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A National Study Examining Emergency Medicine Specialty Training and Quality Measures in the Emergency Department

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Abstract

The objective of this study was to measure the relationship between emergency medicine (EM) specialty training and quality measures in the emergency department (ED). Data were gathered from the 2003-2004 National Hospital Ambulatory Medical Care Survey. The outcome was proportion of patients with acute myocardial infarction (AMI), pneumonia (PNA), and long-bone fracture (LBF) who received recommended therapy. These measures were analyzed with respect to EM residency completion. Compared with EDs with more than 80% EM-trained physicians, EDs with fewer than 80% EM-trained physicians had similar rates of aspirin (43% vs 42%) and β-blocker (26% vs 19%) use for AMI, appropriate antibiotics (78% vs 83%) and pulse oximetry (51% vs 55%) for PNA, and analgesia (85% vs 79%) for LBF. Additionally, a composite end point and an adjusted model showed no statistical difference across these measures. The proportion of residency-trained EM physicians did not affect the use of recommended treatment for AMI, PNA, and LBF.

Keywords

quality of health care, pneumonia, myocardial infarction, long-bone fracture, emergency medicine, patient safety, emergency medicine training, emergency department

When patients present to the emergency department (ED) for care, they assume that they will be cared for by a physician qualified to diagnose and treat their ills. This trust is even more sacred in emergency settings because patients with emergent conditions generally do not have the opportunity to choose the location or provider who will render this care. For this reason, the American College of Emergency Physicians and the American Board of Emergency Medicine advocate specific training (ie, emergency medicine [EM] residency) for physicians who treat patients in EDs.[1]

Yet across the United States, only 69% of physicians who work in the ED are EM residency trained or EM board certified.[2] Fewer than 40% of EDs have a majority of physicians with EM residency training,[3] and only 1 state has an adequate supply of EM-board-certified emergency physicians.[4] Although recent EM physicians are much more likely to be EM residency trained,[2] this deficiency has been attributed to at least 4 different causes: (1) overall shortage of EM-trained physicians; (2) because EM is a relatively young specialty, a significant proportion of the workforce is composed of so-called legacy emergency physicians[1] (ie, those engaged in EM practice prior to the proliferation of EM specialty training programs); (3) the lower staff cost of hiring non-EM-trained physicians; and (4) the difficulty of recruiting specialty trained physicians to rural locations. This variability in training of ED physicians has elicited some controversy,[5-11] but the impact of the differences in training on clinical outcomes has not been assessed. EM-trained physicians are less likely to have expensive malpractice claims against them compared with their non-EM-trained counterparts.[12] Whether specialty training when compared to care provided by generalists

[1]Johns Hopkins University School of Medicine, Baltimore, MD

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Corresponding Author:
Julius Cuong Pham, MD, PhD, Meyer 297, 600 N. Wolfe St, Baltimore, MD 21287
Email: jpham3@jhmi.edu

leads to improved clinical outcomes for specific conditions has been reviewed more broadly in medicine, but not in the context of EM.

Because the Institute of Medicine's 1999 report identified shortcomings in the quality of care in the US health system,[13] there has been renewed emphasis on identifying measures of quality and performance. Treatment of acute myocardial infarction (AMI), pneumonia (PNA), and long-bone fractures (LBFs) has been used to evaluate quality across EDs. These characteristics have been recognized as ED quality measures to varying extents.[15-17] These measures evaluate the extent to which patients receive recommended therapies. Given these parameters, the purpose of this study is to address the relationship between quality measures in the ED and physician specialty training. We hypothesize that EDs with a greater proportion of EM-trained physicians will have better ED quality.

Methods

Study Design, Setting, and Population

This study was approved by the Institutional Review Board of the National Center for Health Statistics (NCHS). We performed a national cross-sectional study of ED visits for 2003 through 2004 using the National Hospital Ambulatory Medical Care Survey (NHAMCS) and its related supplements (staffing, capacity, ambulance diversion, ambulance diversion log, and the bioterrorism and mass casualty preparedness supplement), which contained data on physician specialty training. The NHAMCS is administered by the Centers for Disease Control and Prevention's NCHS and is endorsed by the Emergency Nurses Association, the Society for Academic Emergency Medicine, the American College of Emergency Physicians, and the American College of Osteopathic Emergency Physicians.[18] It is a national probability sample of visits to the EDs of non-governmental general and short-stay acute care hospitals located in the 50 states and the District of Columbia. It does not include federal, military, and Veterans Administration hospitals.

The NHAMCS uses a 4-stage probability sampling design that is well described.[18] Briefly, samples are taken from primary sampling units (regions), hospitals within primary sampling units, EDs, and patient visits within EDs. Each patient visit is assigned a weight. This visit weight is used to make national estimates. The selection process is designed to provide a nationally representative sample of ED visits.

Individual ED staff collect the data elements for the NHAMCS. ED staff are provided training, educational material, and data collection tools by trained field representatives from the US Census Bureau. Depending on the year, ED participation rates range from 92% to 98%.[19]

Data are collected for 100 visits over a period of 4 weeks at each participating ED. Data are reviewed for quality by NCHS using a 2-way 10% independent verification procedure. In 2003, coding errors for various items ranged from 0% to 0.6%.[19] The quality and validity of this survey and database has been evaluated in more than 100 prior publications. The complete operation manual of the NHAMCS has been previously published.[18]

Study Protocol and Outcome Measures

We combined the data from the 2003-2004 survey into 1 data set to maximize sample size, and we extracted patient characteristics (age, sex, race, ethnicity, insurance status, chief complaint, nursing home resident status, and arrival mode), visit characteristics (length of visit, alcohol-/work-related injury, triage acuity, severity of pain, return visit within 72 hours, follow-up visit, diagnostic studies received, procedures received, medication received, and treatment received), physician characteristics (EM residency completed), staffing characteristics (physician employer type, degree of non-ED responsibility, percentage nursing positions vacant, levels in triage system, and specialty coverage available), and hospital characteristics (metropolitan statistical area, region, academic status, and hospital type). Metropolitan statistical area was defined by the US Office of Management and Budget[20] and measured by the US Census Bureau, 1980 Census.[19] An academic center was defined as one in which a resident or intern saw more than 50% of patients.

The primary outcome of this study is the proportion of patients with AMI, PNA, and LBF who received recommended therapies. These measures were assembled into a composite quality indicator score. A composite end point was used because there was insufficient sample size to make conclusions using individual indicators. These indicators of quality were chosen based on the level of medical evidence to support their practice and endorsement by professional societies. The specific indicators for the treatment measures were the following: aspirin and β-blockers for AMI, appropriate antibiotics and oxygen assessment for PNA, and analgesia for LBF. The numerator for the indicators requiring a medication (aspirin, β-blocker, antibiotics, analgesia) was determined by examining medications administered in the ED both by drug name (variable "med") and drug class (variable "drugcl"). The numerator for oxygen assessment was determined by whether pulse oximetry was measured in the ED (variable "pulsoxim"). The denominator for each quality indicator was determined by examining the final ED diagnosis *International Classification of Diseases* (Ninth Revision, Clinical Modification) code (variable "diag").

The cutoff value appropriate for comparison between proportion of EM-trained groups was determined by visual
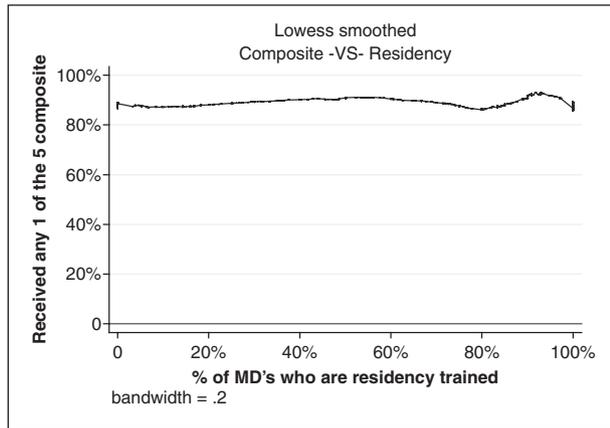
Figure 1. Lowess smoothed evaluation of quality on 5 composite indicators as a function of the proportion of MDs with EM residency training

examination of individual proportionate outcomes plotted against different specialty training percentage levels (Figure 1). This examination did not reveal a consistent trend or cutoff. Consequently, for the purposes of this study an 80% cutoff was subjectively chosen. Subsequent analyses using different percentage thresholds demonstrated similar results.

Primary Data Analysis

The complete NHAMCS database and supplement database were obtained and extrapolated into STATA 8.2 (Stata Corp, College Station, TX). Data for years 2003 and 2004 were combined to provide more reliable estimates. Survey sampling data analysis was used to account for the 4-stage survey design. We used the "svy" set of commands from STATA in our analyses.[21] Descriptive statistics (proportions, mean, and standard deviation) were used to describe predictor variables. Characteristics of the patients, the visit, the staff, and the institution were then analyzed based on proportion of physician specialty training. Quality measures were compared across these characteristics. Statistical differences were calculated using the χ^2 test for categorical variables. Multiple logistic regression was used to adjust for patient, visit and institutional characteristics associated with physician specialty training and/or quality measures. All variables that were clinically different (>5%) and had a *P* value < .05 (mean length of visit, academic status, metropolitan statistical area, hospital type, region, non-ED patient-care responsibility, level of triage system, and cardiology coverage availability) were considered for inclusion in the model. To create a parsimonious model, a forward stepwise process (inclusion *P* < .10) was used to select the final variables in the model (metropolitan statistical area and levels in triage system).

Table 1. Patient Characteristics of ED Visits by Physician Specialty Training

Patient and Visit Characteristics	Seen in ED With <80% EM-Trained Physicians (n = 23 247)	Seen in ED With >80% EM-Trained Physicians (n = 27 457)
Age, mean + SE (years)	36 + 0.8	36 + 0.5
0-17	25%	22%
18-39	32%	35%
40-64	27%	28%
>65	16%	15%
Male	46%	45%
Race		
White	77%	75%
Black	20%	22%
Other	2.9%	3.2%
Hispanic	12%	15%
Nursing home resident	2.6%	2.6%
Arrival		
Ambulance	14%	17%
Public service	0.8%	1.7%
Walk-in	85%	81%
Payment source		
Private	37%	36%
Medicare	17%	16%
Medicaid	21%	22%
Self-pay/Other	25%	26%

Abbreviations: ED, emergency department; EM, emergency medicine; SE, standard error.

Results

When comparing EDs with fewer than 80% EM-trained physicians with those with more than 80% EM-trained physicians, patient and visit characteristics (Tables 1 and 2) were largely the same across the following parameters: age, sex, race, nursing home status, arrival mode, payment source, chief complaint, triage acuity, presenting pain level, work- or alcohol-related visit, previous visit in last 72 hours, follow-up visit, received diagnostic studies, medication, and procedure. EDs with fewer EM-trained physicians had a lower length of stay (177 + 5.6 minutes vs 199 + 5.9 minutes) compared with those with >80% EM-trained physicians.

Examination of institutional characteristics (Table 3) in EDs with fewer than 80% EM-trained physicians, when compared with those with more than 80% EM-trained physicians, demonstrated respective differences in percentage academic centers, metropolitan statistical area, hospital type, region, non-ED patient care responsibility, levels in triage system, and cardiology specialty coverage. There were no significant differences in other institutional

Table 2. Visit Characteristics of ED Visits by Physician Specialty Training

Visit Characteristics	Seen in ED With <80% EM-Trained Physicians (n = 23 247)	Seen in ED With >80% EM-Trained Physicians (n = 27 457)
Chief complaint(s)		
General	16%	16%
Psychiatric	2.0%	2.7%
Neurological	6.5%	6.9%
Cardiovascular	1.5%	1.3%
Eyes/Ears/Nose/Throat	3.6%	3.3%
Pulmonary	12%	12%
Gastrointestinal	13%	14%
Genitourinary	3.6%	3.9%
Dermatological	3.6%	3.5%
Musculoskeletal	14%	14%
Injury/Poisoning/Adverse	20%	18%
Miscellaneous	4.7%	4.6%
Triage acuity		
Should be seen in <15 minutes	16%	17%
Should be seen from 15 to 60 minutes	41%	47%
Should be seen from 1 to 2 hours	26%	23%
Can be seen in >2 hours	17%	13%
Presenting pain level		
Unknown	29%	31%
None	18%	16%
Mild	18%	16%
Moderate	21%	22%
Severe	14%	15%
Visit related to		
Alcohol	2.1%	3.0%
Work injury	3.0%	2.7%
Previous visit within 72 hours	2.9%	3.2%
Follow-up visit	6.4%	6.3%
Received diagnostic studies	91%	91%
Received procedure	45%	50%
Received medication	79%	78%
Length of visit, mean + SE (minutes)*	177 + 5.6	199 + 5.9

Abbreviations: ED, emergency department; EM, emergency medicine; SE, standard error.
*significant difference, p < .05.

Table 3. Institutional Characteristics of ED Visits by Physician Specialty Training

Institutional Characteristics	Seen in ED With <80% EM-Trained Physicians (n = 23 247)	Seen in ED With >80% EM-Trained Physicians (n = 27 457)
Academic center*	4.8%	12%
Metropolitan statistical area*	76%	93%
Hospital type*		
Voluntary nonprofit	72%	79%
Government nonfederal	21%	11%
Proprietary	7.4%	10%
Region*		
Northeast	25%	22%
Midwest	24%	23%
South	42%	32%
West	9.3%	23%
Physician employer		
Hospital	28%	26%
Outside entity	72%	74%
Non-ED patient-care responsibility*	30%	21%
Percentage of nursing positions vacant	6.2% + 0.81%	6.2% + 0.75%
Levels in triage system*		
3	49%	42%
4	22%	21%
5	29%	36%
Specialty coverage—cardiology*		
No difficulty	73%	85%
Some/lot of difficulty	7.1%	8.3%
No cardiology	20%	6.3%

Abbreviations: ED, emergency department; EM, emergency medicine.
*significant difference, p < .05.

characteristics such as physician employer type and nursing vacancy rates.

With respect to the primary outcome measures (Table 4), having fewer than 80% of physicians trained in EM versus more than 80% was not associated with differences in percentage receiving aspirin or β-blockers in AMI, percentage receiving appropriate antibiotics and pulse oximetry for PNA, percentage receiving analgesia for LBF, or the composite end point of receiving any of the 5 quality measures. There was little variation in the proportion receiving the composite end point across different proportions of EM training facilities (Figure 1). In the adjusted model, there were no statistical differences within the individual measures or the composite end point (odds ratio = 1.02; 95% confidence interval = [0.69-1.53]).

Discussion

Summary

In this national study, we found that patients were no more likely to receive recommended therapies for AMI, PNA, and LBF if they were cared for in an ED with a greater proportion of EM-trained physicians. Patients were just as likely to receive aspirin and β-blockers for AMI,

Table 4. Quality Indicator of Emergency Department Visits by Physician Specialty Training

Quality Indicator	Seen in ED With <80% EM-Trained Physicians	Seen in ED With >80% EM-Trained Physicians	Unadjusted Odds Ratio of Outcome (95% CI)	Adjusted[a] Odds Ratio of Outcome (95% CI)
ASA in AMI (n = 307)	43%	42%	0.94 (0.61-1.46)	0.99 (0.60-1.63)
BB in AMI (n = 270)	26%	19%	0.67 (0.36-1.26)	0.73 (0.39-1.36)
Appropriate Abx in PNA (n = 948)	78%	83%	1.35 (0.89-2.04)	1.22 (0.76-1.96)
Pulse oximetry in PNA (n = 948)	51%	55%	1.17 (0.72-1.89)	0.96 (0.56-1.65)
Analgesia in LBF (n = 607)	85%	79%	0.69 (0.39-1.22)	0.62 (0.34-1.12)
Received any of the 5 composite indicators (n = 1848)	89%	91%	1.22 (0.81-1.83)	1.02 (0.69-1.53)

Abbreviations: ED, emergency department; EM, emergency medicine; CI, confidence interval; ASA, aspirin; AMI, acute myocardial infarction; BB, β-blocker; Abx, antibiotics; PNA, pneumonia; LBF, long-bone fracture.
[a]Adjusted model controls for metropolitan statistical area and levels in triage system.

appropriate antibiotics and oxygen assessment for PNA, and analgesia for LBF regardless of the proportion of EM-trained physicians present. These data suggest that these simple measures do not highlight the value of EM specialty training.

Implications

The only prior study examining the effect of EM residency training found that EM-trained physicians have a lower cost of malpractice claims compared with non-EM trained physicians ($2212 vs $4905 per physician/year).[12] The broader research examining specialty versus generalist care tends to favor specialty training in providing higher quality.[13] For example, care by gastroenterologists for upper-gastrointestinal bleeding is associated with lower hospital cost and shorter length of stay when compared with care by internists and surgeons.[22] Care by cardiologists for AMI is associated with lower mortality when compared with care by generalists.[23] Specialization applied at the hospital level, for example, in hospitals with greater experience performing pancreaticoduodenectomies, is associated with lower rates of inpatient mortality for this procedure.[24] Similarly, increased staffing by intensivists is associated with lower intensive care unit mortality and decreased length of stay when compared with lower intensity staffing.[25]

This study did not demonstrate a difference in ED quality by EM-trained physicians. Most hospitals performed similarly on these measures of quality, suggesting that the treatment for AMI, PNA, and LBF is not sensitive enough to differentiate quality. Does providing accurate treatment for AMI, PNA, and LBF represent a situation in which specialty training would make a difference? The answer to this question is controversial and represents a shortcoming in assessing the role of specialty training and quality in EDs.

We argue that the measures used were not sufficiently sensitive and that the added benefit of EM training is not readily derived from standard ED documentation. Specialty training in EM teaches physicians to quickly identify and treat critically ill patients who are at risk for severe disability and death without timely appropriate treatment, become familiar with and use evidence from EM-based literature, treat a broad range of patients and conditions (eg, adults, children, obstetrics, trauma, cardiac conditions, poisonings), perform a broad range of procedures (eg, intubation, suture repair, thoracotomy, central venous access, child delivery), and simultaneously manage multiple complicated patients efficiently and effectively. This training may allow EM-trained physicians to order diagnostic tests and treatments more appropriately (eg, applying NEXUS c-spine and NEXUS II head computed tomography rules). As such, the benefits of EM training may most likely be seen in the diagnosis and treatment of complex patients rather than the use of recommended therapies for common conditions. For example, EM training may lead to faster identification of the person with asthma who does/does not need early intubation and may lead to fewer consultations for procedural assistance. Measures such as risk-adjusted mortality from sepsis or asthma might be more sensitive, but the data to accurately describe and analyze these outcomes sufficiently in context are not readily available on a national scale. Furthermore, analysis of such outcomes might suffer currently from confounding by indication, limitations associated with the complexity of patient presentations, and lack of nationally standardized treatment paradigms. As such, the measures used in this study, although not entirely sensitive, do reflect objective methods. These results highlight the shortcomings in currently available measures of ED quality and should serve as an impetus for additional research in this field. Further attempts to characterize the role of quality and specialty training within EDs should be

preceded by attempts to standardize and validate additional process and, ideally, outcome measures.

Limitations

There are several potential limitations to this study. First, the validity of this study rests on the face validity of the quality indicators. To minimize this threat, we chose indicators that have strong empirical evidence from quality studies and are endorsed by professional societies. Despite this, we recognize that there may still be some controversy about the value of these indicators because they may not be sensitive enough to discern differences in quality between the analyzed groups. In addition, there was little variation among hospitals in performance on these measures. However, they are among the very few validated and quantifiable measures that are applicable to EM. Second, the percentage used to differentiate majority EM-physician-trained hospitals (>80%) was arbitrarily chosen because no clear cutoffs were found in the data. However, sensitivity analysis of other cutoffs did not reveal a difference in results.

Third, there is potential for misclassification because of the quality of ED documentation. Some therapies may be administered in the ED but may not be well documented. We expect therapies that require a physician order (medication administration) to be better documented than those that do not (pulse oximetry). We predict this misclassification to underestimate ED quality.

Fourth, there is potential for misclassification because of limited information available in the NHAMCS database. There are no data on patient comorbidities or prehospital management. Because of this, we were unable to discern if patients had a contraindication to a therapy (eg, allergy to aspirin) or received that therapy prior to hospital arrival (aspirin in the ambulance or at home). Specifically, we were unable to determine if the patient had an allergy to a β-blocker, heart failure, or second- or third-degree heart block on electrocardiogram in those patients without pacemakers. We expect this limitation to underestimate ED quality as well.

Fifth, there is potential misclassification in the diagnosis of AMI and PNA. We used the most conservative estimate: provider discharge diagnosis. Many patients who might have had an AMI (eg, diagnosis of chest pain, unstable angina, acute coronary syndrome) or PNA (diagnosis of dyspnea, hypoxia, bronchitis, respiratory failure) were not included in our denominator. We expect this to overestimate ED quality. However, there is no reason to believe that any of these latter limitations reflecting quality will affect one group more than another, given that both groups face the same barriers to accurate measurement.

Sixth, we did not directly compare the practices of individual physicians (EM vs non-EM residency trained). These data were not available to us; we only knew the proportion of residency-trained physicians who were at a particular institution. Therefore, it is possible that these results are related to the characteristics of the institution rather than the individual physician. We limited this potential bias by adjusting for institutional differences between the 2 groups, but there may have been subtle differences that were not controlled for. Alternatively, we might have compared the extremes of the study population (100% EM trained vs 0% EM trained). However, the sample size was insufficient to perform this analysis.

Despite these limitations, this study does adjust for physician practice settings (eg, region, case-mix, hospital type, employer type) and other relevant variables unlike much of the broader research that examines specialty versus generalist care.[13] In addition, it is the first study to quantitatively and clinically examine the field of EM. This study's findings are also consistent with previously published studies examining the overall rates of receiving recommended therapy for AMI, PNA, and LBF.

Conclusion

In conclusion, we found that patients seen in hospital EDs with a greater proportion of EM-trained physicians were no more likely to receive recommended therapies for AMI, PNA, and LBF than patients seen in hospitals with a lower proportion of EM-trained physicians. There was little variation in use of these measures among EDs, and they may be too simple to demonstrate the value of EM physicians. Future efforts to assess the role of EM training in ED quality should focus more on measures that demonstrate the unique skills of EM-trained physicians.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the authorship and/or publication of this article.

References

1. American College of Emergency Physicians. The role of the legacy emergency physician in the 21st century. American College of Emergency Physicians. *Ann Emerg Med.* 2006;48:511.
2. Ginde AA, Sullivan AF, Camargo CA Jr. National study of the emergency physician workforce, 2008. *Ann Emerg Med.* 2009;54:349-359.
3. Burt CW, McCaig LF. Staffing, capacity, and ambulance diversion in emergency departments: United States, 2003-04. *Adv Data.* 2006;(376):1-23.
4. Sullivan AF, Ginde AA, Espinola JA, Camargo CA Jr. Supply and demand of board-certified emergency physicians by U.S. state, 2005. *Acad Emerg Med.* 2009;16:1014-1018.

5. McCabe JB. Turbulent times for emergency medicine: health care reform, board certification, contract management, and the growth of new organizations in emergency medicine. *Ann Emerg Med.* 1994;24:289-293.

6. McNamara R. On turbulent times for emergency medicine. *Ann Emerg Med.* 1995;25:269.

7. Timmons J. On turbulent times for emergency medicine. *Ann Emerg Med.* 1995;25:269-270.

8. Cummings IW. On turbulent times for emergency medicine. *Ann Emerg Med.* 1995;25:270.

9. Krauss BS. On turbulent times for emergency medicine. *Ann Emerg Med.* 1995;25:270-271.

10. Braen GR. On turbulent times for emergency medicine. *Ann Emerg Med.* 1995;25:271.

11. Sciammarella J, Gerard WA. The credentialing debate: on the outside of the house of emergency medicine looking in. *Ann Emerg Med.* 1994;24:293-295.

12. Branney SW, Pons PT, Markovchick VJ, Thomasson GO. Malpractice occurrence in emergency medicine: does residency training make a difference? *J Emerg Med.* 2000;19: 99-105.

13. Smetana GW, Landon BE, Bindman AB, et al. A comparison of outcomes resulting from generalist vs specialist care for a single discrete medical condition: a systematic review and methodologic critique. *Arch Intern Med.* 2007;167:10-20.

14. Kohn LT, Corrigan JM, Donaldson MS, ed. *To Err Is Human: Building a Safer Health System.* Washington, DC: National Academies Press; 2000.

15. Swing SR, Schneider S, Bizovi K, et al. Using patient care quality measures to assess educational outcomes. *Acad Emerg Med.* 2007;14:463-473.

16. Welch S, Augustine J, Camargo CA Jr, Reese C. Emergency department performance measures and benchmarking summit. *Acad Emerg Med.* 2006;13:1074-1080.

17. Ritsema TS, Kelen GD, Pronovost PJ, Pham JC. The national trend in quality of emergency department pain management for long bone fractures. *Acad Emerg Med.* 2007;14:163-169.

18. McCaig LF, McLemore T. Plan and operation of the National Hospital Ambulatory Medical Survey. Series 1: programs and collection procedures. *Vital Health Stat 1.* 1994;(34):1-78.

19. Centers for Disease Control and Prevention. 2003 NHAMCS micro-data file documentation. ftp://ftp.cdc.gov/pub/Health _Statistics/NCHS/Dataset_Documentation/NHAMCS/ doc03.pdf. Accessed March 30, 2010.

20. Office of Management and Budget. Final report and recommendations from the metropolitan area standards review committee to the office of management and budget concerning changes to the standards for defining metropolitan areas. http://www.census.gov/population/www/metroareas/masrp. html. Accessed March 11, 2010.

21. Stata Corporation. *Stata Survey Data Reference Manual.* 8th ed. College Station, TX: Stata Corp; 2003.

22. Pardo A, Durandez R, Hernandez M, et al. Impact of physician specialty on the cost of nonvariceal upper GI bleeding care. *Am J Gastroenterol.* 2002;97:1535-1542.

23. Norcini JJ, Kimball HR, Lipner RS. Certification and specialization: do they matter in the outcome of acute myocardial infarction? *Acad Med.* 2000;75:1193-1198.

24. Ho V, Heslin MJ. Effect of hospital volume and experience on in-hospital mortality for pancreaticoduodenectomy. *Ann Surg.* 2003;237:509-514.

25. Pronovost PJ, Angus DC, Dorman T, Robinson KA, Dremsizov TT, Young TL. Physician staffing patterns and clinical outcomes in critically ill patients: a systematic review. *JAMA.* 2002;288:2151-2162.