Impact of Critical Bed Status on Emergency Department Patient Flow and Overcrowding

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Abstract

Objective: To compare measurements of emergency department (ED) patient flow during periods of acute ED overcrowding and times of normal patient volume (NPV). **Methods:** Retrospective ED chart review comparing ED flow for patients treated in a tertiary care teaching hospital during periods of ED overcrowding, defined as critical bed status (CBS), and NPV. All periods of CBS during July 2001 were identified. CBS time intervals were matched with NPV times by month, day of the week, time of day, and number of care providers. All patients registered during these matched time intervals were reviewed. Times were collected for each of the following activities: check-in, bed placement, physician assessment, first intervention, and disposition. Corresponding intervals were calculated in minutes. Triage category was used as a marker of illness severity (1 = most severe, 5 = least severe). Descriptive statistics were performed. **Results:** One hundred eighteen patient charts were reviewed: 61 CBS and 57 NPV. There was no statistical difference in illness severity between the two groups. In the cumulative analysis, patients waited significantly longer for an ED bed (30.4 min, $p = 0.01$) but did not experience significant delays in other intervals. Triage category analysis revealed no significant difference in triage 2 patients. Intermediate-severity patients (triage 3) waited longer in every interval and significantly longer for physician assessment (30.8 min longer, $p < 0.05$). Low-severity patients (triage 4) waited longer for an ED bed (40 min, $p = 0.02$) but did not experience other significant delays. **Conclusions:** During times of acute overcrowding, the most significant delay occurs awaiting placement in the ED bed.
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Emergency department (ED) overcrowding has reached epidemic proportions nationwide.[1] Overcrowded EDs have been linked to diminished patient satisfaction,[2] decreases in health care quality, and higher patient mortality.[3] Reasons for ED overcrowding are myriad[4]; although anecdotal evidence of ED overcrowding is easy to recognize—patients in hallways, crowded waiting rooms, harried physicians and staff—it is difficult to quantitatively define. Yet, in EDs across the country, patients are waiting longer and longer.

What happens to ED systems during times of overcrowding is poorly understood. This lack of information has limited the application of systems-wide quality improvement measures. To identify areas likely to benefit from systems improvement measures, we undertook this pilot study to evaluate ED flow patterns during periods of normal patient volume (NPV) and acute overcrowding.

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METHODS

Study Design. We conducted a retrospective chart review of all patients evaluated during times of acute ED overcrowding and matched times of NPV during July 2001. In our ED, departmental overcrowding is indicated by the designation ''ED critical bed status'' (CBS). CBS is defined by ED policy as: a department overwhelmed by triage level 1 and 2 (severe) patients, inadequate stretcher space for additional critical or stretcher patients, or reasonable anticipation of multiple injured patients. The beginning and ending times of CBS are documented in the ED log by the administrative attending physician. CBS is defined according to departmental status, not shift or time of day; it can represent any time interval when the department meets the CBS criteria. All times not documented to be CBS were considered to be times of NPV. The university institutional review board approved the study.

Study Setting and Population. This study was performed in a tertiary care university-based Level 1 teaching hospital with an annual adult ED census of 60,000 patient visits and an emergency medicine residency training program. All patients triaged to the acute care section during times of CBS and its matched time period of NPV were reviewed. Patients already in the department and under evaluation at the time CBS was declared were not reviewed. Two triage categories were excluded from the analysis. First, triage level 5 patients are evaluated in a low-acuity treatment area of the ED and thus excluded from this study. Second, only one triage level 1 patient presented to the department during the study interval; therefore, no comparison interval could be calculated, and this patient was excluded.

Individual patient demographics such as race, sex, and age were not acquired. Rather, the Emergency Severity Index (ESI) triage categories 1 through 5, with 1 being most severe, were used as a surrogate marker of patient acuity and utilization of ED resources. ESI uses the predicted resources the patient will require while in the ED as a portion of the criteria for triage. The reliability and validity of this five-level triage system have been established at the study site.[5,6]

Study Protocol. We identified all times of ED CBS during the month of July 2001, and matched these with times of NPV. The criteria for time interval matching were: month, day of the week, time of day, and number of ED physician and nurse providers. All patient triaged into the department during the matched time interval were considered in the study data collection. Time intervals for patients already in the department at the time of CBS declaration were not collected. Time data were abstracted from ED charts and the clinical information system (CIS), which is a computerized medical record. Times were recorded for the following actions: patient check-in, placement in a treatment room, physician assessment, first intervention (either blood draw, imaging, or consultant called), and disposition (see Table 1 for complete definitions).

Data Analysis. All data were compiled anonymously and results tabulated. Data collection was performed by one investigator (SL) who was trained in review and analysis of the ED record and CIS. Reliability of the data collection was ascertained by a small review of selected charts by one senior investigator (CH) to determine agreement in data collection. Time between each event was calculated; along with cumulative ED length of stay (LOS) after placement in the ED bed. Comparisons between CBS and NPV were made for each time interval, both cumulatively and stratified by individual triage category.

Statistical analysis was performed using SAS (Statistical Analysis Software, Cary, NC). For the cumulative time interval analysis, statistical difference between the two groups was calculated using the t-test. Differences between time intervals in each individual triage category were evaluated using the Wilcoxon rank sum test. The distribution of triage categories among CBS vs. NPV was evaluated using the Cochran-Mantel-Haenszel statistic. Statistical significance was defined as $p < 0.05$.

RESULTS

One hundred eighteen patient charts were reviewed: 61 CBS and 57 NPV. There was no statistical difference in the distribution of patient triage categories between the two groups, with a nonzero correlation value of 1.66 and $p = 0.1973$. The secondary review of data collection in a subset of charts revealed 100% agreement between the two data collectors. Study intervals were widely distributed through all days of the week and times of the day. There was no clear pattern in the likelihood of CBS occurrence.

All time intervals and the differences between intervals are presented in Table 2. In the cumulative analysis, patients seen during CBS experienced

TABLE 1. Category of Activity and Definitions of the Time Intervals Studied

Category	Definition
Patient check-in	First time stamp on triage entry log.
Placement in a treatment room	Time documented on nursing notes by nursing assistant when patient is transported and placed into treatment room.
Physician assessment	Any one of the following three time points could be used. The hierarchy of utilization was: 1. Time documented by physician as ``time of assessment.'' 2. Time documented by nursing as ``physician at bedside.'' 3. Time of physician orders.
First intervention 1. Blood draw/specimen 2. Imaging 3. First consultation	Time recorded as: 1. Laboratory specimen ``draw time'' or specimen acquisition recorded in CIS.* 2. Imaging time = computerized time stamp from radiology bar-coded dictation system recorded in CIS. 3. First consultation = time recorded as ``consult called'' on physician record.
Disposition	Time of physical discharge from the department performed by the nurse and recorded in nursing notes.

*CIS = clinical information system.

TABLE 2. Total Mean Measured Time Intervals (Minutes) and Differences in Time Intervals: Normal Patient Volume (NPV) vs. Critical Bed Status (CBS)

	Cumulative			Triage 2			Triage 3			Triage 4		
	NPV	CBS	Diff	NPV	CBS	Diff	NPV	CBS	Diff	NPV	CBS	Diff
Check-in to room	33.3	63.7	30.4 (p = 0.01)	34.4	37.4	3.0	47.3	78.7	31.4	14.4	54.4	40.0 (p = 0.02)
Room to physician	22.7	35.2	12.5	28.1	18.7	−9.5	18.5	49.3	30.8 (p = 0.02)	25.7	31.2	5.5
Orders to first intervention	31.7	22.5	−9.2	29.4	16.3	−21.1	31.5	29.7	38.2	38.3	13.3	−20.0
First intervention to disposition	178.4	207.5	29.1	218.9	262.6	43.8	174.2	241.4	67.2	91.6	97.9	6.3
Length of stay	217.7	255.2	37.5	293.3	316.9	23.6	224.8	310.1	85.3	124.4	120.4	4.0

a 30.4-minute longer wait for an ED bed ($p < 0.01$). Once placed in a bed, patient ED flow characteristics did not statistically differ during CBS.

Analysis of patient flow by individual triage category revealed several interesting trends. Patients with higher-acuity problems (triage 2) did not experience delays in bed placement during CBS. In fact, once in a bed, they were seen by a physician 9.5 minutes faster, and the first intervention was performed 21.1 minutes faster than during NPV. However, these patients still experienced a 43.8 min longer time to disposition despite a more rapid achievement of all other intervals.

During CBS, intermediate-acuity patients (triage 3) waited longer in all time intervals and significantly longer to be seen by a physician (30.8 min, $p = 0.02$). Interestingly, lower-acuity patients (triage 4) had an extended wait for an ED bed, 40 minutes ($p = 0.02$). However, this delayed the time to disposition by only 6.3 minutes and the LOS by only 4 minutes.

DISCUSSION

Emergency department overcrowding is well recognized as a national problem,[4,7–9] and a number of hypotheses have been proposed to determine its causes. Some of these reflect changes beyond the scope of individual hospital control, such as increasing acuity of patients, managed care, and increases in elder patients.[4,9,10] Other causes are intrinsic to each hospital system and include unavailable inpatient beds and nursing shortages.[4] Others are specific to individual EDs, e.g., the use of "intensive therapy" to avoid admission.[4,10]

Chan et al. quantified variables that impact ED patient throughput time.[11] They determined ED throughput time was significantly impacted by daily census, pediatric volume, ambulance arrivals, and patient admissions. Other commonly assumed factors, such as nursing hours worked and day of the week, were not significant.[11]

The current study analyzed how ED throughput time changes during periods of rapidly expanding ED census and acutely overcrowded conditions. These periods of CBS represent a very different ED environment from times of NPV. The study controlled for time of day and day of the week and eliminated variables such as staffing variances, pediatric volume, and patient acuity.

Our cumulative results suggest that during times of CBS, most patients experience their most significant delay waiting for an ED bed. Once placed in a bed, there are no significant differences between time intervals while in the ED. Although not statistically significant from times of NPV, it should be noted that the delay in disposition is nearly identical to the increase in the ED LOS (bed to disposition). Further, the increase in LOS closely mirrors the delay experienced in obtaining an ED bed. Thus, in this ED equation, "steady state" has occurred: (check-in to bed = first intervention to disposition = LOS). Therefore, simple improvements in disposition, such as changes in hospital policy to provide accelerated admissions to hospital wards, could improve the waiting time for ED beds, and result in improved throughput times.

Our stratified analysis suggests that at the extremes of patient acuity, enhanced efficiencies in care delivery may occur. Evaluation and treatment of sicker patients, triage level 2, and lower-acuity patients, triage level 4, were initiated more quickly than those of intermediate-severity, triage level 3, patients. Intermediate patients also waited substantially longer for orders to be performed and for final disposition. This indicates that ED staff may change their work patterns during periods of acute overcrowding, based on patient illness severity. We believe this represents an attempt to achieve patient disposition more quickly. Patients at both extremes of illness severity are treated more rapidly because decisions to admit and discharge can be achieved rapidly. A more extensive evaluation of this change in work patterns may provide important insights for systems-wide quality improvement methods.

LIMITATIONS

This study has several important limitations. First, the small sample size and single study site limit its generalizability. Future studies should include larger sample sizes and be performed at multiple sites. This study was conducted for a single month, July, in a teaching institution, when new trainees join the medical staff. This may have influenced our throughput times, but should have done so equally for both groups. We also did not account for potential differences in final disposition, such as admission vs. discharge to home, but we know that statistically the groups were of similar levels of acuity.

Our study indicates a need for further studies comparing ED function in institutions with innovations such as ED observation units and rapid patient admission protocols. Future studies should specifically evaluate the observed changes in staff work patterns to identify potential measures that may enhance the delivery of efficient care and determine whether safe and effective care is being compromised.

CONCLUSIONS

During times of acute ED overcrowding, patients experience their most significant delay waiting for an ED bed. Improvements in achieving patient disposition are most likely to result in enhanced ED throughput times. Additional studies of this type will be important in determining what systems improvement measures are likely to be effective in improving patient throughput times during periods of severe ED overcrowding.

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