Fast does not imply flawed: Analyzing emergency physician productivity and medical errors

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Abstract
Objective: To determine whether emergency physician productivity is associated with the risk of medical errors.
Methods: We retrospectively analyzed quality assurance (QA) and billing data over 3 years at 2 urban emergency departments. Faculty physicians working 400 hours or more at either site were included. We measured physician years of experience, age, gender, patients seen per hour (PPH), and relative value units billed per hour (RVU/h). From an established QA process, we obtained adjudicated medical errors to calculate rates of medical errors per 1000 patients seen as the outcome. We discretized numeric variables and used Kruskal–Wallis testing to examine relationships between independent variables and rates of medical errors.

Results: We included data for 39 physicians at site A and 42 at site B. The median rate of errors per 1000 patients was 1.6 (interquartile range [IQR], 1.1–1.9) at site A and 3.3 (IQR, 2.4–3.9) at site B. At site A, RVU/h was associated with error rates ($P = 0.03$), with medians of 2.0, 1.2, 1.7, and 1.3 errors per 1000 patients, from slowest to fastest quartiles. At site B, PPH was associated with error rates ($P < 0.01$), with medians of 3.9, 3.7, 2.4, and 2.7 errors per 1000 patients, from slowest to fastest quartiles. There was no significant relationship between error rates and RVU/h at site A.

Conclusions: Rates of medical errors were associated with 1 metric of physician productivity at each site, with higher error rates seen among physicians with slower productivity.

Keywords
Efficiency, Emergency Medicine, Medical Errors, Patient Safety, Workload

1 | INTRODUCTION

1.1 | Background

The Institute of Medicine defined 6 aspects of healthcare quality that our system should aim to achieve: safe, effective, patient-centered, timely, efficient, and equitable. Given that resources are not unlimited, however, some of these goals may conflict with others. In a busy emergency department (ED), physician time and bed space are often limited resources, so in this setting, the goal of safe care must be balanced with competing goals of timely and efficient care.

The ED represents a unique work environment, with numerous factors that adversely impact the delivery of patient care including numerous interruptions, frequent task switching, and irregular work hours. Further jeopardizing care is ED crowding, which is widespread...
and caused by myriad factors, including prolonged inpatient boarding. These considerations, together with high-risk illnesses, underscore the challenges to safety in emergency medicine.

The effects of maximizing clinical productivity have been studied previously, using outcomes other than patient safety. High productivity was not found to adversely impact education, physician time spent at the bedside, or the overall patient experience. We are unaware of previous work examining whether high physician productivity compromises safety in the ED. One study evaluated the impact of ED crowding on preventable medical errors. The results showed that the risk of errors more than doubled with crowding, and this effect was seen disproportionately in the most-crowded circumstances.

1.2 | Importance

In the United States, annual ED visits rose from 94.7 million in 1995 to 143.5 million in 2018, yet during the same period, the number of EDs declined from 4923 to 4577. Physicians must therefore cope with increasing workload demands. Physician and departmental productivity also impact the revenue and financial viability of their organizations, creating pressure to maintain lean, efficient operations.

If a relationship exists between clinical productivity and medical errors, knowledge of the point at which safety becomes compromised may guide hospital leadership to manage staffing levels or deploy targeted interventions, to jointly optimize productivity and safety.

1.3 | Goals of this investigation

Our primary goal was to examine whether an association exists between clinical productivity and medical errors. We hypothesized that the risk of medical errors would increase as the rate of delivery of patient care increased. Our secondary goal was to examine whether an association exists between physician demographics and medical errors. We hypothesized that no association would be found between the risk of medical errors and physician demographics.

2 | METHODS

2.1 | Study design and setting

We conducted this study at two EDs in Houston, Texas. Site A was the adult ED of an urban, quaternary care, non-profit hospital with level 1 trauma accreditation, providing 55,000 visits per year. Site B was the ED of a county hospital with level 3 trauma accreditation that primarily serves vulnerable populations, with 80,000 visits per year. Both adult and pediatric ED visits were included at site B. These sites belong to separate hospital systems, yet emergency physician staffing for each is provided by the same academic faculty. With the exception of the medical directors, most faculty work at both sites. For each shift, faculty may be scheduled in any care area at either site. The long-term division of hours between sites remains generally consistent.

2.2 | Selection of participants

The analysis included faculty physicians who worked 400 hours or more at either site during the 3-year study period.

2.3 | Measurements

For included physicians, we recorded gender, age, years of experience since initial board certification in emergency medicine, hours on duty, patients seen, and relative value units billed. We calculated the rates of patients per hour (PPH) and relative value units per hour (RVU/h) as measures of clinical productivity.
2.4 | Outcomes

The outcome measure was the number of adjudicated medical errors for each physician, which was normalized as a rate per 1000 patients seen. Outcome data were obtained from the MIRS database, which includes error reports and adjudicated errors for both study sites. For some adjudicated errors, multiple physicians participated in the patient's care. In such cases, this was recorded as an error for all involved. No attempt was made to determine relative degrees of responsibility among the physicians.

2.5 | Analysis

Descriptive statistics were assessed using frequencies and percent-ages for categorical data and with medians and interquartile ranges (IQR) for numerical data. We discretized age, PPH, and RVU/h into quartiles, separately for each site. We discretized years of experience into <2 years, 2–10 years, and >10 years. We evaluated the relationship between each independent variable and the rate of medical errors with the Kruskal–Wallis test at an alpha level of 0.05. We evaluated for possibly confounding relationships among independent variables using Pearson correlation. All statistical analyses were performed using R (version 4.1.3, http://www.r-project.org).

3 | RESULTS

3.1 | Characteristics of study subjects

Productivity data were available for 49 physicians during the 3-year study period, of which 39 worked 400 hours or more at site A and 42 did so at site B. Among these, 34 physicians met the criteria and were included at both sites. At site A, the included physicians worked 44,867 hours, treated 120,548 patients, and billed for 353,729 RVUs during the study period. At site B, the included physicians worked 56,928 hours, treated 139,027 patients, and billed for 384,457 RVUs. Demographic and productivity data for included physicians are shown in Table 1.

Pairwise analysis of the 34 physicians who were included at both sites showed that, on average, at site A they saw 0.2 more patients per hour, generated 1.1 more RVUs per hour, and had 1.5 fewer errors per 1000 patients, in comparison with site B.

3.2 | Main results

At site A, there were 297 adjudicated errors identified, of which 213 (71.7%) involved 1 physician, 62 (20.9%) involved 2 physicians, and 22 (7.4%) involved 3 or more. The most frequent error types included 119 (40.1%) cases of suboptimal management, 71 (23.9%) missed diagnoses, 40 (13.5%) delayed diagnoses, and 22 (7.4%) procedural errors. Kruskal–Wallis testing showed significant differences in error rates among quartiles of RVU/h (P = 0.03). From slowest to fastest quartiles of RVU/h, the medians were 2.0, 1.2, 1.7, and 1.3 errors per 1000 patients. No significant differences in error rates among groups were found with age, gender, years of experience, or PPH. Figure 1 shows the relationship between error rates and productivity at site A.

At site B, there were 509 adjudicated errors identified, of which 283 (55.6%) involved 1 physician, 163 (32.0%) involved 2 physicians, and 63 (12.4%) involved 3 or more. The most frequent error types included 230 (45.2%) cases of suboptimal management, 97 (19.1%) missed diagnoses, 50 (9.8%) delayed diagnoses, and 33 (6.5%) inappropriate dispositions. Kruskal–Wallis testing showed significant differences in error rates among quartiles of PPH (P < 0.01). From the slowest to fastest quartiles of PPH, the medians were 3.9, 3.7, 2.4, and 2.7 errors per 1000 patients. A similar but non-significant trend existed in error rates among quartiles of RVU/h (P = 0.06); from the slowest to fastest quartiles of RVU/h, the medians were 3.9, 3.6, 2.6, and 2.7 errors per 1000 patients. No significant differences in error rates among groups were found with age, gender, or years of experience. Figure 2 shows the relationship between error rates and productivity at site B.

At both sites, no significant correlations existed for age or experience with PPH or RVU/h.

4 | LIMITATIONS

First, this research was conducted at 2 hospitals that shared 1 group of academic emergency physicians, so the results may not be general-ized to other settings. Due to recent faculty expansion, more of our physicians are younger and less experienced, compared with other physician groups. Also, physicians in our practice are not compensated.
FIGURE 1  Rates of medical errors among faculty physicians per 1,000 patients seen at site A, plotted by quartiles of productivity as measured by patients seen per hour (left) and RVUs billed per hour (right). Quartile 1 denotes the lowest and quartile 4 denotes the highest productivity, relative to peer faculty members. Abbreviation: Relative value units-relative value units.

FIGURE 2  Rates of medical errors among faculty physicians per 1,000 patients seen at site B, plotted by quartiles of productivity as measured by patients seen per hour (left) and RVUs billed per hour (right). Quartile 1 denotes the lowest and quartile 4 denotes the highest productivity, relative to peer faculty members. Abbreviation: Relative value units-relative value units.

Based on RVU productivity, so findings may differ at sites where incentives also differ. Second, in our environment, ED flow is often limited by factors other than physician throughput, like inpatient boarding, so the productivity data may not reflect the potential of each physician. However, we mitigated this with long-term estimates by including up to 3 years of data for physicians.

Third, we used our departmental QA process to define the outcome measure of medical errors. This definition was pragmatic, yet dependent on local standards of care. Sites with differing standards of care may reach different conclusions in the error adjudication process. It is also possible that our QA process missed identifying some medical errors during the study period. This limitation was mitigated by designing the process to be robust, aggregating case referrals from diverse sources to minimize the likelihood of missed events.

Fourth, the sample size of physicians was small, so individual outliers may disproportionately influence the results. The study may also be underpowered to detect the relationships of interest. This limited sample size made multivariable regression modeling less feasible, so our findings cannot adjust effects for other independent variables. Univariate analysis did not show correlations for age or experience with productivity, lessening our suspicion of confounding by those variables.
5 | DISCUSSION

The findings showed that differences existed among physicians grouped by productivity, for 1 measure of productivity at each site. The group medians did not support our hypothesis that physicians with higher productivity would have increased risk of medical errors. Conversely, the group medians suggested that physicians with lower productivity had the highest error rates. This finding was identified when analyzing PPH at site B and RVU/h at site A. A similar trend existed in the analysis of RVU/h at site B that did not reach statistical significance. We found no association between medical errors and PPH at site A, possibly due to the limited sample size in our study. To explain this inverse relationship between productivity and medical errors, we propose that some physicians develop adaptive traits for practicing emergency medicine, thus optimizing productivity without diminishing safety. Our findings do not eliminate the possibility that safety might become compromised at higher rates of clinical productivity than we observed here. However, this suggests opportunities to mitigate risk among physicians with slower productivity rates, to improve time efficiency and situational awareness.

The rate of medical errors for physicians at site B was approximately double, in comparison to site A. We suggest 3 possible explanations for this finding. First, more than half of patients at site B are seen by a physician assistant or nurse practitioner alone, with faculty available for discussion. These services are billed under the physician assistant or nurse practitioner. Faculty may be included in MIRS reports and errors for such visits, but they do not receive productivity credit for these visits, except when they personally see the patient and document it as a shared visit. Second, at site A, most patients are seen by a resident and directly supervised by a faculty physician, and much of the remaining volume is seen by a physician assistant or nurse practitioner in a shared visit with faculty. This increased level of supervision at site A, compared with site B, may contribute to the difference in error rates. Third, more errors at site B involved multiple physicians, when compared with site A. Prolonged boarding, with more patient hand-offs, may lead to increased error rates. Furthermore, boarding patients are often managed by emergency physicians across multiple shifts at site B, whereas inpatient teams take responsibility promptly for boarding patients at site A.

In conclusion, we found that the rate of medical errors differed among physician groups stratified by RVU/h at site A and by PPH at site B, with higher rates of errors among physicians with lower productivity. Further research is needed to determine the generalizability of this finding, and what interventions might jointly optimize clinical productivity and patient safety.

AUTHOR CONTRIBUTIONS

The study idea was originally conceived by Jonathan G. Rogg and was developed further with Nathan R. Hoot and Timothy J. Barbosa. All statistical analysis was performed by Nathan R. Hoot and Hei Kit Chan. All authors reviewed the manuscript for important intellectual content and approved the final version.

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How to cite this article: Hoot NR, Barbosa TJ, Chan HK, Rogg JG. Fast does not imply flawed: Analyzing emergency physician productivity and medical errors. JACEP Open. 2022;3:e12849. https://doi.org/10.1002/emp2.12849