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Original Article

A new strategy for emergency department crowding: High-turnover utility bed intervention

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Abstract

Background: This study applied a new strategy, termed *high-turnover utility bed intervention*, to offer early admission chances for emergency department (ED) patients and alleviate ED crowding.
Methods: This before-and-after observational cohort study was conducted at the ED of an urban tertiary hospital. On January 1, 2012, 14 utility beds were prepared exclusively for ED patient use. A strict 48-hour course limit for each patient was formulated to govern these high-turnover beds. The primary outcome measure for this study was ED length of stay. Secondary outcome measures were the number of ED admissions, patients who left without being seen, and revisits within 72 hours of discharge, as well as the outcomes of cardiac arrest management and ambulance diversion hours.
Results: There were 70,515 adult ED visits enrolled during the preintervention period (January−December 2011), and 69,706 during the postintervention period (July 2012−June 2013). In the postintervention period, this new strategy offered 1401 early admission opportunities. The ambulance diversion hours decreased prominently from 5.4 hours to 1.6 hours per day. A shortening in ED length of stay from 9.7 hours to 8.0 hours was achieved, mainly in cases of nontrauma. More patients (31.2% vs. 29.7%) were admitted to the wards with a lower discharge rate in the postintervention period. Additionally, there was no difference in ED revisit within 72 hours and cardiac arrest management.
Conclusion: The high-turnover ED utility bed intervention offered improved admission chance and alleviated ED crowding output. ED efficiency improved, with shortened ED length of stay and fewer ambulance diversion hours.

Keywords: ambulance diversion; crowding; emergency department; length of stay; turnover rate

1. Introduction

Emergency department (ED) crowding has been described in emergency medicine literature as a concern for > 20 years,[1] and it has become a modern international health delivery problem.[2] It has been previously demonstrated that ED crowding has a detrimental effect on quality of care and medical management, including a longer duration of hospital stay, a higher risk of mortality, subsequent hospital admission,

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lower levels of patient satisfaction, increased costs for admitted patients, and delays in the life-saving intervention and treatment of several crucial illnesses such as myocardial infarction, pneumonia, and painful conditions.[3−9] Potential mechanisms for the harmful effects of ED crowding may include impaired decision-making, unwillingness to order tests or consultations, incomplete examinations, insufficient monitoring, suboptimal physiotherapy, deficient treatment, or a lack of discharge planning and follow-up arrangements.[10] In addition, it has been illustrated that ED overcrowding can affect the interaction between the educator and the learner.[11] This has a negative impact on the clinical education of medical students, owing to the sacrifice of certain aspects of the educational process and increased environmental stress.[12,13] Essentially, it is reasonable to assume that ED crowding is not an isolated phenomenon, but more probably a manifestation of general hospital crowding. Crowding is influenced by the number of patients and medical crew, the number of beds in the ED, and the number of available beds in the hospital, as well as by wait times for laboratory results and radiology examinations and the availability of consulting specialists.[14]

A conceptual model of ED crowding is composed of three elements: input, throughput, and output.[15] Input is about patient demand for emergency services before ED arrival, which typically includes uncontrolled variables. Throughput focuses on the operations within the ED comprising the illness severity of patients in the ED, the number of adjunct exams and procedures performed in the ED, and the number of physicians and nurses on duty. Finally, the output depicts the transferring or discharge of patients from the ED. Among the output components, prolonged boarding time, such as waiting for an available hospital bed links to delay definitive testing and increase length of stay (LOS), short-term mortality, and associated costs.[16] The poor availability or supply of inpatient beds has been described as one of the major causes of ED crowding.[17]

In order to maximize inpatient bed occupancy effectively and to increase the prevalence of admitted patients boarding in the ED, we have applied a new policy, termed high-turnover ED utility bed management, to relieve ED crowding since 2012. Now, we have sought to determine whether the introduction of ED utility beds resulted in actual improvements in ED crowding in our hospital.

2. Methods

2.1. Study population and hospital setting

We carried out a retrospective, observational cohort study at Taipei Veterans General Hospital (VGH), a 2700-bed tertiary care medical center in Taipei, Taiwan. The hospital has all types of specialties, and serves an average of 6900 outpatients, 240 emergency visits ,and 320 daily admissions. In general, the hospital beds are used by all types of specialties, and the overall bed occupancy rate is 85%. Because of the shortage of hospital inpatient beds, approximately 50 patients per day are admitted to the ED-attached observation unit for a *hold* until their inpatient bed is ready or for short-term observation. The mean LOS of patients in the ED-attached observation unit is 25 hours.

On January 1, 2012, our hospital administrator set up 14 utility beds for ED patient use only in order to improve ED overcrowding. We also formulated strict regulations to govern the occupancy of these high-turnover beds, which contained rules stipulating that. (1) ED patients waiting for admission would receive ED utility beds in the following order of priority: (a) patients in observation units with wait times for admission > 24 hours; (b) patients from resuscitation units under relatively stable hemodynamic status with the need for admission; (c) patients in observation units with wait times for admission < 24 hours; and (d) any patients who were evaluated as needing admission. (2) There would be a restriction of a 48-hour course limit for each patient who was admitted to ED utility beds to maintain the high turnover and effective occupancy state of these beds. (3) If cases failed to be transferred back to their specialty wards within the course limit, the attending physician in charge would be responsible daily for explaining the reason for the prolongation to our vice superintendent unit the occupied bed was empty; additionally, the management of ED utility beds would be directed by the ED Quality Control Committee every 2 months.

2.2. Data collection and definition

Consecutive patients were enrolled between January 2011 and June 2013, and all relevant data were obtained from the ED registry database. Because the implementation of ED utility beds went into effect during first half of the year 2012, the preintervention period was defined as January−December 2011 and postintervention period from July 2012 to June 2013. Adult patients aged ≥ 20 years were eligible for inclusion. Exclusion criteria were age < 20 years or pregnancy, given that the ED utility beds were not suitable for children or pregnant patients. The Taiwan Triage and Acute Scale was used to categorize patients by both injury and physiological findings, and rank them on a scale of 1−5, with 1 being the most critical (resuscitation), and 5 being the least critical (nonurgent).[18] The primary outcome measure was ED LOS. Secondary outcome measures were the number of ED admissions, patients who left without being seen, and patients who returned to the ED within 72 hours of discharge, as well as outcomes of cardiac arrest management and ambulance diversion hours, which occur when ED staff can no longer safely care for new patients and ambulances are diverted to nearby facilities.[19] The study was approved by the Committee on Ethics of Institutional Review Board of Taipei VGH, with no need for patients' written informed consent.

2.3. Statistical analysis

Results are expressed in numbers and percentages for categorical variables. Descriptive statistics are reported as means and standard deviation for continuous variables. Also, continuous variables were assessed using the Mann−Whitney

U test for independent samples. Analysis of categorical variables was performed using Pearson Chi-square test or Fisher's exact test, as appropriate. Statistical analysis was performed with SPSS 19.0 version (SPSS Inc., Chicago, IL, USA). A two-tailed $\alpha = 0.05$ level of significance was applied.

3. Results

3.1. Patient characteristics

In this study, there were 70,515 adult ED visits registered during the preintervention period and 69,706 during the postintervention period. Patients' basic characteristics are summarized in Table 1. Patients in the postintervention period were older and had more critical conditions, with higher percentages of Taiwan Triage and Acute Scale Levels I and II.

3.2. Effect of high-turnover ED utility bed management

In the postintervention period, this new strategy offered 1401 early admission opportunities, including 1245 (88.9%) nontrauma and 156 (11.1%) trauma. The occupancy rate of 14 ED utility beds was 93.1% and the bed turnover rate was 99.2. The average duration of stay in the ED utility beds was 57.8 hours in nontrauma and 48.0 hours in trauma.

3.3. Effect on crowding model and care quality

The ambulance diversion hours decreased substantially from 5.4 hours to 1.6 hours per day after the implementation of ER utility beds (Table 2). We discovered a definite shortening in ED LOS from 9.7 hours to 8.0 hours. Furthermore, the shortening effect in ED LOS was observed in all triage levels of nontrauma, but not in the subgroups of trauma. The case number of ED stays 24−48 hours and > 48 hours declined significantly from 13.8 cases/d to 9.1 cases/d and from 5.5 cases/d to 3.0 cases/d, respectively. For patients who did not need to be admitted, the overall LOS in the pre- and postintervention periods was not statistically different (4.1 ± 3.5 hours vs. 4.1 ± 3.6 hours). Furthermore, more ED patients were admitted to the wards with a lower ED discharge rate in the postintervention period. The number of patients who left without being seen, transferred to another hospital, or were discharged against medical advice showed no significant difference in both periods.

With regard to ED care quality analysis, the ED revisit rate within 72 hours was similar before and after the implementation of ED utility beds. There was also no difference in the number of out-of-hospital cardiac arrest events, the rate of return of spontaneous circulation in out-of-hospital cardiac arrest patients, and the ED in-hospital mortality (Table 3).

3.4. Analysis of adult nontraumatic patients

The implementation of ED utility beds had a more predominant effect on the improvement of ED LOS in cases of nontrauma; therefore, it is necessary to dissect the characteristics of these subgroups. In Table 4, ED utility bed intervention decreased LOS effectively in all triage levels of patients with ED direct discharge or admission. There were approximately 25−28% of the nontrauma patients who needed ED observation during the study periods. The implementation of ED utility beds had an apparent shortening on the duration of patient stays from observation units to ED departure in all severity grading from 26.0 hours to 20.8 hours, without a change in the duration from triage to the observation unit.

4. Discussion

The present study demonstrates that the proper implementation of ED utility beds has the significant advantage of shortening ED LOS in adult patients. The study results suggest that its main impact is on nontrauma. This strategy, by using 14 high-turnover ED utility beds, offers more early admission opportunities for those who need admission to the ED. In the postintervention period, more ED patients were admitted to the wards with a lower ED discharge rate. The purpose of this strategy is to ameliorate ED crowding output, and subsequently to improve ED efficiency with shortened ED LOS and fewer ambulance diversion hours. The fewer patients who need admission to the observation units, the more time ED staff have to focus on the care processes and provide patient services. However, there was no difference in some ED quality of care indicators, such as ED revisit within 72 hours and cardiac arrest management.

Table 1
Characteristics of patients in the study.

	Preintervention (2011/1/1−2011/12/31)	Postintervention (2012/7/1−2013/6/30)	*p*
No. of adult patients arriving at ED			
Total	70,515	69,706	
Age (y)	61.2 ± 20.9	61.8 ± 21.0	< 0.001
Geriatric (≥ 65 y)	33,215 (47.1)	32,993 (47.3)	0.39
Male	40,154 (56.9)	39,045 (56.0)	< 0.001
Nontrauma	56,826 (80.6)	56,109 (80.5)	0.66
Taiwan Triage and Acuity Scale			
Levels I & II	11,786 (16.7)	12,632 (18.1)	< 0.001
Levels III−V	58,729 (83.3)	57,074 (81.9)	< 0.001

Data are presented as mean ± standard deviation or *n* (%).

Table 2
Emergency department (ED) crowding model-related characteristics.

	Preintervention (n = 70,515)	Postintervention (n = 69,706)	p
Input			
Ambulance diversion (h/d)	5.4 ± 2.4	1.6 ± 1.1	< 0.001
No. left without being seen	85	88	0.76
Throughput			
ED length of stay, h			
Overall	9.7 ± 17.2	8.0 ± 13.7	< 0.001
Nontrauma	10.6 ± 18.1	8.5 ± 13.9	<0.001
Triage Levels I & II	14.8 ± 20.5	10.9 ± 14.7	<0.001
Triage Levels III–V	9.6 ± 17.3	7.8 ± 13.6	<0.001
Trauma	6.0 ± 12.7	6.0 ± 12.5	0.86
Triage Levels I & II	8.6 ± 14.5	8.6 ± 13.6	0.98
Triage Levels III–V	5.8 ± 12.5	5.8 ± 12.4	0.79
No. of ED stays 24–48 h/d	13.8	9.1	< 0.001
No. of ED stays >48 h/d	5.5	3.0	< 0.001
Output			
No. of discharges	47,909 (67.9)	46,340 (66.5)	< 0.001
No. of admissions	20,946 (29.7)	21,757 (31.2)	< 0.001
No. of transfers to other hospital	299	312	0.52
No. of discharges against medical advice	1044	994	0.39

Data are presented as mean ± standard deviation, n, or n (%).

Table 3
Emergency department (ED) quality-related characteristics.

	Preintervention (n = 70515)	Postintervention (n = 69706)	p
No. of ED re-visits within 72 h	3220 (4.6)	3154 (4.5)	0.38
No. of OHCA patients	174	160	
No. of ROSC patients	56	60	0.44
Rate of ROSC (%)	32.2	37.5	0.56
No. of ED in-hospital mortalities	232 (0.3)	215 (0.3)	0.50

Data are presented as n or n (%), unless otherwise indicated.
OHCA = out-of-hospital cardiac arrest; ROSC = return of spontaneous circulation.

ED crowding is an ongoing issue in the emergency medical services field, and was noted as early as the 1980s.[20,21] As populations in developed countries age, an immense increase in the volume, complexity, and acuity of patients presenting to the ED has been observed.[22] During the past few decades, countries around the globe have experienced a surge in ED crowding, including both western and eastern countries alike.[2,23] Despite the prevalence and effect of ED crowding, most developed countries lack a coordinated national policy response.[2] According to previous studies, the overcrowding of EDs presents a number of serious consequences, including an increase in patient waiting times, a higher number of patients who self-discharge, poor quality of care, such as timely

Table 4
Demographic data for nontrauma adult patients.

	Preintervention (n = 56,826)	Postintervention (n = 56,109)	p
Total ED direct discharge or admission	40,976 (72.1)	41,863 (74.6)	
ED length of stay (h)			
Overall	2.9 ± 2.9	2.8 ± 2.7	< 0.001
Triage Levels I & II	3.1 ± 2.2	3.0 ± 3.0	< 0.05
Triage Levels III–V	2.9 ± 3.0	2.8 ± 2.6	< 0.001
No. of admission	12,217 (29.8)	12,915 (30.9)	< 0.05
Total ED observation	15,850 (27.9)	14,246 (25.4)	
Duration from triage to observation unit (h)			
Overall	4.4 ± 2.6	4.4 ± 2.6	0.61
Triage Levels I & II	3.3 ± 2.1	3.3 ± 2.1	0.65
Triage Levels III–V	4.9 ± 2.7	4.9 ± 2.6	0.09
Duration from observation unit to ED departure (h)			
Overall	26.0 ± 24.3	20.8 ± 18.7	< 0.001
Triage Levels I & II	24.0 ± 23.5	18.8 ± 16.9	< 0.001
Triage Levels III–V	26.9 ± 24.6	21.9 ± 19.5	< 0.001
No. of admissions	5043 (31.8)	4710 (33.1)	< 0.05

Data are presented as n (%) or mean ± standard deviation.
ED = emergency department.

antibiotics administration and reperfusion for patients with acute myocardial infarction, and increased inpatient LOS and in-hospital mortality.[24−28] ED crowding is worsening, demanding that hospital directors and policymakers realize the complexity of front-end hospital services and the impact it has on the larger *patient journey*. In the previous literature, several methods have been proposed to relieve ED crowding and its downstream effects, such as increased nursing scope of practice, physician-assisted triage, and medical assessment units.[29]

To reduce ED crowding, there are three basic approaches based on the demand−supply theory: reduce medical care demands, increase resources, or improve the match between demand and supply.[30] In reality, it is arduous to reduce medical care demands or to increase resources under the modern healthcare system. The number of hospital beds cannot be expeditiously or inexpensively increased, so the number of beds currently in the system must be managed more efficiently. Therefore, we offered a strategy concentrated on better matching and effective usage of impatient beds. The implementation of high-turnover ED utility beds with the firm restriction of a 48-hour course limit offers additional early admission opportunities for ED patients who need admission. This strategy forces other specialties to clear out space to take care of these patients in a timely manner, and manage their inpatient beds more effectively. In the postintervention period, these 14 high-turnover ED utility beds offered 1401 early admission opportunities. ED throughput and diversion status improved with the introduction of this active inpatient bed management.

The LOS calculation was based on all of the elements of the patient's stay in ED, including those who stayed who were awaiting admittance. The LOS shortening after intervention may be due to the waiting time for admission decrease, not due to the efficiency of ED management improvement. The average number of days patients stayed in ED > 24 hours decreased from 19 patients per day to 12 patients per day in this study, which demonstrates that the LOS decrease was affected by the decreased number of patients waiting for admission. However, the LOS of patients who did not need to be admitted was not significantly different between both periods, which would be a better indicator of throughput.

Our results show that the implementation of ED utility beds helps to reduce boarding time, primarily for cases involving adult nontrauma. Earlier literature has shown that ED crowding had the most profound effect on the patients of the trauma subset and infection subset.[8] One of the explanations for this surprising result is that a particular ED population was in this veteran's hospital, where the nontrauma-to-trauma ratio was 4:1 in adult patients. Although the trauma admission rate increased from 26.9% to 30.4% in the postintervention period, fewer trauma patients required considerable time spent on diagnosis, management, and consultation, which made the reduced boarding time less obvious. Our ED patients were older and most of them had more major comorbidities. The key step in nontrauma boarding time is the shortage of admission beds. This intervention offers more early admission opportunities to match demand and supply in such patients. Moreover, for adult nontrauma cases that require patient observation for clinical symptoms, treatment response, or disease clarification, this new strategy shortened the duration from observation units to ED departure, without changing the duration from triage to observation unit. This implies that we may be able to simplify the routine for those patients who need to enter observation units.

Our study has several limitations. First, data were collected via retrospective chart review, so some clinical presentations or records may not have been completely documented. Second, we used LOS as the primary outcome. While LOS is a key throughput factor, it can be affected by resources, such as the number of doctors and nurses per patient. The study result may have been confounded by these factors. Third, episodes of ambulance diversion for reasons other than ED saturation, such as hospital internal disaster or temporary lack of subspecialty or imaging services, were not excluded from this investigation. Fourth, although crowding in ED is related to input, throughput, and output, this intervention focused on the output part. Therefore, this study demonstrated an increased admission number after intervention (increased about 4% admission number). Additionally, this study is a historical control study. Therefore, the comparison is affected by the change of patient ED visit number (input) decreasing from 70,515 to 69,706, a decrease of approximately 1%. Lastly, there is also the possibility of other confounding factors that could not be measured, which emphasizes the fact that ED quality of care may depend on very complicated factors that are difficult to quantify.

In conclusion, the ED utility bed intervention offered more early admission chances and subsequently improved ED efficiency, with shortened ED LOS and fewer ambulance diversion hours. The great improvement in the reduction of ED boarding time affected mainly adult nontrauma patients. With the current health status and aging of the population, ED crowding might become a national crisis, gradually resulting in declining patient satisfaction, poor clinical care experience, and increased patient morbidity for specific conditions. This strategy could be one of the solutions to alleviate ED crowding. Ongoing data collection was still required to identify its influence on comprehensive quality of care and patient outcome.

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