The Journal of Emergency Medicine, Vol. ■, No. ■, pp. 1–9, 2018

0736-4679/$ - see front matter

ELSEVIER

https://doi.org/10.1016/j.jemermed.2017.12.041

Administration of Emergency Medicine

INTERPHYSICIAN DIFFERENCES IN EMERGENCY DEPARTMENT LENGTH OF STAY

Stephen J. Traub, MD,*† Soroush Saghafian, PHD,‡ Kurtis Judson, MD,*† Christopher Russi, DO,†§ Bo Madsen, MD,†§ Stephen Cha, MS,|| Hannah C. Tolson,* Leon D. Sanchez, MD,¶ and Jesse M. Pines, MD, MBA, MSCE**

*Department of Emergency Medicine, Mayo Clinic Arizona, Phoenix, Arizona, †College of Medicine, Mayo Clinic, Rochester, Minnesota, ‡Harvard Kennedy School, Harvard University, Cambridge, Massachusetts, §Department of Emergency Medicine, Mayo Clinic, Rochester, Minnesota, ||Division of Health Systems Informatics, Mayo Clinic Arizona, Phoenix, Arizona, ¶Department of Emergency Medicine, Beth Israel Deaconess Medical Center, and Harvard Medical School, Boston, Massachusetts, and **Department of Emergency Medicine and Health Policy & Management, George Washington University, Washington, DC

Reprint Address: Stephen J. Traub, MD, Department of Emergency Medicine, Mayo Clinic Arizona, 5777 E. Mayo Boulevard, Phoenix, AZ 85054

☐ **Abstract—Background: Emergency physicians differ in many ways with respect to practice. One area in which interphysician practice differences are not well characterized is emergency department (ED) length of stay (LOS). Objective: To describe how ED LOS differs among physicians. Methods: We performed a 3-year, five-ED retrospective study of non-fast-track visits evaluated primarily by physicians. We report each provider's observed LOS, as well as each provider's ratio of observed LOS/expected LOS ($LOS_{O/E}$); we determined expected LOS based on site average adjusted for the patient characteristics of age, gender, acuity, and disposition status, as well as the time characteristics of shift, day of week, season, and calendar year. Results: Three hundred twenty-seven thousand, seven hundred fifty-three visits seen by 92 physicians were eligible for analysis. For the five sites, the average shortest observed LOS was 151 min (range 106–184 min), and the average longest observed LOS was 232 min (range 196–270 min); the average difference was 81 min (range 69–90 min). For $LOS_{O/E}$, the average lowest $LOS_{O/E}$ was 0.801 (range 0.702–0.887), and the average highest $LOS_{O/E}$ was 1.210 (range 1.186–1.275); the average difference between the lowest $LOS_{O/E}$ and the highest $LOS_{O/E}$ was 0.409 (range 0.305–0.493). Conclusion: There are significant differences in ED LOS at the level of the individual physician, even after accounting for multiple confounders. We found that the $LOS_{O/E}$ for physicians with the lowest $LOS_{O/E}$ at each site averaged approximately 20% less than predicted, and that the $LOS_{O/E}$ for physicians with the highest $LOS_{O/E}$ at each site averaged approximately 20% more than predicted.**

☐ **Keywords—Emergency Department; length of stay; provider differences**

INTRODUCTION

The practice patterns of individual emergency physicians, differ in multiple ways, including the rate of utilization of advanced imaging, degree of testing, and decision to admit (1–6). Another area of potential interphysician difference that has not been extensively explored is the extent to which emergency physicians differ with respect to emergency department (ED) length of stay (LOS).

ED LOS is a publicly reported metric for the Centers for Medicare and Medicaid Services, factors into national quality rankings, and serves as a driver of patient satisfaction (7). Efforts to improve ED LOS often focus on process improvements, without considering the difference in LOS attributable to personnel (8–10).

Presented, in part, at the 2016 American College of Emergency Physician Research Forum, Las Vegas, NV.

RECEIVED: 8 April 2017; FINAL SUBMISSION RECEIVED: 27 November 2017;
ACCEPTED: 17 December 2017

We sought to better understand the differences in ED LOS between physicians, and describe the degree of inter-physician differences in ED LOS at five sites. We report provider-specific observed LOS and the provider-specific ratio of observed LOS to expected LOS ($LOS_{O/E}$), with the goal of characterizing and better understanding the degree of variation in ED LOS that may exist between providers.

METHODS

Study Design Settings

This was a retrospective study of routinely gathered operational data. This work was part of a quality-improvement initiative, and was identified as exempt by the Mayo Clinic Institutional Review Board.

Study Settings and Populations

EDs at five hospitals provided data for this study; all were a part of the Mayo Clinic system. None had emergency medicine training programs, although two sites (A and D) had resident physicians from multiple services rotating through the ED. These residents assisted in the evaluation of approximately 5% of patients at each of these two sites. We used the common electronic medical record (EMR; Cerner®, Kansas City, MO) in use at all sites to identify ED visits over a 3-year (January 1, 2013–December 31, 2015) period. We excluded visits that we could not associate with an individual physician, such as patients who left without being seen, patients not associated with any provider, and patients seen primarily by a nurse practitioner or physician assistant (together, NP/PA). We excluded visits for which any data point was missing, illogical (i.e., LOS < 0), or uninterpretable (i.e., disposition of "other").

All visits seen by physicians who practiced at any point during the 3-year period (and not simply those who practiced during all 3 years) were eligible for inclusion. To control for changes in the operating environment over time, which could affect the LOS results for individual physicians who entered a practice after the study period began or left it before the study period ended, we included study year as a factor in our regression analysis.

We excluded visits seen by low-volume physicians, who were identified by site medical directors as those who worked substantially less than others at that site. Site directors identified low-volume providers based on a subjective assessment, as substantial variation between sites precluded the use of global numerical criteria. Of note, at each site every low-volume provider saw fewer patients than every non-low-volume provider. We also excluded all visits with a documented LOS > 10,080 min (7 days) due to their significant impact on calculating 95% confidence intervals.

Measurements

All data were extracted from the EMR into custom Microsoft Excel® (Microsoft Corporation, Redmond, WA) operations reports for each site. One author (SJT) was responsible for data review and abstraction.

We report age in years, and gender based on patient declaration. We measured acuity as the Emergency Severity Index (ESI) score, which the nursing staff assigned. We categorized disposition as admitted, discharged (including death), transferred, or placed into ED observation status. Only one site (Site D) utilized ED observation; for those patients, LOS ended with placement into observation status. We used registration date and time to assign date- and time-based parameters. We categorized shift as day (07:00–14:59), evening (15:00–22:59), or night (23:00–06:59). We divided days of the week into Monday, Tuesday–Friday, or Saturday-Sunday based on preliminary results from regression analyses suggesting that a three-category division was appropriate. We divided season into Winter (January–March), Spring (April–June), Summer (July–September) and Autumn (October–December). We designated study year as 1, 2, or 3; these were synonymous with calendar years 2013, 2014, and 2015, respectively.

Data Analysis

For each visit, we calculated three distinct values. First, we determined observed LOS, defined as the time interval (in minutes) between ED arrival and ED checkout. Second, we determined expected LOS (in minutes) by taking the mean 3-year LOS for each site and adjusting (via a regression model) for patient age, gender, and acuity; disposition; and shift, day of week, season, and calendar year. Third, we determined the ratio of observed/expected LOS ($LOS_{O/E}$).

We then determined mean observed LOS and mean $LOS_{O/E}$ for each provider. We note that outlier values may or may not have led to each individual physician's data to qualify as being normally distributed. However, due to the use of each physician's mean value, and the properties inherent in the Central Limit Theorem, we report each site's data and the overall physician data using the descriptor "mean," and not "median."

Statistical analysis was performed with SAS version 9.3 (SAS Institute Inc., Cary, NC).

RESULTS

Characteristics of Sites and Study Subjects

There were five EDs in four states. ED characteristics appear in Table 1. There were 395,890 ED visits during

Table 1. Site Characteristics

Site	Yearly Volume*	State	Teaching Hospital	Median LOS (IQR)†	Admission Rate	Number of Physicians	Early-Career Physicians (%)
A	28,500	AZ	Yes	211 (140–298)	32%	20	0 (0%)
B	14,500	MN	No	131 (82–213)	12%	14	5 (36%)
C	31,000	WI	No	171 (112–243)	28%	16	3 (19%)
D‡	27,500	FL	Yes	191 (129–275)	30%	18	0 (0%)
E	30,500	MN	No	151 (98–216)	21%	24	16 (67%)

LOS = length of stay; IQR = interquartile range; ED = emergency department.
Early-Career Physicians were defined as those in their first 36 months of postresidency practice.
Site characteristics reflect all ED visits, not simply those eligible for analysis.
* Yearly Volume rounded to nearest 500 visits.
† LOS reported in minutes.
‡ At Site D, ED Observation patients included in admission rate.

the study period across the five EDs, of which 327,753 were eligible for analysis. Site-specific and total visits and exclusions appear in Table 2.

Patient characteristics for eligible visits at each site appear in Table 3. Gender distribution was similar at all sites, but there was substantial variability between sites with regard to age and ESI score.

Main Results

Summary data by site for observed LOS and $LOS_{O/E}$ appear in Table 4. At each site, the difference between the lowest LOS and highest LOS ranged from 69 to 90 min, with an average of 81 min. The difference between the lowest $LOS_{O/E}$ and the highest $LOS_{O/E}$ ranged from 0.305 to 0.493, with an average of 0.401. Figure 1 shows a site-stratified graphical representation of individual provider results for observed LOS (Figure 1) and $LOS_{O/E}$ (Figure 2) for all 92 providers.

We divided the 92 physicians into quartiles based on $LOS_{O/E}$. Each quartile was statistically different from every other quartile (results not shown).

Outputs for site-specific regressions performed to determine $LOS_{O/E}$ are included as the Appendix (available online).

DISCUSSION

EDs are complex operating environments. Operations research and operations management principles may generate insights or help to improve ED operations, but the success of such work is contingent upon a detailed understanding of ED data, workflow, and variation (11,12).

Emergency physicians are not monolithic in their work patterns. Previous work has found significant interphysician variation in the use of advanced imaging, the use of laboratory tests, and the rate of admission to the hospital (1–6). Differences in individual work patterns are also reported in other medical specialties as well as in nonmedical industries, suggesting that such variation is not an EM-specific phenomenon (13–15).

LOS is an important performance metric in ED operations. Hospital Compare uses ED LOS as a quality measure, and the Medicare Stars rating program includes ED LOS as a factor (16). Despite the importance of ED LOS in ED operations, however, there are few reports regarding quantitative differences between physicians with respect to LOS.

Previous cohort-based studies have found that pediatrics-trained physicians have a somewhat shorter LOS than emergency medicine-trained physicians in a

Table 2. Visit Elimination Profile

Site	EMR Visits	No Physician Assigned in EMR*	Missing/Illogical Data	Seen by Low-Volume Provider	Extreme LOS†	Total Eligible Visits	Eligible Visits as % of EMR Visits
A	85,468	1206	559	2458	2	81,243	95%
B	43,325	10,409	504	5077	0	27,335	63%
C	93,591	28,950	1243	786	1	62,611	67%
D	82,265	4163	262	737	2	77,101	94%
E	91,241	4934	1198	5641	5	79,463	87%
Totals	395,890	49,662	3766	14,699	10	327,753	83%

EMR = electronic medical record; LOS = length of stay.
* No Physician Assigned in EMR includes patients evaluated primarily by Nurse Practitioners/Physician Assistants.
† Extreme LOS defined as LOS > 10,080 min (7 days).

Table 3. Patient Characteristics by Site

	Site A (n = 81,243)	Site B (n = 27,335)	Site C (n = 62,611)	Site D (n = 77,101)	Site E (n = 79,463)
Age, years: mean (SD)	58.8 (20.8)	47.9 (27.3)	47.7 (25.5)	55.6 (22.4)	41.2 (25.9)
Gender					
Male	47%	47%	47%	45%	47%
Female	53%	53%	53%	55%	53%
Acuity					
1	1%	0%	1%	1%	1%
2	14%	11%	19%	19%	19%
3	73%	61%	62%	61%	52%
4	12%	25%	17%	18%	26%
5	1%	4%	1%	1%	2%

pediatric ED setting, but these studies did not explore differences between individual providers (17,18). One three-site study (in a fast-track setting) examined physician-level differences in LOS and found that the 90th percentile LOS was 1.4–2.6 times longer than that of the 10th percentile (19). We did not find any previous studies that report on differences between ED providers when caring for non-fast-track ED patients.

Given our combined experience, we were not surprised that there were significant differences between individual emergency physicians with respect to observed LOS (Figure 1). These data, however, may be difficult to interpret without additional context. Within a given facility, LOS may be influenced by multiple factors, such as patient or time characteristics, that may be beyond (or at best only partially under) a physician's control. As such, observed differences in mean LOS at a single site may not necessarily reflect intrinsic differences between physicians, but may reflect, to some extent, "the luck of the draw." In addition, the overall operating environment of any given facility may have a significant effect on LOS. As such, it may not be reasonable to conclude that physicians at one facility (such as Site B) are more efficient than those at another (such as Site A), although a graphical representation of observed LOS may visually suggest this. For these reasons, the unadjusted data presented in Figure 1 may not represent an optimal means for comparing physicians, either within a facility or between facilities.

To facilitate what we believed would be a clearer comparison between sites and physicians, we derived an expected LOS for each visit. The expected LOS accounted for several factors, such as mean site LOS; patient characteristics such as age, gender, ESI score and disposition; and time characteristics such as shift, day of week, season, and calendar year. We then calculated the ratio of observed LOS to expected LOS ($LOS_{O/E}$) for each visit, and derived a mean $LOS_{O/E}$ for each physician. A physician's relative position on this scale is therefore a function not only of LOS, but whether or not the LOS was less than or greater than one would expect given the multiple factors (including site) for which we controlled.

The resulting data (Figure 2) suggest far more similarity between sites. Across sites, the $LOS_{O/E}$ of physicians with the lowest $LOS_{O/E}$ was on the order of 20% less than expected (i.e., mean $LOS_{O/E}$ of approximately 0.8), and the $LOS_{O/E}$ of physicians with the highest $LOS_{O/E}$ was on the order of 20% greater than expected (i.e., mean $LOS_{O/E}$ of approximately 1.2), with a continuum of providers between the two extremes.

Although our data set is somewhat limited, we believe that these results may contribute to the nascent understanding of interphysician differences with respect to emergency medicine practice. Although our finding that emergency physicians differ in LOS may not be surprising, we quantify this difference and demonstrate that

Table 4. Site-Specific Summary Data: Mean Observed LOS and Mean $LOS_{(O/E)}$

Site	Lowest LOS	Highest LOS	Difference in LOS	Lowest $LOS_{(O/E)}$	Highest $LOS_{(O/E)}$	Difference in $LOS_{(O/E)}$
A	184	270	86	0.798	1.186	0.388
B	106	196	90	0.702	1.195	0.493
C	155	228	73	0.800	1.201	0.401
D	185	253	68	0.887	1.192	0.305
E	126	212	86	0.817	1.275	0.458
Mean	151	232	81	0.801	1.210	0.409

LOS = length of stay; $LOS_{(O/E)}$ = ratio of observed LOS/expected LOS.

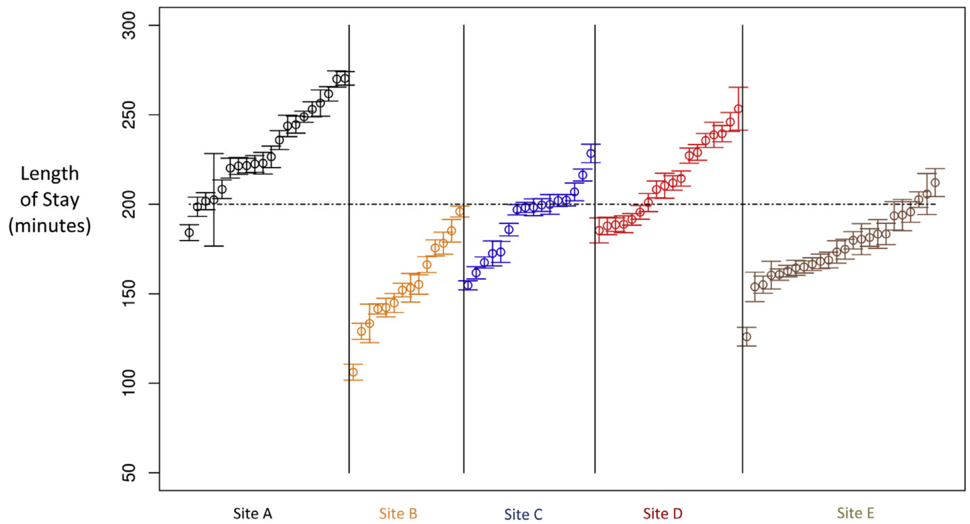

Figure 1. Unadjusted length of stay by provider by site.

the pattern of LOS at each site is relatively similar after controlling for multiple confounders.

To confirm that differences between groups were significant, rather than the result of random variation, we performed a quartile analysis of all 92 physicians based on $LOS_{O/E}$. We found that each quartile of physicians was different from every other quartile.

Our findings, if reproducible, may have operational implications. If physicians with a lower $LOS_{O/E}$ possess specific learnable skills, there may be an opportunity to identify these skills and attempt to diffuse them to physicians with a longer $LOS_{O/E}$ or to residents in training. Alternatively, if such behavior is fixed, it is possible that a scheduling algorithm that took such factors into account could improve ED throughput. Future research may help to answer these questions.

We note that, although our work suggests that the emergency physicians may play a significant role in determining LOS, we identify only the degree of differences between providers, and not its drivers. Testing, treatment, and radiology utilization may all affect LOS, and physicians may differ significantly in how they utilize such services (20,21). In addition, nonphysician factors such as hospital occupancy, intensive care unit census, daily percentage of ED patients who are admitted, and the need for interpreter services may all impact an individual provider's LOS (22–25). Further research with more precise visit-level data (which we lacked for

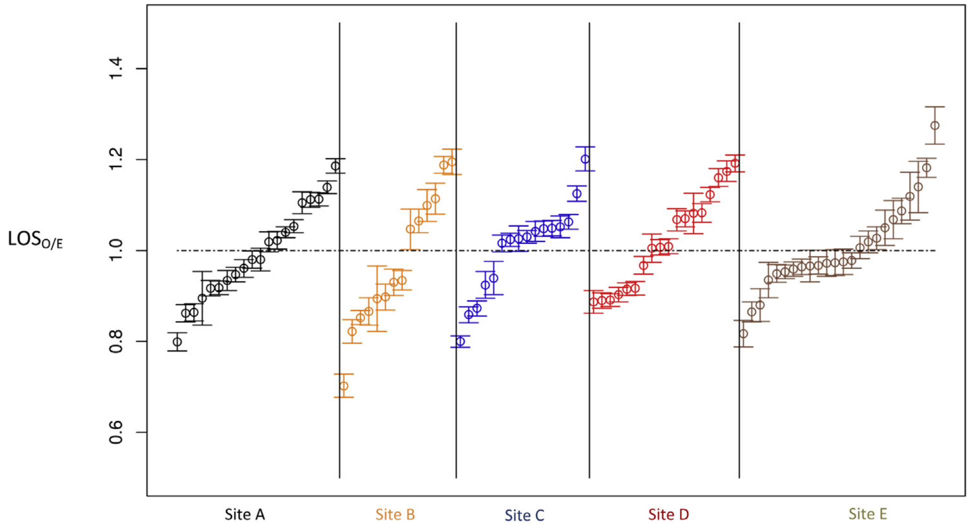

Figure 2. $LOS_{O/E}$ by provider by site. $LOS_{(O/E)}$ = ratio of observed LOS/expected LOS.

this study) may help to isolate the drivers of the differences we found.

One valid criticism of our data is that they represent empiric observations, and not necessarily the patient-processing abilities of individual physicians. For example, if a physician with a low $LOS_{O/E}$ routinely sees fewer patients per unit time than others in his or her group, the finding of a low $LOS_{O/E}$ may be due simply to a lower workload. Alternatively, if a physician with a low $LOS_{O/E}$ preferentially selects patients with complaints associated with shorter lengths of stay, the finding of a low $LOS_{O/E}$ may be due simply to physician-driven patient selection bias, which has been demonstrated in emergency medicine residents (26). We lacked data to account for either of these possibilities.

Data from two of our sites, however, suggest that neither of these factors is likely to play a significant role. We found significant interphysician differences in LOS not only in those EDs in which physicians had discretion over which patients they saw (Sites B, C, and E), but also in those EDs in which physicians were assigned patients algorithmically on a rotational basis (Sites A and D). The rotational assignment approach in use at each site tends to equalize work over time, and our experience suggests that this removes virtually all physician bias with respect to patient acquisition (27). We believe that the similarity of our findings for Sites A and D to those of sites B, C, and F with respect to $LOS_{O/E}$ makes it less likely that our results are attributable to either differential workload or physician-driven selection of patients.

Our results were fairly consistent across a small group of hospitals that differed in geographic location, yearly volume, admission rate, extent of NP/PA utilization, and workflow with respect to physician/patient assignment. However, our findings would be strengthened by the inclusion of larger facilities or facilities from a different health care system.

We note that our sole outcome, LOS, is only one quality measure when analyzing ED operations. Unfortunately, there is no consensus on an ideal metric to gauge non-LOS quality outcomes when interpreting large data sets such as ours. Easily quantifiable endpoints, such as 72-h returns to the ED or 72-h returns to the ED with admission, have been shown to be inconsistent markers of quality (28–30).

We believe that our one-dimensional findings must be kept in perspective. We establish only that there are differences in LOS between physicians, and make no conclusions regarding the positive or negative consequences of this. It is possible that other important ED measures, such as clinical outcomes, might be positively correlated with LOS. Even if they are not, it is possible that quality might be adversely affected if a physician with a longer LOS was simply tasked with working faster. Importantly, we do not believe that LOS data alone can be used to “score” or “rank” emergency physicians.

Finally, although this work suggests that there is significant variation between emergency physicians with respect to LOS, it does not logically follow that interphysician differences are the most important driver of LOS. Previous work has suggested that hospital factors (such as bed availability) may have a greater impact than physician factors in determining ED LOS (31).

Limitations

Although our data are multisite and the departments vary significantly, all sites are part of one health care system. We also chose not to include the one site within our system that has an emergency medicine training program. We believed that the robust presence of trainees would make that site qualitatively different from the others and make it more difficult to attribute LOS to a single provider, as residents might explain a portion of any observed variation. These factors limit the generalizability of our findings.

Although our model includes several variables that may confound LOS, it also omits many. Day-to-day variation in hospital-level variables such as overall occupancy and occupancy of high-acuity units can significantly impact LOS, but we lacked this information (22,23). Although we suspect that our focus on provider-level data (coupled with our long observation time) mitigates the effects of day-to-day variability, we cannot be certain that this is true.

We excluded low-volume providers, who collectively saw approximately 5% of otherwise eligible visits. We believed that low-volume providers, by nature of their decreased clinical time, likely represent a distinct class of providers who may not have understood workflow and processes to the extent that regular providers did. As such, these providers may not have had an equal opportunity to achieve a shorter mean LOS. We believe that excluding them allows for a better understanding of the inherent differences between physicians with an equivalent working knowledge of how a given ED functions, but acknowledge that our decision results in the exclusion of a significant number of visits.

We excluded patients who were assigned to an NP/PA, to focus on differences among one group of providers (physicians). However, the time individual physicians spent overseeing patients evaluated by an NP/PA at the three sites (B, C, and E) that utilized NP/PAs may have differed. This could have a significant impact on the LOS of other patients assigned primarily to that physician, and we lacked the data necessary to account for this.

Our sites differ significantly with respect to the number of early-career providers, defined as those who completed training within 3 years of the beginning of the study period, and we did not account for this in our regression model. However, analysis of the three sites that utilized early-career providers during the study period demonstrated that the majority of the early-career providers had an $LOS_{O/E}$ in the lower half of providers at all four sites (data not shown), a finding that was unexpected. After a discussion with site directors at these facilities, we believe that this finding may be due in large part to the fact that newer hires at many of these sites were more likely to be trained in Emergency Medicine, as opposed to another specialty (such as Family Practice).

We rely almost exclusively on EMR-generated data. Although we reviewed these data at a high level and eliminated visits with missing or illogical values, the fact that we had to do so is a concern. We note that our remaining values, although logical, are only as accurate as the system that generated them, and that any errors may be directional in nature or affect some providers more than others. We acknowledge the limitations in this approach, but assert that a manual review of a data set of this size is not feasible.

We lacked data regarding transfers of care from physician to physician, such as may occur at change of shift. We did not have an accurate means to determine which patients were involved in care transfers, a method of identifying the physician to whom such a patient was transferred, or a way to assess the degree to which each physician involved in a care transfer was responsible for a patient's LOS. We therefore assigned the entire responsibility for each patient visit to the initial treating physician. Accordingly, a patient's LOS may be attributed to one physician, but influenced by another.

We eliminated all visits > 10,080 min (7 days). However, we did not eliminate other patients with a markedly prolonged LOS (such as those > 12 or 24 h). The extended LOS in such visits may be due to circumstances beyond the physician's control, such as delays associated with behavioral health patients, but in our model the LOS for such visits was still ascribed to the initial physician. To the extent that such patients distribute at random to all members of a group, however, any effects on relative LOS should be small.

Finally, our effort is one-dimensional. We report results only regarding LOS, without taking into account other critically important issues. Specifically, although LOS is recognized as a measure of quality in emergency care, it does not take into account other factors that might impact quality or diminish the patient experience, such as physician and staff spending less time spent at the bedside or providing patient education. Although we know of no data that have linked shorter LOS to medical errors, it is theoretically possible that in some circumstances a shorter LOS may be associated with less careful ED decision-making (i.e., more "rushed care"), which may in turn increase adverse events.

CONCLUSIONS

We found significant interphysician differences in ED LOS after controlling for multiple confounders in a five-ED analysis, but that the range of differences (after adjusting for confounders) was similar across sites. Further research may help to clarify the role of the individual physician in determining ED LOS.

REFERENCES

1. Marin JR, Wang L, Winger DG, Mannix RC. Variation in computed tomography imaging for pediatric injury-related emergency visits. J Pediatr 2015;167:897–9043.
2. Pines JM, Hollander JE, Isserman JA, et al. The association between physician risk tolerance and imaging use in abdominal pain. Am J Emerg Med 2009;27:552–7.
3. Aronson PL, Thurm C, Alpern ER, et al. Variation in care of the febrile young infant <90 days in US pediatric emergency departments. Pediatrics 2014;134:667–77.
4. Florin TA, French B, Zorc JJ, Alpern ER, Shah SS. Variation in emergency department diagnostic testing and disposition outcomes in pneumonia. Pediatrics 2013;132:237–44.
5. Bourgeois FT, Monuteaux MC, Stack AM, Neuman MI. Variation in emergency department admission rates in US children's hospitals. Pediatrics 2014;134:539–45.
6. Abualenain J, Frohna WJ, Shesser R, Ding R, Smith M, Pines JM. Emergency department physician-level and hospital-level variation in admission rates. Ann Emerg Med 2013;61:638–43.
7. Bursch B, Beezy J, Shaw R. Emergency department satisfaction: what matters most? Ann Emerg Med 1993;22:586–91.
8. Wiler JL, Gentle C, Halfpenny JM, et al. Optimizing emergency department front-end operations. Ann Emerg Med 2010;55:142–1601.
9. Imperato J, Morris DS, Binder D, et al. Physician in triage improves emergency department patient throughput. Intern Emerg Med 2012; 7:457–62.
10. Traub SJ, Wood JP, Kelley J, et al. Emergency department rapid medical assessment: overall effect and mechanistic considerations. J Emerg Med 2015;48:620–7.
11. Soremekun OA, Terwiesch C, Pines JM. Emergency medicine: an operations management view. Acad Emerg Med 2011;18:1262–8.
12. Saghafian GAS, Traub S. Operations research/managment contributions to emergency department patient flow optimization: review and research prospects. IIE Trans Healthc Syst Eng 2015;5:101–23.
13. Mercuri M, Natarajan MK, Norman G, Gafni A. An even smaller area variation: differing practice patterns among interventional cardiologists within a single high volume tertiary cardiac centre. Health Policy 2012;104:179–85.
14. Tan A, Zhou J, Kuo YF, Goodwin JS. Variation among primary care physicians in the use of imaging for older patients with acute low back pain. J Gen Intern Med 2016;31:156–63.
15. Gans LN, Madelbaum A, Shen H, Ye H. Service times in call centers: agent heterogeneity and learning with some operational consequences. In: Berger JO, Cai TT, Johnstone IM, eds. Borrowing strength: theory powering applications – A Festschrift for Lawrence D. Brown. Beachwood, OH: Institute of Mathematical Statistics; 2010:99–123.
16. Mullins PM, Pines JM. National ED crowding and hospital quality: results from the 2013 Hospital Compare data. Am J Emerg Med 2014;32:634–9.

17. Seow VK, Lin AC, Lin IY, et al. Comparing different patterns for managing febrile children in the ED between emergency and pediatric physicians: impact on patient outcome. Am J Emerg Med 2007;25:1004–8.
18. Weiner SG, Ruffing RP, Barnewolt BA. A comparison of resource utilization between emergency physicians and pediatric emergency physicians. Pediatr Emerg Care 2012;28:869–72.
19. McCarthy ML, Ding R, Pines JM, et al. Provider variation in fast track treatment time. Med Care 2012;50:43–9.
20. Gardner RL, Sarkar U, Maselli JH, Gonzales R. Factors associated with longer ED lengths of stay. Am J Emerg Med 2007;25:643–50.
21. Kocher KE, Meurer WJ, Desmond JS, Nallamothu BK. Effect of testing and treatment on emergency department length of stay using a national database. Acad Emerg Med 2012;19:525–34.
22. Forster AJ, Stiell I, Wells G, Lee AJ, van Walraven C. The effect of hospital occupancy on emergency department length of stay and patient disposition. Acad Emerg Med 2003;10:127–33.
23. Lucas R, Farley H, Twanmoh J, et al. Emergency department patient flow: the influence of hospital census variables on emergency department length of stay. Acad Emerg Med 2009;16:597–602.
24. Wiler JL, Handel DA, Ginde AA, et al. Predictors of patient length of stay in 9 emergency departments. Am J Emerg Med 2012;30:1860–4.
25. Wallbrecht J, Hodes-Villamar L, Weiss SJ, Ernst AA. No difference in emergency department length of stay for patients with limited proficiency in English. South Med J 2014;107:1–5.
26. Patterson BW, Batt RJ, Wilbanks MD, Otles E, Westergaard MC, Shah MN. Cherry picking patients: examining the interval between patient rooming and resident self-assignment. Acad Emerg Med 2016;23:679–84.
27. Traub SJ, Stewart CF, Didehban R, et al. Emergency Department Rotational Patient Assignment. Ann Emerg Med 2016;67:206–15.
28. Abualenain J, Frohna WJ, Smith M, et al. The prevalence of quality issues and adverse outcomes among 72-hour return admissions in the emergency department. J Emerg Med 2013;45:281–8.
29. Pham JC, Kirsch TD, Hill PM, DeRuggerio K, Hoffmann B. Seventy-two-hour returns may not be a good indicator of safety in the emergency department: a national study. Acad Emerg Med 2011;18:390–7.
30. Klasco RS, Wolfe RE, Wong M. Assessing the rates of error and adverse events in the ED. Am J Emerg Med 2015;33:1786–9.
31. Krall SP, Cornelius AP, Addison JB. Hospital factors impact variation in emergency department length of stay more than physician factors. West J Emerg Med 2014;15:158–64.

ARTICLE SUMMARY

1. Why is this topic important?

Emergency department length of stay (LOS) is a key operations metric as well as a marker of quality in emergency medicine. Little is known, however, about how individual physicians differ with respect to LOS.

2. What does this study attempt to show?

This study describes the differences in LOS between physicians evaluating non-fast-track visits at five emergency departments (EDs) over 3 years, in both absolute terms and in terms of the ratio of observed LOS to expected LOS ($LOS_{O/E}$).

3. What are the key findings?

Physicians differ substantially in LOS. With regard to the interphysician differences for $LOS_{O/E}$, the patterns of differences were similar at all five sites: physicians with the lowest $LOS_{O/E}$ averaged approximately 20% lower than expected, and physicians with the highest $LOS_{O/E}$ averaged approximately 20% higher than expected.

4. How is patient care impacted?

Although these results do not impact patient care *per se*, they add to our knowledge of how physicians in the ED work, quantifying the differences between physicians with regard to length of stay. Future work may build upon these findings, determining the drivers of the differences between physicians, work traits that contribute to these differences, and the implication of these differences for ED operations.

Appendix

Model to Predict LOS (Site A)

Variable	Estimate	Standard Error	*p*-Value
Intercept	139.506	2.806	< 0.0001
Female	11.880	1.100	< 0.0001
Age	0.169	0.027	< 0.0001
ESI345	2.803	1.645	0.0885
ADTO = A	105.434	1.273	< 0.0001
ADTO = T	381.285	4.991	< 0.0001
Year 2014	4.051	1.371	0.0031
Year 2015	1.775	1.344	0.1867
Spring	6.929	1.352	< 0.0001
Winter	6.506	1.318	< 0.0001
Monday	19.051	1.733	< 0.0001
Tues–Friday	13.765	1.268	< 0.0001
Morning or afternoon	27.588	1.317	< 0.0001
Night	6.321	2.163	0.0035

LOS = length of stay; AT = admission vs. transfer.

Model to Predict LOS (Site B)

Variable	Estimate	Standard Error	*p*-Value
Intercept	123.156	3.008	< 0.0001
Female	7.246	1.287	< 0.0001
Age	0.797	0.025	< 0.0001
ESI345	−24.241	2.176	< 0.0001
ADTO = A	68.976	2.095	< 0.0001
ADTO = T	55.320	2.626	< 0.0001
Year 2014	−9.082	1.612	< 0.0001
Year 2015	−16.598	1.605	< 0.0001
Spring	0.645	1.553	0.6777
Winter	4.663	1.615	0.0039
Monday	15.315	2.072	< 0.0001
Tues–Friday	8.619	1.457	< 0.0001
Morning or afternoon	10.796	1.483	< 0.0001
Night	−8.779	2.019	< 0.0001

LOS = length of stay; AT = admission vs. transfer.

Model to Predict LOS (Site C)

Variable	Estimate	Standard Error	*p*-Value
Intercept	144.852	1.903	< 0.0001
Female	7.699	0.902	< 0.0001
Age	0.636	0.019	< 0.0001
ESI345	−8.549	1.212	< 0.0001
ADTO = A	50.846	1.142	< 0.0001
ADTO = T	106.354	3.948	< 0.0001
Year 2014	−11.193	1.119	< 0.0001
Year 2015	−11.007	1.093	< 0.0001
Spring	−0.097	1.091	0.9293
Winter	1.124	1.123	0.3173
Monday	9.880	1.415	< 0.0001
Tues–Friday	4.640	1.027	< 0.0001
Morning or afternoon	10.030	1.035	< 0.0001
Night	2.599	1.490	0.0811

LOS = length of stay; AT = admission vs. transfer.

Model to Predict LOS (Site D)

Variable	Estimate	Standard Error	*p*-Value
Intercept	115.322	2.786	< 0.0001
female	9.566	1.178	< 0.0001
Age 10–20	0.431	0.027	< 0.0001
Age 30 m	4.218	1.581	0.0076
ADTO = A	102.380	1.457	< 0.0001
ADTO = T	71.007	6.521	< 0.0001
ADTO = O	−22.569	3.070	< 0.0001
Year 2014	−37.666	1.417	< 0.0001
Year 2015	−25.723	1.437	< 0.0001
Spring	4.165	1.427	0.0035
Winter	17.071	1.425	< 0.0001
Monday	37.972	1.858	< 0.0001
Tues–Friday	33.909	1.361	< 0.0001
Morning or afternoon	36.821	1.374	< 0.0001
Night	4.263	2.277	0.0611

LOS = length of stay; ATO = admission vs. transfer vs. observation.

Model to Predict LOS (Site E)

Variable	Estimate	Standard Error	*p*-Value
Intercept	147.531	2.399	< 0.0001
Female	9.866	1.117	< 0.0001
Age	0.351	0.024	< 0.0001
ESI345	−41.735	1.530	< 0.0001
ADTO = A	55.458	1.552	< 0.0001
ADTO = T	197.921	3.727	< 0.0001
Year 2014	18.340	1.363	< 0.0001
Year 2015	11.728	1.374	< 0.0001
Spring	−3.233	1.355	0.0171
Winter	0.193	1.374	0.8881
Monday	9.127	1.756	< 0.0001
Tues–Friday	7.105	1.250	< 0.0001
Morning or afternoon	20.350	1.238	< 0.0001
Night	−15.965	1.829	< 0.0001

LOS = length of stay; AT = admission vs. transfer.