

Shifting Toward Balance: Measuring the Distribution of Workload Among Emergency Physician Teams

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Study objective: The objective of this investigation is to determine time-dependent workload patterns for emergency department (ED) physician teams across work shifts. A secondary aim was to demonstrate how ED demand patterns and the timing of shift changes influence the balance of workload among a physician team.

Methods: Operational measurements of an adult ED were collected from a clinical information system to characterize physician workload patterns during all current work shifts. Plots of patient load versus time were developed for each physician shift, in which patient load was defined as the number of patients a physician simultaneously managed at a point in time. Patient-load curves for each shift were superimposed during 24 hours to display how patient load was distributed among a team of physicians.

Results: Resident shift changes during daily peak occupancy periods caused patient load imbalances so that residents on a particular shift consistently managed a disproportionate number of patients (mean 9.4 patients; 95% confidence interval [CI] 6.7 to 12.1 patients) compared with other residents on duty (mean 3.4 patients; 95% CI 2.1 to 4.7 patients).

Conclusion: Physician patient load patterns and ED demand patterns should be taken into consideration when physician shift times are scheduled so that patient load may be balanced among a team. Real-time monitoring of physician patient load may reduce stress and prevent physicians from exceeding their safe capacity for workload. [Ann Emerg Med. 2007;50:419-423.]

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INTRODUCTION

Background

High demand periods in the emergency department (ED), characterized by high occupancy levels, increased waiting room census, and access block to inpatient beds, are hypothesized to pose significant risks to patient safety and patient satisfaction.¹⁻⁸ High demand increases the amount of clinical workload that must be distributed among a team of attending and resident physicians on staff. While performing an observational study to characterize and quantify the workload and communication patterns of individual emergency physicians working during periods of high demand, the authors noticed an apparent imbalance in the distribution of workload among physicians working concurrently.^{9,10} It appeared that although some

physicians were extremely busy to the point of nearly exceeding their functional limits, other physicians were experiencing low workload.

Importance

The microenvironment of each physician must be conducive to providing safe, timely care regardless of the operational state of the entire ED. Excessive cognitive workload and increased stress have been shown to adversely affect worker performance across many industries.^{11,12} O'Donnell and Eggemier¹² refer to mental workload as the portion of an operator's limited capacity required to perform particular tasks. The assumption behind this theory is that humans have a fixed amount of processing capacity, and if at any time the processing demands exceed the available processing capacity, performance quality decreases. High levels of workload can lead to error and adverse patient events. In hospital care, increasing nursing

Editor's Capsule Summary

What is already known on this topic

Many studies have documented variations in total emergency department (ED) workload during a 24-hour cycle, but few have focused on the distribution of this load among individual physicians.

What question this study addressed

How physician workload varies over time and how variation in new patient arrivals and emergency physicians' shifts relates to variations in physician workload.

What this study adds to our knowledge

Shift changes occurring at peak presentation times are associated with much higher peak workloads for the oncoming physicians than other shifts.

How this might change clinical practice

This information might allow development of more equitable patterns of scheduling and organization of work among emergency physicians.

Research we'd like to see

Workload was defined as the total number of patients a physician was managing, but even within a single patient, workload varies dynamically over time. More detailed estimates of actual workload would be useful in refining these results.

patient load above 4 patients has been associated with a 7% increase in 30-day mortality rate and a 7% increase in the odds of failure-to-rescue per additional patient.¹³ Increased patient load has also been distinguished as a major contributor to physician stress in the ED.^{14,15}

High demand intervals in the ED increase the likelihood that physicians will experience workload levels that exceed their capacity to provide safe care. Balancing workload across all physicians on staff as determined by training level and clinical experience will reduce the chances of an individual physician managing unsafe amounts of workload.

Goals of This Investigation

The objective of this investigation was to determine time-dependent workload patterns for dynamic emergency physician teams. For this study, a physician team is defined as a group of physicians working together during a specific work shift or defined period. A secondary aim was to demonstrate how demand patterns and shift change times influence the balance of workload among a physician team.

MATERIALS AND METHODS

Study Design

The study design was a retrospective observational study of emergency physicians. Patient load and ED operational

information were collected from a clinical information system during the 8-month study period, lasting from September 8, 2003, to May 14, 2004.

Setting and Selection of Participants

The study was performed at the adult ED of an urban, academic, tertiary care, Level I trauma center in the southeastern United States. The 27-bed ED was designed to handle an annual volume of 20,000 visits but received more than 43,000 visits per year during the study. All emergency physicians present during the course of the study were included.

The study focuses on daily peak operational periods (Monday to Friday) between 3 and 7 PM, during which 2 to 3 attending and 3 to 5 resident physicians are on shift. Physician shift times are staggered throughout the day, with only 1 physician working each shift, which caused individual physicians within a group on duty to be at different stages (beginning, middle, or end) of their respective shift during peak operational periods. Specific physician shifts that start immediately before daily peak operational periods will be referred to as "burdened" shifts. Burdened shifts are characterized by physicians managing high patient loads as a result of daily peaks in occupancy.

Methods of Measurement and Data Collection

ED operational metrics were collected from the ED information system database. Time-stamped information pinpointing the step (ie, waiting room, treatment area, boarded) in ED care each patient was experiencing was extracted from the database. Corresponding patient records documenting the managing attending and resident physicians allowed us to determine the patient load for each physician on duty. Patient load was defined as the number of patients a physician simultaneously managed at a point in time. Minute-by-minute patient-load information was extracted for each physician on duty during the study period. Patient-load curves for each attending and resident physician were generated and then stratified by shift. Weekday (Monday to Friday) shifts and weekend (Saturday to Sunday) shifts were aggregated separately. Patient-load curves averaged during the 8-month study period (ie, ensemble average) for each shift were superimposed during 24 hours to display how patient load was distributed among a team of physicians as a function of time of day.

We used staffing schedules to determine the physicians on duty at specific points. We assumed that attending and resident physicians start their shift on time; we assumed that attending physicians end their shift 1 to 2 hours and residents 1 hour after their formal shift end time. Knowledge gained through physician interviews led to the creation of these assumptions, which are intended to reflect the actual behavior of the emergency physicians studied.

Primary Data Analysis

Descriptive statistics, including mean and 95% confidence interval (CI), were used to characterize the operational state of the ED and physician patient load.

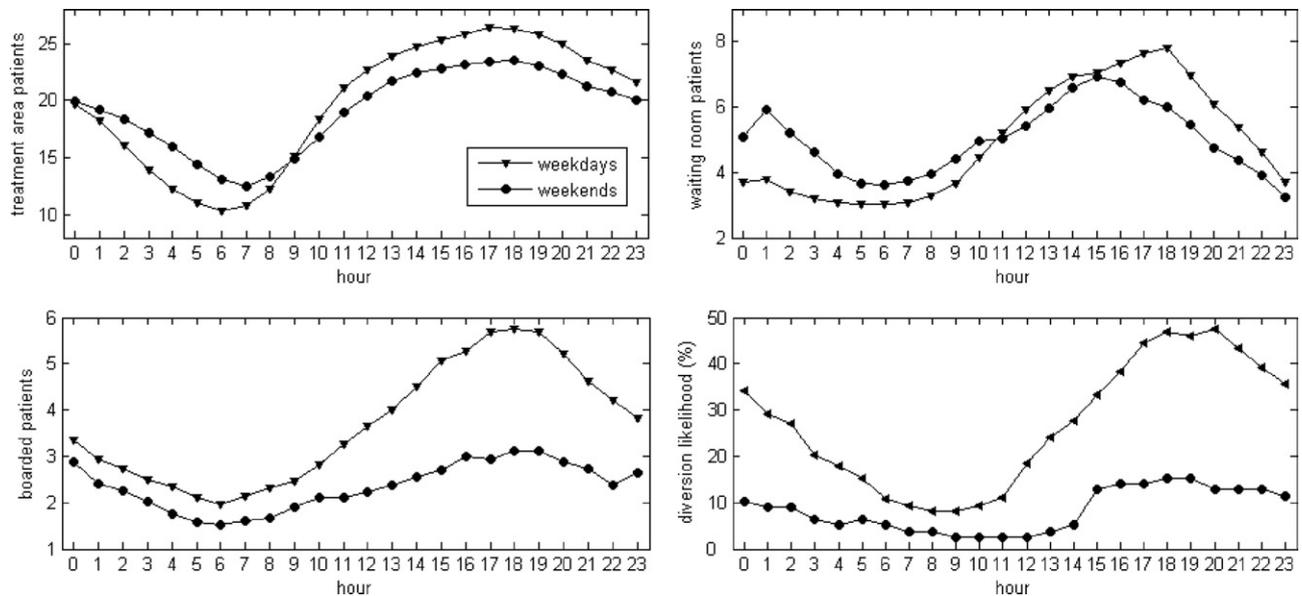


Figure 1. Operational characteristic by hour of day for the 27-bed ED of study.

RESULTS

Operational characteristics of the ED with respect to time are displayed in Figure 1. The ED of study reached peak operations during weekdays (Monday to Friday) between 3 and 7 PM, which is when all observations took place. The average treatment area census was 25.9 patients (95% CI 25.1 to 26.2), the average boarding burden was 5.5 patients (95% CI 5.3 to 5.7), the average waiting room census was 7.4 patients (95% CI 7.1 to 7.6) and the likelihood of the ED being on diversion was 41.7%. ED diversion occurred when occupancy levels exceeded 100% and there were more than 10 patients present in the waiting room.

Average patient loads over time for attending and resident physicians stratified by weekday shift are displayed in Figure 2A and B. Each curve is representative of the time-dependent patient load experienced by the physician on a routine shift during a typical weekday. Patient-load curves for attending and resident physician shifts demonstrate the common pattern of accumulating patients at the beginning of a shift and then decreasing patient load as shift draws to an end. The “burdened” resident or attending shifts highlighted are distinguished by their start times, which occur immediately before daily peak operational (weekdays 3 to 7 PM) periods. The burdened resident shift begins at 3 PM and the burdened attending physician shifts begin at 2 PM and 3 PM. Burdened shifts are characterized by high patient loads and are most affected by the peaking censuses displayed in Figure 1. Residents working the burdened shift accumulate 1 new patient every 15 minutes and reach their maximum patient load 2.5 hours after their shift begins. Attending physicians working burdened shifts accumulate 1 new patient every 22 and 30 minutes, reaching their maximum patient load within 5 hours and 5.8 hours, respectively. Figure 2C represents the distribution of patients

among the team of resident physicians at 6 PM on weekdays. Resident shift changes during daily peak occupancy periods caused patient-load imbalances at 6 PM on weekdays so that residents on a particular shift consistently managed a disproportionate number of patients (mean 9.4 patients; 95% CI 6.7 to 12.1 patients) compared with other residents on duty (mean 3.4 patients; 95% CI 2.1 to 4.7 patients).

LIMITATIONS

The ED information system used to collect patient-load information only recorded the physician who discharged a patient. Missing information concerning which physicians managed patients before a handoff was estimated. The results of the estimation were verified by data collected from a sample of observed physicians. In addition, missing information was captured from an alternate clinical information system and matched to estimates to ensure accuracy. The study was also limited to 1 academic ED; thus, results may not be generalizable to other EDs.

This research has produced 2 previous publications that characterize the subjective workload and task and communication patterns of the emergency physicians on whom this study is based. The research designs for the previous studies were created before patient-load imbalance findings and were not developed to support hypotheses on workload imbalances. However, our previous findings have relevant implications to the current work and should be referred to if more detailed information on physician work characteristics is desired.^{9,10}

DISCUSSION

There are numerous factors that may influence the distribution of emergency physician workload during the period of a work shift: the total number of patients being managed, the complexity and

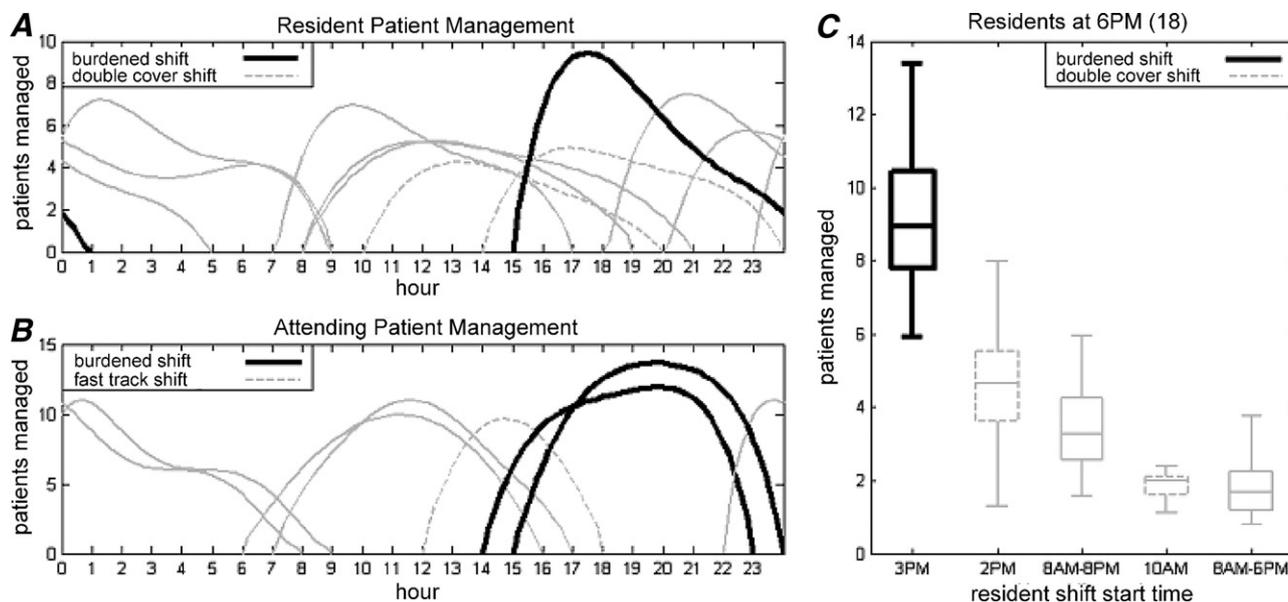


Figure 2. Physician patient load distribution. Burdened shifts are most affected by peaking censuses displayed in Figure 1. Double-cover shifts represent resident shifts that were not permanently scheduled. Double-cover shifts starting at 10 AM and 2 PM were filled 38% and 67% of the time, respectively.

severity of these patients, or the level of training and experience of the physician providing care to these patients. This study focused on the distribution of patient load among residents working weekday afternoon shifts characterized by high patient demand because we perceived, during direct observations for a previous study, an imbalance of workload among resident physicians on duty. Time-varying plots of patient load were created for each of the on-duty residents to examine the distribution of workload across residents working either the same or overlapping afternoon shifts. The study revealed that residents working a particular weekday afternoon shift (starting at 3 PM) were managing much higher patient loads than other residents working at the same time but on different shifts (ie, as defined by shift start time). The results indicate that shift timing relative to peak operational periods may consistently produce workload imbalances among a team of residents and produce unsafe conditions for the providers working those shifts and for their patients.

During periods of high demand, physicians approaching the end of their shift are unlikely to take on new patients; thus, the surge of incoming patients falls on the shoulders of physicians who are, depending on scheduling structure, either at the beginning or middle of their shifts. Residents accumulate patients more quickly because they are assigned patients as they enter the treatment area. Attending physicians are relayed information and assigned to these patients after residents are assigned them. Thus, the surge of incoming patients between 3 and 6 PM on weekdays is rapidly absorbed by residents working the burdened shift. This behavior influences patient-load imbalances among a team of resident physicians. Although the physicians on burdened shifts record the highest patient loads, other physicians such as the residents on shifts starting at 7 AM, 6 PM, or 11 PM also managed high patient loads.

However, during these shifts there was not a daily surge of incoming patients, fewer physicians were on duty, and patient load was distributed more evenly. During peak ED operations (6 PM on weekdays), a resident working a burdened shift (start time 3 PM) typically managed 43% of patients in the ED while there were generally 3 other residents present. The average patient load distribution at 6 PM on weekdays in the ED is displayed in Figure 2C. Third-year residents were placed in the burdened shift 92% of the time during the study period. This situation makes it difficult to determine the exact cause of the high patient loads experienced. It is undetermined whether these high loads were caused by senior residents accumulating the most patients or by shift timing during periods of high demand. It is the authors' hypothesis that both factors contribute. Thus, it is important to monitor physicians (especially residents) who come on shift during these busy times. This occurrence may be alleviated by placing shift start and stop times farther from (not during) daily high demand time periods (3 PM to 7 PM) or by creating an overlapping shift during these times.

The workload imbalance may be detrimental to the resident on the burdened shift, considering that high patient loads increase physician stress.^{14,15} In addition, this resident has a greater likelihood of reaching cognitive workload limits at which performance degradation and human error is probable, which may especially be true for burdened residents 2.5 hours into their shift, when it is common for them to be managing more than 9 patients. Within the first 2.5 hours of the burdened shift, a resident must absorb and process a large quantity of new information. During this time, the physician's working environment is rapidly changing and uncertain, which has been proposed to further strain an emergency physician's capacity to deliver safe care.¹⁶ Coupling these circumstances with the highly disruptive, time-pressured

environment that is present within emergency medicine increases the potential for clinical errors to be made.^{9,17-19} Junior clinicians have been noted to be particularly vulnerable to the rigors of this work environment.²⁰ Situations are most hazardous during periods of high demand. Circumstances in which specific staff members (ie, burdened resident) are feeling the brunt of high demand periods only decrease the safety of the ED. Physicians must be cognizant of their own workload management abilities, along with the abilities of other staff members, which is of particular concern in an academic medical setting in which a broader range of abilities and experience is present. A complete understanding of each physician's microenvironment, along with how they operate as a team, is essential in safely managing high levels of ED workload.

Studying ED operational patterns and physician behaviors collectively shed light on a situation that is potentially hazardous and occurring almost daily in the ED of study. Further studies delving into the components of emergency medicine work processes have potential to uncover similar deficiencies that may be corrected. Emergency medicine is characterized by a wide variety of task complexity, uncertainty, continual multitasking, and production pressure, which may contribute to the higher risks for error compared to that in other hospital settings.^{17,21} It is unlikely that a simple set of improvement strategies will improve the emergency medicine system to deliver health care flawlessly. Numerous studies aimed at characterizing ED work processes, identifying flaws, and subsequently developing knowledge-based strategies for improvement will undoubtedly have a cumulative effect on the progression of emergency medicine.

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