for pulmonary hypertension visits, we ran logistic regression models with year as a continuous variable. All analyses were conducted using SAS version 9.4 (SAS Institute, Cary, NC) software. A two-sided P-value of < 0.05 was considered statistically significant.

RESULTS

Characteristics of Study Subjects

From 2011 to 2015, there was a weighted estimate of 4,233,762 US ED visits, with an annual average of 846,752 visits among adults with PH, which accounted for 0.78% (95% confidence interval [CI], 0.75-0.80%) of all US ED visits for adults. Table 1 shows the weighted results. Patients with PH were significantly older than the entire ED cohort, with a higher percentage of visits for patients 61 years and older, and were comprised of more women, at 61.0% compared to 57.3% for all ED visits ($P < 0.001$). PH patients were more likely to have public insurance (84.4% vs 49.8%, $P < 0.001$) and have been seen at metropolitan teaching hospitals (53.0% vs 46.3%, $P < 0.001$). A PH code was the primary code for 118,351 visits, unweighted, for a weighted frequency of 525,904 visits (0.096%, 95% CI, 0.092-0.10).

Main Results

Of the weighted 4,233,762 ED visits for patients with a diagnosis of PH, 86.9% were admitted to the hospital, compared to an admission rate of 16.3% for all other ED visits ($P < 0.001$) (Table 2). Likewise, hospital LOS was higher in the PH group than the remainder of the ED patients admitted at 6.2 days vs 4.8 days ($P < 0.001$), and the inpatient mortality was also higher for the PH group (4.5% vs 2.6%, $P < 0.001$). The rate of death in the ED was lower in the PH cohort compared to all other ED visits, at 0.13% vs 0.17% ($P < 0.001$). The admission rate was over 85% for all years studied, although there was a slight decrease in admission rates for PH visits between 2011 and 2015, with a peak in 2012 at 88.0% and 86.3% in 2015 ($P < 0.001$). The top 10 ICD-9 primary diagnosis codes for admitted patients were hearing loss (389), pneumonia (486), obstructive chronic bronchitis (49,121), acute kidney failure (5849), urinary tract infection (5990), atrial fibrillation (42,731), acute subendocardial myocardial infarction, (41,071), cerebral artery occlusion (43,491), other chest pain (78,659), and acute pancreatitis (5770).

Patients with PH had an unadjusted odds ratio mortality of 1.24 (95% CI, 1.22-1.26) and an adjusted odds ratio (aOR) of inpatient mortality of 1.34 (95% CI, 1.31–1.37), compared to all other ED visits. Over the five-year period, the inpatient mortality remained relatively stable, between 3.8 and 5.1% ($P = 0.09$) (Figure 1). Age had the strongest association with morality, with significant increases in mortality for each decile of life, including an aOR of 10.6 for those over 80 years old (95% CI, 10.06–11.22) compared to a reference of ages 18-30 years. Visits by PH patients in metropolitan teaching hospitals and those with trauma level designation were also associated with increased mortality. Female gender and private insurance status were associated with decreased aOR for mortality (Table 3).

DISCUSSION

In this nationally representative sample of ED visits, presentations by patients with ICD-9-CM and ICD-10-CM codes corresponding to PH were relatively common, accounting for 0.78% of weighted visits, similar to the results of a recent, single-center study.[10] PH can arise from numerous etiologies, including idiopathic, connective-tissue disease, or drug-related causes (Group 1); left heart failure (Group 2); hypoxemic respiratory disease (Group 3); chronic thromboembolic disease (Group 4); and miscellaneous causes, such as sarcoidosis or sickle cell disease (Group 5). An older study using the NEDS database evaluated the rate of ED visits for patients with Group 1 PH,[12] a rare condition with a reported prevalence of only 6.6-25 cases per million per year.[17,18] A single-center study analyzed the demographics of all five PH groups presenting to the ED,[10] but no study has previously assessed ED visits for patients with all five groups in a large, nationwide dataset. Present in almost 1% of all ED visits, PH is relatively common for a condition that has not been previously well described in the ED literature and is associated with significantly increased resource utilization and inpatient mortality.

In this investigation, most patients with PH were women, consistent with prior studies of PH.[10,12,19] PH patients were significantly older than the remaining ED patient population, likely tracking with the development of PH secondary to comorbidities, such as left heart failure, hypoxic lung disease, and other chronic medical conditions. With improved treatments for PH, the life expectancy is increasing,[20] and coupled with the aging of the population, recognizing PH in the ED will become more important. Not only does the management of PH differ from other chronic medical conditions,[4] but among patients with comorbidities such as congestive heart failure, chronic obstructive pulmonary disease or interstitial lung disease, PH is associated with an increased attributable mortality.[21-29]

Patients with PH were significantly more likely to be admitted to the hospital than all other patients, at a rate of approximately 87%, similar to the previously published report of ED patients with Group 1 PH, at 82%.[12] Likewise, other studies have found an increasing rate of hospitalizations associated with PH, including both Group 1 and secondary PH.[30,31] A prior study demonstrated that the mean hospital LOS for PH increased from 5.89 days to 6.67 days ($p = 0.04$) between 2010 and 2013.[31] These values are consistent with our findings for PH admissions originating from the ED, at 6.2 days, significantly longer than the average LOS for all other admissions from the ED. These findings indicate that patients with PH have high acuity in the ED. Although emergency physicians traditionally have not focused on this patient population,[4] they recognize the acuity of their ED presentations, as they only discharge about 11%.

Table 1. Demographics and hospital characteristics for adult patients with pulmonary hypertension visiting United States emergency departments (ED), 2011-2015.

ED Visit and Hospital Characteristics	Sampled Unweighted ED Visits, n	PH Visits Weighted, n (%)	95% CI	All Other ED Visits Weighted, n (%)	95% CI	P-value
Overall	121,503,743	4,233,762 (0.78)	0.75-0.80	541,266,724 (99.22)	99.20-99.25	< 0.001
Age, years						< 0.001
18-30	31,633,471	67,213 (1.59)	1.49-1.69	141,853,675 (26.21)	25.96-26.46	
31-40	20,130,189	114,276 (2.70)	2.58-2.82	90,156,103 (16.66)	16.54-16.78	
41-50	19,095,656	257,371 (6.08)	5.87-6.28	85,328,858 (15.76)	15.65-15.88	
51-60	17,817,726	539,174 (12.74)	12.42-13.05	79,640,167 (14.71)	14.60-14.83	
61-70	12,909,470	793,668 (18.75)	18.53-18.97	57,234,217 (10.57)	10.48-10.67	
71-80	10,092,759	1,034,252 (24.43)	24.18-24.67	44,269,286 (8.18)	8.04-8.32	
>80	9,824,472	1,427,806 (33.72)	33.06-34.39	42,784,418 (7.90)	7.71-8.10	
Gender						< 0.001
Male	51,679,738	1,651,243 (39.00)	38.74-39.27	231,359,767 (42.74)	42.51-42.98	
Female	69,824,005	2,582,519 (61.00)	60.73-61.26	309,906,957 (57.26)	57.02-57.49	
Primary health insurance						< 0.001
Public	60,683,058	3,576,092 (84.47)	83.86-85.07	269,425,287 (49.78)	49.21-50.35	
Private	33,302,392	493,085 (11.65)	11.05-12.24	150,158,160 (27.74)	27.18-28.30	
Self-pay	20,338,141	86,003 (2.03)	1.88-2.18	89,467,529 (16.53)	15.95-17.11	
Other	7,180,152	78,582 (1.86)	1.70-2.01	32,215,748 (5.95)	5.62-6.28	
Median household income by ZIP code						< 0.001
1 (lowest)	40,894,148	1,235,970 (29.19)	27.81-30.58	180,555,833 (33.36)	32.18-34.53	
2	31,486,020	1,064,985 (25.15)	24.02-26.29	141,378,476 (26.12)	25.29-26.95	
3	26,541,369	989,032 (23.36)	22.40-24.32	119,089,347 (22.00)	21.21-22.80	
4 (highest)	19,926,113	863,663 (20.40)	18.82-21.98	88,385,486 (16.33)	15.31-17.35	
unknown	2,656,093	80,112 (1.89)	1.65-2.14	11,857,582 (2.19)	2.06-2.32	
Geographic location						0.004
Northeast	22,026,007	733,850 (17.33)	15.62-19.05	103,308,707 (19.09)	17.72-20.45	
South	24,564,967	1,027,327 (24.27)	22.04-26.49	124,582,458 (23.02)	21.55-24.49	
Midwest	52,412,565	1,756,352 (41.48)	38.91-44.06	215,506,895 (39.82)	38.00-41.63	
West	22,500,204	716,233 (16.92)	15.34-18.49	97,868,663 (18.08)	16.98-19.19	
Trauma center						0.11
No	51,678,478	1,757,596 (41.51)	39.03-44.00	232,190,969 (42.90)	41.18-44.61	
Yes	69,825,265	2,476,166 (58.49)	56.01-60.97	309,075,755 (57.10)	55.39-58.82	
Hospital teaching status						< 0.001
Metropolitan teaching	54,365,929	2,242,816 (52.97)	50.49-55.46	250,316,054 (46.25)	44.41-48.08	
Metropolitan non-teaching	47,415,858	1,532,608 (36.20)	33.87-38.53	198,375,635 (36.65)	35.05-38.25	
Nonmetropolitan	19,721,956	458,338 (10.83)	9.80-11.86	92,575,034 (17.10)	16.21-17.99	
Urban location						< 0.001
No	6,492,623	76,945 (1.82)	1.53-2.11	30,706,683 (5.67)	5.24-6.10	
Yes	115,011,120	4,156,817 (98.18)	97.89-98.47	510,560,041 (94.33)	93.90-94.76	

CI, confidence interval; *ED,* emergency department; *PH,* pulmonary hypertension.

Accordingly, the inpatient mortality was significantly higher for patients with PH than other patients admitted via the ED, with a persistent inpatient mortality rate of 4-5% over the years studied. These findings are concordant with the previously published mortality rate for Group 1 PH patients, at 5.4%.[12] A population-based analysis of mortality data from the National Vital Statistics System for 2001–2010 found that PH as any contributing cause of death was 5.5 per 100,000 in 2001 and 6.5 per 100,000 in 2010.[30]

Prior studies of PH have had disparate results regarding gender-related differences in mortality, with some finding increased mortality in women,[30,32] and others, increased mortality in men.[12,33] In the current study, while PH patients were more commonly women, men had a higher risk of inpatient mortality, consistent with prior studies based in the ED.[10,12] The reason for the discrepancy in prior, gender-based findings is not clear and merits further investigation.

Not surprisingly, older age was most strongly associated with increased inpatient mortality, with significant increases in mortality for each decile of life, including an aOR of 10.6 for those over 80 years old. While intuitive, this finding has been shown in other studies of Group 1 and secondary PH alike.[30,34] Visits by PH patients to metropolitan teaching hospitals and those with trauma level designation were also associated with increased mortality, likely reflecting the complexity of patients at these institutions.

Patients with PH often experience a substantial delay between the onset of symptoms and diagnosis, with one study finding a two-year lag for 21% of patients with Group 1 PH,[35] leading to patients being diagnosed late in their course. Delay in diagnosis correlates with decreased survival.[36] As this current study demonstrates, patients with an existing diagnosis of PH were relatively common among ED visits, and with the historical under-appreciation of PH,[5] more undiagnosed patients may also be presenting. The ED is a major point of contact with the healthcare system for many patients,[37] providing an opportunity for the emergency physician to consider the diagnosis and make timely referrals. The most common presenting symptom for patients with PH is dyspnea,[38] a common and nonspecific complaint in the ED.[39] Given this vague presentation for patients with a high-acuity condition, increased awareness among emergency physicians is essential to improving timely diagnosis.

Table 2. Outcomes for United States emergency department (ED) visits for patients with pulmonary hypertension (PH), 2011-2015.

Outcome	PH	All Other ED Visits	P-value
ED Disposition, n (weighted %)			
Discharged	98,270 (10.44)	92,972,703 (77.26)	< 0.001
Admitted to hospital	820,892 (86.89)	19778120 (16.28)	< 0.001
Death in ED	1,230 (0.13)	209,273 (0.17)	< 0.001
Hospital LOS (days), mean (95% CI)	6.21 (6.13-6.28)	4.83 (4.78-4.88)	< 0.001
Inpatient mortality, n (weighted %)	36,708 (4.51)	517,463 (2.63)	< 0.001

CI, confidence interval; *ED,* emergency department; *LOS,* length of hospital stay; *PH,* pulmonary hypertension

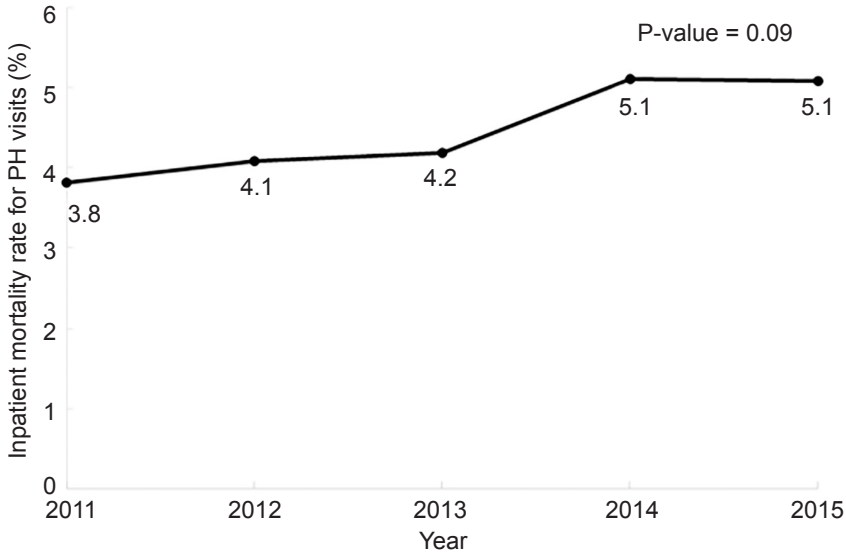


Figure 1. Change in inpatient mortality rate for pulmonary hypertension (PH) emergency department visits in the United States, 2011-2015. P = 0.09 for trend.

LIMITATIONS

The NEDS database relies on administrative rather than clinical data, and this study was not designed to reflect details of clinical care in the ED that may have affected mortality or admission rates. Second, studies based upon ICD-9-CM and ICD-10-CM codes are always at risk of classification bias, and this is a particular issue with a previously under-reported condition such as PH. A review of patients with moderate to severe PH in the VA system found that only 17% of these patients had PH documented as a diagnosis in their medical records.[5]

Other studies have shown that Group 1 PH is recorded in public records at a higher prevalence than it is at specialized centers.[19] It is unknown whether the larger records are overestimating the prevalence or whether the specialized centers are underestimating. As PH can arise from multiple comorbidities known to be associated with increased mortality, such as left-sided heart failure and chronic obstructive pulmonary disease, these comorbidities may be responsible for the increased utilization and mortality seen in the PH cohort. However, patients with PH complicating heart failure[26] and pulmonary disease[28] have higher mortality that patients with those conditions without PH.

Changes in the ICD-9-CM and ICD-10-CM coding during the study period may also have affected the results. The top ICD-9 primary diagnosis codes for admitted patients refer to the indication for the outpatient visit in the HCUP database, and therefore, do not necessarily reflect the reason the patient was admitted. NEDS does not contain patient identifiers. We were therefore unable to assess the frequency of return visits, repeat admissions, or long-term outcomes.

CONCLUSION

In this nationally representative sample of US ED visits, presentations by patients with ICD-9-CM and ICD-10-CM codes corresponding to PH were relatively common, accounting for 0.78% of visits by adults. Patients with PH were significantly more likely to be admitted to the hospital than all other patients and had an increased risk of inpatient mortality compared to all other ED visits. Older age was most strongly associated with increased inpatient mortality. With the aging of the population, recognizing PH will become increasingly important for ED clinicians. As PH often presents with only vague symptoms, emergency physicians should be aware of this common, high-acuity condition to improve timely diagnosis.

Table 3. Association of pulmonary hypertension (PH) emergency department (ED) visits with inpatient mortality in the United States, 2011-2015.

Variables	aOR	95% CI	P-value
PH disease			
No	1 (Reference)		
Yes	1.34	1.31-1.37	< 0.001
Age			
18-30	1 (Reference)		
31-40	1.39	1.34-1.44	< 0.001
41-50	2.39	2.29-2.50	< 0.001
51-60	3.97	3.79-4.16	< 0.001
61-70	5.69	5.41-5.97	< 0.001
71-80	7.38	7.01-7.78	< 0.001
> 80	10.63	10.06-11.22	< 0.001
Gender			
Male	1 (Reference)		
Female	0.78	0.77-0.78	< 0.001
Primary health insurance			
Public	1 (Reference)		
Private	0.90	0.88-0.92	< 0.001
Self-pay	1.02	0.98-1.05	0.36
Other	0.96	0.91-1.02	0.15
Geographic location			
Northeast	1 (Reference)		
South	0.88	0.84-0.92	< 0.001
Midwest	0.92	0.88-0.96	< 0.001
West	1.10	1.05-1.16	< 0.001
Trauma center			
No	1 (Reference)		
Yes	1.13	1.09-1.18	< 0.001
Hospital teaching status			
Metropolitan teaching	1 (Reference)		
Metropolitan non-teaching	0.85	0.82-0.89	< 0.001
Nonmetropolitan	0.89	0.85-0.93	< 0.001

aOR, adjusted odds ratio; *CI,* confidence interval; *PH,* pulmonary hypertension.

Address for Correspondence: Susan R. Wilcox, MD, Massachusetts General Hospital, Department of Emergency Medicine, Zero Emerson Place, Office 3B, Boston, MA 02114. Email: swilcox1@partners.org.

Conflicts of Interest: By the WestJEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. This work was supported by an institutional grant, The Eleanor and Miles Shore Fellowship Program, through Harvard Medical School, hosted by the Department of Emergency Medicine at Massachusetts General Hospital. There are no conflicts of interest or other sources of funding to declare.

REFERENCES

1. Hoeper MM, Bogaard HJ, Condliffe R, et al. Definitions and diagnosis of pulmonary hypertension. *J Am Coll Cardiol.* 2013;62(25 Suppl):D42-50.
2. Harjola VP, Mebazaa A, Celutkiene J, et al. Contemporary management of acute right ventricular failure: a statement from the Heart Failure Association and the Working Group on Pulmonary Circulation and Right Ventricular Function of the European Society of Cardiology. *Eur J Heart Fail.* 2016;18(3):226-41.
3. Savale L, Weatherald J, Jaïs X, et al. Acute decompensated pulmonary hypertension. *Eur Respir Rev.* 2017;26(146):170092.
4. Wilcox SR, Kabrhel C, Channick RN. Pulmonary hypertension and right ventricular failure in emergency medicine. *Ann Emerg Med.* 2015;66(6):619-28.
5. Maron BA, Choudhary G, Khan UA, et al. Clinical profile and underdiagnosis of pulmonary hypertension in US veteran patients. *Circ Fail*. 2013;6(5):906-12.
6. Naeije R, Brimioulle S, Dewachter L. Biomechanics of the right ventricle in health and disease (2013 Grover Conference series). *Pulm Circ*. 2014;4(3):395-406.
7. Russell FM, Kline JA, Lahm T. High rate of isolated right ventricular dysfunction in patients with non-significant computed tomographic pulmonary angiography. *Am J Emerg Med*. 2017;36(2):281-4.
8. Russell FM, Moore CL, Courtney DM, et al. Independent evaluation of a simple clinical prediction rule to identify right ventricular dysfunction in patients with shortness of breath. *Am J Emerg Med*. 2015;33(4):542-7.
9. Simonneau G, Gatzoulis MA, Adatia I, et al. Updated clinical classification of pulmonary hypertension. *J Am Coll Cardiol*. 2013;62(25 Suppl):D34-41.
10. Bowman JK, Dutta S, Zheng H, et al. Patients with pulmonary hypertension presenting to the emergency department. *Am J Emerg Med.* 2019;pii: S0735-6757(19)30679-5.
11. Rich JD, Rich S. Clinical diagnosis of pulmonary hypertension. *Circulation*. 2014;130(20):1820-30.
12. Stein PD, Matta F, Hughes PG. Scope of the problem of pulmonary arterial hypertension. *Am J Med*. 2015;128(8):844-51.
13. Cruz M Dela, Devey JS. Emergency department diagnosis of pulmonary hypertension in a patient with left atrial sarcoma. *Int J Emerg Med.* 2014;7:32.
14. Olaes K, Mailhot T, Perera P. Pulmonary hypertension, hemoptysis and an echocardiographic finding of a ventricular septal defect. *West J Emerg Med*. 2012;13(6):516.
15. Chen Y, Guo L, Li Y, Chen G-LL, et al. Severe pulmonary arterial hypertension secondary to lupus in the emergency department: proactive intense care associated with a better short-term survival. *Int J Rheum Dis*. 2014;18(3):331-5.
16. Healthcare Cost and Utilization Project (HCUP). Overview of the Nationwide Emergency Department Sample (NEDS). 2016. Available at: https://www.hcup-us.ahrq.gov/nedsoverview.jsp. Accessed October 26, 2017.
17. Thenappan T, Ryan JJ, Archer SL. Evolving epidemiology of pulmonary arterial hypertension. *Am J Respir Crit Care Med*. 2012;186(8):707-9.
18. Humbert M, Sitbon O, Chaouat A, et al. Pulmonary arterial hypertension in France. *Am J Respir Crit Care Med*. 2006;173(9):1023-30.
19. Peacock AJ, Murphy NF, McMurray JJ V, et al. An epidemiological study of pulmonary arterial hypertension. *Eur Respir J*. 2007;30(1):104-9.
20. Agarwal R, Gomberg-Maitland M. Current therapeutics and practical management strategies for pulmonary arterial hypertension. *Am Heart J*. 2011;162(2):201-13.
21. Nathan SD, Barbera JA, Gaine SP, et al. Pulmonary hypertension in chronic lung disease and hypoxia. *Eur Respir J.* 2019;53(1):1801914.
22. Hayes D, Black SM, Tobias JD, et al. Influence of pulmonary hypertension on patients with idiopathic pulmonary fibrosis awaiting lung transplantation. *Ann Thorac Surg*. 2016;101(1):246-52.
23. Hayes D, Black SM, Tobias JD, et al. Influence of pulmonary hypertension on survival in advanced lung disease. *Lung*. 2015;193(2):213-21.
24. Hayes D, Black SM, Tobias JD, et al. Prevalence of pulmonary hypertension and its influence on survival in patients with advanced chronic obstructive pulmonary disease prior to lung transplantation. *COPD.* 2016;13(1):50-6.
25. Zolty R. Challenges in pulmonary hypertension associated with left heart disease. *Expert Rev Cardiovasc Ther*. 2019;17(6):461-72.
26. Rosenkranz S, Gibbs JSR, Wachter R, et al. Left ventricular heart failure and pulmonary hypertension. *Eur Heart J*. 2016;37(12):942-54.
27. Opitz CF, Blindt R, Blumberg F, et al. Pulmonary hypertension: hemodynamic evaluation: hemodynamic evaluation - recommendations of the Cologne Consensus Conference 2010. *Dtsch Med Wochenschr.* 2010;135 Suppl:S78-86.
28. Seeger W, Adir Y, Barberà JA, et al. Pulmonary hypertension in chronic lung diseases. *J Am Coll Cardiol.* 2013;62(25 Suppl):D109-16.
29. Voswinckel R, Reichenberger F, Enke B, et al. Acute effects of the combination of sildenafil and inhaled treprostinil on haemodynamics and gas exchange in pulmonary hypertension. *Pulm Pharmacol Ther.* 2008;21(5):824-32.
30. George MG, Schieb LJ, Ayala C, et al. Pulmonary hypertension surveillance: United States, 2001 to 2010. *Chest*. 2014;146(2):476-95.
31. Sikachi RR, Sahni S, Mehta D, et al. Nationwide trends in inpatient

admissions of pulmonary hypertension in the United States from 2000 to 2013. *Adv Respir Med.* 2017;85(2):77-86.

32. Chang W, Weng S, Hsu C, et al. Prognostic factors in patients with pulmonary hypertension: a nationwide cohort study. *J Am Heart Assoc.* 2016;5(9).
33. Lahm T, Tuder RM, Petrache I. Progress in solving the sex hormone paradox in pulmonary hypertension. *Am J Physiol Lung Cell Mol Physiol.* 2014;307(1):L7-26.
34. Link J, Glazer C, Torres F, et al. International Classification of Diseases coding changes lead to profound declines in reported idiopathic pulmonary arterial hypertension mortality and hospitalizations: implications for database studies. *Chest.* 2011;139(3):497-504.
35. Brown LM, Chen H, Halpern S, et al. Delay in recognition of pulmonary arterial hypertension: factors identified from the REVEAL registry. *Chest*. 2011;140(1):19-26.
36. Humbert M, Sitbon O, Yaici A, et al. Survival in incident and prevalent cohorts of patients with pulmonary arterial hypertension. *Eur Respir J*. 2010;36(3):549-55.
37. Nawar EW, Niska RW, Xu J. National Hospital Ambulatory Medical Care Survey: 2005 emergency department summary. *Adv Data*. 2007;(386):1-32.
38. Rich JD, Rich S. Clinical diagnosis of pulmonary hypertension. *Circulation*. 2014;130(20):1820-30.
39. Mockel M, Searle J, Muller R, et al. Chief complaints in medical emergencies. *Eur J Emerg Med*. 2013;20(2):103-8.

It's In The Bag: Tidal Volumes in Adult and Pediatric Bag Valve Masks

Benjamin Dafilou, BA*
Daniel Schwester, MICP*
Nathan Ruhl, PhD†
Andreia Marques-Baptista, MD*

*Capital Health Hospital System, Department of Emergency Medical Services, Trenton, New Jersey
†Rowan University, Department of Biological Sciences, Glassboro, New Jersey

Section Editor: Gabriel Wardi, MD
Submission history: Submitted November 4, 2019; Revision received March 19, 2020; Accepted March 11, 2020
Electronically published April 27, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.3.45788

Introduction: A bag valve mask (BVM) is a life saving device used by all levels of health care professionals during resuscitative care. We focus most of our time optimizing the patient's position, firmly securing the mask, and frequency of ventilations. However, despite our best efforts to control these factors, we may still be precipitating harm to the patient. Multiple studies have shown the tidal volumes typically delivered by the adult BVM are often higher than recommended for lung-protective ventilation protocols. In this study we measure and compare the ventilation parameters delivered by the adult and pediatric BVM ventilators.

Methods: A RespiTrainer Advance® adult mannequin was used to simulate a patient. Healthcare providers were directed to manually ventilate an intubated mannequin for two minutes using adult and pediatric sized BVMs. Tidal volume, minute ventilation, peak pressure, and respiration rate was recorded.

Results: The adult BVM provided a mean tidal volume of 807.7mL versus the pediatric BVM providing 630.7mL, both of which exceeded the upper threshold of 560mL of tidal volume necessary for lung protective ventilation of an adult male with an ideal body weight of 70kg. The adult BVM exceeded this threshold by 44.2% versus the pediatric BVM's 12.6% with 93% of participants exceeding the maximum threshold with the adult BVM and 82.3% exceeding it with the pediatric BVM.

Conclusion: The pediatric BVM in our study provided far more consistent and appropriate ventilation parameters for adult patients compared to an adult BVM, but still exceeded the upper limits of lung protective ventilation parameters. The results of this study highlight the potential dangers in using an adult BVM due to increased risk of pulmonary barotrauma. These higher tidal volumes can contribute to lung injury. This study confirms that smaller BVMs may provide safer ventilatory parameters. Future studies should focus on patient-centered outcomes with BVM. [West J Emerg Med. 2020;21(3)722–726.]

INTRODUCTION

High volumes delivered during positive pressure ventilation can precipitate lung injury in a patient already suffering from an underlying pulmonary pathology. Barotrauma refers to damage sustained to the lung from rapid or excessive increases in pressure. Volutrauma describes structural lung injury due to over-distention of the alveoli that occurs when higher than physiologic volumes are delivered. Barotrauma is defined as trauma caused by rapid or extreme changes in pressure affecting enclosed cavities within the body.[1] Positive pressure ventilation provided via bag valve masks (BVMs) may expose patients to high airway pressures and volumes, potentiating similar alveolar damage. Conditions such as interstitial emphysema, pneumothorax, pneumomediastinum, subcutaneous emphysema, and pneumoperitoneum are clinical presentations of barotrauma.[2] The purpose of the study is to determine whether healthcare providers are unintentionally delivering pressures and volumes that could potentiate injury during manual ventilation using

BVMs.

Stroke volumes of BVMs are defined by the manufacturer as the projected delivered tidal volume by manually squeezing the bag. To achieve lung-protective ventilation for intubated patients, the average tidal volume should be between 5-8 milliliters per kilogram (mL/kg) of ideal body weight.[3,4,5,6] The reservoirs of adult BVMs contain between 1500-2000 mL of air, depending on manufacturer and model, with projected stroke volumes of between 900-1000 mL.[7,8,9] The volume of pediatric BVMs can range anywhere between 500-1000 mL with stroke volumes of 450-650 mL,[7,8,9] closer to the targeted tidal volume for adult patients who are critically ill or in cardiac arrest.[3] We assessed adult and pediatric BVM ventilation in a simulated scenario, comparing the mean tidal volume, peak pressure, and respiratory rate for each.

Population Health Research Capsule

What do we already know about this issue?
Healthcare providers at all levels are generally very ineffective at providing appropriate ventilations with bag valve masks.

What was the research question?
Whether bag valve masks (BVM) provide appropriate tidal volume for lung protective ventilation.

What was the major finding of the study?
The tidal volumes provided by standard size BVMs significantly exceed safe thresholds for lung protective ventilation.

How does this improve population health?
BVMs are used widely to resuscitate and ventilate critically ill patients, and they may actually be causing harm in practical use.

METHODS

Study Setting

This study took place at Capital Health Hopewell Medical Center, Capital Health Regional Medical Center, and the 2016 New Jersey Statewide Conference on Emergency Medical Services (EMS). One hundred and thirty people participated in this study: 1 patient care advocate, 1 licensed practical nurse, 4 respiratory therapists, 5 physician assistants, 11 critical care technicians, 13 medical doctors, 25 paramedics, 28 emergency medical technicians, and 42 registered nurses. All participants are active health care providers working in the in-hospital or pre-hospital setting. All data was collected between September and October of 2016. Participants were selected out of convenience and those willing to participate.

Study Design

Institutional Review Board approval was given for this study. This study was conducted using the QuickLung RespiTrainer Advance® set to the adult setting, which means that the respiratory mechanics were set to a compliance of 50 milliliters per centimeter of water (mL/cm H_2O) and a resistance of 5 centimeters of water per liter per second (cmH_2O/L/s). These settings allowed for the RespiTrainer® to accurately calculate tidal volumes (V_t), peak pressures (P_{peak}), breath rates (BR), and minute ventilations (MV). P_{peak} was recorded by the RespiTrainer Advance as the highest value of pressure during a single positive pressure ventilation. MV is calculated by the RespiTrainer Advance as the prorated average tidal volume per minute from a sample of one breath. BR were calculated by the RespiTrainer Advance in real time from the previous breath and reported as the average of these measurements. V_t were calculated by $V_t = (P_{peak} - P_{min}) / (50 \text{ mL/cm } H_2O)$

The RespiTrainer® was intubated with a standard size 7.5 millimeters (mm) endotracheal tube at 25 centimeters (cm) at the lip. The endotracheal cuff was then inflated with 10 mL of air. The chest rise mechanism was not utilized during data collection because, during a real cardiac arrest, clinicians providing ventilations would not be able to see chest rise while compressions were in progress in an intubated patient. An AirFlow AF1140MB Adult BVM® and an AirFlow AF2140MB Pediatric BVM® were used for this study. The range of tidal volumes used for this study for an adult male patient with an ideal body weight of 70 kg was 350-560 mL based off a lung protective range of 5-8 mL/kg.[10] The adult BVM, an AirFlow AF1140MB, had a maximum capacity of 1900mL and the pediatric BVM, an AirFlow AF2140MB, had a maximum capacity of 1000mL.

A simulated cardiac arrest scenario was selected to encourage providers to ventilate slowly and use lower volumes. This standardized approach allowed observation of the true ventilatory metrics delivered when using the two BVMs. Prior to data collection, each participant was given the following instruction: "You are in a cardiac arrest scenario. You have been directed to provide ventilations to an adult intubated patient for two minutes of cardio-pulmonary resuscitation (CPR) using an adult BVM; and then another two minutes, using a pediatric BVM." Each participant was instructed that they were only responsible for ventilations; they did not need to provide compressions, medications, pause for pulse checks or any other CPR related activity. The only demographic information collected for the participants was their highest medical certification level.

Statistical Analysis

All data was analyzed using JMP 12.0. Sample size was not sufficient to test for interactive effects between the different metrics of BVM performance (tidal volume, peak pressure,

respiration rate and minute ventilation) and the different certification types of study participants, so differences in adult vs. pediatric BVM performance were analyzed using discrete Wilcoxon signed-rank tests (paired differences). Wilcoxon signed-rank tests were also used to compare tidal volume for both adult and pediatric BVMs to an idealized upper-threshold of 560 mL (upper threshold for an adult male with an ideal body weight of 70 kg).[3]

RESULTS

The four metrics measured during this study were tidal volume in mL, respiratory rate in breaths per minute (bpm), peak pressure in cmH_2O, and minute ventilation in liters (L). There was a significant difference between adult and pediatric BVM performance (Table 1) as measured by tidal volume (p=<0.001), peak pressure (p=<0.001), and minute ventilation (p=<0.001), but not respiration rate (p=0.549).

The mean tidal volume measured using the adult BVM was 807.7 mL versus the pediatric BVM mean tidal volume of 630.7 mL. The mean peak pressure measured in the adult BVM was 17 cmH_2O versus the mean peak pressure of the pediatric BVM of 13.4 cmH_2O. The mean minute ventilation measured for the adult BVM was 11.6 L versus 8.8 L for the pediatric BVM. The mean respiration rate measured with the adult BVM was 14.2 bpm versus 13.9 bpm in the pediatric BVM group.

Tidal volume for both adult (p=<0.001) and pediatric (p=<0.001) BVMs significantly exceeded the threshold of 560 mL for an adult male with an ideal body weight of 70 kg, but the difference was far greater for the adult BVM (Figure 1A; adult mean tidal volume = 807.7 mL; pediatric mean tidal volume = 630.7 mL). The mean tidal volume delivered by the adult BVM exceeded the upper threshold of 560 mL for an adult male with an ideal body weight of 70 kg patient by 44.2%, versus the pediatric BVM where the mean tidal volume exceeded the upper threshold by 12.6%. The mean measured peak pressure for the adult BVM was 26.9% higher than it was in the pediatric BVM. The mean measured minute ventilation for the adult BVM was 31.8% higher than it was in the pediatric BVM.

While both BVMs are capable of delivering appropriate tidal volumes, 93% (n=121) of participants exceeded the upper threshold for tidal volumes using the adult BVM and 82.3% (n=107) exceeded the upper threshold for tidal volumes using the pediatric BVM.

DISCUSSION

Studies have shown that ventilation using low tidal volumes is associated with reduced morbidity and mortality.[4,5,6,11,12] Higher tidal volumes can lead to increased organ dysfunction and inflammation in intubated patients.[5,6] Ideal conditions for intubated patients on mechanical ventilation is a tidal volume of 5-8 mL/kg, or 350-560 mL in an adult male with an ideal body weight of 70 kg.[10] Most providers in our study ventilated the simulator mannequin with over 800 mL of tidal volume using the adult BVM (Figure 1A and Table 1), which is over 200 mL higher than the upper threshold of most recommended lung-protective ventilator settings.[13] The pediatric BVM provided slightly elevated, but more physiologically appropriate, tidal volumes and peak pressures for adult patients. Although our study was not conducted on patients, exceeding the physiologically appropriate metrics could have a negative impact on patient care due to the consequences of barotrauma and volutrauma. Studies have consistently shown low volume mechanical ventilation in the setting of acute lung injury results in significantly lower mortality.[11,12]

There was no significant difference in breaths per minute when using the BVMs. This is significant because even in a simulated environment under ideal conditions all providers consistently ventilated above the recommended rate 8-10 bpm in a cardiac arrest scenario.[14] Ventilating at higher than recommended rates potentiates the damage caused by the higher volumes and pressures. As shown in Figure 1B, there was no significant difference in respiratory rate between the adult and pediatric BVMs, which indicates that participants understood the directions correctly and did not switch ventilatory rates when switching BVMs.

This study adds to an emerging body of literature on the use of smaller BVMs[5] for achieving closer to ideal physiologic parameters during manual ventilations of intubated patients.[4,5,6] Siegler et al examined whether or not pediatric BVMs could provide sufficient tidal volume to adult patients via several different airway securing devices. Though they had a smaller cohort, their results were similar to our own.

Table 1. Mean and standard deviation (SD) for adult and pediatric bag valve mask metrics and results from Wilcoxon Signed-Rank analysis.

	Adult		Pediatric		Wilcoxon Signed-Rank Test		
BVM metric	Mean	SD	Mean	SD	Difference	SD	P value
Tidal volume (mL)	807.7	160.3	630.7	84.9	177	111.9	<0.001
Respiration rate (RR)	14.2	6.7	13.9	6.6	0.3	3.2	0.549
Peak pressure (cm H_2O)	17	3.8	13.4	2.4	3.6	2.3	<0.001
Minute ventilation (L)	11.6	6.1	8.8	4.7	2.7	2.9	<0.001

BVM, bag valve mask; *mL*, milliliters; *RR*, respirations per minute; *cm H_2O*, centimeters of water; *L*, liters.
Differences were calculated as Adult-Pediatric; positive values indicate adult metrics were higher.

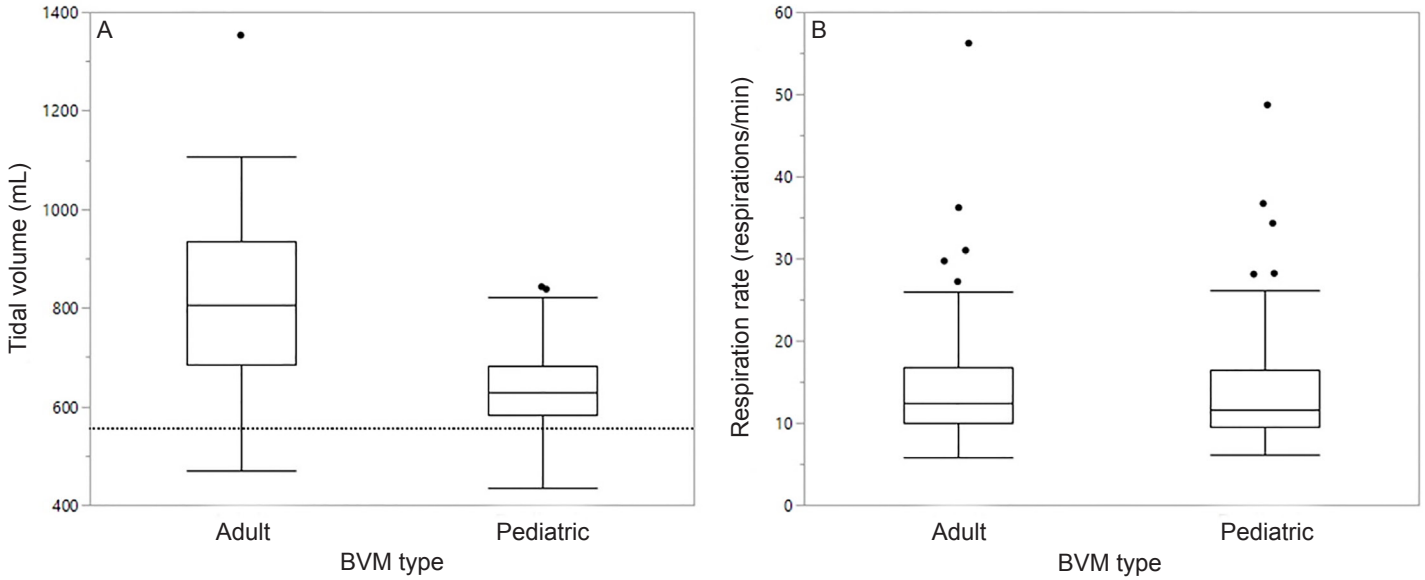


Figure 1. Side-by-side boxplots of adult vs. pediatric for mean tidal volume (A) and mean respiration rate (B). The dashed line in A represents the idealized upper threshold for an adult male with an ideal body weight of 70 kilograms (kg) at 8 milliliters (mL)/kg, or 560 mL. *BVM*, bag valve mask; *min*, minutes.

LIMITATIONS

This study is limited to the accuracy of the Quick Lung RespiTrainer Advance®. It is a very advanced simulator, but it assumes standard pulmonary compliance and resistance whereas human subjects vary widely and significantly. This study was conducted under a controlled environment that differs from a true patient care situation.[15] We did not randomize the order in which we conducted ventilations with the different BVM types, so it is possible that some amount of variation between BVM types could be due to factors such as fatigue, but the observation that respiratory rate did not decline between treatments (Figure 1B) indicates that fatigue was not a meaningful issue in this study. We were also limited by the fact that this study does not include human patients and therefore could not measure patient outcomes or complications. The fact that the adult BVM was always used first may have influenced subjects to provide more volume with the pediatric BVM because the order was not randomized. Also, the lack of chest wall movement because this was a simulated cardiac arrest scenario may have caused subjects to provide more volume than they normally would if chest compressions were not being performed. Additionally, although we were simulating a cardiac arrest scenario because we did not use the chest rise function of the mannequin participants may have overventilated the mannequin due to not being able to see chest rise. This study was also limited because it only did an analysis for an adult male patient with an ideal body weight of 70 kg, this is significantly higher than a female adult patient.

CONCLUSION

The results of this study showed extreme tidal volumes were delivered while using a standard size adult BVM. The pediatric BVM in our study provided far more consistent and appropriate ventilation compared to an adult BVM in a simulated adult patient, though it still exceeded upper limits for lung-protective ventilation. Additional data obtained from clinical trials comparing a smaller or newly designed BVM to standard BVM are needed; however, it seems prudent to consider reducing the size or redesigning the standard adult BVM to minimize the risk of barotrauma.

Address for Correspondence: Benjamin Dafilou, BA, Capital Health Hospital System, Department of Emergency Medical Services, 433 Bellevue Avenue, Trenton, NJ 08618. Email: bdafilou@gmail.com.

Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

REFERENCES

1. Jr. WCS. Barotrauma. MedicineNet. Available at: https://www.medicinenet.com/script/main/art.asp?articlekey=31722. Accessed January 6, 2020.
2. US Naval Sea Systems Command. *US Navy Diving Manual*. 6th ed. United States; 2006.
3. Siegler J, Kroll M, Wojcik S, et al. Can EMS Providers Provide Appropriate Tidal Volumes in a Simulated Adult-sized Patient with a Pediatric-sized Bag-Valve-Mask? *Prehosp Emerg Care*. 2016;21(1):74-8.
4. Gu W-J, Wang F, Liu J-C. Effect of lung-protective ventilation with lower tidal volumes on clinical outcomes among patients undergoing surgery: a meta-analysis of randomized controlled trials. *CMAJ*. 2015;187(3):101-9.
5. Lellouche F, Dionne S, Simard S, et al. High Tidal Volumes in Mechanically Ventilated Patients Increase Organ Dysfunction after Cardiac Surgery. *Anesthesiology.* 2012;116(5):1072-82.
6. Oliveira RPD, Hetzel M, Silva MDA, et al. Mechanical ventilation with high tidal volume induces inflammation in patients without lung disease. *Crit Care*. 2010;14(2):R39.
7. Ventlab. Airflow Manual Resuscitator. *Airflow Manual Resuscitator*. 2017.
8. Ambu. Ambu Spur II. *Ambu Spur II*. 2017.
9. Intersurgical. Bag-Valve-Mask (BVM) manual resuscitation systems. *Bag-Valve-Mask (BVM) manual resuscitation systems*. 2017.
10. Kilickaya O, Gajic O. Initial ventilator settings for critically ill patients. *Crit Care*. 2013;17:123.
11. Ventilation with Lower Tidal Volumes as Compared with Traditional Tidal Volumes for Acute Lung Injury and the Acute Respiratory Distress Syndrome. *N Engl J Med*. 2000;342(18):1301-8.
12. Amato MBP, Barbas CSV, Medeiros DM, et al. Effect of a Protective-Ventilation Strategy on Mortality in the Acute Respiratory Distress Syndrome. *N Engl J Med*. 1998;338(6):347-54.
13. Brower RG, Matthay MA, Morris A, et al. Ventilation with Lower Tidal Volumes as Compared with Traditional Tidal Volumes for Acute Lung Injury and the Acute Respiratory Distress Syndrome. *N Engl J Med*. 2000;342(18):1301-8.
14. Link MS, Berkow LC, Kudenchuk PJ, et al. Part 7: Adult Advanced Cardiovascular Life Support. *Circulation*. 2015;132(18):444-64.
15. Elling R, Politis J. An evaluation of emergency medical technicians ability to use manual ventilation devices. *Ann Emerg Med*. 1983;12(12):765-8.

This Article Corrects: "Assessment of Physician Well-being, Part Two: Beyond Burnout"

Michelle D. Lall, MD, MHS*
Theodore J. Gaeta, DO, MPH†‡**
Arlene S. Chung, MD, MACM§**
Sneha A. Chinai, MD¶**
Manish Garg, MD‖#**
Abbas Husain, MD**
Cara Kanter, MD#**
Sorabh Khandelwal, MD††**
Caitlin S. Rublee, MD, MPH††**
Ramin R. Tabatabai, MD‡‡**
James Kimo Takayesu MD, MS§§**
Mohammad Zaher, MBBS¶¶**
Nadine T. Himelfarb, MD‖‖**

*Emory University School of Medicine, Department of Emergency Medicine, Atlanta, Georgia
†New York-Presbyterian Brooklyn Methodist Hospital, Department of Emergency Medicine, Brooklyn, New York
‡Weill Cornell Medicine, Department of Emergency Medicine in Clinical Medicine, New York, New York
§Maimonides Medical Center, Department of Emergency Medicine, Brooklyn, New York
¶University of Massachusetts Medical School, Department of Emergency Medicine, Worcester, Massachusetts
‖Lewis Katz School of Medicine at Temple University, Department of Emergency Medicine, Philadelphia, Pennsylvania
#Temple University Hospital, Department of Emergency Medicine, Philadelphia, Pennsylvania
**Staten Island University Hospital Zucker School of Medicine at Hofstra/Northwell, Department of Emergency Medicine, Staten Island, New York
††The Ohio State University, Department of Emergency Medicine, Columbus, Ohio
‡‡Keck School of Medicine of USC, Department of Emergency Medicine, Los Angeles, California
§§Harvard Medical School, Department of Emergency Medicine, Boston, Massachusetts
¶¶Prince Mohammed Bin Abdulaziz Hospital, Consultant of Emergency Medicine, Riyadh, Saudi Arabia
‖‖Alpert Medical School of Brown University, Department of Emergency Medicine, Providence, Rhode Island

Electronically published March 26, 2020
Full text available through open access at http://escholarship.org/uc/uciem_westjem
DOI: 10.5811/westjem.2020.3.47433

West J Emerg Med. 2019 March;20(2):291-304.
Assessment of Physician Well-being, Part Two: Beyond Burnout
Lall MD, Gaeta TJ, Chung AS, Chinai SA, Garg M, Husain A, Kanter C, Khandelwal S, Rublee CS, Tabatabai RR, Takayesu JK, Zaher M, Himelfarb NT

Erratum in
West J Emerg Med. 2020 May;21(3):727. Author name misspellled. The sixth author, originally published as Abbas Hussain, MD is revised to Abbas Husain, MD.

Abstract
Part One of this two-article series reviews assessment tools to measure burnout and other negative states. Physician well-being goes beyond merely the absence of burnout. Transient episodes of burnout are to be expected. Measuring burnout alone is shortsighted. Well-being includes being challenged, thriving, and achieving success in various aspects of personal and professional life. In this second part of the series, we identify and describe assessment tools related to wellness, quality of life, resilience, coping skills, and other positive states.

PMCID: PMC6404719 [PubMed - indexed for MEDLINE]

JOIN CAL/AAEM!

CALAAEM

CALIFORNIA CHAPTER DIVISION OF THE
AMERICAN ACADEMY OF EMERGENCY MEDICINE

Championing individual physician rights and workplace fairness

BENEFITS

- *Western Journal of Emergency Medicine* Subscription
- CAL/AAEM News Service email updates
- Discounted AAEM pre-conference fees
- And more!

CAL/AAEM NEWS SERVICE

- Healthcare industry news
- Public policy
- Government issues
- Legal cases and court decisions

In collaboration with our official journal

WestJEM Integrating Emergency Care with Population Health

FACEBOOK.COM/CALAAEM

FOLLOW US @CALAAEM

HTTP://WWW.CALAAEM.ORG




ADVANCED›

INSPIRED

› CALIFORNIA ACEP'S ANNUAL CONFERENCE 2020

Education is targeted to Medical Students and Residents, but all are welcome to attend.

Friday, September 25, 2020
Westin San Diego Gaslamp Quarter

CALIFORNIA ACEP
AMERICAN COLLEGE OF EMERGENCY PHYSICIANS