Emergency department crowding: Factors influencing flow
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Chapter 11

Evaluation of a flexible acute admission unit: effects on transfers to other hospitals and patient throughput times

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ABSTRACT

Introduction
To prevent overcrowding of the emergency department, a flexible acute admission unit was created, consisting of 15 inpatient regular beds located in different departments. We expected the flexible acute admission unit to result in fewer transfers to other hospitals and in a lower length of stay of patients needing hospital admission.

Methods
A before-and-after interventional study was performed in a level 1 trauma centre in the Netherlands. Number of transfers and length of stay of admitted emergency department patients in a 4-month period in 2008 (control period) and a 4-month period in 2009 (intervention period) were analysed.

Results
Of 1,619 regular admission patients, 768 were admitted in the control period and 851 in the intervention period. The number of transfers decreased from 80 (10.4%) to 54 (6.4%) ($P = 0.004$). The emergency department mean length of stay of both the non-admitted patients and the admitted patients needing special care significantly increased (105 vs. 117 minutes, $P = 0.02$; and 176 vs. 191 minutes, $P < 0.001$ respectively). However, the mean length of stay of flexible acute admission unit-admissible patients was unaltered (226 vs. 225 minutes, $P = 0.87$).

Conclusions
The flexible acute admission unit reduced the number of transfers of admitted patients to other hospitals. The increase in length of stay for special care patients and non-admitted patients was not observed for regular, flexible acute admission unit-admissible patients. Flexible bed management might be useful in preventing overcrowding.
INTRODUCTION

Emergency department (ED) crowding because of constraints in capacity, is associated with decreased patient safety, increased 10-day inpatient mortality rates, long patient waits, and ambulance diversion [1-3]. Ambulance diversion may result in increased mortality rates [4]. Empirical evidence confirms that a lack of ready and available admitting beds contributes to the problem of ED crowding [4-6]. Although there are multiple causes of ED crowding, inadequate inpatient capacity seems to be the main cause [7-9]. The inability to move admitted patients from the emergency department to an inpatient bed forces the emergency department to board these patients until inpatient beds are available. Boarding leads to delays in the care of new patients [10,11].

Schneider et al. [12] concluded that rapidly transferring admitted patients from the emergency department to a hospital bed had the single greatest impact in alleviating ED crowding. Computer simulation modelling by Khare et al. [13] subscribed to this conclusion.

Our hospital has a ‘no diversion’ policy, accepting all incoming patients. Since 2006, we have had difficulty in obtaining inpatient beds for ED patients. Crowding of the ED patient treatment area and transfers to other hospitals for patients needing admission were common. This occurred despite submaximal hospital occupancy, mainly because specialists were reluctant to admit patients from other specialties on ‘their beds’. For example: a patient with rectal carcinoma had to wait in the emergency department until transfer to another hospital, despite enough available beds on other, non-oncology wards.

Dutch emergency departments do not experience overcrowding yet, but crowded conditions and ED throughput times are steadily increasing, including in our centre. To prevent this trend from continuing, we started using flexible bed management and created a flexible acute admission unit (FAAU). At least 15 potential FAAU beds divided over several departments were identified on a daily basis. The empty beds on every floor were changed into ‘FAAU’ beds from 4 p.m. until 8 a.m. the next day. During office hours, if necessary, emergency admissions were transferred from the FAAU beds to the departments where they belonged.

With this study, we tested the hypothesis that flexible bed management would lead to fewer transfers to other hospitals and to a lower length of stay (LOS) for ED patients needing hospital admission.
METHODS

Study design
We performed a before-and-after interventional study in an inner-city, level 1 trauma centre in the Netherlands with approximately 50,000 patient visits per year. We analysed all patients registered during off hours at our emergency department during a 4-month period in 2008 (control period) and a 4-month period in 2009 (intervention period). Patients who presented during weekends were excluded. The regional medical research ethics committee and the institutional review board approved the study.

Intervention
A FAAU was implemented, consisting of 15 inpatient regular beds during off hours. Eight months after implementation of the FAAU, an extra intervention was introduced to sustain its effect. An ‘admissions coordinator’ was appointed to pay regular visits to the admission floors to scout for empty beds.

Measurements
Transfers
In both periods, we counted the number of regular admission patients transferred to other hospitals.

Throughput
We measured throughput of ED patients by determining patient LOS, defined as the interval between patient registration and the moment the patient leaves the emergency department. Our group of interest was the ‘regular admission patients’ (n =1,619). These patients were not in need of special care (coronary care unit, cardiology, intensive care unit (ICU), stroke, obstetric, or paediatric care) and thus – in the intervention period - qualified for admission to a FAAU bed. We also report LOS for the non-admitted patients and for the admitted special care patients.

All data were collected from the hospital’s electronic database (ChipSoft, Amsterdam, the Netherlands).

Analysis
Data were transferred to PASW (Predictive Analytics Software, version 17, Chicago, Illinois, USA). Data validation comprised checking the data against medical records, complementing missing data, and inspecting the outliers in LOS for their correctness.
We used the $\chi^2$ statistic to test the difference in the relative frequencies in number of transfers to other hospitals between the control period and the intervention period. The difference in mean LOS between both periods was tested by use of a 2-tailed, unpaired $t$ test. Length of stay data were corrected for patient age, triage code and patient census by use of multivariable linear regression. Residuals were inspected for their approximate normality to check the assumptions of the regression model.

**RESULTS**

In total, 17,308 patients visited our emergency department, of whom 8,377 were seen in the control period and 8,931 in the intervention period. Of those patients, 1,130 patients needed hospital admission in the control period and 1,271 needed admission in the intervention period. There were 792 special care patients, leaving 1,619 FAAU-eligible patients ($n = 768$ in the control period and $n = 851$ in the intervention period) ('regular admission patients') (Figure 1). The inpatient mortality rate in regular admission patients was similar for the control period (6.8 in 1,000) and the intervention period (6.4 in 1,000).

![Patient flow scheme](image)

**Figure 1.** Patient flow scheme
Table 1 summarises the characteristics of all patients visiting the emergency department in the control and intervention periods. There were negligible differences in distribution of age, medical specialty, triage code and type of admission (regular admissions and special care admissions) between the control and intervention periods, although some differences were statistically significant because of the large sample size.

Table 1. Patient characteristics

<table>
<thead>
<tr>
<th>Observation period</th>
<th>Control period (n = 8,377)</th>
<th>Intervention period (n = 8,931)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean age (SD) (y)</strong></td>
<td>35.65 (21.04)</td>
<td>35.41 (21.25)</td>
</tr>
<tr>
<td><strong>Medical specialty [n (%)]</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiology</td>
<td>631 (8)</td>
<td>687 (8)</td>
</tr>
<tr>
<td>Neurology/neurosurgery</td>
<td>612 (7)</td>
<td>687 (8)</td>
</tr>
<tr>
<td>Internal medicine&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1,522 (18)</td>
<td>1,777 (20)&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>Surgery</td>
<td>4,309 (51)</td>
<td>4,374 (49)&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>Paediatrics</td>
<td>198 (2)</td>
<td>302 (3)</td>
</tr>
<tr>
<td>Gynaecology</td>
<td>438 (5)</td>
<td>417 (5)</td>
</tr>
<tr>
<td>Other&lt;sup&gt;2&lt;/sup&gt;</td>
<td>650 (8)</td>
<td>686 (8)</td>
</tr>
<tr>
<td>No specialism assigned</td>
<td>17 (0)</td>
<td>1 (0)</td>
</tr>
<tr>
<td><strong>Triage code [n (%)]</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red, immediate</td>
<td>40 (1)</td>
<td>62 (1)</td>
</tr>
<tr>
<td>Orange, very urgent</td>
<td>1,147 (14)</td>
<td>1,322 (15)</td>
</tr>
<tr>
<td>Yellow, urgent</td>
<td>2,806 (34)</td>
<td>2,770 (31)&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>Green, standard</td>
<td>3,829 (46)</td>
<td>4,227 (47)&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>Blue, non-urgent</td>
<td>92 (1)</td>
<td>112 (1)</td>
</tr>
<tr>
<td>No triage category assigned</td>
<td>463 (6)</td>
<td>438 (5)</td>
</tr>
<tr>
<td><strong>Admissions [n (%)]</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not admitted</td>
<td>7,237 (86)</td>
<td>7,660 (86)</td>
</tr>
<tr>
<td>Regular admission</td>
<td>768 (9)</td>
<td>851 (10)</td>
</tr>
<tr>
<td>Special care admission</td>
<td>372 (4)</td>
<td>420 (5)</td>
</tr>
</tbody>
</table>

* P < 0.05
1) Including gastroenterology and pulmonary medicine.
2) Including dermatology, ophthalmology, oral and maxillofacial surgery, otolaryngology, plastic surgery, psychiatry, radiology, rehabilitation medicine, rheumatology, and urology.
**Transfers**

The number of patients who were transferred to other hospitals because there was no available bed decreased from 80 of 768 (10.4%) in the control period to 54 of 851 (6.4%) in the intervention period ($P = 0.004$). If we exclude transfers to the other location of our hospital, the number of transfers decreased from 10 of 768 (1.30%) in the control period to 1 of 851 (0.12%) in the intervention period ($P = 0.004$). The results of both methods of calculation were significant.

**Throughput**

For the 14,897 patients who did not need to be admitted (of the total 17,308), the mean LOS in the intervention period was significantly higher than the mean LOS in the control period (117 minutes vs. 105 minutes, $P < 0.001$) (Table 2). In addition, for the 792 special care patients (patients that could not be admitted to an FAAU bed), the mean LOS was significantly higher in the intervention period (191 minutes vs. 176 minutes, $P = 0.02$). For patients admissible to an FAAU-bed, this increase in LOS did not occur. The mean LOS of the 1,619 regular admission patients – eligible for an FAAU bed - did not significantly differ between the intervention period (2009) and the control period (2008) (226 minutes vs. 225 minutes, $P = 0.87$).

Correction for patient age, triage code, and patient census by use of multivariable linear regression did not alter these results in a noteworthy manner.

**Table 2.** Length of stay of non-admitted patients, regular admission patients (FAAU), and special care patients during the control period and the intervention period

<table>
<thead>
<tr>
<th></th>
<th>Control period (n = 8,377)</th>
<th>Intervention period (n = 8,931)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LOS in minutes</td>
<td>LOS in minutes</td>
</tr>
<tr>
<td>Non-admitted patients</td>
<td>105</td>
<td>117*</td>
</tr>
<tr>
<td>Regular admission patients (FAAU) (n = 1,619)</td>
<td>225</td>
<td>226</td>
</tr>
<tr>
<td>Special care admission</td>
<td>176</td>
<td>191*</td>
</tr>
</tbody>
</table>

* $P < 0.05$

**DISCUSSION**

The instalment of the FAAU reduced the amount of transfers of admitted patients to other hospitals. The increase in LOS for special care patients and non-admitted patients was not observed for regular, FAAU-admissible patients, suggesting that the FAAU prevented ED crowding from increasing.
According to the American College of Emergency Physicians, moving admitted ED patients out of the emergency department to inpatient areas is a high-impact solution to reduce boarding and improve ED patient flow [14]. When inpatient beds are not available, patient flow barriers continue for those admitted [15], so it is imperative to match inpatient capacities to the number of ED admissions. Because the influx of patients into emergency departments is reasonably predictable [16], the number of inpatient beds needed can be assessed in advance. In our centre, on average, ten patients per day are admitted on regular floors during off hours. The assignment of 15 FAAU beds per day during off hours resulted in a substantial decrease in patient transfers to other hospitals.

Various measures exist to alleviate boarding. One is to create special waiting units (e.g., clinical decision units, short-stay units, or acute admission units) for these patients [17-19]. Another strategy is to send admitted patients up to the units’ hallways until a bed is available, instead of boarding these patients in the halls of the emergency department. This is called the ‘adopt-a-boarder’ or ‘full-capacity’ approach to ED crowding [16,20-22]. The boarding of ED patients becomes a hospital problem as opposed to an ED problem [23] and motivates physicians and staff to make beds available because their awareness of crowded conditions grows [24]. The FAAU is a combination of both strategies.

It is difficult to compare our results with those of other studies on the effect of ‘real’ (centralised) acute admission units on LOS. In a US hospital, Buckley et al. [17] determined the impact of an express-admit ED unit on median LOS and found a 10% improvement (from 8 hours 21 minutes to 7 hours 41 minutes for all admitted patients). Hong et al. [22] found a significant decrease in ED LOS of 62 minutes between patients admitted to an express-admit unit and non-express-admit unit patients (9 hours 47 minutes vs. 8 hours 45 minutes). Bazarian et al. [25] showed that implementing a short-stay unit shortens LOS not only for admitted patients but also for certain groups of patients who were discharged home. Buckley et al. found a small improvement (4%) in LOS for discharged patients as well (from a median of 3 hours 41 minutes to 3 hours 35 minutes) [17]. Our LOS for discharged ED patients did not decrease but increased and so did the LOS for special care patients. We believe this is the effect of crowding and expect the overall mean LOS to increase further. For a few years, we have struggled with a shortage of beds in the emergency department and a sharp increase in the number of patients registering for treatment. The FAAU would only affect the regular admitted patients and not the special care patients and discharged patients.
Contrary to some other European countries and in the United States, ED crowding is a relatively recent problem in the Netherlands. Although the ED of our centre is one of the busiest emergency departments in the Netherlands, its mean LOS (<2 hours) is shorter than that in many other countries. Valuable lessons can be learned from these countries in the prevention of ED crowding, because various approaches, such as observation units and hospital bed access, have been evaluated extensively [26].

A direction for further research would be to assess the cost-effectiveness and long-term effects of the FAAU and to compare these with the effects of regular acute admission units or other holding units.

Limitations
Because of our quasi-experimental design, this study has various limitations. First, although a causal relationship between instalment of the FAAU and the number of transfers or LOS is likely, it is difficult to prove such a relationship. Although we corrected for age of patients, triage code, and patient census, we could not correct for physician and nursing staffing and clinical experience level of staff between the control and intervention periods because we did not have these data. However, to our knowledge, no substantial changes in staffing, protocols, or processes occurred. Other sources of unmeasured variability may be related to laboratory and radiology turnaround times, number of intensive care patients in the emergency department, number of resuscitations, response times of consulted physicians, diagnosis, comorbid diseases, consultation rate, and other factors that may have complicated the evaluation process, making it more time-consuming. These variables may all affect LOS and probably have contributed to the small observed decrease in LOS between the control and intervention periods. This finding is in line with other reports on the increase in complexity and acuity of patients presenting to emergency departments [1,9].

Second, weekends and office hours were excluded, because the FAAU was in function only during off hours on weekdays.

A final limitation regards external validity, because our study was performed at a single centre.
Implications for emergency nurses
With the start of the FAAU, maximal bed flexibility was expected. Beds that otherwise were ‘empty for admission the next day’, or ‘from another specialty’ but were equipped and staffed, were assigned for acute admissions. Thus, admitted patients from most specialties could be directly transferred from the emergency department to other floors. The new procedure was implemented hospital wide, with high commitment of inpatient nursing wards. Hospital admission processes are often time-consuming and a source of patient and staff dissatisfaction [27]. For the ED nurses, ‘finding a bed’ is demanding, especially during off hours [28]. Despite the fact that the ED LOS stayed the same for the regular patients, ED nurses are very pleased with the flexible bed arrangements, knowing that there is always a bed available for their patient and often no transfer to another hospital is needed. Emergency department crowding is not just an ED problem and requires a systematic facility-wide multidisciplinary response [29]. Recognition of that insight by our hospital management led to the flexible bed arrangement. The ED nurses feel supported in their battle against ED crowding, because the entire hospital contributes to the ED flow.

CONCLUSION

In our hospital the implementation of the FAAU helped alleviate ED crowding by reducing boarding of regular admission patients waiting for transfer and by preventing an increase of ED LOS of these patients.
REFERENCES


