Key High-efficiency Practices of Emergency Department Providers: A Mixed-methods Study

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ABSTRACT

Objective: The objective of this study was to determine specific provider practices associated with high provider efficiency in community emergency departments (EDs).

Methods: A mixed-methods study design was utilized to identify key behaviors associated with efficiency. Stage 1 was a convenience sample of 16 participants (ED medical directors, nurses, advanced practice providers, and physicians) identified provider efficiency behaviors during semistructured interviews. Ninety-nine behaviors were identified and distilled by a group of three ED clinicians into 18 themes. Stage 2 was an observational study of 35 providers was performed in four (30,000- to 55,000-visit) community EDs during two 4-hour periods and recorded in minute-by-minute observation logs. In Stage 3, each behavior or practice from Stage 1 was assigned a score within each observation period. Behaviors were tested for association with provider efficiency (relative value units/hour) using linear univariate generalized estimating equations with an identity link, clustered on ED site.

Results: Five ED provider practices were found to be positively associated with efficiency: average patient load, using name of team member, conversations with health care team, visits to patient rooms, and running the board. Two behaviors, "inefficiency practices," demonstrated significant negative correlations: non–work-related tasks and documentation on patients no longer in the ED.

Conclusions: Average patient load, running the board, conversations with team member, and using names of team members are associated with enhanced provider productivity. Identification of behaviors associated with efficiency can be utilized by medical directors, clinicians, and trainees to improve personal efficiency or counsel team members.

Continually increasing emergency department (ED) patient volumes and a decline in the number of EDs nationwide have required ED providers to strive to become more efficient.[1–4] Increased reporting of efficiency metrics further prompt ED providers to increase efficiency. Variation in ED efficiency has been observed both among different EDs and among ED providers. High interfacility variability in efficiency can

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be explained in part by previously reported extrinsic, department-level factors (e.g., triage type, staffing models, and technology use),[5–8] but individual provider efficiency also contributes to intrafacility variation. Much of this observed variation in ED provider efficiency remains unexplained.

Given the rising demand for efficiency, medical directors, clinicians, and trainees could benefit from a better understanding of factors that contribute to personal efficiency and from interventions proven to increase individual provider performance.[2,9–12] Performance and efficiency in EDs can decrease length of stay, waiting times, and number of patients leaving before receiving care.[13] Some emergency medicine (EM) providers are compensated based on productivity, so data-driven identification of efficiency behaviors could be a tool for individual providers to increase personal compensation. Several authors have suggested that identifying highly efficient ED practices could provide opportunities for audit and feedback to increase future efficiency.[14–16] Thus, focusing on identifying key efficiency practices among ED providers could improve departmental efficiency without requiring large, systemic changes in ED management and structure.

The objective of this study was to determine provider practices associated with high ED provider efficiency in community (nonacademic) EDs by 1) creating an inventory of practices likely to be exhibited by high-efficiency ED providers, 2) gathering observational data in multiple EDs by recording actual provider behaviors, and 3) identifying provider practices associated with efficiency.

METHODS

Study Design

A theoretical model of provider- and system-level sources (Figure 1) of efficiency was designed and tested. This study focused on the provider-level factors, specifically ED provider behaviors. This is a mixed-methods study (Figure 2) composed of semistructured interviews eliciting themes used to guide a multicenter observational study of ED providers. For this study, efficiency was defined as physician work relative value units (RVUs) per hour,[17] and a sensitivity analysis was conducted using patients per hour. RVUs are a measure of productivity that incorporates both the number of patients seen and the complexity of care the patient required.[18] RVUs per hour is a standard measurement across EDs in the United States and used ubiquitously by medical directors and hospitals.[19] The study was approved by the institutional review board with a waiver of documentation of informed consent.

Study Setting and Population

Observational data were collected from four Midwestern community EDs (annual volume 30,000–55,000 visits) between June and August 2016, and observations were correlated with efficiency data provided by the medical directors of each ED. Community ED participants for both the qualitative interview and the quantitative observational stages of the study were recruited from relatively large (>13 ED providers) regional hospitals (within 100 miles of the academic medical center). To be included in this study, providers needed to spend the majority of their clinical time working in an ED setting. Of 35 total study participants, 23 were EM board-certified physicians, seven were physicians with family medicine board certification, and five were trained as nurse practitioners or physician assistants. No resident physicians were included in this study. Study participation was voluntary. Clinical compensation schemes for the EM providers varied by site. Two of four sites were compensated with a salary/hourly pay and RVU bonus scheme; the remaining two did not receive any productivity bonuses.

Qualitative Interviews. A purposive sample of academic EM physicians, physician assistants, and ED nurses were selected from a 60,000-visit Midwestern academic ED, and a cohort of community ED medical directors was recruited from large surrounding community hospitals.

Quantitative Stage. For the observational stage of the study, ED providers (physicians, physician assistants, nurse practitioners) at the four participating sites were eligible if they worked at least 40 clinical hours in the ED between 11:00 AM and 12:30 AM during a 2-week study period. Observational data were collected by a single observer. Participants provided verbal informed consent prior to observations occurring. At the four ED sites, consent rates were 85% (35/41 providers consented).

Study Protocol

Qualitative Interviews. Semistructured, qualitative interviews were conducted to generate a comprehensive list of EM provider behaviors and practices

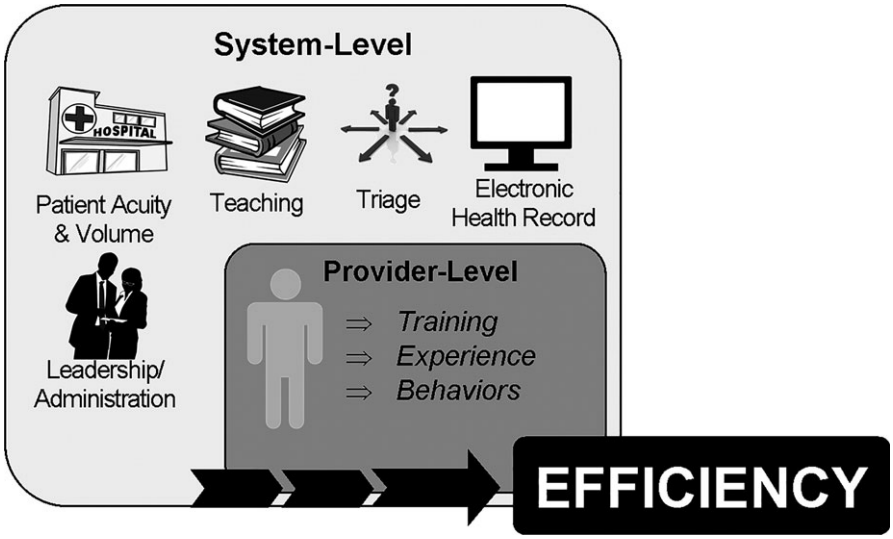

Figure 1. Thematic model of factors influencing ED efficiency.

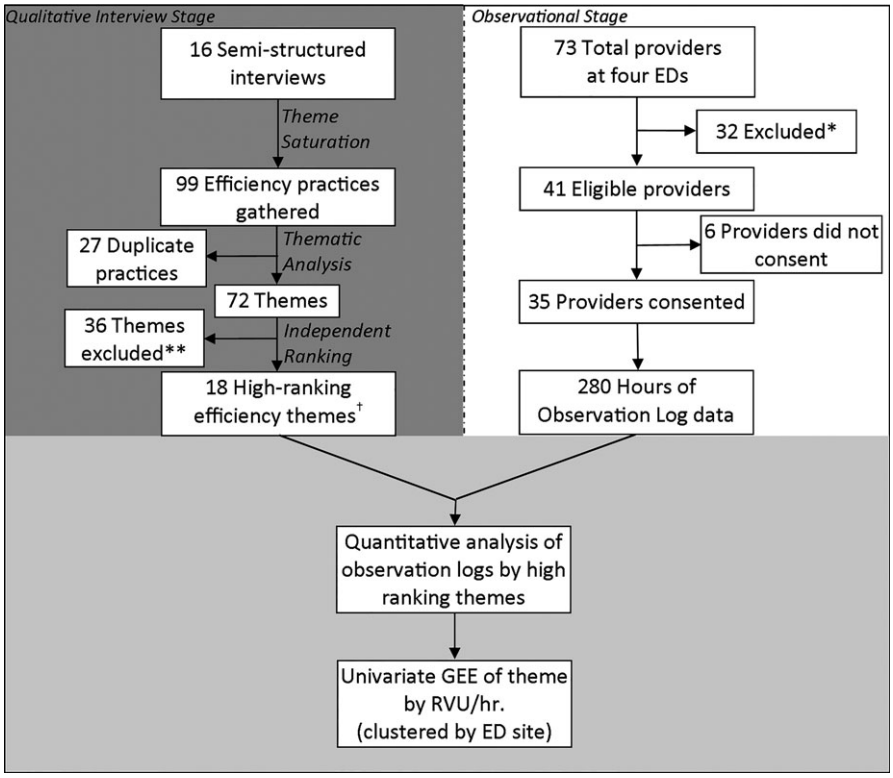

Figure 2. Flow chart of study enrollment and methods. *Thirty-two providers excluded for less than 40 hours of ED shifts or exclusive nighttime (after 9:00 PM) shifts during observation period. **Twenty-five themes excluded due to uniqueness to a teaching hospital (3), necessity to review patient charts to observe (11), institution-dependent theme (8), and practice of nonclinician (3). †High ranking was defined as any theme above the median impact score. GEE = generalized estimating equations.

thought to be associated with efficiency. Participants were asked one open-ended question, "What practices and behaviors of providers do you think are associated with efficiency in the emergency department?" to develop a list of potential efficiency practices. Interviews were conducted face to face or by telephone. All interviews were conducted by a single research assistant. Responses were recorded as a list of potential efficiency behaviors/practices. Participants were encouraged to generate an exhaustive list, but there was no further probing of interview responses.

Theme Saturation. Analysis was conducted in parallel with data collection to assess for theme

saturation. Interviews were conducted in blocks of two within each subgroup (two medical directors, two physicians, etc.) and were analyzed in parallel with data collection until theme saturation was achieved. Four individuals from each subgroup were interviewed, for a total of 16 interviews. An inductive approach was used, as the interview responses formed the basis of the study hypotheses of the quantitative portion of the project.

Quantitative Stage. Observations of 35 ED providers were conducted at four community EDs in rural, suburban, and urban settings. Participating providers were observed over 8 hours (two independent 4-hour sessions) selected from the busiest times in each respective ED. Observations were conducted from 11:00 AM to 12:30 AM to capture high-volume times in the ED. Minute-by-minute written observation logs of the provider's activities and conversations were recorded, with specific attention given to observable behaviors identified in the qualitative phase of the study. Observations were performed by a single research assistant blinded to outcome (provider efficiency). Provider activities occurring in the same minute were given equal parts of the minute (e.g., if four events occurred in a minute, each would be given 15 seconds).[20] Participants were advised to continue normal clinical activities, and time the participant spent interacting with the observer was excluded from the total observation time for analysis.

Observation logs were transcribed into an electronic format for analysis. For each efficiency theme identified in the qualitative interviews, the time a provider spent performing the practice and the frequency of the practice were calculated. As each provider was observed during two different shifts, the time spent and frequencies of behaviors are reported as a mean of the values for each shift.

Measures

Efficiency was defined as RVU/hour and was obtained from billing data, averaged over 6 to 12 months, based on administrative data availability at each site. Average patient per hour data were also collected for each provider to perform a sensitivity analysis.

Data Analysis

Qualitative Interviews. Interview data were rated and analyzed by three independent, experienced ED clinicians: an ED nurse manager, an academic EM physician, and a community EM physician.

Thematic Analysis. The comprehensive list of behaviors was reviewed using thematic content analysis by the three independent reviewers to identify themes and an iterative process until a common list of themes was constructed. Each item on the comprehensive list was assigned a defined theme independently until a comprehensive list of themes was defined by consensus. Items determined to have duplicate content were mapped to a single theme.

Independent Ranking of Themes. The three independent reviewers rated themes on 1) perceived correlation with provider efficiency, 2) ability to teach or modify in a provider (i.e., can the behavior be changed), and 3) capacity to measure through observation. Raters were asked to rate each theme on a scale of 1 to 5, with 1 being associated with minimal impact and 5 with maximal impact, assigned for each theme identified by thematic analysis. Composite ratings on each category were generated as the mean of the three independent rankings, and impact scores were generated by calculating the sum of the behaviors. To generate a final rank-ordered list, themes were ranked by their impact score. Practices with impact scores in the top 50th percentile of scores were used for the quantitative analysis.

Quantitative Stage. Each provider was assigned a score (time spent performing or frequency of behavior) for each candidate efficiency behavior, calculated as the mean of the two observation periods. Descriptive statistics of each practice is reported (mean and SD). A univariate generalized estimating equations (GEE) model (identity link, exchangeable correlation matrix, clustered on hospital) was used to determine the association between each provider practice and efficiency. Provider efficiency was defined as RVU/hour, and this continuous outcome was assessed for a linear relationship for each provider practice. Linearity was assessed by visualization of the residuals of the initial regression model. Slope of the association, β, with a 95% confidence interval (CI) were reported ($\alpha < 0.05$ using two-tailed tests was used to define statistical significance). For each reported β, the magnitude of the β signifies the increase in the behavior as a percent time or frequency of the behavior for an increase of one RVU/hour. Behaviors that could potentially interact with

Table 1
Description of Measured Provider Practices

Provider Practice	Unit(s)*	Description
Time at computer workstation	%	Proportion of total clinical time provider is physically located at computer
Time in patient room	%	Time provider is physically located in patient room currently under provider's care
Average patient load	Pt	(# of patients being seen simultaneously) × (time)/ total observation time
Task-switching	#/h	Frequency per hour of provider being interrupted during a task and then returning to the task
Nonwork tasks	%, #/h	Frequency per hour and time spent of provider engaging in activities not related to clinical activities
Eating and restroom	%, #/h	Frequency per hour and time spent eating or in restroom
Using team member's name	#/h	Provider uses name or nickname of team member when addressing this person
Task delegation	#/h	Provider delegates task normally done by provider to another person
Taking patient history with nurse	#/h	Provider takes patient history with nurse in room or listens to nurse taking history (or part of history)
Conversations with nurse	%, #/h	Frequency per hour and time spent talking with nurse about work-related topics
Conversations with any care team member	%, #/h	Frequency per hour and time spent talking with any other care team member about work-related topics
Visits to patient rooms	#/h	Frequency a provider enters a patient's room per hour/average total patient load
Reviewing electronic medical record (EMR)	%, #/h	Frequency per hour and time spent viewing EMR of current patient without actively editing or adding to patient's record
Running the board	%, #/h	Actively reviewing the status of patients' care for each of the patients for which the provider is caring
Checking the board	%, #/h	Looking at the patients in the department without actively reviewing the patients in the provider's care
Documentation Time	%	Actively editing or adding to patient record in EMR for patients currently under provider's care
Previous Patient Documentation Time	%	Actively editing or adding to patient record in EMR for patients NOT currently under provider's care
Patients seen between clinician's use of computer	Patients	Number of patients seen each time provider leaves computer workstation

EMR = electronic medical record.
*Percent (%) calculated as a percent of total observation time; frequency per hour (#/hr) is calculated a rate of number of occurrences during the total observation time (in hours)

one another were reassessed in a multivariable model to assess for interaction by modeling behaviors as independent covariables in a model predicting RVU/hour. A multivariable GEE analysis with an identity link, clustered on ED site was used to test for interaction.

Sensitivity analysis was performed using the outcome of patients/hour. A univariate GEE model clustered on hospital was again constructed, and the slope of the linear relationship, β, with 95% CI were reported for each practice. All analyses were performed with SAS (Version 9.4, SAS Institute, Inc.).

RESULTS

Thematic content analysis of efficiency practices gathered from 16 semistructured interviews established 72 themes out of the 99 responses. Thirty-six themes were excluded (Figure 2), and the remaining 36 themes were ranked on a Likert scale on the three domains of 1) perceived correlation with provider efficiency, 2) ability to teach or modify in a provider (i.e., can the behavior be changed), and 3) capacity to measure through observation. Based on impact score, the sum of three average rankings, 18 practices had an impact score equal to or greater than the median impact score (median = 12.67, range = 8.33 to 15.00). The 18 highest ranking provider practices, described in Table 1, formed the basis for the quantitative analysis of the observational data.

Thirty-five providers at four community sites were observed for a total of 280 observation-hours, and mean RVUs per hour earned by participants were 6.45 RVUs/hour (SD = 1.16). Provider performance of the 18 efficiency practices are summarized, with a mean (SD), in Table 2. Of the 18 postulated efficiency practices, five practices were found to be significantly associated with efficiency (Table 3); three practices, "inefficiency practices," were found to have a significant negative association with efficiency. The practices positively associated with efficiency were as follows: average patient load (patients, β = 0.66, 95%

Table 2
Observed Summary Statistics of Provider Practices

Provider Practice	Mean (±SD)	Median (IQR)
Time at computer workstation	35.07% (±29.61%)	47.42% (0.69%–62.19%)
Time in patient room	29.93% (±9.46%)	27.46% (23.00%–34.41%)
Average patient load	4.88 patients (±1.22)	4.57 patients (3.89–5.86)
Task switching	2.93 #/h (±0.72)	2.89 #/h (2.39–3.39)
Nonwork tasks	14.64% (±7.31)	16.32% (8.28–19.29)
	18.31 #/h (±17.31)	11.91 #/h (4.32–32.60)
Eating and restroom	0.57% (±0.37)	0.51% (0.38–0.69)
	3.58 #/h (±2.64)	2.90 #/h (1.28–5.66)
Using team member's name	0.70 #/h (±0.61)	0.63 #/h (0.20–0.88)
Task delegation	0.31 #/h (±0.27)	0.25 #/h (0.12–0.53)
Taking patient history with nurse	0.48 #/h (±0.36)	0.46 #/h (0.20–0.60)
Conversations with nurse	7.43% (±2.26)	7.27% (5.79–8.13)
	4.99 #/h (±1.46)	4.92 #/h (3.95–5.53)
Conversations with any care team member	18.04% (±4.62)	17.64% (15.54–21.71)
	10.19 #/h (±2.38)	10.51 #/h (8.86–11.66)
Visits to patient rooms	4.00 #/h (±1.05)	3.75 #/h (3.29–4.40)
Reviewing electronic medical record	12.15% (±4.33)	12.77% (9.41–15.13)
	9.09 #/h (±3.29)	8.90 #/h (6.59–11.27)
Running the board	0.39% (±0.56)	0.18% (0.00–0.55)
	0.35 #/h (±0.52)	0.13 #/h (0.00–0.58)
Checking the board	3.21% (±1.84)	2.92% (1.42–4.65)
	2.78 #/h (±1.38)	2.44 #/h (1.68–3.96)
Documentation time	20.70% (±5.94)	19.55% (16.56–24.34)
Previous patient documentation time	4.17% (±7.24)	1.01% (0.29–2.07)
Patients seen between clinician's use of computer	1.16 patients (±0.13)	1.13 patients (1.06–1.22)

N = 35 providers observed.
IQR = interquartile range.

CI = 0.36 to 0.96); using name of team member #/hour, β = 0.69, 95% CI = 0.51 to 0.88); conversations with health care team (#/hour, β = 0.12, 95% CI = 0.07 to 0.16); visits to patient rooms (visits/hour, β = 0.57, 95% CI = 0.22 to 0.93); and time spent running the board (% time, β = 0.46, 95% CI = 0.17 to 0.76). For this study, "running the board" was defined as systematically reviewing the status of all patients for which the provider was caring. In addition, two practices found to have negative associations are frequency of non–work-related tasks (tasks/hour, β = –0.01, 95% CI = –0.01 to –0.01) and documentation on previous patients (% time, β = –0.02, 95% CI = –0.03 to –0.01). No interactions were detected between the two pairs of variables theoretically likely to interact: average patient load with visits to patient rooms and running the board with checking the board.

A sensitivity analysis was performed using an alternative definition of efficiency (defined as patients/hour). Two of the eight identified provider practices were not found to have significant associations in the sensitivity analysis: nonwork tasks (tasks/hour) and previous patient documentation time (% time).

DISCUSSION

There is observed variability in efficiency between providers to support the assertion that ED efficiency can be influenced by provider behavior (and not solely influenced by care delivery systems), as hypothesized in the theoretical model (Figure 1). This multicenter observational study identified common provider-level efficiency practices that are associated with high-performing providers. Previous research explains that ED efficiency can vary with patient volume,[21,22] number of learners,[6] and department-level processes.[7,20] Clustering by ED site in this study allows for elimination of these department-level factors (i.e., health care teams, shift mixes, leadership, nature and rate of care, provider compensation designs) to identify physician behaviors associated with efficiency.

Table 3
Association of Provider Practices With Efficiency Using Univariate GEE

		Primary Outcome (RVU/h)			Secondary Outcome (Pts/h)		
Provider Practice	Unit(s)	β	95% CI	p-value	β	95% CI	p-value
Time at computer workstation	%	0.01	–0.02 to 0.05	0.463	0.00	0.00 to 0.01	0.225
Time in patient room	%	0.00	–0.01 to 0.01	0.563	0.00	0.00 to 0.00	0.895
Average patient load	Pts	0.66*	0.36 to 0.96	<0.001	0.14*	0.08 to 0.19	<0.001
Task-switching	#/h	–0.01	–0.02 to –0.01	0.253	0.00	–0.06 to 0.05	0.957
Nonwork tasks	%	0.00	–0.03 to 0.03	0.891	–0.03*	–0.03 to 0.00	0.029
	#/h	–0.01*	–0.01 to –0.01	0.001	0.00	0.00 to 0.00	0.260
Eating and restroom	%	0.03	–0.04 to 0.10	0.377	0.00	–0.01 to 0.01	0.655
	#/h	0.37	–0.02 to 0.75	0.061	0.11*	0.06 to 0.16	<0.001
Using team member's name	#/h	0.69*	0.51 to 0.88	0.013	0.12*	0.11 to 0.14	<0.001
Task delegation	#/h	–0.20	–1.34 to 0.93	0.729	–0.09	–0.23 to 0.05	0.207
Taking patient history with nurse	#/h	0.23	–0.23 to 0.69	0.263	0.09*	0.04 to 0.14	0.001
Conversations with nurse	%	–0.03	–0.14 to 0.09	0.691	–0.01	–0.04 to 0.02	0.465
	#/h	–0.04	–0.23 to 0.14	0.707	–0.01	–0.05 to 0.02	0.468
Conversations with any care team member	%	0.03	–0.02 to 0.08	0.279	0.00	–0.01 to 0.01	0.900
	#/h	0.12*	0.07 to 0.16	< 0.001	0.02*	0.01 to 0.03	0.001
Visits to patient rooms	#/h	0.57*	0.22 to 0.93	0.002	0.12*	0.05 to 0.19	0.001
Reviewing electronic medical record	%	–0.03	–0.06 to 0.01	0.230	0.00*	–0.01to 0.00	0.018
	#/h	0.01	–0.02 to 0.04	0.508	0.00	–0.01 to 0.01	0.926
Running the board	%	0.46*	0.17 to 0.76	0.023	0.10*	0.00 to 0.19	0.044
	#/h	0.40*	0.05 to 0.74	0.002	0.09	–0.02 to 0.20	0.127
Checking the board	%	–0.03	–0.17 to 0.10	0.936	–0.02	–0.05 to 0.02	0.431
	#/h	–0.01	–0.15 to 0.13	0.644	–0.01	–0.06 to 0.06	0.576
Documentation time	%	–0.02	–0.04 to 0.01	0.152	0.00	–0.01 to 0.01	0.733
Previous patient documentation time	%	–0.02*	–0.03 to –0.01	< 0.001	0.00	0.00 to 0.00	0.100
Patients seen between clinician's use of computer	Pts	–0.49	–3.75 to 2.78	0.758	0.19	–0.05 to 0.43	0.124

N = 35 providers in four clusters by ED site .
GEE = generalized estimating equations.
*Statistically significant at α = 0.05, two-tailed test.

Most of the behaviors we outline as predictors of effectiveness fall in three dimensions described in management literature: common understanding, accountability, and predictability.[23,24] From a social context, an ED provider knowing and recognizing team members by name is much more efficient than trying to deduce who is caring for the patient and shows a mutual respect (which in turn engenders a stronger work ethic and builds trust). This finding is in line with the study by Strömgren et al.[23] associating higher health care worker social capital with increased trust, work engagement, and clinical improvement. Further, leadership and team frameworks have previously been shown to affect efficiency in trauma resuscitation,[25] so it is logical that these principles would also apply to overall ED provider efficiency.

The sensitivity analysis performed using patients per hour as the efficiency outcome showed variation from the primary analysis for two inefficiency behaviors: nonwork tasks (tasks/hour) and previous patient documentation time. Discrepancies in the sensitivity analysis are likely related to the differences in provider practices for care of patients requiring higher complexity care (increasing RVUs/hour) without affecting the number of patients a provider is seeing each hour. The majority of efficiency practices did not change in the sensitivity analysis, indicating an association with efficiency of caring for ED patients regardless of complexity of care.

LIMITATIONS

First, the observational design of the study allows only the identification of an association between behaviors and efficiency. Behaviors identified could be downstream of our outcome, provider efficiency, but this design can only assess for association. There could be an element of reverse causality where a measured behavior is associated with efficiency because an

external factor (such as another team member) is increasing the provider's efficiency, not due to the measured behavior directly contributing to the provider's efficiency. In this study, each provider was observed during two separate shifts in an attempt to capture provider practices that remained consistent while working with different team members. In addition, there also could be variation between provider shifts. Each provider was observed twice during two separate shift times on different days to capture some of the potential shift variation, and hours of observation were limited to higher patient volume times.[26]

Second, a research assistant was present during clinical shifts to observe each participating provider and could have introduced a Hawthorne effect where providers performed differently because they knew they were being watched. To thwart this effect, each provider was observed two separate periods of 4 hours each. Further, this effect is likely to be universal across all providers, which would not change or dilute the associations observed.

Third, the study was conducted in community EDs in one state. There could be geographical differences that limit the external generalizability of the results. However, care was taken to ensure the study was performed in rural, suburban, and urban settings EDs with differences in patient populations to increase the applicability of the results. Fourth, not all behaviors contributing to efficiency can be identified with this study design. Efficiency behaviors adopted by all providers would not be identified as efficiency behaviors in this study. Detecting significance in behaviors requires variance in the observation data set, so the interquartile range is reported in Table 2. Additionally, efficiency behaviors that are not measurable, such as intangible character traits, are missed in our observational study design. Further, the use of efficiency in the scoring system for ranking qualitative behaviors could have biased the behaviors selected for quantitative analysis. Although our goal is to identify behaviors, this method cannot identify an exhaustive list of behaviors.

Fifth, RVUs are determined by medical coding and are sensitive to acuity and coding techniques. In our study, coding measures remained constant for providers over the study period, which reduces any chance of bias. Further, we conducted a sensitivity analysis with patients per hour to provide another measure of provider efficiency. Finally, high efficiency may not equate to high quality, and quality measurements were not conducted as part of this research project.

CONCLUSIONS

The results of this study could be valuable for emergency medicine providers, educators, and administrators. This study demonstrates proof of concept that provider behaviors can be associated with efficiency and identifies discrete behaviors associated with efficiency. The next steps would be to investigate the causal relationship between the identified behaviors and provider efficiency. The future identification of efficiency behaviors can aid ED providers in self-assessment and improvement of personal efficiency. For the individual emergency medicine physician, implementing key high efficiency can be a tool to boost personal efficiency (relative value units/hour) and increase income earnings. This information could also provide ED medical directors with evidence to counsel lower efficiency members of their health care team and provide medical educators the needed tools to formulate an evidence-based curriculum to teach efficiency practices to emergency medicine trainees. By focusing on measurable provider practices, these results can have high utility without the large, costly changes required by systemic efficiency solutions.

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