
Administration of Emergency Medicine

TRENDS IN BOARDING OF ADMITTED PATIENTS IN US EMERGENCY DEPARTMENTS 2003–2005

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□ **Abstract—Background:** Boarding of admitted patients in the Emergency Department (ED) is common and is associated with poor patient outcomes. **Objectives:** We sought to estimate the magnitude of and trends for ED boarding in the US. **Methods:** We used the 2003–2005 National Hospital Ambulatory Medical Care Survey to estimate the time patients spent boarding in EDs in the US. We used fixed and imputed times required to evaluate, treat, and decide to admit each patient using the number of medications and diagnostic tests received. We calculated the absolute and relative patient-care hours spent boarding in US EDs over the 3-year period. **Results:** Total patient-hours spent in US EDs increased from 209 million to 217 million between 2003 and 2005. Overall admission rates decreased between 2003 and 2005 (13.9% in 2003, 12.3% in 2005), whereas intensive care unit admission rates increased (1.3% in 2003, 2.0% in 2005). Mean ED length of stay decreased (5.4 h in 2003, 4.6 h in 2005). The proportion of patient-hours accounted for by ED boarding decreased over the study period (11.3–17.1% in 2003, 5.9–15.3% in 2004, and 2.8–12.0% 2005). **Conclusions:** Boarding of admitted patients in the ED accounts for a substantial portion of ED patient-care hours. Overall boarding time decreased over the 3 years. © 2010 Elsevier Inc.

□ **Keywords—**emergency medicine; health policy; ED boarding

INTRODUCTION

Emergency department (ED) crowding has been recognized as a public health crisis in the United States (1–3). One of the principal causes for crowding is the use of EDs to care for admitted patients for extended periods of time (4). This practice has been termed ED boarding. Reasons for the practice of ED boarding are complex. Hospitals board admitted patients when hospitals are at full capacity or inpatient beds are reserved for other patients (transfers from other hospitals or elective admissions). In addition, financial considerations may influence a hospital's decision to use the ED to board admitted patients for long periods because it allows a higher proportion of overall hospital capacity to be used for elective high-margin admissions such as scheduled surgeries (5).

The boarding time has been defined as the time from inpatient bed request to physical departure from the ED (6). Although there is no widely accepted definition for when an ED patient moves from the status of active patient to ED boarder, a recent summit defined this as: “an admitted patient for whom the time interval between decision to admit and physical departure of the patient

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from the ED treatment area exceeds 120 minutes” (7). ED boarding is associated with poorer quality ED care and adverse outcomes (8–12). Despite widespread concern over the boarding of admitted patients in US EDs, the absolute and relative magnitude of and trends for ED boarding are currently unknown.

We sought to estimate US ED boarding times over 3 years by determining the total patient-care hours that admitted patients spend in the ED after the decision to admit using varying assumptions about the time required for ED care. We hypothesized that the overall boarding burden would have increased over the study period.

MATERIALS AND METHODS

Study Design and Data Processing

We performed an analysis of data from the 2003–2005 National Hospital Ambulatory Medical Care Survey (NHAMCS) to estimate the boarding burden. NHAMCS is a national probability sample survey of US ED visits that is collected and reported annually. In each year, ED visits are abstracted prospectively, de-identified, and patient-level data are reported, including demographics, patient characteristics, visit characteristics such as number of medications received and number of diagnostic tests ordered, waiting time to be evaluated by a physician, total ED length of stay, and disposition. For patients admitted to the hospital, there is information on admission to the intensive care unit or hospital floor beds. The probability sample design of the NHAMCS allows the data to be weighted to produce national estimates of care in the United States (13). The data are publicly available through the National Center for Health Statistics and were downloaded through the Centers for Disease Control website. The NHAMCS data from 2003 to 2005 were chosen for analysis because 2003 was the first year in which both waiting time to be evaluated by a physician and total time spent in the ED were reported. We excluded patients who left without being seen, left against medical advice, were transferred to another facility, expired in the ED, or were dead on arrival. To account for over-sampling in NHAMCS and to produce accurate point estimates and standard errors, we used weighted estimates as described by the National Center for Health Statistics. All data were analyzed using Stata 9.0 (StataCorp LP, College Station, TX). The study was determined to be exempt from review by the institutional review board of the University of Pennsylvania.

Data Analysis

We tested whether any differences existed in the demographics (age, gender, and black race) of ED admissions

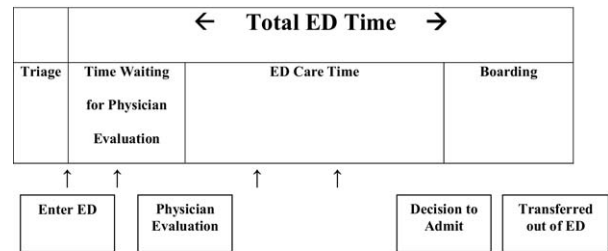


Figure 1. Determination of ED boarding estimates. Boarding time = Total ED time – (Time Waiting for Physician Evaluation + ED Care Time). ED care time was estimated using fixed (2 h, 3 h, and 4 h) and imputed methods to generate boarding estimates.

through the 3-year period using *t*-tests and chi-squared tests. In NHAMCS, the time that an admitted ED patient becomes a boarder is not recorded because there is no reported time that the decision was made to admit the patient to the hospital. To generate an estimate of boarding time we subtracted ED care time and time waiting to see a physician from the total time spent in the ED (Figure 1). Time to see a physician is recorded in the data, but ED care time is not. We therefore used multiple estimates of when an admitted ED patient moved from the status of ED patient to ED boarder. Our underlying assumption was that all patients admitted to the hospital from the ED require some amount of time (ED care time) before a decision to admit can be made. ED care time is an estimate of the time that it may take for ED evaluation, stabilization, treatment, diagnostic testing, medical decision-making, and disposition. We generated four different estimates for ED care time.

First, to estimate an individualized time estimate for ED care time, we used linear regression to determine the incremental time required for each medication and diagnostic test. We used these incremental times to predict the total ED stay (not including waiting time) for patients who were treated and discharged using number of medications and number of diagnostic tests as continuous variables. For this calculation, we excluded admitted patients, patients who were dead on arrival, expired in the ED, were transferred to other hospitals, and those who left without being seen and against medical advice. After determination of an incremental time for each test and medication, we imputed an estimated time for each admitted patient using the regression coefficients from the model. In addition to the regression model, we generated three fixed time estimates for ED care and decision to admit. We assumed that ED care time would take 2 h, 3 h, or 4 h after being seen by a physician, and generated estimates for each time interval. By using multiple assumptions of the amount of time required for ED care, we were able to evaluate trends

Table 1. Emergency Department Patient Care Data 2003–2005

	2003	2004	2005
Total patient-care hours (in thousands)	208,922 (95% CI 181,403–236,442)	206,817 (95% CI 178,225–235,408)	217,350 (95% CI 191,681–243,019)
Floor admission rate	12.6%	12.3%	10.3%
ICU admission rate	1.3%	1.1%	2.0%
Overall admission rate	13.9%	13.3%	12.3%
ED LOS for floor patients (mean, in hours)	5.57 h (95% CI 4.84–6.30)	5.27 (95% CI 4.40–6.14)	4.63 h (95% CI 4.30–4.96)
ED LOS for ICU patients (mean, in hours)	4.26 h*	4.93 (95% CI 3.88–5.96)	4.44 h (95% CI 3.91–4.97)
Overall ED LOS (mean, in hours)	5.44 h (95% CI 4.74–6.13)	5.24 h (95% CI 4.43–6.06)	4.60 (95% CI 4.27–4.93)

* Confidence intervals (CI) could not be calculated because one stratum contained only a single data point.

ICU = intensive care unit; ED = emergency department; LOS = length of stay.

in boarding time and to generate a range of boarding estimates.

We estimated the boarding burden by calculating the total patient-care hours for all admitted patients by summing the total ED length of stay (excluding time waiting for physician evaluation) and subtracting either imputed or fixed increments for ED care (Figure 1). Imputed times were calculated as described above. The fixed time intervals required for ED care preceding the decision to admit were set a priori at 2, 3, and 4 h after physician evaluation. This range in time was based on consensus opinion in our departmental research conference to reflect a range of boarding estimates representing differences in patient presentations. Although emergency physicians may immediately recognize that a seriously ill patient is in need of admission, time is required for stabilization. In less seriously ill patients, time may be required for diagnostic testing and care coordination before a decision to admit can be made.

Observations for which there were missing data for time awaiting physician evaluation or ED length of stay were excluded from the analysis. To test whether observations in which there were missing data were different from those with complete data, we compared demographics factors (gender, black race, age), and hospital-factors (metropolitan statistical area, region, and non-profit status) using *t*-tests and chi-squared tests. We compared trends over the 3-year period using linear regression analysis and a non-parametric test for trend. A *p*-value of < 0.05 was considered significant.

RESULTS

Over the 3 years analyzed, there were no significant changes in the demographics of the population of admitted patients. The entire 3 years of data reflect 44.3 million ED admissions; the entire cohort had a mean age

of 56 years (standard deviation \pm 24), were 54% female, 79% white, 17% black, 3% Asian, and 1% other. Care times were available for 75% of all records. There were no differences with respect to patient characteristics (gender, black race, age), and hospital characteristics (metropolitan statistical area, region, and non-profit status) for those with missing and complete data. Table 1 lists annual total patient-care hours, admission rates, and ED length of stay for floor and intensive care unit (ICU) patients.

Over the 3-year period, total patient care hours increased from 208.9 million in 2003 to 217.4 million in 2005 ($p < 0.001$ for trend). Overall admission rates decreased from 13.9% of ED visits in 2003 to 12.3% in 2005 ($p < 0.001$ for trend). ICU admission rates were higher in 2005 than in both 2003 and 2004 (2.0% vs. 1.3% and 1.1%, respectively, $p < 0.001$). There was a decrease in overall mean length of ED stay for admitted patients from 2003–2005 from 5.4 to 4.6 h ($p < 0.001$). Most of the reduction in ED length of stay was accounted for by a decrease in mean length of stay for patients admitted to the floor (5.6 h in 2003 vs. 4.6 h in 2005).

Using the linear regression model, we determined the incremental time increase for each diagnostic test performed. These estimates were relatively similar across the 3 years, with each test accounting for 19.2 (95% CI 17.0–21.4) min in 2003, 19.0 (95% CI 16.3–21.7) min in 2004, and 19.8 (95% CI 18.0–21.6) min in 2005. Incremental times required for each medication administered were 9.4 (95% CI 5.4–13.5) min in 2003, 12.0 (95% CI 6.3–16.6) min in 2004, and 10.5 (95% CI 7.9–13.0) min in 2005. Across the 3 years, the median amount of additional ED care time was within the range of our fixed assumptions. ED care accounted for 154 (IQR 97–221) min in 2003, 176 (IQR 107–238) min in 2004, and 158 min (IQR 99–210) in 2005.

Table 2 lists estimates of the proportion of time spent boarding admitted patients using the imputed estimates

Table 2. Emergency Department Boarding Estimates at 2, 3, and 4 Hours of ED Care Time for 2003–2005

	2003	2004	2005
2 h fixed ED care time (patient-care hours in thousands)			
Floor	33,339 (95% CI 30,750–35,928)	29,022 (95% CI 20,371–37,673)	22,466 (95% CI 18,170–26,762)
ICU	2429 (95% CI 1817–3041)	2586 (95% CI 1300–3872)	3716 (95% CI 2653–4479)
Total	35,768 (95% CI 33,108–38,429)	31,608 (95% CI 22,512–40,705)	26,182 (95% CI 21,114–31,250)
3 h fixed ED care time (patient-care hours in thousands)			
Floor	26,924 (95% CI 24,457–29,390)	20,156 (95% CI 12,063–28,248)	13,921 (95% CI 10,478–17,363)
ICU	1848 (95% CI 1279–2418)	1702 (95% CI 568–2835)	2193 (95% CI 1291–3095)
Total	28,772 (95% CI 26,240–31,303)	21,858 (95% CI 13,411–30,304)	16,113 (95% CI 12,061–20,166)
4 h fixed ED care time (patient-care hours in thousands)			
Floor	22,119 (95% CI 19,772–24,466)	11,290 (95% CI 3530–19,049)	5375 (95% CI 2460–8290)
ICU	1446 (95% CI 916–1976)	817 (95% CI 0–1830)	670 (95% CI 0–1486)
Total	23,565 (95% CI 21,159–25,971)	12,107 (95% CI 4061–20,153)	6046 (95% CI 2640–9451)
Imputed ED care time (patient-care hours in thousands)			
Floor	24,399 (95% CI 16,071–32,727)	24,393 (95% CI 16,388–32,398)	20,795 (95% CI 17,132–24,458)
ICU	735 (95% CI 403–1452)	1878 (95% CI 826–2930)	3012 (95% CI 2231–3794)
Total	25,135 (95% CI 16,487–33,783)	26,272 (95% CI 17,935–34,609)	23,807 (95% CI 19,633–27,982)

and the three fixed interval estimates for floor and ICU patients. Using these three fixed intervals for ED care time, the overall boarding burden for 2003 was estimated to be 11.3–17.1% of total patient-care hours. In 2004, boarding accounted for 5.9–15.3% of patient-care hours, and in 2005, boarding accounted for 2.8–12.0% of patient-care hours. In all 3 years, both absolute overall patient-care hours and the relative percentage of total patient-care hours boarding decreased ($p < 0.001$ for trend). Absolute and relative boarding time decreased for floor patients in all 3 years. For the 2- and 3-h ED care estimates, there was an increase in total boarding time for ICU patients ($p < 0.001$), but at 4 h, the boarding burden was significantly lower ($p < 0.001$).

DISCUSSION

To our knowledge, this is the first estimate of the absolute and relative magnitude and trends for the boarding of admitted patients in EDs in the United States. The burden of caring for admitted patients on ED is considerable, with admitted patients accounting for up to 17% of all ED patient-care hours. We were surprised to find that despite increases in the total patient-care hours in US EDs, both the absolute and relative boarding times decreased over the study period. In part, the effect may be explained by the decrease in admission rates that we observed. However, other factors, including the increased awareness of the central role that boarding plays in ED crowding, may have contributed to the decline. Novel measures to reduce boarding, such as moving

admitting patients to inpatient hallways may also have contributed to the decrease in boarding (14,15).

In 2005, however, ED boarding still accounted for 3–12% of total patient-care hours, and the economic and human costs associated with boarding patients are substantial. Hospitals with high levels of ED boarding have been demonstrated to have longer door-to-needle times in acute myocardial infarction and longer time to antibiotics in pneumonia (8,9). Boarding is arguably most important for the sickest of patients, as ICU patients who are boarded have been shown to have a higher incidence of ventilator-associated pneumonia, longer length of stay, and greater mortality (10,11,16). The mechanisms by which boarding has decreased should be explored and steps should be taken to ensure that these trends continue. In addition, the finding that the boarding of ICU patients has not seen as much reduction as the boarding of floor patients should be further explored. Continued reduction of ED boarding is essential to reduce ED crowding, improve patient outcomes, and increase surge capacity for disasters.

LIMITATIONS

The estimates and trends reported in this study have limitations. The primary limitation is that there is no time stamp for decision to admit in the database. Therefore, our assumptions about time intervals for ED care might potentially over- or under-estimate the magnitude of ED boarding. In particular, our derived ED care time estimate using the linear regression model is sensitive to the number of tests or medications ordered in the ED. There

may be a cyclical nature to this as boarded patients may have inpatient tests performed while in the ED when no inpatient bed is available. Only 75% of the patient-level contacts in the data set had time data available. In addition, the nature of the data prevented us from commenting on any direct or indirect causes for reductions in boarding or effects on patient outcomes. Finally, although we demonstrate a significant decrease in ED boarding over the 3 years included in our analysis, it is possible that our findings would not be true if we were able to estimate the boarding burden over a broader time period.

CONCLUSION

We offer the first national estimate of the magnitude of and change in ED boarding in the United States. Our analysis demonstrates the range of patient care hours spent boarding and suggests that boarding may account for almost a fifth of all time patients spend in US EDs. Although the problem is still substantial, there were significant reductions in the absolute and relative boarding of admitted patients from 2003 to 2005.

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ARTICLE SUMMARY

1. Why is this topic important?

Emergency department boarding has been associated with poorer quality ED care and adverse outcomes.

2. What does this study attempt to show?

We offer an epidemiologic analysis of the national magnitude of the emergency department boarding burden.

3. What are the key findings?

Total patient-hours spent in US EDs increased from 2003 to 2005. Average ED length of stay, however, decreased over the same time period. The proportion of patient hours accounted for by ED boarding ranged from 2.8% to 17.1% of total ED time, and decreased from 2003 to 2005.

4. How is patient care impacted?

We offer an epidemiologic method of monitoring trends in ED boarding in the United States. Decreasing overall boarding time may lead to a decrease in adverse events and an improvement in the quality of ED care.