
Measuring the Opportunity Loss of Time Spent Boarding Admitted Patients in the Emergency Department: A Multihospital Analysis

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EXECUTIVE SUMMARY

Emergency department (ED) crowding is an international crisis affecting the timeliness and quality of patient care. Boarding of admitted patients in the ED is recognized as a major contributor to ED crowding. The opportunity loss of this time is the benefit or value it could produce if it were used for something else. In crowded EDs, the typical alternative use of this time is to treat patients waiting to be seen. Various ED performance benchmarks related to inpatient boarding have been proposed, but they are not commonly reported and have yet to be evaluated to determine whether they correlate with the opportunity loss of time used for boarding.

This study quantified several measures of ED boarding in a variety of hospital settings and looked for correlations between them and the opportunity loss of the time spent on boarding. In particular, average boarding time per admission was found to be easy to measure. Results revealed that it had a near-perfect linear correlation with opportunity loss. The opportunity loss of every 30 minutes of average boarding time equaled the time required to see 3.5 percent of the ED's daily census. For busy hospitals, the opportunity loss allowed sufficient time for staff to be able to see up to 36 additional patients per day. This correlation suggests that average boarding time per admission may be useful in evaluating efforts to reduce ED crowding and improve patient care.

For more information on the concepts in this article, please contact Dr. Lucas at rlucas@mfa.gwu.edu.

Crowding in emergency departments (EDs) has become an international crisis (Derlet and Richards 2000; Gordon et al. 2001; Graff 1999; Hoot and Aronsky 2008; Trzeciak and Rivers 2003). Literature by Asplin and colleagues (2003) and Solberg and colleagues (2003) uses an input, throughput, and output model to describe this problem. Of the output factors affecting ED crowding, boarding of admitted patients in the ED has received considerable attention and in many hospitals is considered the main cause of the issue (American College of Emergency Physicians 2008a). Approximately half of hospital EDs have reported extended boarding times for admissions (Andrulis et al. 1991), and others have reported that greater boarding times are associated with increased ambulance diversion rates and increased waiting times (Fatovich, Nagree, and Sprivulis 2005; Schull et al. 2003a, 2003b).

Few of these reports, however, quantified the amount of boarding that took place in the ED or considered the best way to measure it. In 2003, therefore, a task force of experts developed and refined potential measures of ED crowding. Their work resulted in three output measures: ED boarding time, ED boarding time components, and boarding burden (Solberg et al. 2003). Of these measures, ED boarding time (the mean time from inpatient bed request to physical departure from the ED) and boarding burden (the mean number or ratio of patients waiting for an inpatient bed during a specified period of time) were rated as the most useful and feasible. The third, ED boarding time components, measures specific segments

contributing to boarding time, such as the time required to assign a bed, clean the bed, obtain an accepting physician or admission order, and transport the patient. This measure was seen as more useful to individual hospitals for performance improvement initiatives, whereas boarding time and boarding burden were found to be more suitable as benchmarks within and across hospitals.

EDs forgo the opportunity to see new patients (who have long wait times or leave without being seen) by using their time, space, and resources to board inpatients instead. Inpatient boarding performance should thus be assessed on the basis of this opportunity loss.

The aim of this study was to quantify and describe the amount of time spent boarding inpatients in the ED in a variety of hospital settings. An additional goal was to find a benchmark for ED boarding that would have the highest correlation with the opportunity loss of time spent on this task.

METHODS

The subjects of this study were from a convenience sample of all ED patients presenting to the study hospitals during the second week of each month (to avoid holidays) from September 2006 until January 2007. The study cohort comprised five hospitals, each in a different state, with ED volumes ranging from 81 to 272 patients per day. The cohort included academic and community hospitals as well as trauma and nontrauma centers. The institutional review boards at all participating sites approved the study or exempted it from full review.

Data were collected prospectively, and all EDs in the cohort had electronic

patient tracking systems capable of measuring the time of patient arrival, time of admission request, and time of patient departure from the ED. For admitted patients, if the interval between the request for admission and departure from the ED to their inpatient bed exceeded 120 minutes, it was counted as boarding time. A reasonable amount of transition time should be allowed between the decision to admit and patient departure; 120 minutes has been proposed as the benchmark for this interval (Welch 2006). In addition to boarding time, data were collected on total length of stay for each patient, daily census, and daily number of admissions.

Defining the Opportunity Loss of the Time in Boarding ED Patients

For purposes of this study, opportunity loss was defined as the number of additional or waiting room patients who could have been seen in the time used to board inpatients. To calculate it, total amount of boarding time each day for all admitted patients was converted to a patient equivalent by dividing it by the average length of stay for all patients that day.

To be meaningful across the study hospitals' wide range of daily volume, the patient equivalent was expressed as a percentage of the daily census. For example, suppose that on a given day, one ED saw 100 patients, made 20 admissions, spent 2,400 minutes on boarding, and had an average length of stay for all patients of 240 minutes. The patient equivalent would equal the total hours spent boarding divided by the mean length of stay (in this case, $2,400 \div 240 = 10$). Thus, the opportunity lost to

boarding inpatients equaled the amount of time in which the ED could theoretically see 10 patients, or 10 percent of the 100 patients seen that day.

Defining and Evaluating Potential Measures of ED Boarding

Using the measures proposed by Solberg and colleagues (2003), ED boarding time was measured on a daily basis as the total boarding time per day, the mean boarding time per admission (total boarding time \div number of admissions), and the mean boarding time per boarder (total boarding time \div number of admitted patients whose boarding time exceeded two hours). Boarding burden was measured as the percentage of daily ED admissions who were boarded. Two-tailed Pearson correlation coefficients were calculated to determine the relationship between each of these measures and the opportunity loss of the time spent boarding each day, as described above. Data were analyzed using SPSS 15.0 for Windows.

RESULTS

The study population consisted of 27,325 ED patients seen in 161 study days in five cohort hospitals. Average daily ED volume, admission rate, and total time spent boarding inpatients for each hospital are displayed in Table 1. When the total boarding time each day was divided by the average length of stay, the patient equivalent lost to boarding time ranged from 7 to 35 patients per day, or 5 to 13 percent of the cohort hospitals' total ED volume. Table 2 displays the average opportunity loss to boarding for each hospital for the study period. Table 3 lists the

TABLE 1
ED Volume and Boarding Times in Study Hospitals

Hospital	Average Number of Patients per Day	Percentage of ED Patients Admitted	Average Total Boarding Time per Day (hours)	Percentage of Admissions Whose Boarding Time Exceeded Two Hours		Average Boarding Time per Admission (minutes)	Average Boarding Time per Boarder (minutes)
				Admissions Whose Boarding Time Exceeded Two Hours	Admissions Whose Boarding Time Exceeded Two Hours		
A	82	18	30.4	57	114	179	179
B	100	22	19.8	28.4	51	185	185
C	165	20	119.5	88.7	212	240	240
D	222	29	114.1	54.3	106	184	184
E	272	26	207.8	66	172	248	248

TABLE 2
Opportunity Loss as Measured in Study Hospitals

Hospital	Patient Equivalents Lost to Boarding Each Day*	Percentage of Daily Census Lost to Boarding Each Day**
A	22	13
B	6	5
C	36	13
D	21	10
E	7	9

*Equals the total amount of boarding time per day divided by median length of stay for all patients

**Equals patient equivalent divided by the average daily census

TABLE 3
Correlation Coefficients Between the Opportunity Loss* of the Time Spent Boarding and Various Measures of Boarding Time

Measure of Boarding Time	Correlation Coefficient	Significance (<i>p</i> value)
Percentage of admissions that board >120 minutes	0.668	<0.001
Average total boarding time per day	0.770	<0.001
Average boarding time per boarding inpatient	0.694	<0.001
Average boarding time per admission	0.909	<0.001

*Opportunity loss equals the percentage of average daily census who could have been seen in the time used to board inpatients.

correlation coefficients between the percentage of ED volume lost to boarding and various measures of boarding time. Of these measures, average boarding time per admission was most highly correlated with the opportunity loss of time spent boarding inpatients in the ED ($r = 0.909$, $p < 0.0001$).

Using regression analysis, the equation describing the linear relationship between the percentage of ED volume lost to boarding and boarding time

per admission is this: Percentage of ED volume lost to boarding = $0.064 \times$ boarding time per admission + 1.61. For hospitals in this study, therefore, the opportunity loss of every 30 minutes of average boarding time per admission equaled the time needed to care for 3.5 percent of the total ED population each day. For a busy ED with high boarding times, this loss could be significant. For the busiest hospital in the cohort, the opportunity loss of the time spent

boarding inpatients equaled the time needed to care for 36 new or waiting ED patients per day.

LIMITATIONS

Although the study included a variety of hospitals and hospital types, the results may not be applicable to hospitals with ED or inpatient boarding volumes that are dissimilar to those of this cohort. In addition, this model assumes that the types of patients who could be seen would have lengths of stay similar to those of average ED patients and that the ED has adequate space and staff to care for additional patients. When the ED treatment area is full, the opportunity loss could also be measured in other terms, such as waiting times, quality of care, and patient and staff satisfaction. These indicators were not measured in this study. This study also was not designed to suggest ways to decrease boarding time, although comparison of average boarding times before and after implementation of intervention strategies may be a good measure of progress.

SUMMARY AND DISCUSSION

This study confirms that a variable but significant amount of time is spent boarding inpatients in the ED in a variety of hospital types and in different communities across the United States. In four of the five hospitals in this cohort, over half of all ED admissions board more than two hours after a request for an inpatient bed. The opportunity loss was also variable yet significant and equaled the time that would be needed to care for 5–13 percent of the daily ED census.

This study suggests that average boarding time per admission may be the best measure of boarding time. First, it correlates highly to the opportunity loss of the time spent boarding, regardless of ED volume or the percentage of patients admitted each day. For the hospitals in this study, every 30 minutes of average boarding time per admission had an opportunity loss equivalent to the time needed to care for 3.5 percent of the ED population each day. Second, average boarding time per admission is sensitive to certain types of patients, such as critical care and psychiatric admissions, who have long boarding times in some hospitals (Cowan and Trzeciak 2005; American College of Emergency Physicians 2008b). Finally, electronic patient tracking systems in the cohort hospitals' EDs made average boarding time per admission easy to measure. In contrast, the number of patients boarded each day was deemed an inferior measure because it may underrepresent the impact of boarding; even a small number of patients who tie up ED beds for prolonged periods hamper output in the ED.

Although this study did not measure the economic opportunity loss of the time spent boarding inpatients, Falvo and colleagues (2007) studied the functional treatment capacity of a single ED used for boarding inpatients throughout 2005. The value of the production lost to inpatient boarding approached \$4 million per year. Applying the same economic assumptions (\$5,432 in lost revenue for each admission and \$384 in lost revenue per each ED outpatient) to hospitals in this study suggests an economic opportunity loss of \$2.5–21

million per year, depending on each hospital's ED and boarding volume.

Assumptions of opportunity loss and potential economic loss aside, boarding incurs costs by reducing the quality and timeliness of ED care and appears to be the main cause of crowding in EDs (American College of Emergency Physicians 2008a). It leads to increased wait times (Dunn 2003) and a greater number of walkouts (Weiss, Ernst, and Nick 2005), errors (Cowan and Trzeciak 2005; Weissman et al. 2007; The Joint Commission 2002), and ambulance diversions (Olshaker and Rathlev 2006; Schull et al. 2003a, 2003b). In deciding where to allocate resources and how to maximize quality care and revenue, hospitals must accurately measure and take into account the opportunity loss and potential economic cost of the time spent boarding inpatients in the ED; this study suggests they are of considerable magnitude.

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PRACTITIONER APPLICATION

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Emergency department (ED) overcrowding has been described by the Institute of Medicine (2006) as a national crisis. Patient utilization of EDs is increasing, the number of EDs nationwide is shrinking, uncompensated care is rising, and patients' dissatisfaction with the healthcare system is growing. This article is a significant contribution to the body of knowledge about the issue of ED overcrowding.

Healthcare leaders have struggled with this crisis for years. However, there has been a paucity of evidence and benchmarks that can be used in crafting solutions to the problem. Generally, boarding patients (most often into "hallway beds" that are not real beds and do not involve the support of staff and ancillary resources) is a stop-gap solution to the unavailability of inpatient beds. ED patient boarding is a problem in its own right, leading to unsafe practices.

Boarding in the ED is not free. It consumes valuable resources, including people, supplies, and space, that should be primarily used for providing emergency care. Boarding causes delays in treatment for those awaiting care, and it is an inherently unsafe way to deliver acute care. Patients are not being treated by clinical staff who specialize in inpatient care. This practice only delays the closure of other inpatient

services and prevents diversion of ambulances, both of which have a cascading effect that results in decreased performance, patient duress, and unsafe patient care.

This study gives hospitals a methodology for quantifying the scope of this issue, not only in financial terms but also in terms of lost opportunity costs and patient service. Also, the study gives healthcare leaders initial benchmarks by which to measure their organization's performance. We hope that similar studies will be conducted in the future to provide us with a more robust data set.

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