


The Effect of Emergency Department Crowding on Patient Outcomes

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Abstract

Background: An extreme excess of patients exceeding the capacity of emergency departments (EDs) to provide care is an emerging threat to patient safety and health systems worldwide.

Aim: The purpose of this literature review was to investigate the effects of emergency department crowding on patients outcome.

Method and Material: A comprehensive search of the medical literature in Pubmed/ MEDLINE database was performed to identify all original articles that were published or available on-line between January 1, 2003, to January 1, 2013, and related to the concepts of "emergency department" and "crowding" or "overcrowding".

Results: Of the 1327 studies that were initially retrieved, 484 were excluded because they had no relevance to the topic and 843 after checking for eligibility criteria. From remaining 61 articles, a total of 35 studies were finally included in the review. The three main categories that were constructed based on the studies, were delays in treatment interventions, increased medical errors or adverse events and increased mortality.

Conclusions: The body of literature in aggregate strongly suggests that ED crowding is associated with potential of poorer performance and adverse clinical outcomes, including mortality. Further research is needed to fully understand the precise mechanism through which crowding adversely affect patient care. Policies must also be targeted to adapt of emergency care system in the fluctuation of inputs for better care that translates into better outcomes for patients visiting EDs..

Keywords: Emergency department crowding; Patient safety

Introduction

Emergency department (ED) crowding has been described as the most serious problem that endanger the reliability of health care system worldwide [1]. The American College of Emergency Physicians defines crowding as a situation in which the identified need for emergency services exceeds available resources for patient care in the emergency department, hospital, or both [2]. The conceptual model partitions ED crowding into 3 interdependent components: input, throughput, and output [3].

The commonly studied cause of crowding is demand for ED care. Between 1997 and 2007 the increase in total annual ED visits in USA was almost double [4] and between 2001-2008 was 60%

faster than would be expected from population growth [5]. A large proportion of all ED visits were for nonurgent conditions that estimated at 37% (range 8%-62%) [6] and from frequent users who comprised 4.5% to 8% of all ED patients but accounted for 21% to 28% of all visits [7].

One main factor that may cause crowding is inadequate staffing. Half of EDs exceed recommended patient to nurse ratio of 4:1 for routine ED beds [8] and 68% a patient to nurse ratio of 1:1 for critical care beds [9]. The mean nurse: patient ratios at morning shift were 1:15, at afternoon shift 1:7 and at night 1:4 [10].

Hospital bed shortages have been studied as factors that potentially affect crowding. Emergency rooms and trauma

centers in U.S.A declined by 3% from period 2003-2007 [11]. Non-availability of ED beds because they are occupied by admitted patients waiting for transfer from the ED to inpatient units restrict the EDs capacity to accept new arrivals and consume EDs resources [12-14]. A recent study concluded that, if current bed use trends persist and as the numbers of frail older patients rise exponentially, a 62% increase in hospital beds will be required to meet expected demand by 2050, at a cost almost equal to the entire current Australian healthcare budget [15].

ED crowding has resulted in poor performance on waiting time and length of stay (LOS). In US hospitals the odds of being examined by a physician within the time recommended at triage declined by 30% from 1997 to 2006 [16], waiting time increased from 46.5 minutes to 58.1 minutes from period between 2003-2009 [17] and ED LOS increased from 132 minutes in 2001 to 154 minutes in 2005 [18]. There was a larger increase among critically ill patients for whom ED LOS increased from 185 minutes in 2001 to 254 minutes in 2005 [18]. In other study found that an increase from the 20th to the 80th percentile in ED arrivals resulted in increases of 42 minutes in waiting time and 49 minutes in LOS [19].

The obvious operational and logistic problems created by crowding have a variety of undesirable consequences on patients, staff and hospitals [20,21]. The six dimensions of quality including safety, effectiveness, patient-centeredness, efficiency, timeliness, and equity that has been described by The Institute of Medicine, may all be compromised when patients experience long waiting time to see a physician or leaving without being examined, patients remains in the ED after they have been admitted to the hospital, but have not been transferred to an inpatient unit, or ambulances are diverted away from the hospital closest to the patient [22].

Therefore, the objective of this review was to describe the scientific literature that investigates the effect of ED crowding on patients outcomes.

Method

A comprehensive search of the medical literature in Pubmed/MEDLINE database was performed to identify all scientific articles that were published or were available on-line between January 1, 2003, to January 1, 2013, and related to the concepts of "emergency department" and "crowding" or "overcrowding".

The inclusive selection criteria were as follows: To be original article, to use crowding measures, to provide odds ratio (OR), risk ratio (RR) or hazard ratio (HR) estimates with confidence intervals and to be published in English. We excluded commentaries and letters to the editor, original article for causes, solution and measures of emergency department crowding and adverse effects on pediatric patients.

Two reviewers independently evaluated the titles and abstracts for relevance to the topic and subsequently obtained full-text versions of all potentially relevant papers, which were then further discussed among authors for final inclusion.

Results

The initial search yielded a total of 1327 citations, 484 were excluded after title/abstract review and 782 did not fulfill inclusion criteria (94% inter-reviewer agreement). After retrieving the

full-text of the remaining 61 articles, another 26 articles, which focus on waiting time, delays for diagnostic test and patients perceptions, related to ED crowding, were excluded from review. Finally, only 35 papers measured the effect of ED crowding on patient outcomes and grouped in three categories: increased delays in treatment, increase medical errors and adverse events and increased mortality. A flowchart of studies included in this review is presented in Figure 1.

Delay in treatment interventions

Seventeen studies [23-39] examined the relationship between ED crowding and delay in treatment. Regarding pain management, Hwnag et al., found that during periods of greater patient volume, hip fracture patients had less documentation of pain on first assessment and longer times to pain assessment [23]. Patients examined during periods of high patient concentration, took up to 55 minutes longer to have documented pain assessment without differences in likelihood of pain assessment [24]. Administration of analgesia during high levels of ED crowding measures was less likely to patients with severe pain [25] and other painful condition [24] while was not statistically significant in patient with back [26] or abdominal [27] pain and hip fracture [23]. Among those who received treatment, ED crowding measures were associated with a higher likelihood of delay in both time from triage to analgesia and time from room placement to analgesia [25,26]. Likely, no relation between workload and time to analgesia was observed in patients with fractured neck of femur or wrist and renal or biliary colic [28].

Regarding time to antibiotic administration for patients with pneumonia, five studies associated increased level of ED crowding with a decrease in the proportion of community-acquired pneumonia (CAP) patients receiving antibiotics within four hours [29-33]. The time from arrival to order a chest radiograph was prolonged by 14.3 minutes and from ordering of antibiotic to administration by 9.3 minutes for every 10 additional ED patients [30]. The effect of additional patients appears to occur even at volumes below the maximum bed capacity [29].

Overcrowding was also associated with increased door-to-balloon and door-to-needle times for the treatment of acute ST-Elevation Myocardial Infarction (STEMI) [34,35]. In contrast, time to achieve emergency percutaneous coronary intervention for acute STEMI did not correlate positively with crowding as measured by the occupancy rate [36] and ED length of stay or left without being examined [33].

Time to acute stroke care however, remained the same in thrombolysis eligible patients regardless of the crowding factor, but not in patients outside of the intravenous thrombolysis window, who experienced delays in a CT-scan order and completion at higher levels of ED crowding [37].

ED crowding as measured by the number of patients visits, was associated with delays in resuscitation efforts and mortality during ED stay. Patients who attended at day with daily visit equal to or greater than 93 (daily ED patient concentration range 57-140) had two-fold increased odds of experiencing delayed resuscitation effort and four-fold increased odds of in-hospital mortality compared with the patients who attended at day with daily visit less than 93 [38].

Medication treatment time in patients with acute asthma was

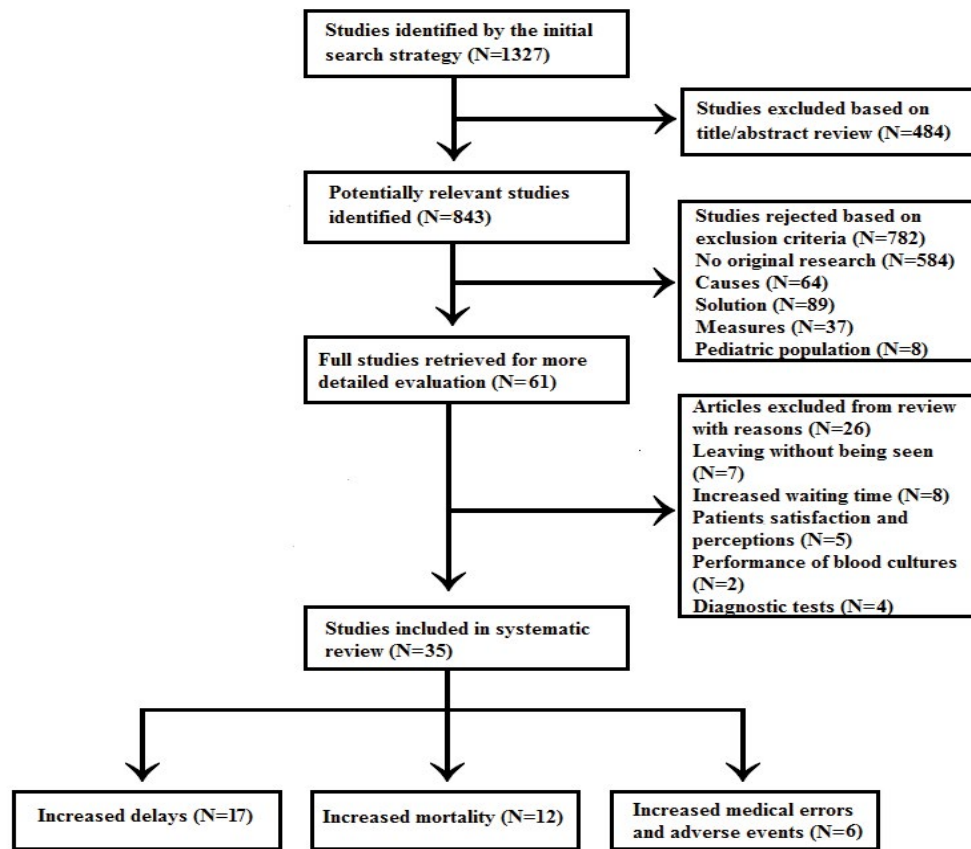


Figure 1 Flow diagram of articles selection

associated with highest percentiles of ED occupancy. Time to a nebulizer order was 6 minutes longer (95% CI=1-13 minutes), and time to a steroid order was 16 minutes longer (95% CI =0-38 minutes) during crowded periods [39].

Increased medical errors and adverse events

Six studies [40-45] assessed the effect that ED crowding had on medical errors and adverse events. ED overcrowding is associated with an increased frequency of medication errors measured in real time by the modified EDWIN score [40] or boarding status [41]. Errors included giving medications at incorrect doses, frequencies, durations, or routes and giving contraindicated medications [40]. Patients whose average crowding exposure was in the highest quartile had two-fold increased odds of experiencing a preventable adverse event compared to patients whose average crowding exposure was in the lowest quartile [42]. For every hour spent in the ED, the odds of experiencing an adverse event in-hospital increased by 3% [43].

Among patients with acute coronary syndrome, several crowding measures showed three to five times higher rates of adverse outcomes as cardiac arrest, congestive heart failure, ventricular tachycardia or fibrillation, supraventricular dysrhythmias, symptomatic bradycardia, hypotension or death during the highest levels of crowding [44]. High hospital occupancy was associated with increased incidence of serious complications defined as shock, need for intubation and death within 24 hours for patients admitted, but still treated in the emergency department and

managed by emergency department providers. The incidence for serious complications was 13.62 per 1000 patient days when hospital occupancy was $\leq 90\%$, and it increased significantly to 17.10 and 22.52 per 1000 patient days for occupancy at 90%-95% and $\geq 95\%$, respectively [45].

Increased mortality

Twelve articles [46-57] specifically examined the association between ED crowding and mortality. Occupancy was linked to increased odds of deaths at 10 days for patients who presented to one Australian hospital (OR=1.34, 95% CI=1.04-1.72) [46]. Using the same crowding measure, patients with CAP had 9-fold increased odds of 28-day mortality [47]. Hospital occupancy $\geq 100\%$ in combination with access block $\geq 20\%$ occupancy was associated with an increased 2, 7 and 30-day mortality (HR=1.3, 95% CI=1.1-1.6, 1.3, 95% CI=1.2-1.5 and 1.2, 95% CI=1.1-1.3 respectively) [48].

Mortality increased with increasing boarding time, from 2.5% in patients boarded less than 2 hours, to 4.5% in patients boarding 12 hours or more ($p < 0.001$) [49]. The in-hospital mortality was 17.4% for critically ill emergency department patients with a >6-hr delay in intensive care unit transfer, versus 12.9% for critically ill patients who were transferred to intensive care unit in <6-hr ($p < .001$) [50]. The risk of death among high and low acuity patients was 1.79 and 1.71 respectively for mean length of stay of ≥ 6 hours compared with <1 hour [51]. Prolonged ED boarding stay that exceeded 8 hours was associated with increased mortality in

patients with necrotizing fasciitis [52]. The long ED stay was not associated with mortality in patients with non-STEMI but was associated with increased rate of recurrent in-hospital MI [53].

ED crowding, as measured by ambulance diversion at 187 hospitals, was associated with increased inpatient death rate occurring in the first 3 days (OR=1.05, 95% CI=1.02–1.08) [54]. Among patients that were admitted for AMI and exposed to 12 or more hours of ambulance diversion, the 30-day, 90-day, 9-month, and 1-year mortality was increased [55]. The mortality for admitted trauma patients on significant diversion days, defined as day when hospitals were on diversion for more than 8 hours, was slightly higher than among those admitted on day when hospitals were on diversion for fewer than 8 hours (3.9% vs. 3.3%), but was statistically significant at the 0.1 level (25% vs 14%) among the most severely ill patients [56]. In contrast, ambulance diversion contributed to 28% reduction in patient mortality at an Australian ED [57].

Discussion

ED crowding is associated with delays in treatment for emergency conditions, thereby increasing the risk of poorer outcomes. Increased crowding levels, according to this review, were associated with the potential of poorer performance regarding pain management standards, such as timely and appropriate assessment or analgesia on which hospitals are judged [23-27]. Delays or not treatment of acute pain has consequences beyond the immediate perception of suffering and can negatively impact patients' well-being on multiple levels [58].

Emergency departments in crowding conditions were not able to meet The Joint Commission and the Centers for Medicare and Medicaid Services (CMS) performance measures targets for patients with CAP, that are used as an indicator of the quality of care, with a 4- hour benchmark [29-33]. Although current guidelines for treating CAP do not recommend administering antibiotics within a certain time limit, [59] early time to first antibiotic dose should be considered as an important marker of optimal patient care in patients with CAP rather than a factor predicting the outcome [60,61]. Although articles attempted to relate degradations in performance to crowded conditions, their evidence suggests that performance begins to deteriorate long before conditions in the ED begin to be identified as crowded [29].

The impact of ED crowding on time-sensitive processes of care such as reperfusion therapy is controversial. The finding that ED crowding, as measured according to EDWIN score, associated with increased time to balloon inflation during PCI for the treatment of acute STEMI [35] does not confirm by the much more robust, prospective data from the same ED in a study designed to follow up that study's findings [36]. ED crowding was not associated with care delays in thrombolysis-eligible patients with stroke [37] but for patients with suspected acute myocardial infarction [34]. The established policies that high prioritize diagnostic and treatment algorithm critically ill patients stroke and acute myocardial infarction may not be affected by competing resource demand [36].

ED crowding exacerbates the rate of medical errors adverse affected quality of care [40-42]. Although a medical error does not necessarily imply the occurrence of a medical harm, patients exposed at risk of medical errors potentially increased their risk

of adverse events. Critically ill patients exposed to crowding are highly likely to be attributable to adverse events caused by medical errors [44]. The increased likelihood of serious adverse events is a plausible mediator of the relationship between crowding and increased lifethreatening complications [45].

Adverse events of emergency department crowding have also been linked to fatalities as measured by eventual mortality on unselected admissions or specific patient subgroups. The possible relationship between crowding and mortality across studies are not directly comparable because of differences in ED crowding measure, study populations, and case-mix adjustment. Although the size of the effect was not consistent across the majority of studies, considering the adjusted ratio risks that ranging from 1.05 to more than 3, the direction of the effect was [46-52,54-56]. Only two studies [53,57] did not find association between mortality and crowding as measured by ambulance diversion at one ED in the first study, but without assessment of patients mortality who was diverted to other hospital [57]. In the second study, ED LOS were associated with decreased use of guideline-recommended therapies and a higher risk of adverse events for patients with non-STEMI [53]. ED crowding was associated with higher mortality rate both during ED stay and up to 30 days after admission, regardless of severity on presentation. The increased risk of death for low acuity patients suggests, that processes might be more likely to break down if patients are thought to be low risk [51].

This review is consistent with 4 previous reviews [20-22,62] looking at the effects of emergency department crowding on patients outcomes. Delays in providing needed care and increased risks of mortality are identified in all articles by adding decreased satisfaction [21] and higher probability of leaving the ED against medical advice or without being examined [22]. Another article focuses on adverse moral consequences of ED crowding, as compromised privacy and confidentiality, impaired communication, and diminished access to care [62].

The results of the current review should be interpreted in the context of some limitations. First, our research is limited only to the Pubmed database and we may have missed some studies published in others databases. Second, the retrospective design of the included studies based on existing patient registers or databases cannot exclude the possibility of confounding that may have affected these results. Accuracy and variability in the quality of documentation among different health care personnel it was not feasible to ensure with retrospective audit of databases. The findings show considerable variability in crowding measures, time intervals, patient populations and hospital status, resulting to inability to generalize. Finally, no study determined the exact mechanism responsible for the association between crowding and adverse events, although some inferences can be made.

Conclusion

The body of literature in aggregate strongly suggests that ED crowding is associated with poorer performance and adverse clinical outcomes, including mortality. Further research is needed to fully understand the precise mechanism through which crowding adversely affect patient care. Policies must also be targeted to adapt of emergency care system in the fluctuation of inputs for better care that translates into better outcomes for patients visiting EDs.

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