8 Emergency Department Overcrowding

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Case scenario

As the director of a busy community emergency department (ED), you are aware that your patient census has risen in recent years, and, adding to the challenge, patients seem to be getting older. In departmental meetings, distressed clinical staff complain about severe overcrowding in your department. Most written patient complaints focus on prolonged waiting, and seriously ill patients frequently spend many hours in the waiting room. Several near-disaster cases have been averted in the last year or so; however, just last week you received a call at home that a 53-year-old woman had collapsed in the waiting room 2 hours after being triaged with chest pain. Her first electrocardiogram (ECG) was performed following her collapse, and it showed an anterior ST elevation acute myocardial infarction (MI). In an urgent meeting you set up with the hospital Chief Emergency Officer (CEO) and risk management staff, you argue that overcrowding in your ED is a serious problem that requires immediate attention from the hospital. The hospital CEO is sympathetic, but she asks for data to demonstrate that the problem is really worsening, and for evidence that quality of care is suffering. You reply that overcrowding is a complex construct to measure, but that every emergency physician and nurse knows it when they see it. As for evidence, you point to the 53-year-old woman who collapsed in the waiting room with an acute MI. However, your CEO reminds you of a similar case a number of years ago of a chest pain patient suffering a cardiac arrest from an undiagnosed acute MI only minutes after being discharged from the ED, and wonders if the recent event was truly a consequence of overcrowding.

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Background

Emergency department overcrowding is generally defined as a mismatch between patient care needs and the available resources of a department to safely meet those needs in timely fashion. ED overcrowding is a new or worsening problem in many modern health care systems. At the same time, the evidence base has grown from one largely based on surveys and professional association consensus statements to one which includes high-quality observational studies and even some randomized controlled trials. However, the absence of a clear and measurable definition of the problem from the outset has meant some difficulty in accurately describing the problem (or comparing it between settings). In addition, the complexity of some of the health system changes instituted to address ED overcrowding have been difficult to evaluate using rigorous experimental designs. None the less, the expanding evidence base and increasing attention paid to the problem merit a careful review focusing on the questions below.

Clinical questions

In order to address the issues of most relevance to your patients and to help in searching the literature for the evidence regarding these issues, you structure your clinical questions as recommended in Chapter 1.

1 In hospital EDs (setting), how is overcrowding (outcome) defined?

2 In hospital EDs (setting), does overcrowding (comparison) impact on patient care (increased morbidity and/or mortality) (outcomes) compared to periods when no crowding exists (control)?

3 In hospital EDs experiencing overcrowding (setting), do interventions to reduce overcrowding (intervention) improve patient flow and care (outcomes) compared to status quo (control)?

4 In hospital EDs experiencing overcrowding (setting), do fast-track systems (intervention) reduce overcrowding and improve patient care (outcomes) compared to status quo (control)?

5 In hospital EDs experiencing overcrowding (setting), do system-wide interventions (intervention) reduce overcrowding and improve patient care (outcomes) compared to status quo (control)?
6 In hospital EDs experiencing overcrowding (setting), does the 4-hour rule (intervention) reduce overcrowding and improve patient care (outcomes) compared to status quo (control)?
7 In hospital EDs experiencing overcrowding (setting), does a full-capacity protocol (intervention) reduce overcrowding and improve patient care (outcomes) compared to status quo (control)?

General search strategy

Emergency department overcrowding can be described using a variety of terms (such as crowding, over capacity, access block, and so on). Consequently, searching can be difficult and strategies need to be employed to be sure to include all ED overcrowding-related articles. You begin to address these questions by searching for evidence in the common electronic databases such as the Cochrane Library and MEDLINE (through OVID) looking specifically for systematic reviews and meta-analyses. The Cochrane Database of Systematic Reviews includes high-quality systematic review evidence on many emergency topics and issues related to professional practice; however, there are no specific systematic reviews on ED overcrowding. You also search MEDLINE to identify randomized controlled trials (RCTs) that have been published on the specific interventions (fast track, 4-hour rule, and so on). In addition, access to relevant health technology assessments and systematic reviews are available through international agency websites such as the Canadian Agency for Drugs and Technologies in Health (CADTH), Agency for Healthcare Research and Quality (AHRQ) and National Institute for Health and Clinical Evidence (NICE). Much of the ED overcrowding literature exists in the gray literature, much of which is beyond the scope of this chapter; however, gray literature searches in health technology assessments and systematic reviews was considered to enhance the quality of the evidence reviewed. Details of an extensive literature search methodology are included in the systematic review by Cooke et al. [1].

Critical review of the literature

Question 1: In hospital EDs (setting), how is overcrowding (outcome) defined?

Search strategy

- MEDLINE: (ED OR emergency department) AND (overcrowding OR crowding) AND definition

The understanding of ED overcrowding has been hampered by the absence of a single, widely accepted definition of the problem. Medical organizations have tended to define overcrowding in descriptive terms, such as "a situation in which the demand for emergency services exceeds the ability to provide quality care within a reasonable time" [2], proposed by the Canadian Association of Emergency Physicians, or "a situation in which the identified need for emergency services outstrips available resources in the ED" [3], proposed by the American College of Emergency Physicians.

These definitions have intuitive appeal; however, they are difficult to express in terms that can be measured and studied, and may have very different interpretations in different settings. To address this problem, a variety of metrics and scales have been proposed, usually based on mathematical formulae consisting of selected ED factors, often measured in real time. Examples include the Emergency Department Work Index (EDWIN) [4], the National Emergency Department Overcrowding Scale (NEDOCS) [5], the Demand Value of the Real-time Emergency Analysis of Demand Indicators (READI) [6] and the Work Score [7]. The feasibility of calculating such scales varies in different settings, as does their performance, and one study suggested that none of these scales were superior to an occupancy measure consisting simply of the number of patients in treatment spaces in the ED over the number of licensed treatment spaces [8].

In a survey [9] of US emergency department directors, multiple possible implicit definitions were suggested: (i) patients waiting more than 60 minutes to see physician; (ii) all ED beds filled more than 6 hours a day; (iii) patients placed in corridors more than 6 hours a day; (iv) emergency physicians feel rushed more than 6 hours a day; and (v) waiting room filled more than 6 hours a day. These definitions have not been operationalized, and their relationship to other measures of overcrowding is not known.

Studies of overcrowding have mostly used proxy or related measures, such as "access block" or the "boarding" of patients (both of which refer to delays getting admitted patients out of the ED and onto wards), ambulance diversion (the practice by some hospitals of temporarily refusing to accept ambulance patients due to overcrowding), "left-without-being-seen" (LWBS) rates (patients leaving prior to being assessed by a physician), and ED length of stay (LOS) or waiting time (usually expressed as the total time a patient spends in the ED, from the point of first contact to physical departure from the ED). Some of these proxy measures of overcrowding could equally be considered contributors to (e.g., boarded patients) or outcomes of (e.g., LWBS rates) overcrowding.

Emergency department overcrowding is a multi-factorial problem that strikes hospital systems, not patients, and hospital systems vary substantially across jurisdictions. So it is not surprising that no single satisfactory definition has emerged within the literature. Yet one thing is the same everywhere: patients have a measurable LOS, or waiting time, from ED arrival to departure, and this tends to be longer in overcrowded EDs reflecting poor patient flow [10]. Thus ED LOS represents a simple, readily measured, patient-focused and comparable metric that is available to document and study the problem of ED overcrowding. In England, the National Health Service (NHS) Plan [11] has defined an excessive wait as more than 4 hours total time in the ED (measured from the time

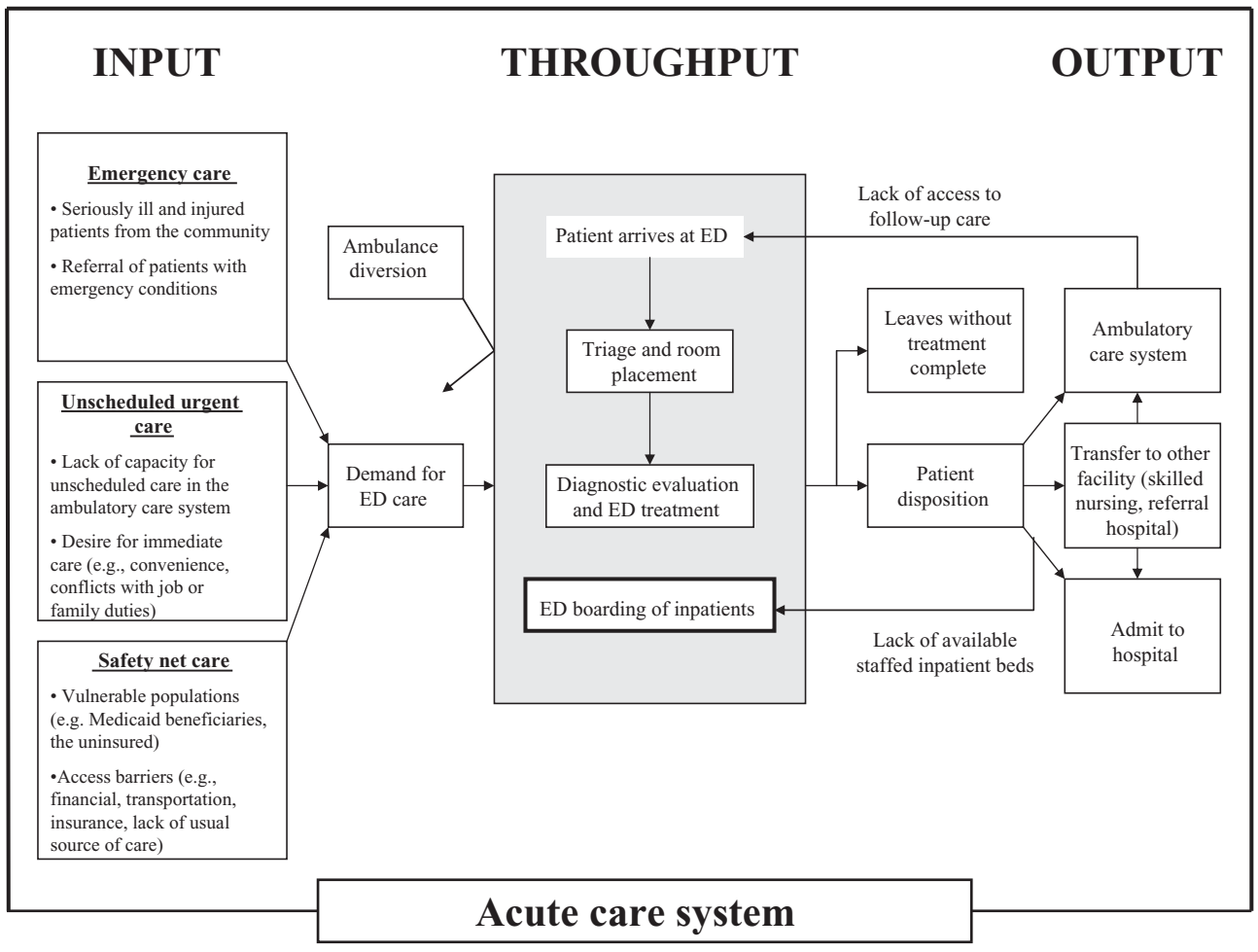

Figure 8.1 The input–throughput–output conceptual model of emergency department (ED) crowding. (Reproduced with permission from Asplin et al. [12].)

a patient arrives until they leave the ED). The NHS concentrates on time spent in the ED, rather than "overcrowding" per se.

Despite definitional difficulties, our understanding of overcrowding has been aided by conceptual models that help to explain factors which are at the root of the problem. The most widely cited is the input–throughput–output model shown in Fig. 8.1. Input factors include any condition, event or system characteristic that contributes to the demand for ED services. Throughput refers to timing and delays in ED patient care from triage to disposition decision. Output refers to actual disposition of ED patients (to home, ward or other in-hospital location, or transfer to another institution), and factors which may slow this phase, such as the inability to move admitted patients from the ED to an inpatient bed [12].

This model reflects what have been called "micro" level factors, i.e., those within a given ED or hospital, and is useful since it demonstrates that overcrowding should be seen as a hospital, not an ED, problem. It provides a framework for understanding and studying causes of overcrowding, though it cannot estimate their relative importance. Yet the model does not address broader "macro" level factors in a region's health system, policy and demographic context that can contribute to crowding, such as the availability of primary health care, changes in public health policy including financing, demographic trends, or evolving clinical care trends and patient expectations [13]. In addition, since the conceptual model concentrates on the issues relevant to the ED, it may focus attention solutions on the ED rather than at a system level.

In summary, definitions for ED overcrowding vary within and between health systems, and even within institutions in the same health system, adding to the complexity of describing and studying the problem.

Question 2: In hospital EDs (setting), does overcrowding (comparison) impact on patient care (increased morbidity and/or mortality) (outcomes) compared to periods when no crowding exists (control)?

Search strategy

- MEDLINE: (ED OR emergency department) AND (overcrowding OR crowding) AND outcome (mortality OR morbidity)

Despite substantial evidence that the problem of ED overcrowding is widespread, there is relatively little high-quality evidence regarding the adverse effects associated with overcrowding [14]. In a national survey of Canadian ED directors, a large majority of respondents felt overcrowding was associated with increased stress and reduced satisfaction for medical staff, as well as worsened ED waiting times for patients. However, only about half believed it was associated with worsened patient outcomes, delays in care or the risk of medical errors [15].

A small number of studies have examined how mortality is association with ED overcrowding. One single-center study examined the ecological association between weekly ED volume and ED mortality in a Spanish hospital, and found that there was an association ($P < 0.01$) between increased ED visits and higher mortality [16]. An Australian study examined the association between hospital overcrowding (based on inpatient occupancy level) and mortality among patients admitted from the ED; compared with an occupancy rate of < 90%, they found absolute increases in relative mortality rates at 7 days post admission of 0.4% with occupancy rates of 90–99%, and 1.0% with occupancy rates > 99%, representing relative increases of 18% (95% CI: 0.5% to 38%) and 46% (95% CI: 14% to 85%), respectively [17]. A second Australian study found increased odds of in-hospital death for patients presenting during overcrowded ED shifts (based on patient-hours in each shift) versus non-overcrowded shifts (OR = 1.34; 95% CI: 1.04 to 1.72) [18]. Another study of mortality among trauma patients found no increase in mortality during periods of ambulance diversion [19]. Such observational studies offer evidence of a possible relationship; however, they must be interpreted with caution since confounding due to variations in severity of illness among patients presenting for care in EDs may be difficult to exclude.

Several studies have examined the association between overcrowding and ED quality of care, with mixed results. One study of thrombolysis for acute ST elevation myocardial infarction in 25 Canadian hospitals found that median door-to-needle time increased from 40 to 47 minutes ($P < 0.001$) during periods of high ED overcrowding versus none (based on ambulance diversion); the adjusted odds of major delay in thrombolysis (> 60 minute door-to-needle time) were also increased (OR = 1.40; 95% CI: 1.1 to 1.8) [20]. Another study of non-ST elevation myocardial infarction found that prolonged ED LOS was associated with a reduced likelihood of receiving five evidence-based therapies, including acetyl-salicylic acid (OR = 0.76; 95% CI: 0.67 to 0.87) [21]. In a case–control study of the effect of ED LOS among intubated trauma patients on the development of pneumonia, each hour in the ED was associated with a small increase in the risk of developing pneumonia while in hospital (OR = 1.20; 95% CI: 1.04 to 1.39) [22]. Several studies have examined the effect of overcrowding on time to antibiotic administration for pneumonia patients. One found that for each additional patient present in the ED at the time of a community-acquired pneumonia patient's arrival, the odds of receiving antibiotics within 4 hours decreased by 4% (adjusted OR = 0.96; 95% CI: 0.93 to 0.99) [23]. In another study, increasing ED overcrowding was associated antibiotic delays for pneumonia patients; under non-crowded conditions, the predicted probability of delayed antibiotic administration was 31% (95% CI: 21% to 42%) versus 72% (95% CI: 61% to 81%) under crowded conditions [24].

A study of analgesia given to older patients with hip fracture found that ED overcrowding (defined as ED census > 120% capacity) at the time of patient arrival was associated with a lower odds of pain assessment documentation (OR = 0.46; 95% CI: 0.21 to 0.98) and an increase in time to pain assessment (+6.1 minutes, $P = 0.01$); however, there was no difference in time to delivery of analgesic or opioid prescribing [25]. A second study looked at analgesia administration in a heterogeneous population of more than 13,000 ED patients complaining of severe pain for any reason at a single center [26]. Only 49% of these patients received any analgesia regardless of crowding levels, but the odds of non-receipt of analgesics (OR = 1.03; 95% CI: 1.02 to 1.03) or delay in receipt (OR = 1.05; 95% CI: 1.04 to 1.06) increased significantly during periods of ED crowding.

Several studies have examined mortality associated with ambulance diversion and found either no association or a reduced mortality among diverted ambulance patients, likely as a result of a reluctance to divert critically ill patients [27]. Other studies have assessed prehospital ambulance transport delays associated with ambulance diversion. In a Canadian study comparing ambulance transport of chest pain patients, a significant increase in the transport time to hospital was seen in a period of high ambulance diversion versus a period of low diversion (13.4 vs 17.2 minutes, $P < 0.001$; a 28% relative increase) [28]. Another study by the same group again found transport delays for chest pain patients associated with ambulance diversion, but only when all EDs within a given geographic area were simultaneously diverting ambulances [29].

Finally, several studies have examined the association between overcrowding and patients who leave the ED without being seen. In one single-center study in the USA, the odds of a patient leaving the ED without being seen almost doubled (OR = 1.96; 95% CI: 1.22 to 3.17) when ED occupancy was > 140% [30]. In another study from Canada, the most common reason behind a decision to leave without being seen was being "fed up with waiting"; the authors also found that 60% of LWBS patients sought medical attention within 1 week of their aborted ED visit [31].

In summary, there is increasing evidence that ED overcrowding negatively affects process of care and quality of care measures, some of which are known to be important predictors of patient outcome. There is some evidence that hospital and ED overcrowding may also increase mortality.

Questions 3: In hospital EDs experiencing overcrowding (setting), do interventions to reduce overcrowding (intervention) improve patient flow and care (outcomes) compared to status quo (control)?

Search strategy

- MEDLINE: (ED OR emergency department) AND (overcrowding OR crowding OR waits) AND trials, systematic reviews. Followed by using the "find similar" facility
- Google Scholar: waits, emergency departments, interventions

Although a variety of interventions have both been described and attempted in EDs to address the issue of ED overcrowding, many have not been scientifically studied. Studies that do examine interventions to address ED overcrowding have mostly been single-site intervention studies and therefore the interaction of a complex array of changes cannot be assessed. It is likely that individual changes are introduced in study hospitals because of a perceived need and they may therefore not be generalizable. Three major reviews [1,32,33] of interventions were located; their results are included in the text below.

Triage may cause delays in care and does not reduce overall waits [34]. The staff undertaking triage have an influence on waits [35]; for example, triage psychiatric support can reduce waits [36]. Triaging out of the ED (whereby patients are redirected to an alternative source of care) can reduce ED patient numbers [37,38] but more work is required to assess the safety of such systems, due to conflicting evidence [39], and to assess whether they have any impact on overcrowding or waiting times for other ED patients. Differential payment systems may reduce ED visits [40], but may equally reduce attendances by those requiring emergency care [41].

Waiting for results of tests is one of the commonest causes of patient delays. Point-of-care testing and satellite laboratories produce quicker results [42] and may reduce LOS [43] although some studies failed to demonstrate this [44]. Nurse ordering of X-rays may speed up processes where fast track does not operate [45], although other studies have found conflicting results [46]. ED staff undertaking ultrasounds may reduce delays for those having this procedure [47]. Results delivery needs further investigation but there are suggestions that electronic reporting may delay results delivery.

There are very few studies looking at the impact of differing staffing levels, skill mix or systems of work. Availability of senior staff may reduce admissions and delays as may increased staffing levels [48]. Having an emergency physician at night also reduces length of stay in the ED [49]. Having a system that allocates patients to ED staff may be better at reducing waits than allowing ED staff to determine allocation [50]. Allowing ED staff to admit to wards will reduce delays. Nurse practitioners are safe and effective but their effect on waits is unknown. The role of other health care professionals in ED care needs evaluation.

A study of extensive restructuring and staff reorganization resulted in an increase in the number of discharges and decreased overcrowding in the ED [51]. Teams of staff available for unpredicted surges in activity may reduce delays [52], but the simple physical expansion of the department does not improve overcrowding [53].

In summary, within the ED changes in staffing numbers and processes can reduce waits. The impact of triage systems on waiting times is still contentious. Improving access to diagnostic tests does improve waits.

Question 4: In hospital EDs experiencing overcrowding (setting), do fast-track systems (intervention) reduce overcrowding and improve patient care (outcomes) compared to status quo (control)?

Search strategy

- MEDLINE: (ED OR emergency department) AND (overcrowding OR crowding OR waits) AND fast track. Followed by using the "find similar" facility
- Google Scholar: waits, emergency departments, fast track

Fast-track systems can be applied to the ED, to specific acuity level of patients in the ED, or to a specific injury or illness seen in the ED. A review of fast-track systems for minor injury and illness concluded that ED fast-track systems appeared efficient, cost-effective, safe and satisfactory for patients. Low acuity patients were confirmed as being seen quicker [54].

Some systems simply placed a senior doctor in the triage area. A Canadian RCT demonstrated a reduction in overall LOS in the ED (4 hours 21 minutes vs 4 hours 57 minutes per patient, $P = 0.001$) as well as a decrease in those leaving before completion of treatment [55]. A UK study demonstrated that the average time for all the patients triaged was "about 50 minutes", compared to 1 hour 8 minutes without the consultant at triage [56]. A similar American interrupted time study showed that on days when faculty triage was undertaken there was a significant decrease in total time in the ED of 82 minutes against the original background of 445 minutes across all patients ($P = 0.005$). It was also noticed that the number of patients leaving without being seen halved to 8% [57]. A Saudi Arabian study reduced the mean waiting time from 58 minutes to 25 minutes ($P < 0.005$) [58].

Other systems used a completely separate stream of care for minor injuries. In one RCT comparing fast track to regular care, the waiting times to be seen by a doctor showed no difference in triage category 2 and 3 patients, with a difference of several minutes for triage category 4 and 5 patients. The time spent in the ED showed no difference in category 2 and 3, but showed a 20–25 minute advantage in categories 4 and 5 for those using the rapid assessment clinic [59]. In an interrupted time series study, a similar system resulted in more rapid initial assessment of the patient across all triage categories (59% within target compared to 39% when no team was working, $P < 0.001$) except for category 1 patients [60]. A UK study showed that the risk of waiting more than 1 hour to see the doctor decreased by 30% to 50% with increased presence of consultants in the department [61], and a

second study demonstrated an increase in the patients seen within 1 hour from 52% to 75% without an increase in staffing [62]. In another study the median length of stay was 36 minutes for fast-tracked patients compared with 63 minutes for the control group [63]. This has worked equally well in pediatric units [64]. A recent study [65] of a fast-track unit also demonstrated an improvement in length of stay from 127 to 53 minutes ($P < 0.001$). However, Saywell et al. [66] undertook an economic evaluation of fast-track systems and found that it did not cover all related costs in their hospital.

Fast-track systems have also been developed for patients with specific injuries or illnesses (e.g., fractured neck of femur). A review [67] of 104 patients with a fractured neck of femur showed that after introducing a fast-track system the transfer time was reduced from 2 hours 45 minutes ± 57 minutes to 1 hour 32 minutes ± 41 minutes ($P < 0.001$). Another system resulted in a decrease in the admission time from 4.5 to 2.5 hours; however, patients were excluded if there was no identifiable orthopedic bed [68], and subsequent non-availability of beds caused the LOS of patients to increase by 40%. In a similar system [69], Finlayson found the major delays lay in performing the X-ray and in junior orthopedic staff resisting admission directly to the ward. A group of 50 patients with hip fractures admitted to a hospital via the ED in Manchester were studied prior to the introduction of a fast-track hip fracture protocol. The median ED-to-ward transfer time was reduced following its introduction by 43%, from 7 hours 4 minutes (range 2 hours 46 minutes to 11 hours 50 minutes) to 4 hours (range 1 hour 8 minutes to 11 hours 58 minutes, $P < 0.0001$) [70]. A major limitation of these studies of hip fracture-specific fast-track systems is that none studied their effect on waiting times for other patients in the ED. Another fast-track system for psychiatric patients only, consisting of a small cadre of nurses specifically trained to undertake psychiatric assessments, resulted in the ED waiting times for psychiatric patients dropping by 44% [71].

In conclusion, fast-track systems have been tested in a variety of environments and most have been shown to be effective as a means to reduce waiting times and overcrowding. Research, including some RCTs, supports the fast tracking of minor illnesses and injuries, though many studies had significant weaknesses. For example, few studies have looked at the influence on other patients, although those that did found no detrimental effects and no study showed any adverse patient effects. Moreover, reported outcomes were mainly related to time, and an effect (either positive or negative) was not demonstrated on important outcomes such as quality of care and/or patient outcomes. Finally, fast tracks may potentially be less effective, inefficient and costly in institutions where such patients are uncommon.

Questions 5: In hospital EDs experiencing overcrowding (setting), do system-wide interventions (intervention) reduce overcrowding and improve patient care (outcomes) compared to status quo (control)?

Search strategy

- MEDLINE: (ED OR emergency department) AND (overcrowding OR crowding OR waits) AND system solutions. Followed by using the "find similar" facility
- Google Scholar: waits, emergency departments, fast track

Three major reviews of interventions were located; their results are included in the text below [32,33,72].

Input to the ED comes from self-referral, emergency medical services (EMS) and referrals from other health professionals. Since EMS patients are often complex and time consuming, the reduction in EMS traffic could be a partial solution to ED overcrowding. Evidence of impact on overcrowding of ambulance dispatch and prioritization systems, including diverting 999 or 911 calls to advice lines, is generally poor. Some 999 or 911 calls can be diverted to advice lines but the safety of such systems is still questioned. Although it has been shown that 36.6% of calls could be diverted to other sources of care, 9% of callers were subsequently admitted to hospital [73]. Physician staffing in ambulance control (dispatch) may have a beneficial effect [74].

Ambulance crews often bring patients to ED by default. Alternatives may include taking patients to the nearest appropriate source of health care, including primary care centers, walk-in centers and minor injury units. The impact of introducing such services has been small or absent [75–78]. The role of paramedics in either discharging patients from the scene or deciding on appropriate destinations has not been adequately studied to confirm its safety and effectiveness and is likely to be highly dependent on training [79].

While interpretation of some evidence suggests that many patients in the ED can be deferred due to their ambulatory nature [80], other evidence contradicts this [81]. Moreover, while some suggest better primary care access may reduce ED utilization [82,83], other studies suggest the opposite, and access to walk-in clinics does not appear to effect ED visits [77,84]. None the less, efforts on the part of health regions to reduce the influx of these patients have been common. Introduction of primary care out-of-hours centers has been shown to have a deleterious effect in some studies and no effect in others [85]. Telephone advisory services have not been demonstrated to reduce attendances at EDs [86] and may increase the attendance of some groups [87]. Primary care gatekeeping (i.e., requiring a referral from a primary care physician for a patient to see a specialist) can reduce ED attendance but its safety is unknown. Gadomski et al. demonstrated that gatekeeping did not influence future ED usage [88]. Easier access to primary care can decrease ED visits by up to 40% [89] and in children by up to 24% [90]. There is no evidence about the effects on waiting times of general practitioners working in EDs. The benefits of creating primary care alternatives to ED care are unclear in terms of reducing visits by low acuity patients, and at least one study demonstrated that such reductions would have little to no effect on the waiting times of other ED patients [91].

Inappropriate or preventable admissions may account for 4.7–37% of hospital admissions, depending on the criteria used. A recent systematic review has defined effective admission avoidance schemes [92], but reduction of admissions can have a variable effect on overcrowding and has not been studied in most admission avoidance research.

No trials of variations in bed management strategies have been discovered, although there is a wealth of advice on good practice in bed management. Two studies [93,94] showed that performance against the 4-hour rule was linked to bed occupancy, however subsequent work failed to demonstrate that changes in bed occupancy were associated with a change in the 4-hour performance. Several studies [95–97] describe whole hospital changes including new policies, bed management and other broad changes that decreased ED LOS for discharged patients

There is a lack of evidence regarding innovations to reduce delays in discharge from hospital for patients awaiting placement in long-term care facilities, such as social care or complex continuing care. Informal evidence from the UK suggests that reducing discharge delays has improved inpatient flow through the hospital, but this has never been formally studied.

In conclusion, there are few system-wide interventions that have been shown to reduce overcrowding in a safe and persistent manner. While some system-wide efforts have been reported, many report short-term outcomes that may not be sustainable. Moreover, most studies simply cannot identify which of the many interventions may have had a critical role on the observed outcomes. Further research is urgently required in this field.

Questions 6: In hospital EDs experiencing overcrowding (setting), does the 4-hour rule (intervention) reduce overcrowding and improve patient care (outcomes) compared to status quo (control)?

Search strategy

- MEDLINE: (ED OR emergency department) AND (overcrowding OR crowding OR waits) AND four hour. Followed by using the "find similar" facility
- Google Scholar: waits, emergency departments, four hour

The 4-hour rule ("By 2004 no one should be waiting more than 4 hours in accident and emergency from arrival to admission, transfer or discharge") was announced in England in 2000 to be gradually implemented until 2005 when all hospitals had to achieve this rule [98]. Strategies to achieve this goal were multi-factorial, and were unique to institutions; however, the goals were incentive based. Most institutions addressed this problem through ED interventions with some system-wide interventions including, but not limited to, nurse practitioners, fast-track systems, development of specialist assessment units, full-capacity protocols for inpatients, improved discharge processes, and increased chronic and social care capacity.

Over this period, patient waiting times in UK EDs gradually decreased. By 2007, 98% of ED patients had waiting times of less than 4 hours, compared to 77% in 2002 [99]. It is recognized that patient waiting time is a major determinant of satisfaction [100], but direct study of the impact of the 4-hour rule has not been undertaken. The impact on quality of care is not well studied, though a survey suggested that patients' lives were on occasions put at risk in order to achieve the rule [101]. A study by the English National Audit Office [102] concluded that the rule had resulted in improvement in waiting times and environment for patients and staff. It did, however, note that changes were mainly in EDs and that changes across the whole system were required to achieve sustainability. It noted the lack of evidence to support or refute issues of quality of care and outcome. One small study suggested that while the rule resulted in better patient care satisfaction and improved staff morale, there may also have been unintended consequences, such as increased staff workload, concerns over the quality of care, pressure on support systems and training, and increased staff turnover [103].

In conclusion the 4-hour rule introduced in England appears to have improved patient satisfaction and the number of patients in EDs; however, there is no convincing evidence regarding its effect on quality of care or patient outcomes.

Questions 7: In hospital EDs experiencing overcrowding (setting), does a full-capacity protocol (intervention) reduce overcrowding and improve patient care (outcomes) compared to status quo (control)?

Search strategy

- MEDLINE: (ED OR emergency department) AND (overcrowding OR crowding OR waits) AND full capacity protocol. Followed by using the "find similar" facility
- Google Scholar: full capacity, protocol

Full-capacity protocols (FCPs) represent efforts to decant the ED by placing patients in the halls or rooms on inpatient floors even when a bed is unavailable. Such innovations have be employed only during certain times (e.g., severe overcrowding) or at all times (e.g., the UK 4-hour rule described above). Overall, despite extensive searching, limited evidence exists upon which to base a decision regarding the implementation of the FCP to address the issue of ED overcrowding.

There is one published study, two websites and one report accessed through personal communication where the FCP has been evaluated (Table 8.1). There were no cost-evaluation studies of the FCPs that we could identify in the published or unpublished literature. The variation in the actual FCP strategies is impressive, as no two FCPs were similar and several were part of a system-wide change. The evidence that does exist, however, demonstrates that the FCP is an effective measure to rapidly reduce LOS for admitted patients, to reduce ambulance diversion, and to increase efficiency within the hospital system.

Rowe: should this study be added to the ref list?

Table 8.1 Available evidence for the implementation of full-capacity protocols to reduce ED overcrowding.

Location	Intervention/ design	Description	Source/outcome	Results
Regina, Canada 2005	FCP Design unclear	Seven beds available for "full capacity'' in two hospitals that would be opened in the event of reaching FC	Regina Health Region website pdf document, http://www.rqhealth.ca (accessed November 10, 2006); outcomes not reported	"The strategy improves the flow of admitted patients through the emergency by transferring them to unit where they will receive care, thus allowing the emergency department staff to continue working efficiently and effectively''
Vancouver, Canada 2006	FCP Unpublished before–after controlled clinical trial	2 hours (ED assessment) + 2 hours (decision to admit) + 2 hours (to transfer to the floor)	Grant Innes (personal communication, November 10, 2006); emergency department length of stay for medical (M), surgical (S) and psychiatric (P) admitted patients with active intervention (SP) and control (c)	LOS M_{SP} = 30.2 to 11.2 hours (−69%) M_C = 19.5 to 15.5 hours (−21%) S_{SP} = 9.2 to 7.6 hours (−17%) S_C = 10.3 to 11.1 hours (+8%) P_{SP} = 56.3 to 47.1 hours (−69%) P_C = 12.2 to 11.1 hours (−9%)
New York, USA 2001	FCP Uncontrolled study	2-hour rule whereby patients would be transferred to the floor after 2 hours from the decision to admit; no more than two patients/unit; must be stable	Dr. Vicellio's wesbite http://www.hospitalovercrowding.com (accessed November 10, 2006)	"Positive effect despite increased volumes''; LOS = 6.2 hours (in ED hall) vs 5.4 hours on floor (FCP)
Maryland, USA 2006	FCP+ Before–after controlled clinical trial	N/A	*Journal of Quality and Patient Safety* The absolute and percentage change in ambulance diversions	"From 2003 to 2004, the hospital reduced ambulance diversion hours from 2365 to 655 – a 72% reduction''

FC, full capacity; FCP, full-capacity protocol; FCP+, full-capacity protocol in addition to other interventions within the health care system; LOS, length of stay; N/A, not available.

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In summary, the introduction of an FCP may improve ED LOS for admitted patients and improve flow in the ED; however, there is no convincing evidence regarding its effect on quality of care or patient outcomes. Moreover, the effects of an FCP policy on patient outcomes, medical staff morale and interactions, infection control, and patient satisfaction remain to be answered.

Conclusions

Using the evidence outlined above, the ED director met with the hospital staff. A task force was created which included representation from senior administration, the ED and internal medicine. A triage liaison physician was introduced, and a fast-track area was created to help decant the ED and improve flow. In addition, the task force identified delays in getting internal medicine patients admitted to a hospital bed after the decision to admit as a key objective to reduce ED overcrowding and improve patient care. Finally, they contacted their regional health authority to begin discussions on developing a region-wide approach to reducing ED overcrowding.

Overall, ED overcrowding is a common problem in many EDs around the world. The causes of the problem are multi-factorial; however, there has been a reluctance to address this issue due to the perceived complexity and the lack of examples of successful interventions. However, worsening overcrowding, combined with increasing evidence of adverse effects on patients and impressive emerging evidence from the UK and other jurisdictions that highly effective interventions exist, has prompted some hospital and regional health system level efforts to tackle the issue. Successful interventions that achieve substantial and sustained improvements in ED overcrowding are likely to be characterized by being site-specific, having a focus on patient flow across the continuum (from prehospital to ED to inpatient care through to discharge), being innovative and involving broad collaboration.

Conflicts of interest

None were reported.

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