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Tracking Emergency Department Overcrowding in a Tertiary Care Academic Institution

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Abstract

Despite the release of a national report describing key markers of emergency department (ED) overcrowding, limited linear data using these markers have been published. We sought to report the degree and trends of ED overcrowding in a typical academic hospital and to highlight some of the key markers of ED patient flow and care. We conducted a prospective study in a large Canadian urban tertiary care teaching hospital that receives approximately 55,000 annual adult ED visits. A database captured demographic and real-time process of care data for each patient from 2000 to 2007. Descriptive data are reported using Canadian Triage and Acuity Scale (CTAS) scores.

Over the study period, the ED patient visit volume and presentation times remained predictable. Emergent cases (CTAS levels 1–2) doubled from 8 to 16.6%, and urgent cases (CTAS level 3) increased from 40.2 to 50.3%. Moreover, semi-urgent presentations (CTAS level 4) decreased from 42.4 to 28.8%, and non-urgent cases (CTAS level 5) dropped from 9.4 to 4.3%. The median wait time from triage to bed location increased from two minutes (inter-quartile range [IQR] 1, 46) in 2000 to 27 minutes (IQR 2, 110) in 2007, while the median time from bed location to physician remained constant (29 minutes in 2001 versus 28 minutes in 2007). Overall, admissions increased from 20.4 to 23%. Semi-urgent and non-urgent admissions dropped from 11.5 to 7.4% and 3.2 to 1.8%, respectively. Admitted patients "boarding" in the ED increased from 70,955 hours in 2002 to 118,741 hours in 2007, while the number of emergent and urgent patients leaving without being seen increased by more than 400%.

ED overcrowding in a tertiary care hospital is primarily a result of access block due to boarding admitted patients, a situation that poses serious risks to the majority of patients who have emergent or urgent conditions that cannot be managed appropriately in the waiting room.

Emergency department (ED) overcrowding has been a concern for many years in both Canada and the United States. In the 1980s and 1990s, US ED physicians reported on the problems caused by delays in getting their admitted patients transferred from the ED to in-patient wards (Andrulis et al. 1991; Gallagher and Lynn 1990). Overcrowding is an increasingly severe impediment to access to emergency care in Canada, causing loss of patient privacy and confidentiality, delays in receiving care and time-sensitive treatments, patient departure prior to the completion of care and staff and patient dissatisfaction. Researchers have identified admitted patients in the ED ("boarding" patients) as the leading determinant of ambulance diversions and ED overcrowding (Schull et al. 2003). In fact, it is currently the number one advocacy issue of the Canadian Association of Emergency Physicians (CAEP 2008).

A report commissioned by the Canadian Agency for Drugs and Technologies in Health (CADTH) in 2006 on ED overcrowding outlined key measures of ED overcrowding (Rowe et al. 2006a). In a survey of Canadian ED directors, 62% reported overcrowding as a major problem over the previous year, and this was more prevalent in cities of >150,000 people, large-volume centres and university or university-affiliated hospitals. ED patient flow is a combination of pressures: input (how patients come to the ED), throughput (time spent in the ED receiving assessment and therapy) and output (where patients go after leaving the ED) (Asplin et al. 2003). For many years, administration and government leaders, often supported by the media, portrayed ED overcrowding as misuse by patients with minor complaints abusing the system (suggesting an input problem). In the CADTH report, however, ED directors identified the top five causes of ED overcrowding as (1) lack of admitting beds, (2) lack of acute care beds, (3) ED

length of stay for admitted patients, (4) increased complexity or acuity and (5) occupancy rates of ED stretchers (primarily caused by output failure).

One of the major findings of the CADTH report was that there was infrequent collection of comprehensive data regarding ED encounters at provincial and national levels (Rowe et al. 2006b). In March 2000, the University of Alberta Hospital introduced an Emergency Department Information System (EDIS) database that time stamps and captures a number of key work processes in real time. While much has been written on ED overcrowding, there are limited linear real-time data published using the key markers of ED overcrowding identified in the CADTH report. Consequently, we sought to explore the degree of ED overcrowding in an academic tertiary care hospital and to highlight key markers of ED patient flow and care for this setting.

Methods

Study Design

This was a prospective study and analysis of an EDIS database that has captured demographic and work process data for each ED patient in real time and stored it in an Oracle database (Oracle Corporation, Redwood Shores, CA) since its implementation in March 2000. These data were secured in aggregate form and analyzed looking at ED overcrowding trends based on the markers outlined in the CADTH report.

Study Setting and Population

This study was conducted in a large Canadian urban tertiary care teaching hospital that functions as a regional trauma, burn, neurosciences, cardiac and transplant centre for Northern Alberta and surrounding provinces and territories, and that receives 50,000–55,000 annual adult ED patient visits. The ED has 55 treatment spaces for adult patients composed of six resuscitation stretchers, 14 critical care treatment stretchers, 16 acute care stretchers, three psychiatric treatment spaces, 11 fast track spaces and five special assessment spaces (i.e., two gynecological examination rooms, two ear, nose and throat [ENT] and eye rooms and one cast room). The ED has 26 computers in the triage and adult clinical areas accessible to clinical users to input patient care and work process data.

Staffing

The ED is staffed 24 hours per day by physicians who practice full-time emergency medicine (EM) and are either fellows of the Royal College of Physicians and Surgeons of Canada or are certified through the College of Family Physicians of Canada in EM. EM physician coverage increased from 57 hours per day in 2000 to 73 hours per day in 2007. A number of medical students and residents are assigned daily to EM preceptors to receive supervision and teaching during their ED rotations.

Variables

Patient demographics (e.g., age and sex) and ED arrival information (e.g., ambulance, car, self) are collected by triage and registration staff on all patients. Triage is used in EDs to prioritize patients on arrival based on their acuity level and risk in an effort to provide patient safety and limit patient suffering by balancing demand and resources. The Canadian Triage and Acuity Scale (CTAS) is the recognized national standard (Beveridge 1998). A CTAS score of 1 indicates a patient requiring resuscitation with immediate physician assessment advised; a score of 2 is considered emergent, and physician assessment is advised within 15 minutes; a score of 3 is considered urgent, and physician assessment is advised within 30 minutes. CTAS scores of 4 and 5 are less urgent, and physician assessment is advised within 60 and 120 minutes, respectively (Beveridge 1998). In 2004, the CTAS guidelines were revised, and nurse reassessment within these same acuity-based timelines was considered acceptable if EDs were too busy for physicians to meet those requirements (Murray et al. 2004).

Study Variable Measures

Input measures included patient volumes and acuity as recorded based on triage scores. *Throughput measures* included time intervals from triage to ED treatment space placement, time to being seen by a physician, time to consultation and time to discharge or bed request. *Output measures* included time from bed request to transfer to the ward for admitted patients (boarding time) and percent and acuity of patients leaving without being seen (LWBS).

Statistics

Descriptive data are presented as proportions for categorical variables and medians with inter-quartile ranges (IQR) as continuous variables were non-normally distributed. All analyses were performed using Stata Statistical Software, Release 10.0 (Stata Corporation, College Station, TX). Bivariable analyses for dichotomous variables were performed by chi-square tests for trend. Analyses for continuous variables were performed using the Kruskal-Wallis test. As this database includes a considerable number of registries (N = 362,488), inconsistencies were considered as missing values during the analyses: 119 (0.03%) in triage-to-physician times, 79 (0.02%) in triage-to–bed location times, 50 (0.01%) in bed location–to-physician times and 5,346 (1.47%) in boarding times.

Ethics

This study was approved by the University of Alberta Health Research Ethics Board and administratively approved by the University of Alberta Hospital (previously part of Capital Health and currently part of Alberta Health Services). Physicians and staff were not aware of the study during the period examined.

Results

Input

Since 2001, the number of annual adult ED visits has remained constant (range 51,674–52,858), leading to a consistent and highly predictable patient presentation rate for each hour of the day (Figure 1). Patient acuity, however, has changed significantly. Emergent cases (CTAS levels 1 and 2) doubled from 8 to 16.6%, and urgent cases (CTAS level 3) increased from 40.2 to 50.3%. Over the same period, semi-urgent presentations (CTAS level 4) decreased from 42.4 to 28.8% and non-urgent cases (CTAS level 5) dropped from 9.4 to 4.3% ($p < .0001$) (Figure 2).

Throughput

From 2001–2002 to 2006–2007, the median wait time from triage to treatment space increased from two minutes (IQR 1, 46) to 27 minutes (IQR 2, 110) for all patients, and from two minutes (IQR 1, 15) to 36 minutes (IQR 2, 130) for CTAS level 3 patients. During that time, the median response time from bed location to physician for all patients decreased from 29 minutes (IQR 10, 54) to 25 minutes (IQR 7, 52) in 2005–2006 before increasing to 28 minutes (IQR 7, 57) in 2006–2007. For CTAS level 3 patients, the median bed location–to-physician times were consistently 30–32 minutes until 2006–2007, when they increased to 33 minutes. With CTAS level 3 patients accounting for nearly 50% of the patients, their response times are often considered a marker of ED flow. Figure 3 illustrates the increase in combined median triage-to-physician wait times, maximal for those presenting between 14:00 and 16:00 each day ($p = .0001$).

Output

Despite stable ED volumes since 2001, the rising acuity has seen the admission rate increase from 21 to 23.0% (Figure 4), while admission rates by triage score have remained consistent (79% for CTAS level 1, 47% for CTAS 2 and 25% for CTAS 3). Semi-urgent and non-urgent admissions dropped from 11.5 to 7.4% and 3.2 to 1.8%, respectively.

Figure 1. Annual hourly adult patient presentation rates to emergency department, 2000–2007

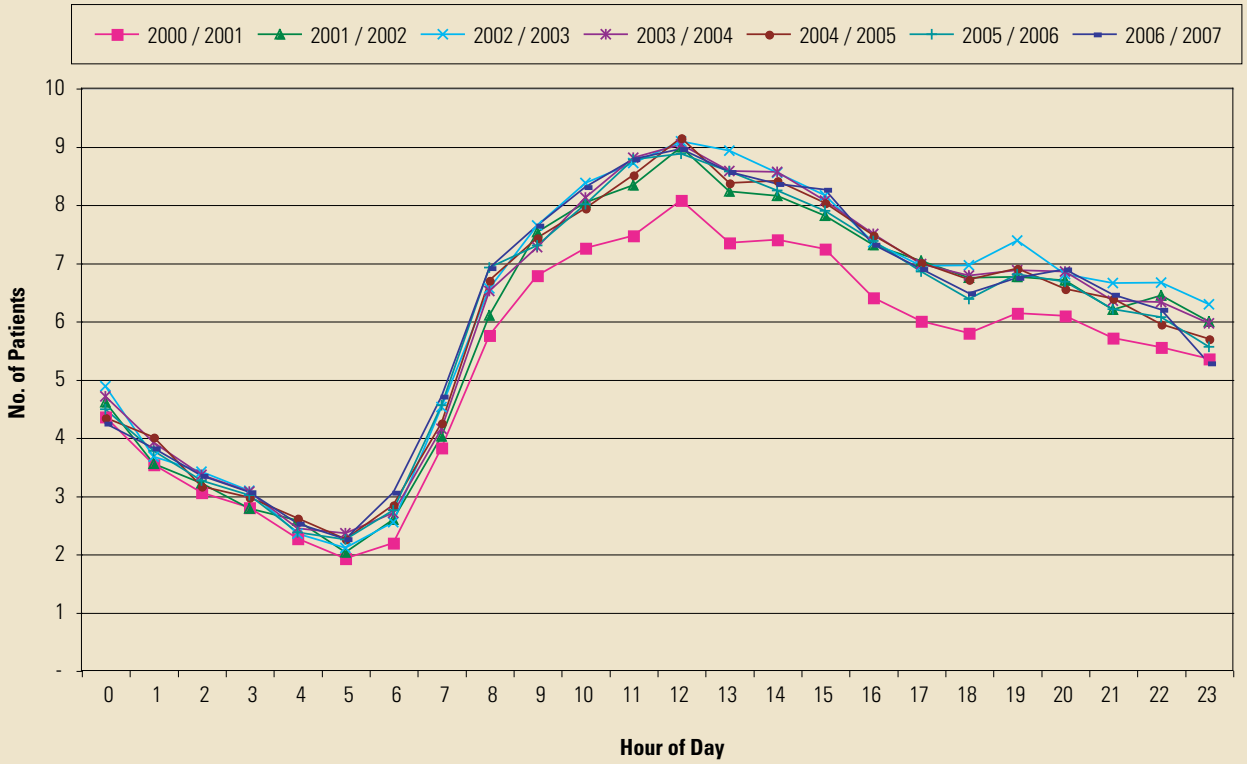
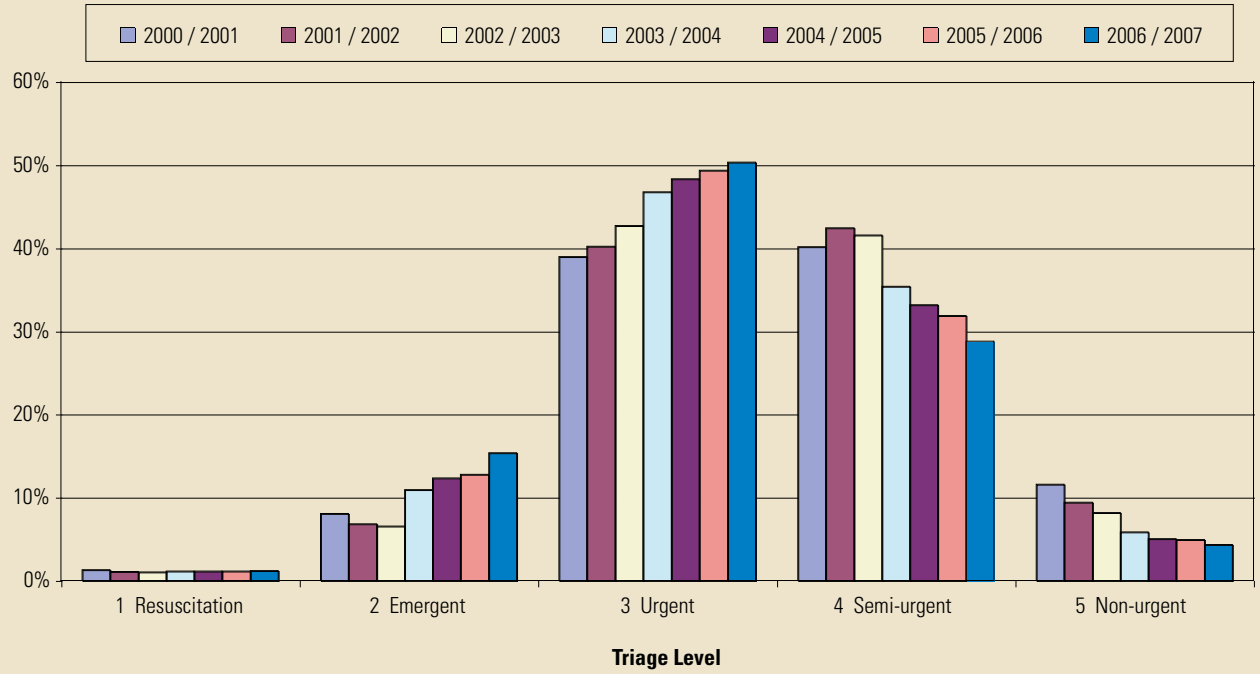
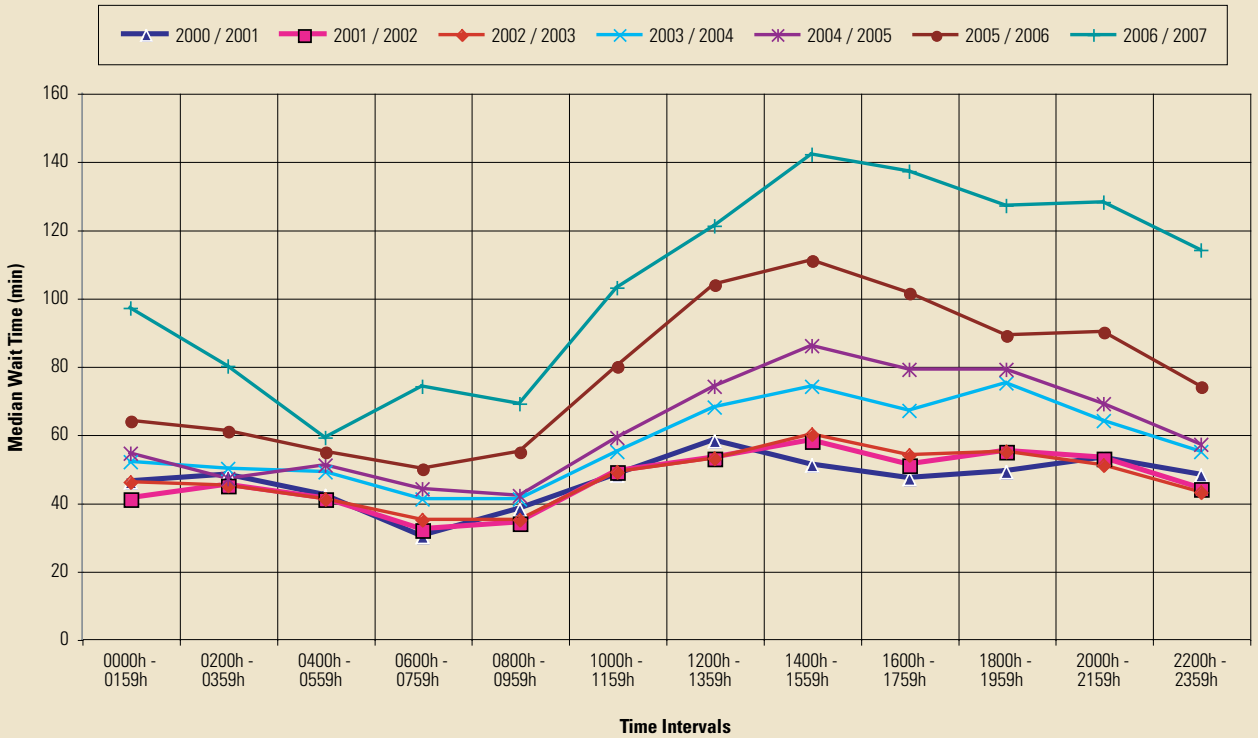


Figure 2. Changes in emergency department acuity, 2000–2007



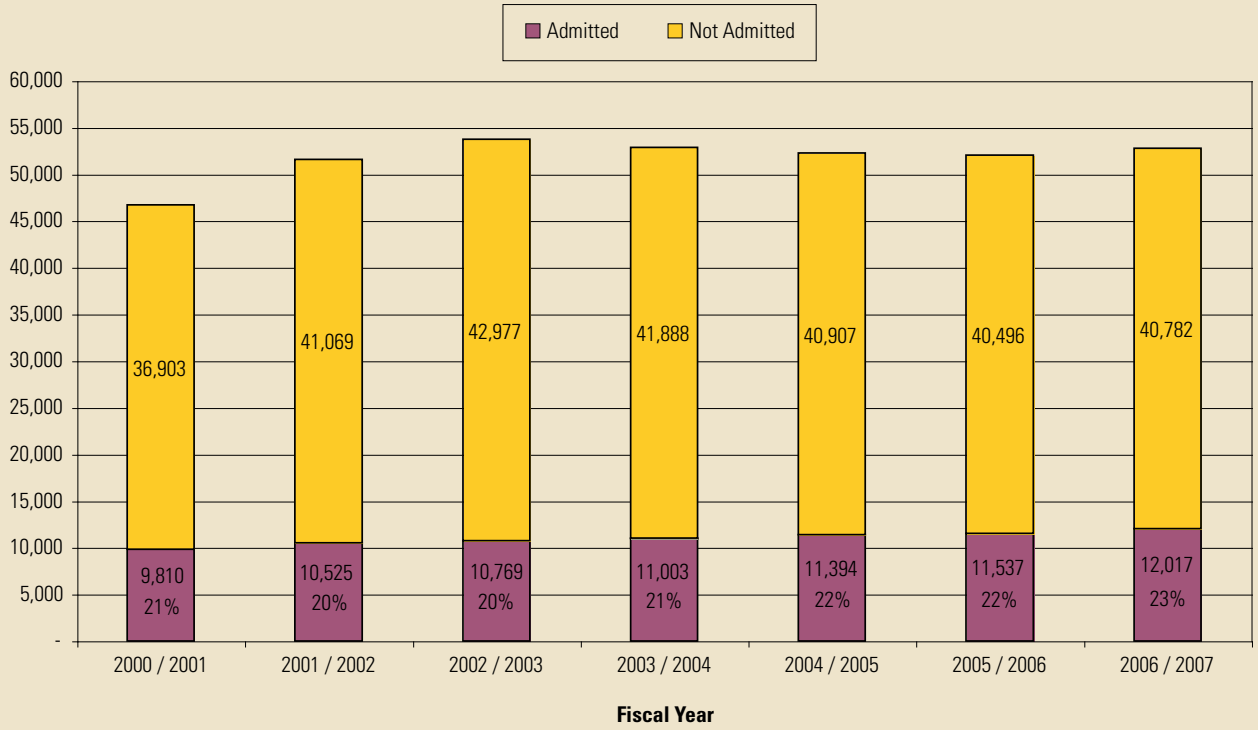
CTAS = Canadian Triage and Acuity Scale.

Figure 3. Median triage-to-physician times for CTAS level 3 patients by two-hour blocks



All changes were related to increased ED wait times as times from bed location to physician remained constant. CTAS = Canadian Triage and Acuity Scale.

Figure 4. Annual emergency department patient visits and final dispositions from 2000 to 2007



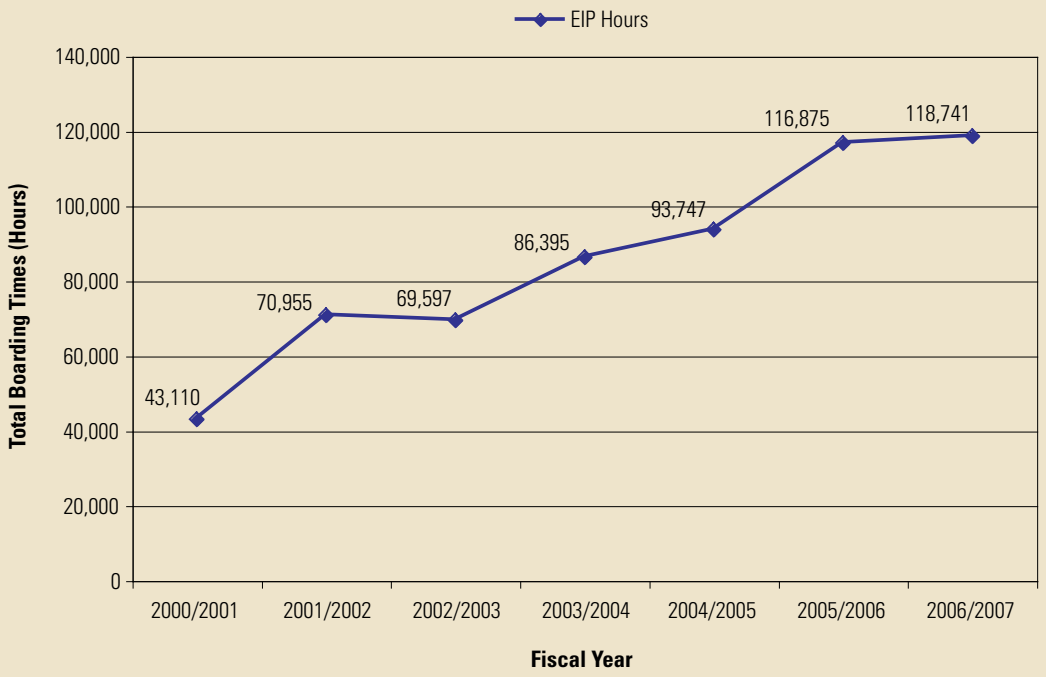
Concurrently, time for admitted patients boarding in the ED increased steadily from 70,955 hours in 2001–2002 to 118,741 hours in 2006–2007 ($p = .0001$) (Figure 5). There was also a significant increase in LWBS patients, with the overall number almost doubling and the number of emergent and urgent LWBS patients increased by more than 400% ($p < .0001$) (Figure 6).

Discussion

For many years there was a perception by both Canadian policy and decision-makers and the public that ED overcrowding was primarily due to inappropriate use by certain members of the community (Schull et al. 2007). Not surprisingly, efforts to curb ED input have been high on their agenda and have included public service announcements regarding the appropriate use of the ED by patients, medical help telephone lines and the expansion of walk-in and urgent care clinics (Hutchison et al. 2003). A relatively consistent volume (but higher acuity and complexity) of adult emergency visits has been maintained over the past seven years despite the widespread availability of input interventions. Concurrently, this university-affiliated hospital has experienced an impressive and critical increase in ED overcrowding by all crowding measures currently used in Canada. For example, increasing LWBS proportions, especially among CTAS level 2 and 3 patients, have been observed. In addition, delays to be seen have increased dramatically, to the point where the institution is no longer able to meet nationally accepted standards for patient assessment time frames. Finally, once admitted, patient stays in the ED awaiting an in-patient bed are getting progressively longer.

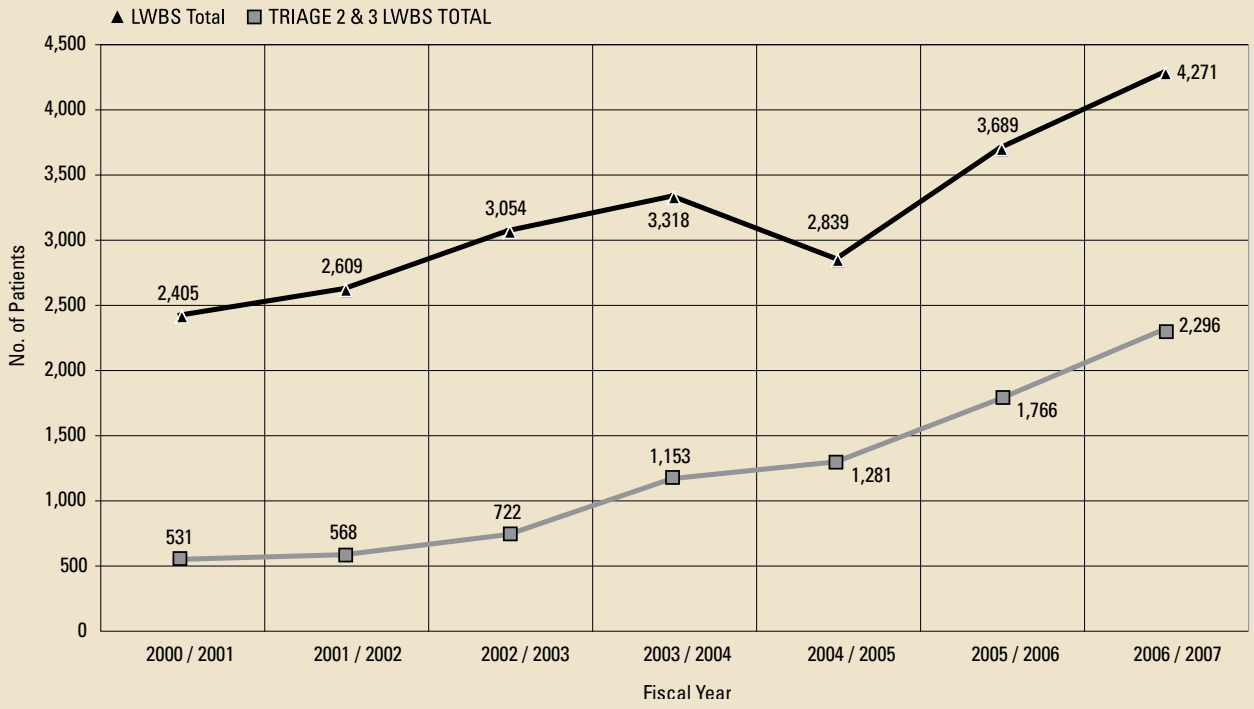
Since Canadian ED directors identify this last issue as the primary contributor to ED overcrowding (Rowe et al. 2006a), the issue of boarded patients requires further exploration. Boarded patients, also referred to as emergency in-patients (EIP) in some locations, represent those patients who have been admitted by an in-patient service but remain in the ED due to a lack of available beds. Boarded in-patients create a number of problems relating to ED throughput. In most large EDs, from 08:00 daily, patient presentations increase up to seven to nine per hour until approximately 22:00, when they begin to decline. More than 50% of these patients are CTAS level 2 or 3, and they need an acute or critical care bed. Unfortunately, since the acuity of patients is high, these are the same beds occupied by most boarding patients awaiting transfer to the floors (Dong et al. 2007). The continuous occupation of more than 50% of these ED stretchers also prevents the emergency nurses caring for these admitted patients from assisting with new arrivals to the ED. This alignment of unchanging patient number, increasing patient

Figure 5. Boarding times* from 2000 to 2007



*Length of stay in the emergency department from the time of admission bed request until patient transferred to the ward. EIP = emergency in-patient.

Figure 6. Emergency patients leaving without being seen*



*Both overall and those triaged as Canadian Triage and Acuity Scale levels 2 (emergent) and 3 (urgent). LWBS = leaving without being seen.

acuity and complexity, decreasing available ED treatment spaces, decreasing ED nurse availability and ever-increasing patient wait times leads to an untenable situation of prolonged delays, patient impatience and staff dissatisfaction.

Perhaps the most important barrier to addressing these ED overcrowding issues is the failure of clinical staff, administrators, institutions and governments to recognize that these ED problems are the consequence of system capacity issues and require system-wide solutions (Fatovich et al. 2005; Schull et al. 2002). Already ED-appropriate patients are electing to delay seeking help or seek help in suboptimal venues. Despite patients avoiding the ED, input still exceeds the capacity of many EDs like this one to perform timely patient triage to an appropriate treatment area. Throughput is often delayed or negatively impacted by efforts to manage patients in inappropriate areas with inadequate nursing support. All of these problems are a direct result of delayed output leading to suboptimal care for both in-patients and emergency patients.

A number of articles have reported on boarding admitted patients in the ED and their impact on overcrowding (Richardson 2006; Sprivulis et al. 2006). Others have noted the relationship between the rate of LWBS patients and wait times (Asaro et al. 2007; Goldman et al. 2005; Rowe et al. 2006c). Research on LWBS patients from the study site ED showed that 44.8% left because they were "fed up with waiting"; 60% sought medical care elsewhere within one week, and 4.3% were admitted to hospital (Rowe et al. 2006c). The rate and acuity of LWBS adult patients should be recognized as serious markers of ED (system) overcrowding, and ones that should be prevented whenever possible.

Finally, this analysis was made possible by access to sophisticated data collected by an EDIS. The introduction of an EDIS requiring staff to enter data on work activities in real time allowed us to portray time-related changes in clear detail over an extended period of time. In addition, a standardized presenting complaint list along with the relevant CTAS modifiers was programmed into the EDIS in 2001 and updated to remain compliant with national standards, clearly showing the rise in acuity as less urgent patients chose alternatives sites for their care. Given the importance of valid and reliable healthcare information regarding ED visits and outcomes, these systems should become requirements for all EDs in Canada (Rowe et al 2006b). Moreover, enhancements to improve data standardization and National Ambulatory Care Reporting System compliance should be local, provincial and national priorities.

Given that ED patient visits, as well as dispositions (admissions and discharges), are highly predictable by the day of the week, month of the year and hour of the day, in-patient bed and ED bed and nursing resources are also reliably predictable. Unless a system is in place to anticipate and plan for tomorrow's needs today, patient morbidity and mortality will continue to rise and staff efficiency and satisfaction will continue to fall.

Study Limitations

This study has several limitations. It was performed within a single university-affiliated ED within a single healthcare region of Western Canada. The data analyzed may contain errors; however, the same group of physicians and nurses (exclusive of turnover) entered the data over the entire study period and any errors would be expected to be random or consistent over time, thereby not invalidating the results. There may be concerns around the accuracy of the data used for this study; however, all data elements were selected based on knowledge of which work processes are most consistently and accurately captured. These include the triage acuity data that were captured using an electronic decision support tool and those time-stamped processes that were consistently captured. All time intervals were subjected to validation by reviewing "impossible" times (e.g., greater than 12 hours to a bed location or greater than 24 hours to be seen by a physician) and excluding those that could not be verified. For critically ill patients, resuscitation activities often began immediately, with triage information entered *after* stabilization. This makes time from triage to physician a negative number. To manage this, we converted these to zero time intervals as these processes were occurring concurrently. Physician sign-ups for patients were generally accurate as this communicated among physician colleagues which patients remained to be seen. Discharge times were defined as the time when a patient vacated the bed and was inserted by the bedside nurse caring for the patient. During busy times, delays in documentation may have occurred, however, this would not invalidate the results. The time patients left for the ward was quite accurate as recording was the last porter task prior to wheeling the patient out of the department. The rates of missing data ranged from 0.01 to 1.47%, as outlined in the "Statistics" section above. Finally, these data did not examine the quality of the care provided or the consequences of the overcrowding. These issues were beyond the scope of this study and have been better covered elsewhere (Miro et al. 1999).

Conclusion

ED overcrowding in a tertiary care hospital is primarily a result of access block due to boarding admitted patients, and the metrics suggest this problem is increasing exponentially. This is particularly dangerous in the ED environment as the majority of patients have emergent or urgent conditions that

cannot be appropriately managed in the waiting room, and these patients are at significant risk of deterioration prior to initial workup.

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