12-8-2015

Medical Students in the Emergency Department and Patient Length of Stay

Kimon Ionnides
University of Pennsylvania

Mira Mamtani
University of Pennsylvania

Frances S. Shofer
University of Pennsylvania

Dylan S. Small
University of Pennsylvania

Sean Hennessey
University of Pennsylvania

See next page for additional authors

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Abstract
Quantitative assessments of how trainees affect patient care have been limited, especially in the emergency department (ED). A US study by Pitts et al found that supervised resident visits were associated with greater resource use, including longer length of stay (LOS) in the ED. As EDs host more core clerkship courses, less experienced students have become involved in bedside care. This study examined the association between the presence of medical students in the ED and patient LOS, an established patient-centered outcome and marker of ED performance.

Disciplines
Life Sciences | Medicine and Health Sciences | Physical Sciences and Mathematics | Social and Behavioral Sciences

Author(s)
Kimon Ionnides, Mira Mamtani, Frances S. Shofer, Dylan S. Small, Sean Hennessey, Benjamin Abella, and Kevin Scott

Medical Students in the Emergency Department and Patient Length of Stay

Quantitative assessments of how trainees affect patient care have been limited, especially in the emergency department (ED). A US study by Pitts et al[1] found that supervised resident visits were associated with greater resource use, including longer length of stay (LOS) in the ED. As EDs host more core clerkship courses, less experienced students have become involved in bedside care.[2] This study examined the association between the presence of medical students in the ED and patient LOS, an established patient-centered outcome and marker of ED performance.[3]

Methods | During a required third-year emergency medicine clerkship at 3 urban, academic EDs associated with the University of Pennsylvania Health System, Philadelphia, students were assigned approximately nine 8- to 12-hour shifts over 3 weeks, during which they were expected to evaluate and follow-up several patients presenting to the ED. The institutional review board at the University of Pennsylvania approved this study and provided a waiver of participant consent.

During the fourth week of each rotation, students participated in an anesthesiology week and were absent from the ED. We examined sequential patient visits from 2000 through 2014, calculating LOS from arrival until ED discharge or admission, and comparing clerkship student presence with student absence from the ED. Summer and winter vacation periods were excluded.

Multivariable generalized linear models included visit-level covariates and dummy variables for all clerkship weeks, and for weeks 1, 2, and 3 individually, and used a γ distribution and clustering by day and hospital. Baseline differences in covariates were assessed for potential confounding factors along with the prevalence of *International Classification of Diseases, Ninth Revision (ICD-9),* diagnosis codes (using the Benjamini-Hochberg correction for multiple comparisons).

Sensitivity analyses were performed by assessing unadjusted differences using *t* tests, examining each year and hospital individually, and reassigning visits in which patients left without being seen to varying percentiles of LOS. Two-sided statistical tests with an α level of .05 were performed using Stata version 13 (StataCorp).

Results | More than 1.3 million ED visits were analyzed (**Table 1**). There were no significant differences among visit covariates, including *ICD-9* code prevalence, between clerkship and control weeks. Weekly resident turnover rate was significantly lower during the clerkship weeks compared with the control weeks (mean [SD], 17.8% [16.1%] vs 19.8% [17.5%], respectively), but was not correlated with LOS.

Mean (SD) LOS was 264.7 (253.7) minutes overall; adjusted LOS was 4.6 minutes (95% CI, 2.7-6.6 minutes) longer ($P < .001$) when clerkship students were present in the ED (**Table 2**). This was significant across all 3 hospitals and consistent across each of the 3 clerkship weeks. Unadjusted differences for the primary outcome and the sensitivity analysis

Table 1. Baseline Demographic and Emergency Department Visit Characteristics[a]

	Clerkship (n =1 029 165 Visits)	Control (n = 343 696 Visits)	Standardized Mean Difference[b]
No. of weeks	540	180	
Age group, y			
<18	15 598 (1.5)	5377 (1.6)	0.004
18-39	468 897 (45.6)	157 012 (45.7)	0.002
40-64	377 854 (36.7)	125 609 (36.5)	0.003
65-90	153 328 (14.9)	51 052 (14.9)	0.001
>90	12 953 (1.3)	4476 (1.3)	0.004
Unknown	535 (0.1)	170 (0.05)	0.001
Male sex	430 106 (41.8)	142 800 (41.5)	0.005
Race/ethnicity[c]			
Black	673 112 (65.4)	224 853 (65.4)	<0.001
White	247 956 (24.1)	82 473 (24.0)	0.002
Hispanic	21 999 (2.1)	7390 (2.2)	0.001
Asian	16 470 (1.6)	5631 (1.6)	0.003
Unknown	69 628 (6.8)	23 349 (6.8)	0.001
Emergency Severity Index			
1 (most acute)	24 531 (2.4)	7891 (2.3)	0.006
2	220 789 (21.5)	73 382 (21.4)	0.002
3	470 087 (45.7)	157 835 (45.9)	0.005
4	263 399 (25.6)	87 943 (25.6)	<0.001
5 (least acute)	28 018 (2.7)	9337 (2.7)	<0.001
Unassigned	22 341 (2.2)	7308 (2.1)	0.003
Arrival date and time			
Midnight-7 AM	165 983 (16.1)	54 008 (15.7)	0.011
Weekend	264 939 (25.7)	88 172 (25.7)	0.002
First month of electronic medical record implementation	2424 (0.2)	811 (0.2)	<0.001
Disposition[d]			
Admitted	234 227 (22.8)	77 971 (22.7)	0.002
Transferred	22 999 (2.2)	7409 (2.2)	0.005
Discharged	711 333 (69.1)	238 831 (69.5)	0.008
Left against medical advice	16 261 (1.6)	5316 (1.5)	0.003
Left without being seen	43 049 (4.2)	13 757 (4.0)	0.009
Died	1296 (0.1)	412 (0.1)	0.002
Emergency department conditions at arrival, mean (SD)			
No. boarding[d,e]	1.90 (2.97)	1.92 (2.98)	0.006
Hourly arrivals	7.77 (4.74)	7.69 (3.90)	0.018
Daily volume	136.13 (40.35)	135.87 (39.74)	0.006
% Weekly resident turnover	17.8 (16.1)	19.8 (17.5)	0.122

[a] Data are expressed as No. (%) unless otherwise indicated. Covariates included in the regression were determined during patient triage prior to medical student contact.

[b] Calculated as difference in means divided by overall SD (used due to the large sample size). Values larger than 0.10 (>10% of an SD) are potentially important.

[c] Recorded at patient triage or from prior patient record, usually selected from predesignated list (varied by hospital site and year). Included to assess for differences in patient population and comorbidities.

[d] Not included as covariates in regression because they are determined after medical student contact with patients.

[e] Patient admitted to hospital but awaiting transfer to an inpatient unit.

Table 2. Length of Stay (LOS) for Clerkship Weeks Compared With Control Weeks

	All Hospitals		Hospital A		Hospital B		Hospital C	
Visits, No. (%)	1 372 861 (100)		799 883 (58.3)		184 154 (13.4)		388 824 (28.3)	
No. of years included	15 (year range, 2000 to 2014)		15 (year range, 2000 to 2014)		6 (year range, 2009 to 2014)		12 (year range, 2003 to 2014)	
No. of average yearly visits	91 524		53 326		30 692		32 402	
Typical No. of students/mo	14		8		2		4	
Person to whom students report			Resident		Attending		Attending	
	Adjusted Differences in LOS (95% CI), min[a]	*P* Value	Adjusted Differences in LOS (95% CI), min[a]	*P* Value	Adjusted Differences in LOS (95% CI), min[a]	*P* Value	Adjusted Differences in LOS (95% CI), min[a]	*P* Value
All clerkship vs control	4.6 (2.7 to 6.6)	<.001	4.1 (1.6 to 6.6)	.001	6.5 (1.7 to 11.4)	.008	5.2 (1.6 to 8.8)	.005
Week 1[b] vs control	4.1 (1.7 to 6.5)	.001	4.7 (1.6 to 7.7)	.003	5.1 (−0.9 to 11.1)	.10	2.0 (−2.5 to 6.6)	.38
Week 2[b] vs control	5.3 (2.9 to 7.7)	<.001	4.4 (1.3 to 7.5)	.006	6.0 (−0.3 to 12.4)	.06	7.6 (3.1 to 12.0)	.001
Week 3[b] vs control	3.7 (1.3 to 6.1)	.002	2.9 (−0.1 to 6.0)	.06	7.3 (1.5 to 13.0)	.01	4.4 (−0.1 to 9.0)	.06
Year								
2000	19.1 (7.6 to 30.7)	.001	19.1 (7.6 to 30.7)	.001				
2001	4.2 (−5.2 to 13.6)	.38	4.2 (−5.2 to 13.6)	.38				
2002	10.4 (1.5 to 19.3)	.02	10.4 (1.5 to 19.3)	.02				
2003	3.9 (−3.6 to 11.4)	.30	4.2 (−3.8 to 12.1)	.31			3.4 (−13.9 to 20.7)	.70
2004	9.2 (0 to 18.5)	.05	6.7 (−4.0 to 17.4)	.22			15.3 (−2.9 to 33.6)	.10
2005	11.0 (4.0 to 18.1)	.002	7.7 (−0.2 to 15.7)	.06			18.5 (3.9 to 33.0)	.01
2006	3.0 (−5.4 to 11.4)	.48	2.8 (−7.6 to 13.2)	.60			3.5 (−10.9 to 17.8)	.64
2007	3.6 (−4.8 to 11.9)	.40	−1.1 (−12.4 to 10.1)	.84			14.7 (−1.4 to 30.8)	.07
2008	9.5 (1.1 to 17.8)	.03	16.4 (4.1 to 28.7)	.009			−2.5 (−15.6 to 10.5)	.70
2009	3.2 (−2.3 to 8.7)	.26	3.8 (−3.6 to 11.2)	.32	9.0 (−7.9 to 26.0)	.30	−3.0 (−11.3 to 5.3)	.49
2010	4.0 (−0.6 to 8.7)	.09	−0.4 (−7.5 to 6.6)	.90	10.0 (0.1 to 19.9)	.05	8.9 (0.6 to 17.3)	.04
2011	3.1 (−1.4 to 7.6)	.17	2.6 (−4.0 to 9.3)	.44	−0.2 (−9.0 to 8.6)	.96	6.4 (−1.9 to 14.7)	.13
2012	3.9 (−0.7 to 8.6)	.10	5.0 (−1.5 to 11.4)	.13	6.0 (−3.5 to 15.4)	.22	−1.6 (−10.7 to 7.5)	.73
2013	−2.0 (−6.7 to 2.7)	.40	−6.2 (−13.2 to 0.8)	.08	−0.4 (−7.7 to 6.9)	.91	8.0 (0.2 to 15.9)	.05
2014	4.5 (−0.1 to 9.1)	.06	4.7 (−1.9 to 11.4)	.16	5.5 (−3.3 to 14.3)	.22	2.8 (−5.6 to 11.2)	.51
Patients left without being seen								
5%	4.1 (2.4 to 5.9)	<.001	3.8 (1.5 to 6.1)	.001	5.8 (1.4 to 10.2)	.01	4.2 (1.1 to 7.3)	.01
50%	4.1 (2.4 to 5.9)	<.001	4.0 (1.6 to 6.4)	.001	6.5 (1.8 to 11.2)	.01	4.9 (1.5 to 8.2)	.004
95%	5.4 (3.3 to 7.5)	<.001	4.6 (1.8 to 7.3)	.001	8.3 (2.6 to 14.0)	.004	6.7 (2.6 to 10.7)	.001
Unadjusted (all clerkship − control)[c]	5.9 (4.9 to 6.9)	<.001	5.8 (4.3 to 7.3)	<.001	4.6 (3.1 to 6.1)	<.001	6.3 (4.9 to 7.6)	<.001
Unadjusted, mean (SD)								
All clerkship and control	264.7 (253.7)		302.6 (293.1)		213.8 (143.2)		211.0 (183.7)	
Median (IQR)	205.3 (118.0 to 336.4)		235.9 (135.4 to 380.1)		185.7 (115.8 to 279.6)		166.0 (91.8 to 275.3)	
All clerkship, wk	266.2 (254.7)		304.0 (294.1)		215.0 (143.3)		212.6 (185.1)	
Control, wk	260.3 (250.5)		298.2 (289.8)		210.3 (142.9)		206.3 (179.6)	

Abbreviation: IQR, interquartile range.

[a] Unless otherwise indicated, data are adjusted regression estimates of increase in LOS for clerkship weeks relative to control weeks using average adjusted predicted marginal effects.

[b] Week 1 vs week 2 yielded *P* values of .33 for all hospitals; .85 for hospital A; .77 for hospital B; and .02 for hospital C. Week 2 vs week 3 yielded *P* values of .19 for all hospitals; .36 for hospital A; .70 for hospital B; and .17 for hospital C. Week 1 vs week 3 yielded *P* values of .74 for all hospitals; .26 for hospital A; .47 for hospital B; and .32 for hospital C.

[c] All data in this row were calculated using the *t* test.

of left without being seen visits were similar. Subanalysis of each year at each site showed that LOS was either longer when students were present or not significantly different from the control weeks.

Discussion | Our findings show an increase in LOS of approximately 5 minutes associated with the presence of medical students in the ED, which was statistically significant but likely too small to be of clinical relevance (equivalent to 2% of 1 SD in LOS). This conclusion was robust for all sensitivity analyses and persisted across 3 different hospitals with distinct teaching models, patient populations, and workflow. Prior studies have had conflicting results and only demonstrated longer LOS for the select patients examined by students directly.[4-6]

An important limitation is the absence of visit-level information on student involvement with patients. Without this, we were able to examine only the association of the clerkship with aggregate overall LOS. In addition, indirect effects, such as attending physicians spending extra time documenting after shifts as a consequence of teaching students during clinical time, were not assessed, and this study took place at 3 hospitals associated with a single medical school. Future studies should assess different student experiences and other patient-centered or financial outcomes.

Kimon L.H. Ioannides, BS
Mira Mamtani, MD
Frances S. Shofer, PhD
Dylan S. Small, PhD
Sean Hennessy, PharmD, PhD
Benjamin S. Abella, MD, MPhil
Kevin R. Scott, MD

Author Affiliations: Perelman School of Medicine, University of Pennsylvania, Philadelphia (Ioannides); Department of Emergency Medicine, University of Pennsylvania, Philadelphia (Mamtani, Shofer, Abella, Scott); Department of Statistics, University of Pennsylvania Wharton School, Philadelphia (Small); Department of Biostatistics and Epidemiology, University of Pennsylvania, Philadelphia (Hennessy).

Corresponding Author: Kevin R. Scott, MD, Department of Emergency Medicine, 3400 Spruce St, Ground Ravdin, Philadelphia, PA 19104 (kevin.scott@uphs.upenn.edu).

Author Contributions: Mr Ioannides had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Ioannides, Hennessy, Scott.
Acquisition, analysis, or interpretation of data: Ioannides, Shofer, Small, Hennessy, Abella, Scott.
Drafting of the manuscript: Ioannides, Mamtani, Scott.
Critical revision of the manuscript for important intellectual content: All authors.
Statistical analysis: Ioannides, Shofer, Small.
Administrative, technical, or material support: Small, Abella, Scott.
Study supervision: Mamtani, Abella, Scott.

Conflict of Interest Disclosures: The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Dr Abella reported receiving grants from the National Heart, Lung, and Blood Institute, Philips Healthcare, Medtronic Foundation, and Stryker Medical; and receiving other (honoraria, stock ownership, serving on advisory boards, or serving as a consultant) from Velomedix Corp, HeartSine Corp, Ikaria Inc, Resuscor, Bard, and Stryker Medical. No other disclosures were reported.

Funding/Support: The Department of Emergency Medicine, University of Pennsylvania, provided funding for this study.

Role of the Funder/Sponsor: The Department of Emergency Medicine, University of Pennsylvania, had no role in the design and conduct of the study; had a role in the collection, management, analysis, and interpretation of the data; had no role in the preparation, review, or approval of the manuscript; and had no role in the decision to submit the manuscript for publication.

Previous Presentations: A preliminary version of these data were presented in part at a pharmacoepidemiology rounds on April 17, 2015, at the University of Pennsylvania and at an internal research-in-progress meeting on April 29, 2015.

Additional Contributions: We thank the following individuals at the University of Pennsylvania for their contributions without compensation: Carmen Farrow, MS, MBA, for special data analysis and technical assistance with EMR databases; Ari B. Friedman, PhD, for analysis and operational feedback; Jennifer R. Kogan, MD, for advising and providing feedback; and Elizabeth D. Lowenthal, MD, MSCE, and Iris M. Reyes, MD, for advising and providing assistance with the protocol.

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COMMENT & RESPONSE

Initial Interventions for Out-of-Hospital Cardiac Arrest

To the Editor Early initiation of basic life support has been proven to decrease mortality, which was reaffirmed by Dr Malta Hansen and colleagues.[1] Since the early 2000s, patients have benefited from induced hypothermia after return of spontaneous circulation after cardiac arrest. A 2002 study demonstrated that 49% of patients who were treated with hypothermia after out-of-hospital cardiac arrest survived with good neurological outcomes as opposed to only 26% treated with normothermia.[2]

The study by Malta Hansen and colleagues,[1] which looked at patient survival and neurological outcomes 8 years after out-of-hospital cardiac arrest, did not differentiate outcomes in patients who received hypothermia vs normothermia. We wonder whether the authors have data regarding therapeutic hypothermia and if it confounded the results of the trial.

Furthermore, the definition of a bystander who performed cardiopulmonary resuscitation (CPR), defibrillation, or both was not discussed. There was also no explanation of how cardiac arrest was confirmed. In a study on rapid defibrillation in casinos,[3] patients were assessed for responsiveness, spontaneous respirations, and palpable carotid pulse; the nearest defibrillator was then used to assess their cardiac rhythm.

Malta Hansen and colleagues did not discuss how it was determined whether a patient had a pulse. It also is unclear