Provider Variation in Fast Track Treatment Time

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Objective: To examine the degree to which fast track (FT) treatment time varies among providers.

Methods: A retrospective cohort study that included 105,783 FT visits at 3 emergency departments (EDs) during a 3-year period. We calculated the median treatment time for 80 primary providers (physicians and physician extenders) and 109 nurses (2 sites only). We used a hierarchical linear regression model that accounted for the clustering of patient visits to the same provider to estimate each provider's median treatment time controlling for patient, clinical, temporal, and ED demand (ie, number of arrivals) characteristics.

Results: Median FT treatment time across the 3 sites ranged from 48 to 134 minutes. Adjusted for other factors, the median FT treatment time of providers at the 90th versus 10th percentiles was 1.4 to 2.6 times longer across the 3 sites. The variation by FT nurses was also large. The median FT treatment time of nurses at the 90th versus 10th percentiles was 1.5 and 1.4 times longer at sites A and C, respectively. At all sites, provider and clinical factors explained more variation in FT treatment time than patient, ED demand, or temporal factors.

Conclusions: There were clinically meaningful differences in FT treatment time among the providers at all sites. Given that the providers share the same environment and patient population, understanding why such large provider variation in FT treatment time exists warrants further investigation.

Key Words: emergency department, performance, treatment time

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Over the past several decades, hospital emergency departments (EDs) have greatly expanded their role in the United States health care system.[1] Initially organized to treat patients with life threatening conditions, they now provide unplanned, nonemergent but needed health care services to increasing numbers of patients who present to them.[2] Consequently, many EDs experience frequent and persistent periods of crowding.[1] As EDs prioritize patients by acuity, patients triaged as semiurgent and nonurgent wait the longest for evaluation and treatment.[3] In 2006, among a nationally representative sample of 366 hospital EDs in the United States, the median of the hospitals' median wait time to see a provider for nonurgent patients was 45 minutes; however, the interquartile range or the middle 50% of the hospitals' waiting time distribution was 27 to 83 minutes.[3]

To improve the timeliness of nonurgent care, 69% and 49% of all large (ie, > 50,000 annual visits) and medium volume (ie, 20,000 to 50,000 annual visits) EDs, respectively, have separate fast track (FT) units to rapidly evaluate, treat, and discharge low acuity patients.[4] The faster each FT patient is evaluated and treated, the shorter the wait time for those in the queue, the less likely patients are to leave without being seen, and the greater the system efficiency (ie, more patients treated per provider).[5–7] As low acuity patients do not typically require an extensive diagnostic workup, specialty consultation, or admission to the hospital, FT treatment time is largely under the control of the treating provider. To our knowledge, no one has investigated the degree to which treatment time varies systematically among FT providers. The purpose of this study was to estimate provider variation in FT treatment time and to compare the relative importance of the provider(s) to other factors.

MATERIALS AND METHODS

Study Design and Setting

We conducted a retrospective cohort design that included the primary providers and nurses of patients treated in the FT area of 1 of 3 urban EDs during a 3-year period. Operational ED visit data were extracted from the ED information systems (EDIS) of the 3 sites and used to determine treatment time for each patient visit completed in FT. Median FT treatment times were compared among the primary FT providers and nurses. The institutional review boards of each study site approved this study by expedited review.

TABLE 1. Description of Study Sites

	Study Sites		
Facility Characteristics	**Site A**	**Site B**	**Site C**
Hospital			
Type of hospital	Teaching Affiliate	Academic, Tertiary Care	Academic, Tertiary Care
Trauma center designation	Level 2	Level 1	Level 1
Annual ED visits	59,790	59,768	65,142
No. of staffed ED treatment spaces	42	42	51
Main ED	31	25	26
Fast Track	8	6	11
Observation unit	0	6	0
Hallway	3	15	14
Fast Track			
Patient population	Adults and children	Adults primarily	Adults primarily
Annual fast track visits	13,714 adult visits and 6223 pediatric visits	9324	18,848
Median hourly arrival (IQR)	2 (1,3)*	2 (1,3)	4 (2,6)
Median length of stay (IQR)	143 (94, 209)*	128 (86, 188)	188 (131, 261)
Median waiting room time (IQR)	80 (49, 132)*	62 (41, 94)	35 (10, 80)
Admission rate	0.5%*	1.0%	2.2%
Primarily staffed by	Attendings	Nurse Practitioners (85%)†	Attendings
Type of coverage	Single	Single and Double (11 AM–8 PM)‡	Single
Ancillary staffing	1 Nurse and 1 Technician	1 Nurse or 1 Technician	1 Physician Assistant and 1 Nurse
Weekday hours of operation	8 AM–MIDNIGHT	8 AM–11 PM	9 AM–2 AM
Weekend hours of operation	8 AM–MIDNIGHT	9 AM–9 PM	12 PM–8 PM

*Median hourly arrival rate for adult patients only.
†Remaining 15% of staffing is by attendings ± physician assistants or residents.
‡Double coverage on weekdays only.
ED indicates emergency department; IQR, interquartile range.

Table 1 summarizes the facility characteristics of the 3 study sites. Two of the 3 EDs are academic, tertiary care centers, whereas 1 is a teaching affiliate. The annual volume of the EDs is similar; however, the total FT volume ranges from 9324 to 19,937 across the sites. At site A, children account for one third of the FT visits. The median hourly volume of adult patients at site C is twice that of the other 2 sites. Sites A and C are primarily staffed by physicians. At site A, a pediatrician attends the pediatric patients and a physician board-certified in emergency, family, or internal medicine treats the adult patients. The FT at site B is primarily staffed by certified registered nurse practitioners and is the only facility with double coverage during weekdays.

There were 137,510 adult FT visits across the 3 study EDs during the study period (January 1, 2007 to December 31, 2009 for 2 sites and January 1, 2007 to August 31, 2009 for 1 site). At site A, we eliminated 16,595 FT visits treated by the pediatricians, as they are not ED staff. We excluded 6691 visits whose arrival time occurred during hours when FT was closed and 2328 left without being seen visits. We used the Spearman-Brown prophecy formula to determine that we needed a minimum of 100 FT visits per provider to reliably estimate ($\geq 80\%$) treatment time by provider.[8,9] We eliminated 6113 visits associated with providers who treated fewer than 100 patients during the study period. Thus, the final sample includes 105,783 FT visits, 80 primary providers, and 109 nurses (sites A and C, only).

Data Sources and Variables

Each site uses a different EDIS (2 use different commercial products and 1 uses an internally developed system). Upon arrival, patients are initially registered into the EDIS by registration or triage staff. At sites A and C, the triage nurse decides the location of care (ie, FT or main ED) and enters the location into the EDIS. When a treatment room becomes available, an FT staff places an FT patient in a room typically in the order in which they arrive. At Site B, patients are triaged and assigned an acuity level in the EDIS. On the basis of the acuity level, FT providers select patients when they are ready to see them, therefore treatment location is not designated until an FT provider places a patient in the room.

The main independent variables of interest were the primary provider and nurse responsible for the care of each FT patient. At site A, if more than 1 provider treated the patient, the EDIS only retains the last attending and nurse designated in the system. At sites B and C, the EDIS tracks all providers who document provision of care of a patient. Of the 25,862 included visits at site B, 5% involved more than 1 primary FT provider. At site B, we did not extract nursing information from the EDIS because nurses do not consistently staff FT. At site C, 93% of all FT visits only involved 1 attending; the remaining 7% involved 2 attendings. At sites B and C, we attributed the FT visit to the first provider.

For each ED visit, we extracted the following information from the EDIS: (1) date and time of initial registration; (2) date and time of room placement; (3) date and time of disposition; (4) treatment location (ie, main ED or FT); (5) primary provider(s); (6) primary nurse; (7) disposition status; (8) demographic characteristics (age and sex); (9) triage level; (10) mode of arrival; and (11) chief complaint.

The main outcome for the analysis was FT treatment time, which was defined as the interval between room placement and ED departure. Although patients may wait in a treatment room for a short period before being evaluated by

the primary provider, it is time attributed to the provider, as the only factor limiting initiation of care at that point is the primary provider.

All 3 sites use the Emergency Severity Index to triage patients. The Emergency Severity Index is a 5-level triage scale that prioritizes patients according to severity of illness and anticipated number of resources needed with 1 reflecting high acuity and 5 meaning low acuity.[10,11] Each site's EDIS has a standard list of chief complaints with the option of free text. To standardize the chief complaints across the sites, we classified each chief complaint according to the Reason for Visit Classification System used by the National Hospital Ambulatory Medical Care Survey.[12]

We used registration date and time to create temporal variables to measure differences in treatment time by day of week, hour of day, holiday, and year. To account for ED demand, we created variables that measured the total number of FT arrivals in the current hour of each FT visit and a lag variable that measured the number of FT arrivals in the past 2 hours. To determine whether demand for services in the main ED influenced FT treatment time and waiting room time, we also measured the total number of main ED arrivals in the current hour and total number of main ED arrivals in the previous 2 hours. At site A, we also included the total number of pediatric FT arrivals in the current hour and total arrivals in the past 2 hours to determine whether the pediatric patients treated in FT influenced the service times of the adult FT patients, as they share some of the same ancillary support staff.

Statistical Analysis

We conducted all analyses separately for each site to examine the degree to which the results were consistent across sites. As treatment time was positively skewed, we focused the analyses on the median. First, we examined the relationship between FT treatment time and the following predictors: (1) patient demographics (age and sex); (2) clinical characteristics (acuity and chief complaint); (3) temporal factors (registration date, day of week, time of day, year, and holiday); (4) ED demand (number of FT arrivals in current hour, number of FT arrivals in previous 2 hours, number of main ED arrivals in current hour, and number of main ED arrivals in previous 2 hours); and (5) provider type (primary FT provider and nurse). As, at each site, FT staffing was the same on each day during the study period and there was no variation in staffing, it was not necessary to include this variable in the analyses.

Second, we log transformed FT treatment time to make the outcome distribution more symmetric. We modeled the natural log of FT treatment time as a function of patient, clinical, temporal, ED demand, and provider factors using a hierarchical linear regression model that accounted for the clustering of patient visits seen by the same provider.[8] To accurately reflect secular and diurnal trends due to season and time of day, we used smoothing splines with 6 degrees of freedom to represent diurnal variation and 4 degrees of freedom per year (total 12) to represent smooth secular trends. All factors included in the model were entered as fixed effects except registration date, which was entered as a random effect to capture the day to day variation in FT treatment time that cannot be explained by provider and other predictors and that controls for residual correlation among them for different patients who visit the ED on the same day.[8] In this model, the provider regression coefficients estimate the relative (percentage) increase or decrease in median treatment time for each of the providers compared with the primary provider or nurse who treated the most patients, adjusted for other factors. To determine whether the variation in FT treatment time was statistically significant by primary provider and by nurse, we computed the log likelihood ratio test based on models that included and excluded the primary providers and nurses. Each provider type was considered statistically significant if the log likelihood ratio test was associated with a P value < 0.05.

To compare the relative importance of different predictors on FT treatment time, we estimated the total proportion of variance explained by different predictors. We also examined whether provider variation in FT treatment time could be explained by provider characteristics, namely experience and sex. To do this, we modeled the primary provider coefficients from our first stage regression models as a function of the sex and years of experience of the primary providers in a second stage regression.[8] Years of experience were measured as the interval between completion of residency and the last year of the study period. We did not include provider age in the second stage model because of the strong correlation between provider age and years of experience ($R = 0.68$).

We conducted all analyses in R, version 2.7 (available at http://www.R-project.org).

RESULTS

The median FT treatment time varied from 48 to 134 minutes across the 3 sites. Table 2 displays the median and interquartile range of the unadjusted FT treatment time for each site by different predictors. At all 3 sites, the largest differences in observed median treatment time by the slowest and fastest categories of a predictor were for chief complaint (range, 25 to 51 min), acuity (range, 17 to 65 min), primary provider (range, 32 to 75 min), and nurse (range, 27 to 137 min). Much smaller differences in median treatment time were observed across the sites by different categories of the patient and temporal factors.

During the study period, 22, 24, and 34 primary providers treated at least 100 patients at sites A, B, and C, respectively. The average number of patients treated by each primary provider ranged from 1078 to 1433 across the sites. There were approximately twice as many different nurses at site C (N = 72) compared with site A (n = 37). The average number of patients treated by the nurses at sites A and C was 844 and 677, respectively.

Table 3 displays the proportion of variation in FT treatment time explained by different factors, after adjusting for all other measured factors. The total variation in FT treatment time is largest at site A. The primary provider and nurse explain a significant proportion of the total variation at all 3 sites (P values associated with log likelihood ratio tests are all < 0.0001). The proportion of variance explained by

TABLE 2. Median and Interquartile Range of Fast Track Treatment Time in Minutes by Site

	Site A					Site B					Site C				
	N	%	Median	Q1	Q3	N	%	Median	Q1	Q3	N	%	Median	Q1	Q3
Treatment Time*	29,473		48	25	83	25,862		53	27	99	48,680		134	92	193
Age*															
0–17	69	0%	60	32	100	448	2%	55	29	99	1,774	4%	123	88	171
18–34	13,111	44%	46	24	79	15,042	58%	51	27	95	22,483	46%	130	90	187
35–44	6782	23%	49	26	84	4,443	17%	53	27	99	8,883	18%	134	92	193
45–54	5585	19%	49	26	85	3,519	14%	56	28	107	8,329	17%	136	94	196
55+	3926	13%	54	28	95	2,409	9%	62	30	112	7,105	15%	147	101	214
Sex*															
Female	14,905	51%	49	26	83	15,229	59%	54	28	101	26,321	54%	137	94	199
Male	14,565	49%	48	25	83	10,633	41%	51	26	97	21,881	45%	130	90	186
Chief complaint															
General	5261	18%	48	25	81	5,370	21%	33	18	65	7,828	16%	126	82	193
Nerve/eye/ear	1209	4%	42	22	73	1,407	5%	38	23	71	3,139	6%	121	85	174
Respiratory	1652	6%	58	30	97	1,620	6%	73	36	115	5,385	11%	139	97	196
Digestive	2731	9%	35	18	57	1,685	7%	35	19	68	2,509	5%	167	103	254
Genitourinary	610	2%	56	32	92	1,677	6%	49	30	86	2,910	6%	140	94	209
Skin/abscess	4582	16%	41	22	68	2,045	8%	43	25	72	1,872	4%	116	83	166
Musculoskeletal	9082	31%	53	29	88	6,287	24%	75	39	120	9,871	20%	141	99	200
Injury	4346	15%	60	31	100	5,771	22%	67	37	111	15,166	31%	132	94	183
Acuity level*															
2–3	531	2%	54	25	100	1,720	7%	84	41	148	13,470	28%	163	111	240
4	24,037	82%	51	27	87	22,020	85%	53	27	98	29,522	61%	130	92	183
5	4861	16%	37	19	62	2,121	8%	39	22	67	5,674	12%	98	68	140
Holiday															
No	30,435	98%	143	94	210	25,286	98%	129	87	189	47,776	98%	188	131	261
Yes	777	2%	131	88	189	576	2%	112	76	163	933	2%	174	123	233
Year															
2007	10,673	36%	47	25	80	7,111	27%	45	22	86	12,185	25%	134	92	193
2008	11,271	38%	48	26	85	8,507	33%	51	26	100	16,273	33%	140	97	202
2009	7529	26%	50	25	86	10,244	40%	60	32	108	20,222	42%	130	89	186
Day of week															
Sunday	4130	14%	39	18	71	2,628	10%	45	23	88	3,724	8%	124	88	175
Monday	4761	16%	53	29	88	4,694	18%	54	28	101	8,740	18%	132	92	190
Tuesday	4353	15%	52	29	86	4,197	16%	52	27	98	8,495	17%	133	92	194
Wednesday	4375	15%	45	22	80	3,956	15%	57	29	102	7,916	16%	140	98	202
Thursday	4014	14%	54	30	92	3,950	15%	56	29	105	8,010	16%	135	91	197
Friday	4092	14%	46	25	82	3,824	15%	56	29	104	7,594	16%	134	91	198
Saturday	3748	13%	50	26	82	2,613	10%	47	24	87	4,201	9%	133	93	185
Time of day															
08:00–10:59	6042	21%	49	27	86	6,911	27%	48	25	95	6,699	14%	119	81	179
11:00–13:59	7670	26%	53	28	91	8,046	31%	56	28	107	14,031	29%	137	95	195
14:00–16:59	7085	24%	49	25	83	6,493	25%	56	29	103	12,306	25%	141	97	203
17:00–19:59	5463	19%	48	25	81	3,852	15%	51	27	89	9,815	20%	134	94	191
20:00–01:59	3213	11%	39	20	65	560	2%	50	26	81	5,829	12%	130	90	185
Daily patient volume quartiles															
0 (lowest)	5773	20%	47	25	80	3,590	14%	49	24	94	4,992	10%	140	96	202
1	6849	23%	50	27	88	5,135	20%	51	26	96	10,113	21%	136	94	193
2	7528	26%	49	26	83	8,323	32%	54	27	101	13,930	29%	137	94	199
3 (highest)	9323	32%	47	24	81	8,814	34%	55	29	101	19,645	40%	130	90	187
Primary provider															
Slowest	4590	16%	60	34	100	332	1%	97	62	145	118	< 1%	183	126	271
Fastest	5592	19%	28	13	55	1,485	6%	24	13	48	1,946	4%	108	74	157
Primary Nurse†															
Slowest	7047	24%	59	34	96						198	< 1%	239	165	340
Fastest	169	1%	32	19	66						349	< 1%	102	72	146

*A small number of patients missing treatment time, age, sex, or acuity.
†Information not extracted for site B, as fast track not consistently staffed by a nurse.

the primary provider is largest at site B (6.7%). At site C, the nurse explains more variation than the doctor. Clinical factors explained the most variation in FT treatment time at sites B and C. Patient and ED demand characteristics contributed relatively little to the variation in FT treatment time at all 3 sites ($\leq 1\%$).

Figure 1 displays the percent change in the median FT treatment time of each primary provider and nurse compared with the primary provider and nurse who treated the most FT patients, adjusted for patient, clinical, temporal, and ED demand factors. The variation in FT treatment time among the primary providers is larger at sites A and B compared

TABLE 3. Proportion of Variation in Fast Track Treatment Time Explained by Different Factors

Fast Track Treatment Time*	Site A	Site B	Site C
Total variance	1.68	0.93	0.32
Total variance explained by all factors in model (R^2)	17%	24%	23%
Primary provider	4.2%	6.8%	2.7%
Nurse	1.4%	NA	5.3%
Patient factors (Age and sex)	0.1%	0.1%	0.6%
Clinical factors (Acuity and chief complaint)	2.4%	11.1%	7.5%
Temporal factors (Registration date, day of week, time of day, and holiday)	1.0%	1.9%	3.1%
ED demand factors (No. of FT, Main ED, and pediatricians FT arrivals in past 3 h)	0.1%	0.1%	1.0%

*Natural log of treatment time.
ED indicates emergency department; FT, fast track.

with C. The median FT treatment time is 1.4 (site C) to 2.6 (site B) times longer for providers at the 90th versus 10th percentiles. There was also substantial variation in FT treatment time among the nurses. The median FT treatment time of the nurses at the 90th versus 10th percentiles was 1.5 and 1.4 times longer at sites A and C, respectively.

Across the 3 sites, the primary providers varied significantly by sex and years of experience (Table 4). At site A, the primary providers were more likely to be male whereas there were more female at site B. The median years of experience was similar at sites A and C. Overall, the median treatment time of male primary providers was 12% faster (95% CI, −21% to −3%) than female ones. At site C, a 10-year increase in experience was associated with a 6% decrease in adjusted median treatment time. Although experience was not statistically significant overall or at the other 2 sites, the trend was in the same direction (ie, more experience, faster treatment time).

DISCUSSION

This is the first study to estimate and demonstrate meaningful variation in performance at the provider level in an ED setting. We observed clinically large differences in

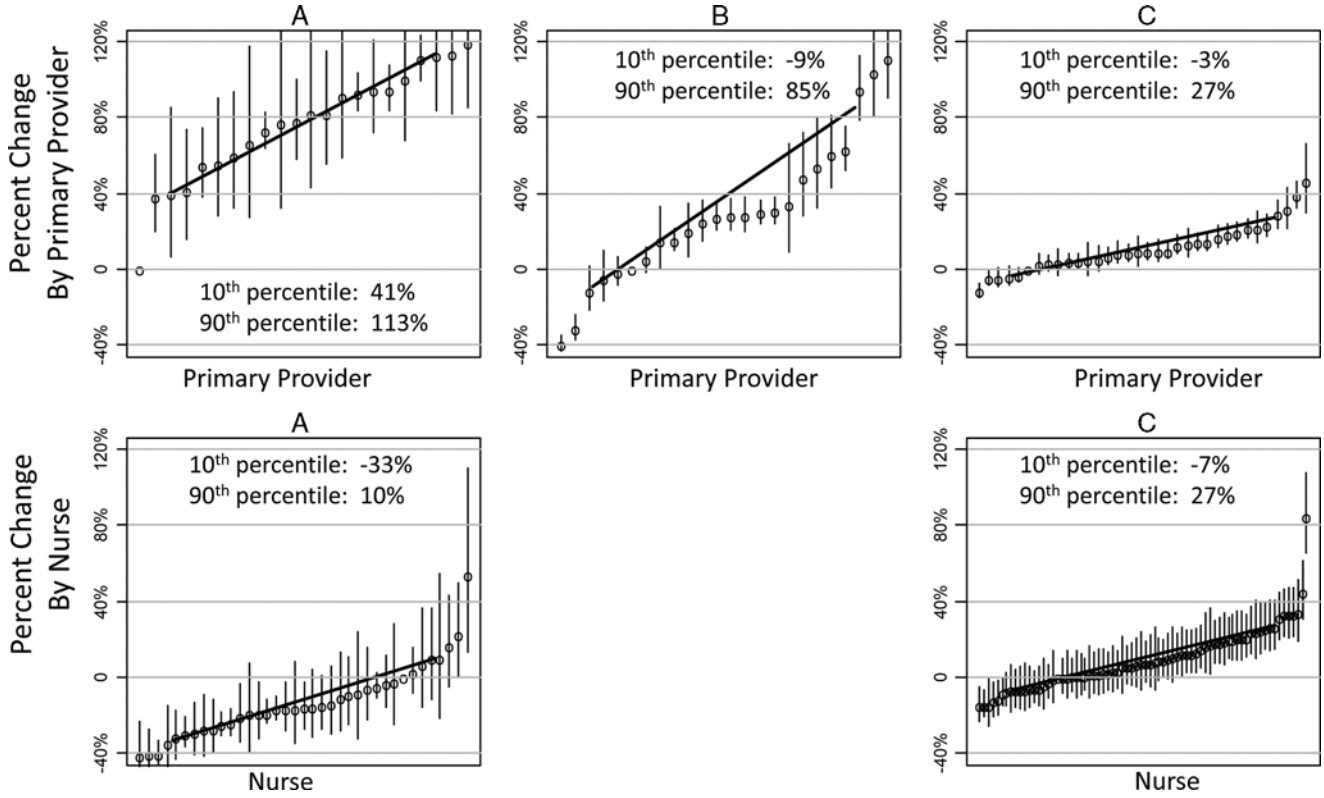

FIGURE 1. Percent change in fast track treatment time by primary provider, nurse, and site. The percent change in the median treatment time of each primary provider compared with the reference provider (one who treated the most patients) is estimated. The error bars represent the 95% confidence interval for the percent change in median treatment time for each provider. The bold line depicts the percent change in median FT treatment time between the providers at the 10th to 90th percentiles of the providers' treatment time distribution.

TABLE 4. Percent Change of Adjusted Median Treatment Time by Primary Provider Characteristics and Site

Provider Characteristics		Overall (N = 80)	Site A (N = 22)	Site B (N = 24)	Site C (N = 34)
Sex	Female (N)	41	6	19	16
	Male (N)	39	16	5	18
	Male vs Female	−12% (−21%, −3%)	−1% (−18%, 19%)	−29% (−45%, −7%)	−7% (−12%, −1%)
Experience (years)	Median (IQR)	7 (3, 14)	15 (5, 22)	5 (2, 9)	7 (3, 13)
	10 y increase	−4% (−9%, 1%)	0% (−8%, 8%)	−12% (−26%, 4%)	−6% (−9%, −2%)

IQR indicates interquartile range.

FT treatment time between the slowest versus the fastest providers at each site. We also observed meaningful variation in FT treatment time among the nurses. The total variation in FT treatment time explained by the providers was greater than the variation explained by patient, temporal, and ED demand factors. In industries outside of health care, managing variation has long been recognized as a major way to improve process performance.[13] In health care, understanding and measuring process variation is relatively new. The results of our study suggest that efforts at reducing variation in FT treatment time at the provider level could lead to improvement in the quality of care provided and system efficiency.

In this study, the largest drivers of variation in FT treatment time were the providers and clinical factors. In a previous study, we used a closely related queuing model to demonstrate that crowding was associated with large increases in waiting room time and boarding time, but relatively small increases in treatment time.[14] This study also found that crowding, as measured by ED demand characteristics, had a relatively small effect on FT treatment time. Our previous study also showed that the more patients being treated substantially increased the waiting room time for patients who arrived subsequently. Thus, treatment time is an important outcome in the FT setting. The longer FT providers take to treat patients, the longer subsequent patients will wait to be seen. We know from previous research that the longer patients wait, the more likely they are to report dissatisfaction with care and to leave without being seen.[15–17]

Consistent with earlier research that has examined physicians' performance related to hospital length of stay, primary care quality indicators, and different disease-specific process measures; we found meaningful performance differences among the FT providers after adjusting for other factors.[18–21] Given that FT providers share the same environment and patient population, our results imply that some providers may be more time efficient than others. The root causes of the provider variation require further study. We attempted to determine whether provider sex and experience explained some of the variation we observed in treatment time. Our analysis suggests that sex and experience may play a role. However, given the limited number of primary providers, this analysis can only be viewed as exploratory, more research is needed. In addition to sex and experience, it will also be important to evaluate the extent to which provider differences in treatment intensity contributes to the variation we observed.[22,23]

To our knowledge, this is the first study to estimate the variability in a process attributable to the nurse, after adjusting for other factors including the primary provider.[18] FT physicians/extenders may have more control over their care responsibilities and time spent with patients than nurses. Nurses are more involved with patient movement between different areas of the hospital (such as the waiting room, treatment area, and radiology suite), which may be harder to control. Our results suggest that if we want to reduce variation in FT treatment time, we should also determine the causes of variability among the nurses, as it can also be a significant source of variation.

The study results must be interpreted in the context of the following limitations. First, the generalizability of this study is limited because it is based on only 3 FTs. Second, due to sample size limitations, we were unable to examine the variation in treatment time among primary provider and nurse dyads. In addition, we were not able to reliably estimate treatment time for all providers who work in FT, only those who do so more frequently. Third, this study found significant variation among providers but did not determine why some providers treat patients more quickly than others. We examined the impact of provider sex and experience on treatment time but were limited by the relatively small number of providers in the study. Finally, this study focused on 1 quality indicator, treatment time. This methodology should be used to examine variation in other important aspects of provider performance such as treatment effectiveness, left without being seen rates, recidivism, and patient satisfaction.

In conclusion, by focusing on treatment time, a quality indicator that is largely under the control of providers in the FT setting, limiting the analysis to a relatively homogeneous group of nonurgent patients, and controlling for differences in patient, clinical, temporal, and ED demand characteristics, we demonstrated large variation in FT treatment time across providers. These results warrant further investigation to determine why some providers are faster or slower than others and what the implications of time efficiency are on other important domains of quality and system efficiency.

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