## Title

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ORIGINAL CONTRIBUTION

# Impact of the COVID-19 pandemic on emergency medicine education: Insights from faculty and residents

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## Abstract

**Objectives:** The COVID-19 pandemic continues to impact health systems across the United States and worldwide in an unprecedented way; however, its influence on frontline medical trainees' educational experiences is unknown. Our objective was to determine the effects of COVID-19 on emergency medicine (EM) training programs and residents.

**Methods:** We performed a mixed-methods cross-sectional survey study of faculty and residents at programs registered with Foundations of Emergency Medicine. Participants completed an online survey consisting of closed and open-ended response items. We reported descriptive statistics for discrete and continuous data. Free-response data were analyzed qualitatively using a thematic approach.

**Results:** Ninety-two percent of faculty (119/129) and 47% (1,965/4,154) of residents responded to our survey. We identified three major themes related to effects on learning: 1) impact on clinical training, 2) impact on didactic education, and 3) impact on the trainee. Nearly all residencies (96%, 111/116) allowed residents to work with patients suspected of having COVID-19, although fewer (83%, 96/115) allowed residents to intubate them. We found that 99% (1918/1928) of residents experienced virtual didactics. Faculty and trainees noted multiple educational challenges and strategies for adaptation. Trainees also expressed concerns about stress and safety.

**Conclusion:** COVID-19 has impacted EM education in many ways including clinical training, didactic education, and trainee emotional state and concentration. Challenges and suggested solutions for learning in the virtual environment were also identified. While the pandemic continues to evolve and impact EM residents in various ways, our results may inform strategies to support medical educators and trainees during pandemics or other periods of significant disruption or crisis.

## INTRODUCTION

The coronavirus (COVID-19) pandemic of 2019 continues to threaten the lives of individuals across the globe and has had far-reaching implications for health care systems.[1] Imbedded within those health care systems are frontline providers and trainees. Emergency medicine (EM) residents comprise a group of trainees who are clearly on the frontline and the impact of the ongoing pandemic on their education warrants careful study.

In-depth clinical experience remains a critical component of medical education to ensure that trainees gain the knowledge and skills necessary to function as independent providers.[2,3] The clinical environment, patient acuity, volumes, and types of pathology may be altered as a result of the pandemic and therefore limit the educational experience for trainees.[4-8] COVID-19 has also led to the cancellation of scientific conferences and the conversion of in-person classes and educational sessions to the virtual environment.[4-10] The pandemic surged in spring 2020,[11] and during this time period EM residents faced risks of personal infection, quarantine, and redeployment from their standard rotation schedules.[12] Subsequently, feelings of fear, vulnerability, and anxiety were not uncommon, especially among frontline trainees.[13] Limited data have demonstrated that trainees in various specialties perceive these changes are negatively impacting their education and the degree to which these unprecedented experiences are affecting trainees remains unknown.[5,10,69]

As frontline providers during this pandemic, EM residents have likely been impacted significantly and in evolving ways. Our objective was to determine how the early months of the COVID-19 pandemic impacted education in EM from the perspective of frontline faculty and residents.

## METHODS

### Study design

We conducted a cross-sectional survey study of Foundations of Emergency Medicine (FoEM) faculty and residents in the United States. This study was deemed exempt by the institutional review board of the third author.

### Setting and participants

Our target population consisted of all U.S. EM residents and site leaders who participate in FoEM,[14] a national free open-access educational program. The program provides curated resources for independent study and small-group and case-based instruction. We chose this convenience sample because it represents a broad cohort of EM faculty and residents. In the 2019 to 2020 academic year 48.7% (129/265) of all EM residencies and 52% (4154/ 8029) of residents in the United States registered for and used FoEM.[15,16] Site leaders are academic EM faculty who coordinated FoEM sessions. All faculty and residents registered by January 2020 were eligible to participate. We excluded sites that reported limited or no use of FoEM materials. Faculty and residents were encouraged to complete the survey to provide feedback for quality improvement of the FoEM free open-access medical education content and research purposes. We encouraged each site to provide one faculty survey, and we asked each program to encourage their residents to complete the survey. We offered no financial or other incentives for participation.

### Study protocol

Participants were recruited via email from the list of faculty and residents who had registered with FoEM and indicated use of the curriculum during the 2019 to 2020 academic year. We distributed the survey via Qualtrics to residents and faculty on April 13, 2020. We sent four subsequent invitations to nonresponders at approximately weekly intervals. The surveys closed on June 24, 2020. Data were stored on a secure server and identifiers were removed before analysis.

### Instrument development

Two surveys, one for faculty and one for residents, were constructed by our study team of expert EM physician educators. Survey development followed established guidelines for survey research.[17] To optimize content validity, the general structure and distribution of the survey was based on the annual FoEM survey, which is iteratively developed by a broad range of clinician educators in EM. We then performed a literature search in PubMed and Google Scholar to review both general educational and literature relevant to education during the COVID-19 pandemic and added and refined items accordingly. To build response-process validity evidence, the surveys were piloted with a small group of reference subjects including faculty, fellows, and residents. We made revisions for content and clarity based on results of our pilot prior to survey distribution. Surveys consisted of closed and open-ended response items. The final versions of the questions used in this study are available in Data Supplement S1 (available as supporting information in the online version of this paper, which is available at http://onlinelibrary.wiley.com/doi/10.1002/aet2.10603/full).

### Data analysis

We calculated and reported descriptive statistics such as measures of central tendency, proportions, and compared groups using two-sample tests of proportions. We set statistical significance at an $\alpha < 0.05$. Two experienced qualitative researchers (PLW, JJ) independently analyzed the data from free-response items using a thematic approach. Data were examined line by line to identify recurring concepts and assign codes, which were then further refined into themes

using the constant comparative method.[18] The two researchers then met to establish a final coding scheme that was independently applied to all data. Discrepancies were resolved by in-depth discussion and negotiated consensus.

## RESULTS

### General results

Response rates were 92% (119/129) and 47% (1965/4154) for faculty and residents, respectively. Quantitative data below provide the number of participants completing each item which varied from 81% to 98% for faculty and 97% to 98% for residents among reported optional items. The distribution of resident postgraduate years (PGYs) is shown in Table 1. Inter-rater agreements for the qualitative analysis were 87.6% and 90.3% for the faculty and resident free-response data, respectively. Results of the qualitative analysis are displayed in Tables 2 and 3. These results are further discussed below. Three major themes emerged regarding the impact of COVID-19 on trainees' ability to learn: 1) impact on clinical training, 2) impact on didactic education, and 3) impact on the trainee.

### Impact on clinical training

Faculty reported that only 15% (17/115) of programs with medical student rotators allowed them to work clinically in the emergency department (ED). Most sites (96%, 111/116) were allowing residents to see COVID-19 persons under investigation (PUIs). A total of 89% (103/116) of programs allowed PGY-1s, 91% (106/116) allowed PGY-2s, and 94% (109/116) allowed PGY-3s to treat PUIs. All respondents from 4-year programs (30/30) allowed PGY-4s to work with PUIs. There were no differences in the proportion of residents allowed to care for PUIs between PGY years. (Table 4). Only 4% (5/116) of sites prohibited residents from working with PUIs.

Fewer residents were allowed to intubate COVID-19 PUI patients; 25% (29/115) allowed PGY-1s, 56% (64/115) allowed PGY-2s, and 81% (93/115) allowed PGY-3s to intubate COVID-19 PUIs and these differences were statistically significant (Table 5). Among 4-year programs, 90% (27/30) allowed PGY-4s to intubate; however, there was no statistically significant difference in the proportion of PGY-3s and PGY-4s allowed to intubate among 4-year programs (Table 5). A total of 17% (19/115) of programs prohibited all residents from intubating COVID-19 PUIs. Of programs that permitted residents to intubate, 34% (33/96) have official opt-out policies, 60% (58/96) allow opt-out with attending discretion, and 5% (5/96) have no policy regarding opt-out from intubation for residents.

Our thematic analysis of faculty and resident responses demonstrated broad impacts of COVID-19 education in the clinical context. Major themes that emerged regarding the impact of COVID-19 on the clinical training environment from faculty perspectives included patient presentations, trainee experience, and institutional regulations (Table 2). As one faculty respondent commented, "[Covid has impacted us] in a tremendous number of ways. Our ED operations are turned upside down, medical students are no longer in the department, and our volumes overall are down." Trainees indicated that their clinical training was impacted during the COVID-19 pandemic in several ways. They noted lower patient volumes; decreased breadth of patient presentations; higher acuity; fewer procedures, canceled procedures, and changes in staffing; and a negative impact on efficiency (Table 3).

**TABLE 1** Distribution of resident respondents by PGY during the COVID-19 pandemic

| PGY | Percent | Number |
|---|---|---|
| 1 | 35 | 692 |
| 2 | 32 | 635 |
| 3 | 27 | 531 |
| 4 | 5.5 | 107 |
| Total | 100 | 1,965 |

Abbreviations: COVID-19, coronavirus disease of 2019, the illness caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2); PGY, post-graduate year.

### Impact on didactic education

Under routine circumstances, 47% (55/117) of programs provide 5 hours of conference didactics weekly, 48% (56/117) provide 4 hours of conference and 1 hour of individualized interactive instruction, and 5% (6/117) provide a different conference structure for their residents with the majority of those programs providing 4 to 5 hours of conference with individualized interactive instruction or asynchronous offerings. Programs planned to provide a mean (±SD) of 4.3 (±0.83) hours of conference didactics during the initial phase of the COVID-19 pandemic (March 2020–June 2020).

As a result of the COVID-19 pandemic, most programs made substantial changes to their weekly didactic programs. Only 9.4% (11/117) of programs reported that they continued to have in-person interactive experiences and 4.3% (5/117) continued to hold in-person conferences. The vast majority of programs, 99% (116/117), held virtual/live lectures, while 90% (105/117) held virtual interactive experiences and 37% (43/117) held virtual prerecorded lectures. In addition, most programs, 60% (70/117), offered individualized interactive instruction to provide for asynchronous learning during this period.

Programs used a variety of videoconferencing software during the COVID-19 pandemic. The majority, 72% (84/117), used Zoom. Other less frequently used platforms included 21% (25/117) WebEx, 8.5% (10/117) Microsoft Teams, 3.4% (4/117) GoToMeeting, 3.4% (4/117) Skype, 2.6% (3/117) Google Hangout, and 1.7% (2/117) Slack. Lesser used programs included Academic Life in Emergency Medicine (ALiEM) Connect, BigBlueButton, FaceTime, Starleaf, or Panopto.

**TABLE 2** Results of qualitative analysis of the faculty survey

| Domain | Theme | Subtheme | Exemplar quotes |
|---|---|---|---|
| Impact of COVID-19 on clinical training environment | Patient presentations | Lower volume | "Most importantly, our volumes are way down, so our residents are seeing many fewer patients than they normally would." |
| | | Higher acuity | "We've seen increased critical care. Patients are sicker …" |
| | | Decreased breadth of patient pathology/presentation | "decreasing resident exposure to non covid cases and particularly decreasing exposure to pediatric cases." |
| | Trainee experience | Canceled rotations | "Some residents lost electives, selectives, and non-required [rotations]." |
| | | Less procedures | "Intern year is our 'procedure year' and I worry about the intubations lost during the pandemic as most attendings do not allow interns to intubate [now]." |
| | Institutional regulations | Guidelines/policies regarding COVID-19 patients | "We have a COVID intubation team to decrease [personal protective equipment] use and standardize approach" |
| | | Changes in resident staffing | "We pulled our senior supervising role to better staff our main two [emergency departments]." |
| | | Prohibition of medical students | "Medical students are no longer in our ED." |
| Changes made to didactic education in response to COVID-19 | Virtual didactics | | "We have stopped meeting in person but have continued virtually with minimal disruption to our educational plan." |
| | Canceled educational experiences | | "Large group sessions (i.e. wellness day, sim, resident research forum, resident retreat) were canceled …" |
| | Dedicated education on COVID-19 | | "We're hosting many COVID related talks (changed originally planned content)." |
| | Utilization of virtual national resources/ lecturers | | "[We've used] more outside lecturers given easier access now that we are doing virtual conference." |
| Additional resources needed to provide high-quality education | Virtual simulation and procedure labs | | "I would like to have a virtual platform for simulation." |
| | External educational resources | | "It would help to have access to external lecturers to be able to lecture virtually." |
| | Technology resources | | "Gamification would be great—we are still trying to build a sense of community even when we can no longer hold any events in person any longer." |

Abbreviation: COVID-19, coronavirus disease of 2019, the illness caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).

The majority of faculty (85%, 99/117) indicated that they were continuing to use FoEM as a resource during the COVID-19 pandemic. Other frequently used resources included ALiEM materials (57%, 67/117) and Emergency Medicine Reviews and Perspectives (EMRAP; 45%, 53/117). Less frequently used resources included 3.4% (4/117) EM Coach, 3.4% (4/117) EM Fundamentals, 2.6% (3/117) Rosh Review, 1.7% (2/117) EMedHome, and 1.7% (2/117) ECG Weekly or University of Maryland cardiology resources. In addition, 6.8% (8/117) of faculty indicated that they used home departmental lectures or interdepartmental sessions.

Major themes that emerged from faculty regarding changes to didactic education in response to the pandemic included virtual didactics, canceled educational experiences, dedicated education on COVID-19, and utilization of virtual national resources and lecturers (Table 2). One faculty respondent commented:

> Now [didactics are] entirely virtual. [We are] no longer doing in person simulation or large group sim in the sim center. [We spend] more time now devoted to COVID/residency updates.

Faculty respondents felt that virtual methods for providing simulation and procedure labs, external educational resources, and technology resources would be helpful.

**TABLE 3** Results of qualitative analysis of the resident survey

| Domain | Theme | Subtheme | Exemplar quotes |
|---|---|---|---|
| Influence of COVID-19 on ability to learn | Impact on didactic education | Virtual didactics | "We have moved our weekly conference entirely online." |
| | | Increased individualized interactive instruction and self-study | "It has opened up a lot more free time for independent reading and learning." |
| | | Canceled educational experiences | "[We have] no sim lab, no procedural instruction …" |
| | | Less engagement | "[Virtual conferences] are still great learning experiences, but I feel it is harder to be an active participant compared to in-person conference." |
| | Impact on clinical education | Lower patient volumes | "[We have] lower patient volumes, therefore fewer patients to learn from." |
| | | Decreased breadth of patient presentations | "I am not seeing the diversity of patients that I would usually be seeing, so I worry I am not getting the repetition I need to build my clinical skills." |
| | | Higher patient acuity | "We are seeing slightly less volume, but higher acuity. It makes us able to talk on shift about sick patients in the moment." |
| | | Fewer procedures | "As an intern, I'm no longer allowed to intubate or do procedures." |
| | | Canceled rotations | "We have been pulled out of various rotations including anesthesia." |
| | | Changes in resident staffing | "I've had a fluctuating schedule and my shifts re-arranged." |
| | | Negative impact on efficiency | "I'm no longer learning how to handle many patients at once." |
| | Impact on the trainee | Increased stress and anxiety | "Mental health stress makes motivation to study difficult." |
| | | Difficulty maintaining attention/focus on training | "It's difficult to focus on core learning given the need to constantly keep up with covid updates and new data." |
| | | Safety concerns | "Risky working conditions without enough PPE." |
| Challenges in receiving virtual conference | Maintaining attention | | "I can't help but be distracted fixing things in my apartment and completing tasks when I just sitting there at home." |
| | Lack of social interaction and community | | "In person meetings are more energizing from being in the same room as peers and friends." |
| | Technology issues | | "It's harder to see shared images … technology issues occasionally making it hard for some members to participate." |
| | Lack of engagement | | "Participation and collaborative learning has suffered." |
| | Lack of hands-on experiences | | "Training of technical skills and physical simulation is pretty impossible." |
| Recommendations for improvement of virtual conferences | Decrease session length | | "Even shorter sessions (20 minutes max per topic) to maintain focus and attention." |
| | Facilitate interactivity and engagement | | "Games or outside readings followed by group discussion." |

(Continues)

**TABLE 3** (Continued)

| Domain | Theme | Subtheme | Exemplar quotes |
|---|---|---|---|
| | Optimize technology | | "Virtual conference would be improved with more reliable high throughput internet connections. Sometimes it is difficult to understand the lecturers due to 'roboting voice' or distortions caused by temporary interruptions in connection." |
| | Facilitate accountability | | "Require camera to ensure we are 'paying attention'." |

Abbreviation: COVID-19, coronavirus disease of 2019, the illness caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).

**TABLE 4** Pairwise comparisons of proportions of residents by PGY allowed to treat COVID-19 PUI

| Comparison | Proportion allowed to treat PUIs | Standard error | 95% CI | p-value | *N* |
|---|---|---|---|---|---|
| PGY-1 | 0.89 | 0.03 | (0.83–0.95) | 0.51 | 116 |
| PGY-2 | 0.91 | 0.03 | (0.86–0.96) | | 116 |
| | | | | | |
| PGY-1 | 0.89 | 0.03 | (0.83–0.95) | 0.16 | 116 |
| PGY-3 | 0.94 | 0.02 | (0.90–0.98) | | 116 |
| | | | | | |
| PGY-2 | 0.81 | 0.03 | (0.86–0.96) | 0.45 | 116 |
| PGY-3 | 0.94 | 0.02 | (0.90–0.98) | | 121 |
| | | | | | |
| PGY-1 | 0.97 | 0.03 | (0.90–1.03) | 0.31 | 30 |
| PGY-4 | 1.0 | 0 | (1–1) | | 30 |
| | | | | | |
| PGY-2 | 0.97 | 0.03 | (0.90–1.03) | 0.31 | 30 |
| PGY-4 | 1.0 | 0 | (1–1) | | 30 |
| | | | | | |
| PGY-3 | 1.0 | 0 | (1–1) | ∞ | 30 |
| PGY-4 | 1.0 | 0 | (1–1) | | 30 |

Abbreviations: COVID-19, coronavirus disease of 2019, the illness caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2); PGY, postgraduate year; PUIs, persons under investigation.

Almost all residents, 99% (1,918/1,928), indicated that they had experienced virtual conferences instead of their normal in-person conferences. However, resident preferences for teaching modality were fairly evenly split with 38% (722/1,909) of residents indicating that they learn equally well via in-person and virtual meetings, 35% (675/1909) indicating that they learn best via in-person meetings, and 27% (512/1909) indicating that they learn best via virtual meetings.

Trainees noted several challenges with virtual conferences including maintaining attention, lack of social interaction, technology issues, difficulty with engagement, and lack of hands-on experiences (Table 3). As one participant aptly summarized:

> [It's] easier to get distracted during virtual conference. [There's] less social time between sessions. Time [is] lost due to technical difficulties. [There's been a] loss of hands-on experiences we would otherwise have access to.

Qualitative analysis of data regarding recommendations from residents for improvement of virtual conferences revealed four major themes: decrease session length, facilitate interactivity, optimize technology, and facilitate accountability. (Table 3). Exemplar quotes include:

> Giving short, quick lectures that are engaging.

> It would be helpful to have more breakout rooms and small group discussion with a leader. I think virtual conferences work better if everyone's camera is on and either you communicate in the chat or everyone takes turns with their mic on.

**TABLE 5** Pairwise comparisons of proportions of residents by PGY allowed to intubate COVID-19 PUIs

| Comparison | Proportion allowed to intubate PUIs | Standard error | 95% CI | p-value | *N* |
|---|---|---|---|---|---|
| PGY-1 | 0.25 | 0.04 | (0.17–0.33) | <0.05 | 115 |
| PGY-2 | 0.55 | 0.05 | (0.47–0.65) | | 115 |
| | | | | | |
| PGY-1 | 0.25 | 0.04 | (0.17–0.33) | <0.05 | 115 |
| PGY-3 | 0.81 | 0.04 | (0.74–0.88) | | 115 |
| | | | | | |
| PGY-2 | 0.55 | 0.05 | (0.48–0.65) | <0.05 | 115 |
| PGY-3 | 0.81 | 0.04 | (0.74–0.88) | | 115 |
| | | | | | |
| PGY-1 | 0.23 | 0.08 | (0.08–0.38) | <0.05 | 30 |
| PGY-4 | 0.90 | 0.05 | (0.79–1.01) | | 30 |
| | | | | | |
| PGY-2 | 0.53 | 0.09 | (0.35–0.71) | <0.05 | 30 |
| PGY-4 | 0.90 | 0.50 | (0.79–1.01) | | 30 |
| | | | | | |
| PGY-3 | 0.8 | 0.07 | (095–0.94) | 0.28 | 30 |
| PGY-4 | 0.90 | 0.50 | (0.79–1.01) | | 30 |

Abbreviations: COVID-19, coronavirus disease of 2019, the illness caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2); PGY, postgraduate year; PUIs, persons under investigation.

> Make the audience participate more, fix some of the technical hiccups.

> Everyone turn on their videos so we know people are there.

## Impact on the trainee

EM trainees indicated that their learning was impacted by COVID-19 and major subthemes that emerged included increased stress and anxiety, difficulty maintaining attention and focus on training, and safety concerns (Table 3). The heightened level of stress experienced by residents during this time often detracted from learning and independent study. As one participant aptly stated:

> The pandemic has affected my mental health and I try to relax and do things I enjoy at home that distract me from medicine.

Another participant commented:

> The emotional toll means that any time away from work is spent decompressing as opposed to asynchronous learning.

This stress and anxiety also prompted a focus on home life. For example, one participant noted:

> Increased stress has led to a stronger desire to focus on family time rather than studying.

Additional exemplar quotes include:

> I have high levels of anxiety that are impeding my ability to function beyond my essential daily tasks at home.

> Extra stress now of losing childcare and having to work in such a stressful environment has made it feel impossible to study.

Further, residents reported difficulty maintaining attention and focus on training. One participant commented, "I cannot concentrate on literally anything." For some residents this difficulty maintaining attention was related to the virtual nature of didactics. One participant noted:

> It is much more difficult for me to focus during our virtual conference and actively participate.

Others noted that distractions, their home environment, or competing responsibilities contributed to difficulty maintaining attention. Exemplar quotes include:

> It is hard to listen [to didactics] at home with kids and husband home.

> I no longer have a quiet space at home to [study].

> It has made it significantly more difficult as a parent whose children are now home from school all the time and I need to teach them and study for myself.

Safety concerns also emerged as a prominent subtheme. There were concerns that, "residents may become ill." Additionally, concerns for safety limited clinical experiences. One resident remarked, "Learning of some skills has been limited due to safety concerns." Personal protective equipment (PPE) was also a safety concern. Exemplar quotes include:

> Risky working conditions without enough PPE.

> I spend most of my shifts anxious about donning and doffing [PPE].

## DISCUSSION

The COVID-19 pandemic has had significant consequences on clinical and didactic education in EM. We found that while resident physicians were generally allowed to work in the ED during the pandemic, they identified significant changes to their traditional clinical training. First and foremost, they pinpointed a substantial contraction in the range of patient presentations to the ED during this time, which is reflective of what was seen nationally early in the pandemic.[19] Many felt not only that was patient volume greatly decreased, but also that the breadth of patient pathology seen was greatly reduced. This sentiment is corroborated by emergency physicians across the country as noted in a *New York Times* article entitled "Where have all the heart attacks gone?"[20] Some felt that while volumes had decreased, patient acuity had increased. They believed that this might be secondary to seeing critically ill COVID-19 patients or those who were sheltering at home and attempting to avoid a visit to the ED. In caring for COVID-19 patients in the ED, the majority of residents had been allowed to care for COVID-19 PUIs; however, the proportion of residents allowed to intubate PUIs increased with advancing PGY level. Other impacts of the pandemic on clinical training included canceled off-service rotations such as anesthesia due to low surgical case volumes, resulting in further loss of procedural opportunities for trainees or canceled professional development electives.

In addition to having a significant influence on clinical training, the pandemic also had ramifications for didactic education. While maintaining the number of didactic hours offered, the vast majority of programs moved their didactic conference online using digital platforms. This subsequently resulted in the cancelation of in-person, hands-on experiences such as procedure labs, simulation sessions, and ultrasound workshops. This further reduced the time spent on procedural training. In lieu of this, many programs have taken advantage of inviting remote speakers from other programs to speak at their weekly didactic conferences. They also indicated utilization of online, open-access resources such as FoEM[14] and Academic Life in Emergency Medicine AIR Series[21] or hosted national virtual conference days.

While many of today's resident trainees are digital natives,[22] the residents surveyed in this study were evenly split regarding their preference for in-person didactic conference compared to virtual didactics. Many felt that virtual didactics allowed them to engage in the chat more freely while eliminating their commute to conference. Others felt that the digital space had significant limitations such as reduced engagement with the speaker or material, loss of social interaction with their colleagues, and technology issues often related to streaming by presenters or WiFi in their own homes. At the same time, residents offered many constructive insights into targeted improvements for virtual conferences such as reducing session length to optimize engagement, increasing interactivity using small groups, using virtual simulation, or optimizing the chat feature available in most digital platforms and enforcing video-on during conference time to improve attentiveness. Educators can use these recommendations to optimize virtual training sessions.

The literature is evolving and best practices for teaching during the COVID-19 pandemic continue to be moving targets. In line with prior studies, we found that EM residents seek interactive learning even in the virtual environment.[23] Some options that have been suggested including virtual morning report,[24] virtual reality instruction,[25,26] gamification,[27] and leveraging social media.[28] Educators should develop standards for virtual education to ensure that the goals of our educational programs are achieved.[29]

While we have discussed the important ramifications of the COVID-19 pandemic on residents' clinical and didactic experiences, our study also highlights the impact of the pandemic on residents themselves including increased stress and anxiety, reduced ability to maintain concentration, and concerns for personal safety. We believe that these subthemes may be contributing to increased burnout among EM residents during the pandemic, which has received little attention thus far in the literature.[30] Early in the pandemic it was suggested that EM providers believed that stress could be reduced by measures meant to keep them safe (e.g., increased access to PPE, rapid/available testing) as well as increased communication and accessibility of mental health resources.[31] Given the dynamic nature of the pandemic, changes in availability of testing and PPE, and vaccine development and distribution, further studies should focus on determining the current ideal strategies for stress and burnout mitigation and promotion of mental health among all frontline health care providers. While the mental health of EM residents is beyond the scope of this article, future studies should focus on burnout and negative mental health effects of the COVID-19 pandemic to identify and promote strategies to ensure EM resident wellness during this ongoing global health crisis.

## LIMITATIONS

This study was carried out during the early months of the pandemic and provides a cross-sectional description of residents' and faculty respondents' perspectives during the pandemic and may not reflect current trends. Because this study is cross-sectional, it

does not provide a longitudinal description of the rapidly changing nature of the pandemic's impacts on clinical training, didactics, and trainees. Additionally, the situation was evolving week to week and location to location and our results provide only an individual snapshot at the time each participant provided their survey submissions.[11] FoEM is not used by all EM programs; thus, the survey did not reach every single training site in the United States; however, faculty from 45% (119/256) of all U.S. programs representing 34 states and Washington, DC, did respond to our survey.[15] We excluded medical residency programs based outside of the United States and so it remains unclear how EM education has been impacted in other countries. We also excluded advanced practice providers (APPs) even though they use FoEM, given relatively small numbers of programs in our cohort. Future studies could focus on international EM residencies or APP residency programs to better elucidate the impact of the COVID-19 pandemic on these learners. Finally, this is a survey-based study, which is typically characterized by some element of recall bias. While the survey was sent in the midst of the first phase of the pandemic, heightened stressors may have influenced the responses received and subsequent data presented in this article. Further study is needed to determine the full, and possibly long-term, impact of reduced clinical exposure and greatly modified didactic experiences for residents in EM. In particular, given the high likelihood of continued virtual didactics during the new academic year, educators in our field must address issues of learner engagement, technology barriers, and limited hands-on experiences. Undoubtedly, there is nuance in the levels of wellness and social interaction that could be determined with more granular study of programs and virtual curricula.

## CONCLUSIONS

This study found many ways that COVID-19 has impacted emergency medicine education including clinical training, didactic education, and trainee emotional state and concentration. Challenges and suggested solutions for learning in the virtual environment were also identified. Given the scope of this disease and the duration of the crisis, the effects and consequential changes on the medical education environment are likely significant and may influence educational outcomes for years to come. Our results may assist educational leaders, institutions, and national organizations in devising strategies to support medical education during future pandemics or other periods of disruption and crisis.

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### CONFLICT OF INTEREST

The authors have no potential conflicts to disclose.

### AUTHOR CONTRIBUTIONS

Paul L. Weygandt contributed to the study concept and design, acquisition of the data, analysis and interpretation of the data, drafting of the manuscript, critical revision of the manuscript for important intellectual content, statistical expertise, and study supervision. Jaime Jordan contributed to the study concept and design, analysis and interpretation of the data, drafting of the manuscript, and critical revision of the manuscript for important intellectual content. Holly Caretta-Weyer contributed to the study concept and design; analysis and interpretation of the data; drafting of the manuscript; critical revision of the manuscript for important intellectual content; and administrative, technical, or material support. Anwar Osborne contributed to the study concept and design, drafting of the manuscript, and critical revision of the manuscript for important intellectual content. Kristen Grabow Moore contributed to the study concept and design; acquisition of the data; drafting of the manuscript; critical revision of the manuscript for important intellectual content; administrative, technical, or material support; and study oversight.

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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