Original Contribution

Drivers of ED efficiency: a statistical and cluster analysis of volume, staffing, and operations☆,☆☆

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ABSTRACT

Study objective: The percentage of patients leaving before treatment is completed (LBTC) is an important indicator of emergency department performance. The objective of this study is to identify characteristics of hospital operations that correlate with LBTC rates.

Methods: The Emergency Department Benchmarking Alliance 2012 and 2013 cross-sectional national data sets were analyzed using multiple regression and k-means clustering. Significant operational variables affecting LBTC including annual patient volume, percentage of high-acuity patients, percentage of patients admitted to the hospital, number of beds, academic status, waiting times to see a physician, length of stay (LOS), registered nurse (RN) staffing, and physician staffing were identified. LBTC was regressed onto these variables. Because of the strong correlation between waiting times measured as door to first provider (DTFP), we regressed DTFP onto the remaining predictors. Cluster analysis was applied to the data sets to further analyze the impact of individual predictors on LBTC and DTFP.

Results: LOS and the time from DTFP were both strongly associated with LBTC rate ($P < .001$). Patient volume is not significantly associated with LBTC rate ($P = .16$). Cluster analysis demonstrates that physician and RN staffing ratios correlate with shorter DTFP and lower LBTC.

Conclusion: Volume is not the main driver of LBTC. DTFP and LOS are much more strongly associated. We show that operational factors including LOS and physician and RN staffing decisions, factors under the control of hospital and physician executives, correlate with waiting time and, thus, in determining the LBTC rate.

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1. Introduction

1.1. Background

Emergency departments (EDs) play a critical role within the American health care system, serving both as the key location for the delivery of acute clinical care as well as the primary access pathway for unscheduled hospital admissions [1]. The clinical operations of EDs are complex and affected by many factors [2]. Some factors are intrinsic to the nature of the hospital and catchment community, such as annual hospital volume, patient acuity, and patient socioeconomic status. Other factors relate to hospital management and administrative decisions such as physician and employee staffing, input and throughput

processes, and hospital patient flow [3]. ED crowding is an increasing national problem that adversely impacts patient care and negatively affects ED operations [4]. In response to crowding, The Joint Commission [5] has made ED patient throughput a hospital priority through the adoption of ED-specific core measures. (See Table 1).

1.2. Importance

Because of the unique features of individual EDs and the interaction of many disparate characteristics, it is difficult for hospital administrators, ED directors, and ED nurse managers to accurately predict the impact of staffing decisions and process changes on patient flow. One operational parameter important to every ED leader is the percentage of patients who leave before treatment is completed (LBTC). This metric is defined as all patients who leave before being discharged by a physician. This includes patients who leave before or after a medical screening examination, those who elope from the ED, and those who leave the ED against medical advice. Not only is LBTC a risk for both the

Table 1
The Joint Commission definitions of ED flow measures

	ED-specific Joint Commission core measures
ED 1	Median time from ED arrival to ED departure for admitted ED patients
ED 2	Admit decision time to ED departure for admitted patients

patients and the hospital, it can be considered the ultimate expression of a poor patient experience.

The recent literature suggests that ED volume is directly correlated with LBTC. Welch et al used 2009 data from the Emergency Department Benchmarking Alliance (EDBA) [6] to demonstrate a direct association between ED volume and acuity with LBTC, door-to-physician times, and length of stay in the ED [7]. Handel et al noted a similar relationship [8]. Implementation of the Affordable Care Act appears to have increased ED volumes [9]; more patients now have insurance coverage, but they do not have adequate access to primary care [10]. Data from Oregon demonstrated a 40% increase in ED usage among patients during the first year of Medicaid coverage subsequent to being without health insurance [11]. Although ED volume appears to play a role in the LBTC rate, we hypothesize that operational factors, such as professional staffing ratios and patient wait time, play an underlying and more important role than volume alone. It is critically important to understand the underlying factors related to ED operations and LBTC to improve the efficiency and effectiveness of high-quality acute care delivery.

1.3. Goals of this investigation

Through the use of data from the EDBA, our study examines the impact of ED operational metrics, specifically physician and registered nurse (RN) staffing ratios, on LBTC. Physician staffing ratios are defined as the number of patients per staffed physician hours per day; RN staffing ratios are the number patients per RN staffed hours per day. Because of the well-known strong statistical correlation between LBTC and the time it takes a patient to see a physician or other provider [12], we also conducted a secondary analysis of operational metrics focusing on the time from door to first provider (DTFP). This interval is defined as the time from the first recorded entry of the patient's arrival in the ED until the first notation of evaluation by a provider (attending physician, resident physician, or mid-level provider). Using 2012 and 2013 data from the EDBA, we specifically looked at the relative impact of physician and nursing staffing on DTFP in the context of other hospital and ED characteristics.

2. Methods

2.1. Study design

This is a retrospective study of 2012 and 2013 EDBA data. EDBA is a nonprofit membership organization that annually collects self-reported ED-level demographic information and performance metrics from EDs across the United States. In 2012, 976 member EDs reported data. This information is collated in a spreadsheet organized into cohorts of departments of 20,000 volume bands for statistical and comparison purposes. The identities of individual EDs are blinded although clustered by state. Data were solicited from participating members at the departmental level in calendar years 2013 and 2014 for calendar years 2012 and 2013, respectively. A spreadsheet is distributed to all members on an annual basis. Because the information is completely free from commercial influence and utilized solely for benchmarking and performance improvement, it is ideal for analysis using statistical techniques. Pediatric, free standing, and urgent care EDs were omitted because of
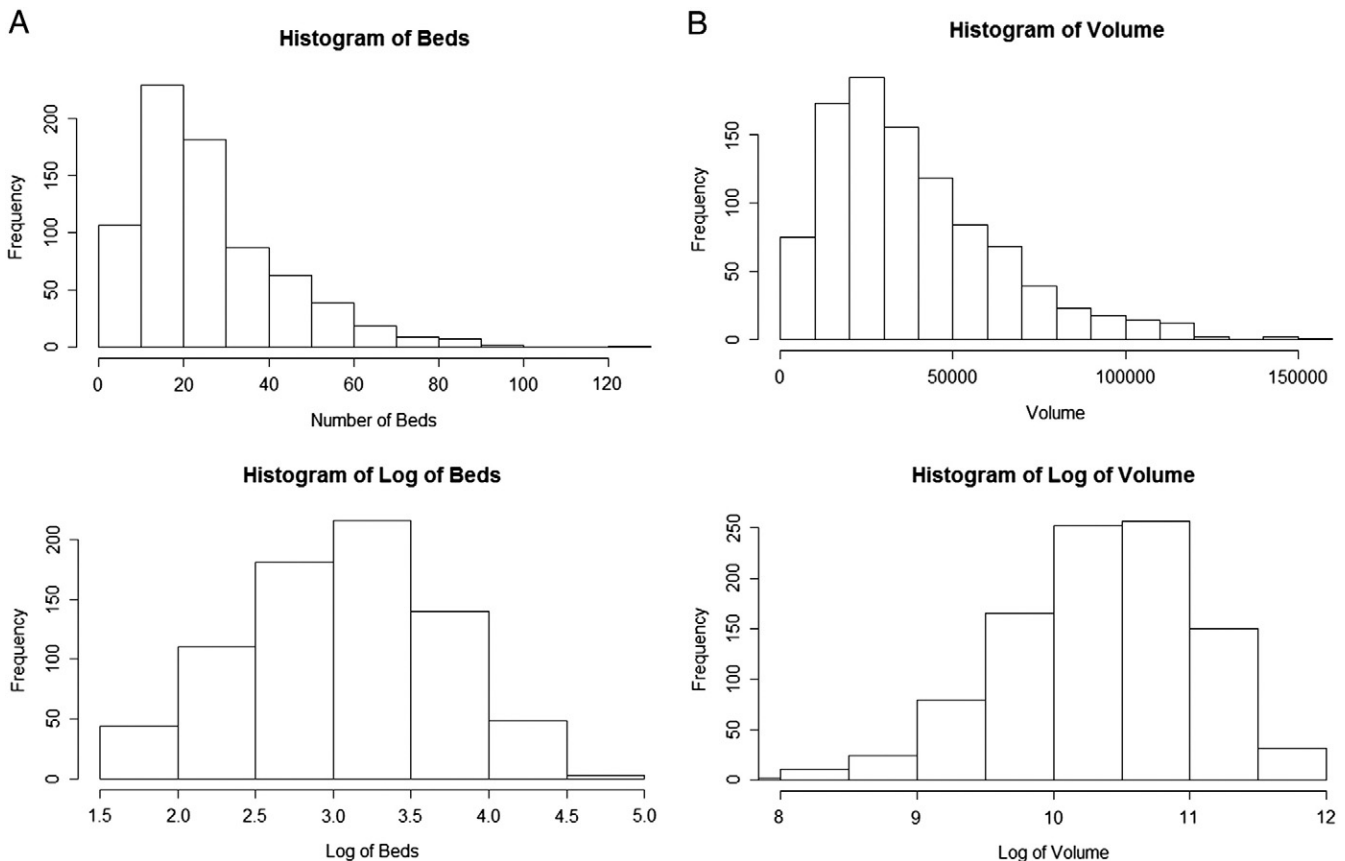

Fig. 1. A: Histogram of number of ED beds in the data set before and after logarithmic transformation. After transformation, the histogram approaches a normal distribution. B: Histogram of ED volume bands in the data set before and after logarithmic transformation. After transformation, the histogram approximates a normal distribution.