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Blood Culture Use in the Emergency Department in Patients Hospitalized with Respiratory Symptoms Due to a Non-Pneumonia Illness

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Abstract

Background—Guidelines and performance measures recommend obtaining blood cultures in selected patients hospitalized with community-acquired pneumonia (CAP). Due to inherent diagnostic uncertainty, there may be spillover effects of these recommendations on other conditions that resemble pneumonia.

Methods—Using data from the 2002-2010 National Hospital Ambulatory Medical Care Survey (NHAMCS), a nationally representative sample of emergency department (ED) visits in the US, we analyzed trends in obtaining cultures in patients hospitalized with respiratory symptoms due to a non-pneumonia illness using linear regression.

Results—The most common primary admission diagnoses for these visits included heart failure (16%), chronic obstructive pulmonary disease (13%), and chest pain (12%). The proportion of cultures collected in the ED during these visits increased from 10% (95% CI, 7%-14%) in 2002 to 20% (95% CI, 16%-26%) in 2010 ($p < .001$ for the trend). This represented a parallel increase compared to patients hospitalized with CAP ($p = .12$ for the difference in trends).

Conclusions—The increase in collecting cultures in the ED in patients hospitalized with respiratory symptoms due to a non-pneumonia illness suggests an important potential unintended consequence of blood culture recommendations for CAP. More attention is needed to the judicious use of blood cultures to reduce harm and costs.

Keywords

Pneumonia; Community-Acquired Infections; Blood/microbiology; Emergency Medicine; Hospitalization; Joint Commission on Accreditation of Healthcare Organizations; Overuse

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Introduction

In 2002, based on consensus practice guidelines,¹ the Centers for Medicare and Medicaid Services (CMS) and the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) announced a core measure mandating the collection of routine blood cultures in the emergency department (ED) for all patients hospitalized with community-acquired pneumonia to benchmark the quality of hospital care. However, due to the limited utility and false positive results of routine blood cultures,²⁻⁶ performance measures and practice guidelines were modified in 2005 and 2007 respectively to recommend routine collection in only the sickest patients with community-acquired pneumonia (CAP).^{2, 7} Despite recommendations for a more narrow set of indications, the collection of blood cultures in patients hospitalized with CAP continued to increase.⁸

Distinguishing CAP from other respiratory illnesses may be challenging. Among patients presenting to the ED with an acute respiratory illness, only a minority of patients (10-30%) are diagnosed with pneumonia.⁹ Therefore, the harms and costs of inappropriate diagnostic tests for CAP may be further magnified if applied to a larger population of patients who present to the ED with similar clinical signs and symptoms as pneumonia. Using a national sample of ED visits, we examined whether there was a similar increase in the frequency of blood culture collection among patients who were hospitalized with respiratory symptoms due to an illness other than pneumonia.

Method

Study Design, Setting, and Participants

We performed a cross-sectional analysis using data from the 2002-2010 National Hospital Ambulatory Medical Care Surveys (NHAMCS), a probability sample of visits to EDs of noninstitutional general and short-stay hospitals in the U.S., excluding Federal, military, and Veterans Administration hospitals.¹⁰ The NHAMCS data are derived through multistage sampling and estimation procedures that produce unbiased national estimates.¹¹ Further details regarding the sampling and estimation procedures can be found on the Centers of Disease Control website.^{10, 11} Years 2005-2006 are omitted because NHAMCS did not collect blood culture use during this period. We included all visits by patients 18 years or older who were subsequently hospitalized.

Measurements

Trained hospital staff collected data with oversight from U.S. Census Bureau field representatives.¹² Blood culture collection during the visit was recorded as a checkbox on the NHAMCS data collection form if at least one culture was ordered or collected in the ED. Visits for conditions that may resemble pneumonia were defined as visits with a “respiratory symptom” listed for at least one of the three “reason for visit” fields, excluding those visits admitted with a diagnosis of pneumonia (ICD-9-CM codes 481.xx-486.xx). The “reason for visit” field captures the patient's complaints, symptoms, or other reasons for the visit in the patient's own words. CAP was defined by having one of the three ED provider's diagnosis fields coded as pneumonia (ICD-9-CM 481-486), excluding patients with suspected

hospital-acquired pneumonia (nursing home or institutionalized resident, seen in the ED in the past 72 hours, or discharged from any hospital within the past 7 days) or those with a follow-up visit for the same problem.⁸

Data Analysis

All analyses accounted for the complex survey design, including weights, to reflect national estimates. To examine for potential spillover effects of the blood culture recommendations for CAP on other conditions that may present similarly, we used linear regression to examine the trend in collecting blood cultures in patients admitted to the hospital with respiratory symptoms due to a non-pneumonia illness.

The data were analyzed using STATA statistical software, version 12.0 (Stata-Corp, College Station, Texas). This study was exempt from review by the institutional review board of the University of California, San Francisco and the San Francisco VA Medical Center.

Results

This study included 4,854 ED visits, representing approximately 17 million visits by adult patients hospitalized with respiratory symptoms due to a non-pneumonia illness. The most common primary ED provider's diagnoses for these visits included heart failure (15.9%), chronic obstructive pulmonary disease (12.6%), chest pain (11.9%), respiratory insufficiency or failure (8.8%), and asthma (5.5%). The characteristics of these visits are shown in Table 1.

The proportion of blood cultures collected in the ED for patients hospitalized with respiratory symptoms due to a non-pneumonia illness increased from 9.9% (95% CI, 7.1%-13.5%) in 2002 to 20.4% (95% CI, 16.1%-25.6%) in 2010 ($p < .001$ for the trend). This observed increase paralleled the increase in the frequency of culture collection in patients hospitalized with CAP ($p = .12$ for the difference in temporal trends). The estimated absolute number of visits for respiratory symptoms due a non-pneumonia illness with a blood culture collected increased from 211,000 (95% CI, 126,000-296,000) in 2002 to 526,000 (95% CI, 361,000-692,000) in 2010, which was similar in magnitude to the estimated number of visits for CAP with a culture collected (Table 2).

Discussion

In this national study of ED visits, we found that the collection of blood cultures in patients hospitalized with respiratory symptoms due to an illness other than pneumonia continued to increase from 2002 to 2010 in a parallel fashion to the trend observed for patients hospitalized with CAP. Our findings suggest that the heightened attention of collecting blood cultures for suspected pneumonia had unintended consequences that led to an increase in the collection of blood cultures in patients hospitalized with conditions that mimic pneumonia in the ED.

There can be a great deal of diagnostic uncertainty when treating patients in the ED who present with acute respiratory symptoms. Unfortunately, the initial history and physical

exam are often insufficient to effectively rule in community-acquired pneumonia.¹³ Furthermore, the challenge of diagnosing pneumonia is amplified in the subset of patients who present with evolving, atypical, or occult disease. Faced with this diagnostic uncertainty, ED providers may feel pressured to comply with performance measures for CAP, promoting the overuse of inappropriate diagnostic tests and treatments. For instance, efforts to comply with early antibiotic administration in patients with CAP have led to an increase in unnecessary antibiotic use among patients with a diagnosis other than CAP.¹⁴ Due to concerns for these unintended consequences, the core measure for early antibiotic administration was effectively retired in 2012.

Although a smaller percentage of ED visits for respiratory symptoms had a blood culture collected compared to CAP visits, there was a similar absolute number of visits with a blood culture collected during the study period. While a fraction of these patients may present with an infectious etiology aside from pneumonia, the majority of these cases likely represent situations where blood cultures add little diagnostic value at the expense of longer hospital stays and broad spectrum antimicrobial use due to false positive results^{5, 15} and higher costs incurred by the test itself.^{15, 16}

While recommendations for routine culture collection for all patients hospitalized with CAP have been revised, the JCAHO/CMS core measure (PN-3b) announced in 2002 mandates that if a culture is collected in the ED, it should be collected prior to antibiotic administration. Due to inherent uncertainty and challenges in making a timely diagnosis of pneumonia, this measure may encourage providers to reflexively order cultures in all patients presenting with respiratory symptoms in whom antibiotic administration is anticipated. The observed increasing trend in culture collection in patients hospitalized with respiratory symptoms due to a non-pneumonia illness should prompt JCAHO and CMS to reevaluate the risks and benefits of this core measure, with consideration of eliminating it altogether to discourage overuse in this population.

Our study had certain limitations. First, the omission of 2005-2006 data prohibited an evaluation of whether culture rates slowed down among patients hospitalized with respiratory symptoms due to a non-pneumonia illness after revisions in recommendations for obtaining cultures in patients with CAP. Second, there may have been misclassification of culture collection due to errors in chart abstraction. However, abstraction errors in NHAMCS typically result in undercoding.¹⁷ Therefore, our findings likely underestimate the magnitude and frequency of culture collection in this population.

In conclusion, collecting blood cultures in the ED for patients hospitalized with respiratory symptoms due to a non-pneumonia illness has increased in a parallel fashion compared to the trend in culture collection in patients hospitalized with CAP from 2002 to 2010. This suggests an important potential unintended consequence of blood culture recommendations for CAP on patients who present with conditions that resemble pneumonia. More attention is needed to the judicious use of blood cultures in these patients to reduce harm and costs.

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Table 1
Characteristics of Visits to the ED by Patients Hospitalized with Respiratory Symptoms
Due to a Non-Pneumonia Illness from 2002-2010*

	Weighted % [†]		
	Years 2002-2004 Unweighted N=2,175	Years 2007-2008 Unweighted N=1,346	Years 2009-2010 Unweighted N=1,333
Blood culture collected	9.8	14.4	19.9
Demographics			
Age, ≥ 65 years	56.9	55.1	50.9
Female	54.0	57.5	51.3
Race/ethnicity			
White, non-Hispanic	71.5 [‡]	69.5	67.2
Black, non-Hispanic	17.1 [‡]	20.8	22.2
Other	11.3 [‡]	9.7	10.6
Primary Payer			
Private insurance	23.4	19.1	19.1
Medicare	55.2	58.0	54.2
Medicaid	10.0	10.5	13.8
Other/Unknown	11.4	12.4	13.0
Clinical Characteristics			
Disposition status			
Non-ICU	86.8	85.5	83.3
ICU	13.2	14.5	16.7
Fever (≥ 38.0°C)	6.1	5.3	4.8
Hypoxia (< 90%) [§]	-	11.5	10.9
Visit Characteristics			
Emergent status by triage	46.1	44.5	35.8
Administered antibiotics	19.6	24.6	24.8
Tests/services ordered in ED			
0-5	29.9	29.1	22.3
6-10	43.5	58.3	56.1
> 10	26.6	12.6	21.6
ED Characteristics			
Region			
West	16.6	18.2	15.8
Midwest	27.1	25.2	22.8
South	32.8	36.4	38.6
Northeast	23.5	20.2	22.7
Hospital owner			
Nonprofit	80.6	84.6	80.7
Government	12.1	6.4	13.0

	Weighted % [‡]		
	Years 2002-2004 Unweighted N=2,175	Years 2007-2008 Unweighted N=1,346	Years 2009-2010 Unweighted N=1,333
Private	7.4	9.0	6.3

Abbreviations: ED, emergency department; ICU, intensive care unit

* Years 2005 and 2006 are omitted for missing the blood culture field in the survey.

[‡] Percentages shown are weighted to reflect complex survey design. All estimates are considered to be reliable (standard errors below the 30% threshold recommended by NHAMCS for reporting data and 30 or more unweighted observations per subgroup).

[‡] Excludes year 2002 due to incomplete ethnicity ascertainment (unweighted N for race/ethnicity ascertainment = 1,496).

[§] Only for years 2007-2010 which included oxygen saturation in the survey.

Table 2
ED Visits with a Blood Culture Collected in Patients Subsequently Hospitalized, Stratified by Select Conditions*

Condition	2002	2003	2004	2007	2008	2009	2010	P-value [†]
<i>National weighted estimates (95 % CI)</i>								
Respiratory symptom [‡]								
%	9.9 (7.1-13.5)	9.2 (6.9-12.2)	10.6 (7.9-14.1)	13.5 (10.1-17.8)	15.2 (12.1-18.8)	19.4 (15.9-23.5)	20.4 (16.1-25.6)	<.001
No., thousands	211 (126-296)	229 (140-319)	212 (140-285)	287 (191-382)	418 (288-548)	486 (344-627)	526 (361-692)	
CAP								
%	29.4 (21.9-38.3)	34.2 (25.9-43.6)	38.4 (31.0-45.4)	45.7 (35.4-56.4)	44.1 (34.1-54.6)	46.7 (37.4-56.1)	51.1 (41.8-60.3)	.027
No., thousands	155 (100-210)	287 (177-397)	276 (192-361)	277 (173-381)	361 (255-467)	350 (237-464)	428 (283-574)	

Abbreviations: ED, emergency department; CAP, community-acquired pneumonia

* Years 2005 and 2006 are omitted for missing the blood culture field in the survey

[†] Linear trend analysis

[‡] Respiratory symptoms were defined by the patient's reason for visit. Excludes visits with an admission diagnosis of pneumonia (ICD-9 481-486).