Chapter 4

Overcrowding in the Emergency Department and Patient Safety

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Additional information is available at the end of the chapter

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Abstract

Emergency department (ED) overcrowding is a recognized problem worldwide. This chapter reviews the scope of the problem, manifestations, repercussions, and potential solutions to this problem.

Keywords: emergency department overcrowding, emergency department safety, emergency department systems, emergency department patient care, emergency department throughput, emergency department output

1. Case vignette

A 68-year-old man presented to the emergency department (ED) with abdominal pain. The pain was fairly abrupt in onset, constant and severe, with accompanying nausea. He had come in not long after it started, on a busy Monday afternoon during flu season. He sat in a chair in the waiting room while his wife waited 15 min to register him at the line at the window. After 30 min, he underwent triage, during which the nurse noted that the patient appeared more comfortable than he stated he was. He was afebrile with an adequate blood pressure, and had a heart rate of 105. She did not count out a respiratory rate in the interest of time, as she still had eight patients to triage and needed to do repeat vital signs on another 10 who had been waiting for over 2 h. The patient was made an emergency severity index score (ESI) of 3, and put back in the waiting room. After 120 min in the waiting room, the patient was brought back into the ED. He was noted by his ED nurse to have a heart rate of 115 with irregular rhythm. He also took note of a respiratory rate of 26 and a blood pressure of 98/56 mmHg. He called for a physician to evaluate the patient immediately. The physician recognized that the patient had severe abdominal pain in the setting of new atrial fibrillation and was concerned for the possibility of ischemic bowel. She

consulted the general surgery service, ordered lactate, type and screen, complete blood count, blood chemistries, coagulation profile, and a CT scan of the patient's abdomen and pelvis. She additionally ordered a fluid bolus and pain medications.

The nurse was able to get an adequate IV line quickly and implemented the orders, fluid resuscitating the patient and improving his comfort. Unfortunately, a multi-car accident occurred on a nearby highway, resulting in several trauma team activations. Since trauma alert patients are ESI 1, the patient's CT was delayed until after completion of the evaluations of the three trauma patients, which took about 90 min. Additionally, since the same surgical team covers both trauma and general surgery, the patient was not evaluated by a surgeon until after the trauma patients were cleared by the trauma team.

By the time the patient underwent CT scanning, all of his labs had resulted, and it was noted that he had a lactate of 5.6 mmol/L, with elevated white blood cells and evidence of hemoconcentration. His CT demonstrated pneumatosis of his small bowel, and the patient was taken to the operating room for small bowel resection secondary to mesenteric ischemia. He had a prolonged intensive care unit stay, but eventually recovered.

2. Introduction

Emergency department (ED) overcrowding is a recognized problem worldwide [1, 2]. Although isolated and not-so-isolated instances of overcrowding likely have occurred for as long as EDs have been in existence, attention was brought to the problem in the United States (US) in the early 1990s, when both the lay press and the research community began to consider the impact of overcrowded EDs on patient care [3]. Although initially described as a phenomenon that was predominantly occurring in large academic centers, overcrowding has now been shown to occur in both public and private EDs of all sizes and locations [4]. The problem has become widespread and is still growing, leading the Institute of Medicine to release a statement in 2006 regarding the future of US emergency care, describing the emergency system as one in crisis [5].

What is ED overcrowding? Although there is no true consensus definition, the best descriptions take into account both the nature of the problem and its outcomes. Overcrowding is not merely a matter of an ED not having adequate resources for the demand placed upon it by the patients or community, it is a supply/demand imbalance in health care needs that results in undesirable outcomes for patients [6, 7]

3. History of overcrowding

The timing of ED overcrowding becoming a major issue in the US coincided with the closing of hospitals across the country, a decrease in the number of available inpatient hospital beds, and an increase in ED visits [8]. By way of comparison, in 1981, there were 1.36 million staffed hospital beds in 6933 hospitals in the US, while the most recent data from the American Hospital Association show 897,961 beds in 5564 hospitals [9]. Meanwhile, there is

no indication that there are fewer sick patients. Since 1991, ED visits have increased nationally from 89 million per year to 130.4 million, and ED patients account for 40% of hospital admissions [10, 11]. Furthermore, 25% of those admitted patients are considered critically ill [11, 12]. Therefore, EDs are seeing a higher volume of higher acuity patients that consume more resources.

In addition to decreased total number of hospitals and beds, this same time period saw the introduction of the emergency medical treatment and active labor act (EMTALA) in 1986 as well as cuts in Medicare reimbursement in 1999. EMTALA mandates that all hospitals with EDs provide emergency care (including "screening exams") to all patients who arrive there, but provides no mandates regarding payment for these services from payors. Emergency medical care is therefore a civil right, but one without funding to match the mandate for care, leading to institutions seeking to find the most cost-economical way to provide that care, often with little margin for error so as to avoid waste and improve the bottom line.

The burden of increasing patients in limited beds has been increased by advances in technology. As medical imaging has improved and expanded, ED workups have grown to utilize more advanced imaging, increasing ED length of stay (LOS) for patients [13]. Furthermore, physicians' medicolegal concerns and fear of lawsuit increase their diagnostic testing as well as impacts their admission decisions, contributing to resource/demand mismatch [14].

Finally, ED overcrowding is impacted by staffing shortages. Although a record number of medical school graduates are entering fields in emergency medicine, the current need for board certified emergency physicians is not projected to be met until 2038 [15]. Furthermore, although nursing is one of the top occupations in terms of projected job growth over the next 5 years, the gap between nursing supply and demand is widening and is reaching critical proportions [16]. In spite of the growing need, thousands of nursing school applicants are turned away every year because of insufficient funding, faculty, and training sites to support them [16].

4. Health care system factors in overcrowding: output, input, and throughput

It is always a failure of understanding to refer to ED overcrowding as an ED issue. Truly, overcrowding is a health care issue, impacted by and affecting every aspect of medical care. Although a full discussion of all the elements involved is beyond the scope of this text, a brief synopsis is warranted.

ED overcrowding occurs when hospitals are full [3, 17, 18]. Full hospitals create a bottleneck to ED output of patients. Although 40% of inpatient admissions pass through the ED, the others are direct admissions, scheduled surgical or procedural admissions, or transfers. When the hospital is at or near capacity, patients who are admitted through the ED are unable to move from the ED to an inpatient bed, resulting in ED holding [19]. ED holding is cited as the number one reason for both ED overcrowding and diversion of ambulances [19]. Hospitals may be operating at or near capacity for a number of reasons. Inpatient beds may be taken because

of seasonal variations (such as flu season). They may fluctuate in predictable ways based on days of the week and operating schedules of surgeons (who often operate earlier in the week to facilitate discharging patients before the weekend). Inpatient bed availability is dependent upon nurse staffing availability, and nursing shortages may limit a hospital's capacity to accommodate patients. Furthermore, beds that are already occupied may stay occupied longer because of inefficiencies of inpatient medical care, delay to consultation, advanced diagnostic testing, or disposition processes that delay discharging or transferring patients from the hospital. For instance, discharge from the hospital may be delayed because of rehabilitation, nursing, or care facilities not having available beds and also operating at capacity.

ED overcrowding also occurs when patients intended for discharge (as well as those for admission) from the ED remain in the ED for longer than necessary. This may occur secondary to delays in contact or input from consulting services, delays to imaging or specialist interpretation of tests, delays to laboratory results, technological failures, or delays in transportation back to a care facility [4–7, 13]. ED throughput processes contribute to overcrowding through inefficient registration and triage processes, laboratory and radiograph turnaround times, clerical and technologist support, inadequate nursing and physician staffing, and delays to decision-making [6, 7, 20].

ED overcrowding is obviously impacted by the number of patients arriving to the ED, or the patient input [6, 20, 21]. Although often cited for the reason for overcrowding, low acuity patients using the ED for their minor injury and primary care needs have not been shown to be a large contributor to the overcrowding process [7]. However, when a given ED becomes overcrowded and diverts ambulances to surrounding EDs, those surrounding EDs often become overcrowded, perpetuating overcrowding in a regional way [20, 21]. Beyond ambulance diversion, patients may increasingly use EDs because they cannot find other ways to access primary or specialist care, whether because there are no appointments available because of physician shortages or because they have been instructed to go to the ED when calling their physicians with their symptoms. ED facilitation (or lack thereof) of close follow-up may result in patients returning to the ED for scheduled rechecks, as well.

5. The impact of overcrowding on patient care

Numerous studies have demonstrated that ED overcrowding is harmful to patient care. In an effort to avoid overextending available resources, some hospitals divert ambulances when they are at capacity (although this is illegal in some states). Although this is done purportedly because the hospital cannot safely accommodate more patients, it is unclear whether this practice is beneficial. In the pre-hospital arena, ambulance diversion results in delay to patient care, and increases ambulance utilization, resulting in fewer available ambulances [22]. In patients with cardiac events, ambulance diversion is associated with increased mortality and decreased revascularization [23, 24]. That said, diversion has not been shown to have an impact on pediatric mortality [25]. Clearly, ambulance diversion as a means to address overcrowding shifts the problem to either pre-hospital providers or other area hospitals, as opposed to solving the problem.

Data for patient harm secondary to ED overcrowding at the ED and hospital level are abundant in numerous patient groups. In patients with acute cerebrovascular accidents, ED overcrowding is associated with delay to CT scanning, and boarding of these patients is associated with increased mortality, complications, and poorer recovery [26, 27]. Overcrowding increases delays to antibiotics in patients with pneumonia as well as febrile neonates [28, 29]. Patients with painful conditions are less likely to receive timely analgesia in an overcrowded ED [30]. Patients with non-ST elevation myocardial infarctions who board in the ED have increased adverse events and less adherence to standard of care therapy, and those admitted with chest pain have higher rates of adverse events [31, 32]. Although ED crowding has not been found to have an impact on resuscitation outcomes or quality in patients suffering out of hospital cardiac arrest, boarding of patients with return of spontaneous circulation is associated with worse outcomes [33, 34]. This relationship holds true for other critically ill patients who are held in the ED for lack of bed space in the intensive care unit [35]. Patients who are seen and discharged from the ED during periods of overcrowding have higher risk of mortality and hospitalization within 7 days as compared to patients who are discharged during non-overcrowded times [36]. Overcrowding is associated with increased number of medication errors [37]. Finally, and not unexpectedly, overcrowding leads to increased length of stay and delay to treatment, even in patients with ESI 2 triage scores [38].

6. Solutions to the problem

Solutions to the problem of ED overcrowding can be seen as broadly falling into one of two arenas: Institutions can focus on efforts to directly decrease crowding and/or mechanisms can be placed to mitigate bad outcomes that are associated with ED crowding. Within the parameters of decreasing overcrowding, the problem is often approached from an input-throughput-output model, with solutions to decrease the number of patients presenting to EDs, decreasing total time spent in the ED, and facilitating either transfer to other locales within the hospital or facilitating outpatient follow-up.

The Agency for Healthcare Research and Quality recommends forming a Patient Flow Team consisting of including a team leader (day-to-day leader), senior hospital leader (e.g., the chief quality officer), individuals with technical expertise related to the strategy, ED physicians and nurses, ED support staff (e.g., clerks, registrars), a research/data analyst, and representatives from inpatient units [39]. Having input from multiple staff with unique insight into the delays specific to their specialty as well as ways that delays may be approached can lead to more effective change. As well, having individuals involved in the clinical arena can improve the team approach to problem solving and implementation of new systems. Prior to initiating solutions, management teams must know their own baseline benchmarks, must identify goals and strategies to decrease crowding in their unique environment, must plan the approach to implementation with estimates of time and costs of implementation, and then must remeasure after implementation to determine how they have approached their benchmark. Introduction of process improvement teams in one health care system resulted in a 72% reduction in the number of ambulance diversion hours [40].

Measures that an ED may track can be individualized, or could follow the CMS measures that are reported nationally to compare ED performance (**Table 1**). With the introduction of electronic health record systems, such measures should become increasingly effortless to obtain and track over time. Implementing "Rapid Cycle Change," where the Patient Flow Team picks a discrete intervention, implements an improvement initiative through the Plan-Do-Study-Act cycle, and measures the outcome, can quickly determine whether a change should be accepted, reworked, or discarded. The data that are generated need to be rapidly disseminated in a transparent manner to reinforce the values of change or to justify reworking the solutions.

Measure name	CMS effective date
Head CT scan results for acute ischemic stroke or hemorrhagic stroke patients who received head CT scan interpretation within 45 min of arrival	2013
Troponin results for ED acute myocardial infarction (AMI) patients or chest pain patients (with probable cardiac chest pain) received within 60 min of arrival	2013
Median time to pain management for long bone fracture	2013
Patient left before being seen	2013
Door to diagnostic evaluation by a qualified medical professional	2013
Median time from ED arrival to ED departure for discharged ED patients	2013
Median time from ED arrival to ED departure for admitted ED patients	2014
Admit decision time to ED departure time for admitted patients	2014
Additional measures to track	
ED arrival to bed placement	
Disposition to departure	
Hours on diversion	
Time of inpatient bed assignment to bed placement	
Time of day of discharge	
Inpatient bed turnaround time (patient discharge to bed readiness)	

Table 1. Measurements of emergency department crowding.

7. Decreasing patient presentations to the ED

Initiating processes to decrease patient presentations to the ED have limited effectiveness in reducing ED crowding. In a study performed in Ontario hospitals, low acuity patients were found to have a negligible effect on ED length of stay [41]. Although ambulance diversion is frequently employed in the setting of ED crowding, a review of ambulance diversion from 2006 found no papers specifically addressing the effect of ambulance diversion on ED crowding [22]. Computer-generated simulation models have suggested that ambulance diversion

will have little effect on an already overcrowded ED [42]. One such model suggested that for every percentage point increase in the time spent on ambulance diversion, ED waiting room time would decrease by 2 min [43]. Further evidence suggesting that ambulance diversion is not an effective method to decrease ED crowding is provided by the state of Massachusetts, who banned ambulance diversion statewide, and saw a small drop in ED LOS [44].

8. Improving emergency department patient throughput

Improving ED front-end operations has been seen as a potential way to increase ED patient throughput. A review of literature found articles that supported that bedside registration decreases patient waiting time, total ED LOS, and the number of patients who leave without being seen [45]. The authors point out that a number of the studies that they reviewed are fraught with methodological flaws and include only single centers, limiting the conclusions that can be drawn from these studies [45].

As ED wait times increase with overcrowding, utilizing the patient waiting time for processes that would otherwise take a long time becomes important. Groups have proposed initiating evaluations or treatments for standard problems from the waiting room [46]. Initiating lab testing from triage has two potential effects. It can effectively decrease the turnaround time (TAT) for lab tests which has been shown to directly decrease ED length of stay (a 17-min increase in ED LOS per 30 min increase in lab TAT) [47]. Additionally, performing labs from triage could potentially identify patients requiring more immediate attention if there is a way to flag critical values to a responsible provider [48]. A systemic review of triage nurses ordering radiographs has demonstrated nearly a 20-min decrease in patient LOS with implementation of triage nursing orders [49]. Studies have suggested that having an advanced practitioner or a physician in triage may reduce the ED LOS and rates of leaving without being seen [45, 50]. Two randomized trials of physician in triage demonstrated reduced patient LOS by 36 min in one study (12% reduction) [51], and 122 min in the other (35% reduction) [52]. Both of these studies occurred in Canada, however, where delivery care might be different than other settings, thus limiting their generalizability [51, 52]. Two other randomized controlled trials demonstrated no affect of physician in triage on LOS [50].

In cases where there are patients in the ED waiting for providers (long ED bed placement to provider evaluation times), adding providers can decrease patient TATs, effectively decreasing crowding. In a study in a Swiss ED, adding a provider to a busy evening shift decreased the average LOS of discharged patients by 35 min. Similarly, if it is determined that patients are awaiting nursing care in the ED, improving nursing ratios may decrease TATs and ED crowding. Although decreasing nursing to patient ratios has not been proven to improve overcrowding, a study demonstrated that when nursing to patient ratios fell out of California-mandated ratios (1:1 for trauma resuscitation patients, 1:2 for critical patients, and 1:4 for all other ED patients), wait times were 16% longer and total ED care time was 37% longer [53].

Although it would seem intuitive that increasing space in the ED (by adding more beds) would decrease ED LOS, this is not the case. In their computer-generated model, increasing

ED bed numbers increased LOS, while increasing the rate at which patients left the ED to be admitted to the floor decreased total ED LOS [54]. Additionally, a pre-post observational study performed in conjunction with nearly doubling an ED's capacity found that this had no affect on the time of ambulance diversion or left without being seen [55].

Introducing a system with a rapid admission policy whereby stable ED patients are admitted to the hospital without having a prior ED evaluation by the admitting staff and with incomplete diagnostic testing, minimally decreased ED LOS (10 min) but decreased weekly ambulance diversion time by nearly 3 h [56].

9. Facilitating the output from the emergency department

The single factor that has been demonstrated to be the most effective at reducing ED crowding is to reduce ED boarding of admitted patients and facilitate movement of ED patients to inpatient beds [19, 57–61]. Therefore, any attempt to focus on improving ED throughput should focus on attempts to minimize ED boarding and facilitate inpatient admission.

Because ED crowding has been associated with holding in the ED while awaiting inpatient bed assignment, an obvious mitigator would be to increase inpatient beds. A study observing overcrowding over 10 years while Toronto restructured its medical system decreasing acute care bed numbers by 39% demonstrated that overcrowding increased [17]. It has been suggested that when average occupancy rates approach 90%, fluctuations in need for inpatient beds will result in periodic bed shortages [17, 18]. A study of the effect of increasing the number of ICU beds in one hospital from 47 beds to 67 beds demonstrated that they reduced the average numbers of ambulance diversion by 66% and decreased the ED LOS of critically ill patients by 25 min. Likewise, increasing beds outside of the ED with the formation of observation or short stay units has been demonstrated to decrease crowding and decrease ambulance diversion [62]. Another strategy that has been suggested is the boarding of patients in inpatient hallways as opposed to the ED. Although effects on hospital crowding have not been documented, survey studies have demonstrated that patients have a preference for inpatient hallway boarding to ED boarding [63–65].

Inpatient hospital process improvement, such as earlier hospital discharge, has been demonstrated to decrease overcrowding when the hospital nears full capacity. Improving time to hospital discharge by as little as 1 h has been demonstrated to have significant effect on crowding [66]. Toward this end, some have advocated that discharge from inpatient hospital beds should occur before 12 o'clock noon and impact on emergency department crowding should be studied before and after [67]. One health network has found that incentivizing housekeeping staff to more rapid inpatient bed turnover has led to significant decreases in ED waiting times and ambulance diversions [68]. Other systems issues that have been targeted for improving hospital flow include smoothing the elective surgical schedule [69].

Ultimately, there is no single fix that will improve the entire system. Rather, the implementation of multiple solutions (**Table 2**) is required to decrease emergency department crowding.

Improved staffing	• Physicians • Nurses • Techs • Registration •
Decreased process turnaround	• Triage • Registration • Diagnostic imaging • Laboratory processes • Specialist consultations
Decreased care time	• Medication availability • Stocking issues • Time to completion of nursing tasks • Workload balance among staff
Physical space	• Hallway beds • Observation units • Flex beds
Standardized resources	• Disease pathways
Hospital dynamics	• Decreased OR scheduling variability • Early hospital discharge • Automated inpatient bed cycling • Automated nursing report • ED-inpatient bed transport • Hallway boarding • Reverse triage

Table 2. Process improvement opportunities to decrease emergency department crowding.

Careful scrutiny of the institution's existing processes and identification of specific areas of improvement is the first step to managing patient flow issues. Beyond this, hospitals must buy in from both administration, nursing, physician, and ancillary staff, and must also be willing to make resource investments to improve patient flow. Implementation of best practice bundles like the Urgent Mattes Toolkit across health systems has demonstrated great successes but demonstrated no improvements in about a third of hospitals, because it is often difficult for smaller, nonteaching, rural hospitals to invest the resources in staff and infrastructure that are required to make change [70, 71].

10. Mechanisms to mitigate bad outcomes in the setting of overcrowding

ED crowding is a reality in many EDs and is likely to persist at times despite implementation of all reasonable strategies to mitigate crowding. In these situations, it is important for all providers to be aware of the increased likelihood of potential errors and to mindfully employ mechanisms to avoid them. Delivery of quality care in the face of crowding can be challenging, but is not impossible.

The first step in quality care occurs with an adequate and accurate triage to identify those individuals who really cannot wait. The future of medicine may include the use of predictive biomarkers in addition to standard triage to identify patients at the highest risk of mortality [72]. At triage, interventions to initiate care like triage EKGs that are reviewed real time by a physicians, drawing of triage labs based on complaint to identify those with severe disease, and ordering of appropriate radiographs may improve delivery of quality care. Likewise, analgesia for fractures, topical anesthetic for lacerations or anti-pyretics for fever could be protocolized to decrease time to effective therapies.

As EDs become busier, the number of simultaneous tasks that need to be coordinated and tracked by staff increases. This cognitive workload can be lessened by the use of protocols, teamwork training to facilitate inter-provider assistance, and by the use of information technology solutions such as flagging abnormal results or communicating a patient's completed care tasks. Existing safeguard mechanisms to appropriately identify patients by wrist bands prior to medication administration and test and procedure performance need to be strictly adhered to despite the time taken to complete these tasks. As departments become busier, interruptions increase which can lead to decreasing performance, so mechanisms to limit interruptions could be important to decreasing errors [73]. Although research priorities into patient safety have been developed, little literature exists regarding how interventions and specific processes affect safety [74].

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