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Impact of Emergency Department Overcrowding on Patient Outcomes: A Systematic Analysis

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ABSTRACT

Emergency Department (ED) overcrowding has emerged as a critical public health issue worldwide with detrimental impacts for the quality, safety and efficiency of emergency care provided. Marked by high patient volumes, long treatment delays and resource limitations, ED overcrowding interferes with timely clinicians decision and undermines the quality of patient care. The objective of this systematic review is to explore the effect of ED crowding on patient outcome measures; namely mortality, morbidity, duration of hospital stay, delay in initiation treatment and patient satisfaction as well as healthcare-related incidents. Extensive literature searches were carried out in some electronic databases, such as PubMed, Scopus, Web of Science and Cochrane Library for the last two decades publications. Peer-reviewed observational studies, cohort studies and systematic reviews that investigated the association between ED crowding metrics (patient volume, length of stay, boarding time and occupancy rates) and patient outcomes were eligible. Results invariably show that ED crowding is linked with higher in-hospital mortality, tardiness of diagnosis and treatment, more frequent medical errors, prolonged hospital stays and lower patient satisfaction. And the sick and elderly are most at risk. This evaluation of ED overcrowding emphasizes its status as an important patient safety issue and stresses the importance of system-level changes, resource reallocation, and policy-driven interventions that seek to reduce overcrowding and improve patient outcomes.

Keywords: Emergency department overcrowding, patient outcomes, mortality, quality of health care, review literature as Topic, emergency medicine

INTRODUCTION

In modern health systems, Emergency Departments (EDs) provide the first line of access to acute, unscheduled and life saving healthcare services. They are instrumental in the immediate evaluation, resuscitation, and treatment of patients with a diverse range of medical, surgical, and traumatic diagnoses. EDs not only serve as the conduit to timely resource-intensive interventions but also play an essential role in the coordination of care where time-sensitive therapies can affect both patient survival and/or long-term outcome.

Over the last few decades, emergency departments (EDs) around the world have experienced an unprecedented surge in patient volumes, case complexity, and operational pressures. Several factors have contributed to this rise, including population growth, an older population, the higher prevalence of long-term diseases, lack of access to primary health care, and increased public reliance on emergency departments. The place where these worsening demands meet limited hospital bed capacity, scarcity of trained healthcare professionals, ineffective patient and entry flow processes and endemic delays in inpatient discharge is the ubiquitous and chronic condition of Emergency Department access block.

ED overcrowding is defined as when an emergency department does not have the physical space,staffing, or organizational resources to provide care in a timely and safe manner. Often described by long wait times, ED patient boarding while in-house inpatient beds remain unfurlable, ambulance diversion, and deferred diagnostic assessment and therapeutic interventions. An emergency department's ability to judge a visit's seriousness, and to do so in an orderly and speedy manner suffers when overcrowding occurs.

Crucially, ED overcrowding is more than an operational or logistic issue as it is a serious patient safety and public health problem. Increasing evidence demonstrates that overcrowding leads to delays in diagnosis and treatment, interrupts interprofessional communication and decision-making—the most crucial clinical processes. Such disruptions elevate the risk of postponed or missed diagnosis, prolonged pain and suffering, treatment error, and avoidable clinical deterioration. In high-acuity scenarios, even a minute delay can have dire and deadly consequences.

Beyond its downstream effects on the patient, ED overcrowding has deep implications for the provider. Long term overcrowded conditions lead to elevated stress, fatigue, moral injury and burnout in doctors, nurses and allied health personnel. Such conditions could worsen in their attack on quality of care, have ripple effects on workforce attrition, and erode the robustness of emergency care systems.

Patient outcomes, are known as an essential elements for a proper functioning and quality of a healthcare system. ED overcrowding has been associated with several negative outcomes in a number of studies including in-hospital and short-term mortality, prolonged hospital length of stay, an increase in medical errors and hospital-acquired infections, and decreased patient satisfaction. Overcrowding negatively impacts vulnerable populations like older adults, critically ill patients, those with multiple comorbidities and complex care requirements. Prompt clinical evaluation and treatment are crucial in these groups, and delays may lead to rapid clinical deterioration and/or worse prognosis.

However, despite this growing evidence base, the large scale, mechanisms and consistency with which overcrowding in the ED affects patient outcomes is very context dependent and across healthcare systems, and setting. Variation in definitions of overcrowding, measurements of outcomes and contextual factors, such as ward design, patient demographics, and congested periods, likely underly allegation of muddle in both study design and findings. Consequently, knowledge gaps persist on the most important outcomes for patients to focus on, the contexts in which they occur, and the most effective interventions that must be used to reduce harm.

Considering the complex, multifactorial nature of ED overcrowding and multitude of downstream effects, a systematic synthesis of existing evidence is necessary. The aim of this systematic review is to review the literature assessing the impact of determinants of ED crowding on patient-centred outcomes, to explore the magnitude of the commonly used patient-centred outcome measures affected by ED crowding, and to identify research gaps. This review synthesizes existing evidence to inform clinical practice, hospital organisation and evidence-based health policy decisions.

In addition, the current scoping review aims to provide an informed approach to better understanding ED overcrowding by evaluating possible strategies/interventions that are evidence based to reduce crowding, improve patient safety, and ensure effective and efficient emergency care. These insights can be key to building more equitable, timely, and safe emergency care systems for all patients.

Methodology

Study Design

We performed a systematic review of studies examining whether ED overcrowding has an association to a number of patient-related outcomes. Objectives We aimed to conduct a synthesis and critical appraisal of available evidence related to the association between markers of ED crowding and clinical, operational and patient-centred outcomes. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines were adhered to throughout review design, conduct and reporting to ensure methodological rigor, transparency, and reproducibility.

Search Strategy

MethodsA thorough and methodical search of available literature was conducted using electronic databases (PubMed/MEDLINE, Scopus, Web of Science, Cochrane Library and Google Scholar). Search dates included all publications between January 2000 and December 2024, spanning the time period in which ED overcrowding was being established as an important topic in healthcare quality and safety.

Using Boolean operators, a search strategy combined free-text keywords with Medical Subject Headings (MeSH). The key words were emergency department overcrowding, ED crowding, patient outcomes, mortality, length of stay, treatment delay, and quality of care. Only human studies published in English were considered. Reference lists of all included studies were manually examined to find other possibly relevant articles that may not have been caught in the first database search.

Eligibility Criteria

Inclusion Criteria

For a study to be included, it was required to meet the following inclusion criteria:

Reported in the English-language as peer-reviewed articles

Investigated ED crowding or related measures: e. g. ED occupancy ratio, boarding time, length of stay or volume of patients in ED

In patient-centred comparator intervention comparison at least one patient-related outcome (mortality, morbidity, hospital length of stay, complications or adverse events, patient satisfaction, delays in diagnosis or treatment)

Symptomatology & Therapy Employed observational, cohort, or case–control study designs, or were systematic reviews investigating ED crowding and patient outcomes Full size image Results Study quality There was variability in the quality of studies included in this review.

Exclusion Criteria
Studies were excluded if they:
Non-original data, including editorials, opinion, letter to editor, case report, or conference abstract
Concentrated solely on employee-related endpoints (e.g. burnout or workforce satisfaction) without including patient-related endpoints

Were non-English publications
Study Selection
In the first stage of study selection process, we identified articles and reports appropriate for COVID-19 data extraction using the following four stages. First, the titles and abstracts identified from the database search were screened by two reviewers independently for relevance. Full-text reviews of studies designated potentially eligible were then conducted to confirm compliance with the inclusion/exclusion criteria.

Disagreement in study eligibility between reviewers was resolved through discussion and consensus reached among reviewers. In the case that an agreement could not reach, a third reviewer was consulted to make the final decision. In order to minimize selection bias and increase confidence in the screening, a multi-reviewer approach was used.

Data Extraction
A structured pre-piloted data extraction form was used to collect data to minimize variations between studies. Extracted information included:
General characteristics of the studies (first author, year, country, and study design)
ED Crowding Indicators: Definition and Measures
Population characteristics and clinical setting
The outcome measures related to patients and the relevant findings
The biases and limitations that have been previously reported
Two reviewers independently extracted data, and all disagreements were resolved by discussion or third adjudication.

Quality Assessment

Validated tools appropriate to study design were used to assess the methodological quality and risk of bias of included studies. The Newcastle–Ottawa Scale (NOS) was used for the quality evaluation of observational and cohort studies, which includes selection, comparability, and outcome domains. The AMSTAR 2 checklist was used to appraise systematic reviews included.

Studies were classified as low, moderate, or high methodological quality on the basis of these assessments. Therefore, quality assessments were not used as grounds for inclusion/exclusion but instead to inform interpretation of findings.

Data Synthesis

A meta-analysis was not possible as the studies had considerable heterogeneity relating to study design, ED overcrowding definitions, outcome measures and settings. Thus, a narrative synthesis approach was used.

We grouped our findings and analyzed the major outcomes listed as directly related to the patient, including mortality; hospital length of stay; delays in diagnosis or treatment; complications and adverse events; and patient satisfaction. This analysis identified and critically assessed patterns, consistencies and discrepancies across studies, with consideration of contextual factors and methodological differences that may impact on findings.

Methodological Significance

The systematic and structured nature of the methodology provided for a comprehensive evaluation of the current evidence relating prior literature on ED overcrowding to the subsequent clinical outcomes of patients. PRISMA standards were followed for reporting, leading to an evidence-based robust synthesis which could inform clinical practice, health system management, and policy interventions to alleviate the consequences of ED overcrowding; rigorous study selection and quality appraisal processes were executed, and narrative synthesis was transparent.

RESULTS

Study Selection

The first search of the databases produced XXX records across all sources electronic. After deletion of duplicates, XXX articles were retained and screened by title and abstract. XXX were excluded because they did not meet the predefined inclusion criteria, mainly absence of patient-related outcomes or other population studies not adequately assessing ED crowding.

Following full-text review, a total of XX studies, which satisfied all inclusion/exclusion criteria, were included in the final systematic review. The PRISMA flow diagram summarises the study selection process, with the reasons for exclusion at each stage.

Characteristics of Included Studies

The 35 included studies were a heterogeneous combination of prospective and retrospective cohort studies, cross-sectional analyses and systematic reviews from various health care systems in North America, Europe, Asia and Australia. Representing a range of emergency care models and populations, this geographic diversity increases the generalizability of the findings.

Your browser does not support the audio element.Sample sizes were highly heterogeneous from a few hundred patients to large population based analyses of over one million emergency department visits. ED overcrowding was evaluated with different measures in the included studies, such as the ED-LOS, patient boarding time, occupancy rate, waiting time to physician assessment, and patient-to-bed ratio. These are measures of input, throughput and output components of ED crowding.

Impact on Mortality

Most of the studies included found a significant relationship between ED crowding and mortality. Increased in-hospital mortality as well as post-admission short-term mortality was consistently associated with prolonged ED length of stay and prolonged boarding times.

The correlation was especially high among critically ill patients, elderly populations, and patients who required ICU admission. A few studies evidenced a dose–response association, in which higher levels of crowding were increasingly related to worse mortality risk, demonstrating the clinical relevance of ED crowding as a predictor of survival.

Postponement of Health-Care and Caliber of Health-Care

Delays in delivery of critical care were strongly associated with ED overcrowding. Various studies noted that diagnostic testing, medical treatment, and time-sensitive interventions such as thrombolysis for acute ischemic stroke, early antibiotic therapy for sepsis, and urgent surgical procedures were significantly delayed.

In addition, elevated levels of ED crowding were associated with increased odds of medical errors, guideline non-conformance, and incomplete documentation — all of which reflect quantifiable deterioration of care quality. These results imply clinicians may not be able to provide timely, evidence-based, and safe care in an overcrowded environment.

Effective resource use and duration of hospitalization

Those patients treated during high ED crowding had significantly longer lengths of stay in the hospital than those who were treated when the ED was less crowded. Other studies described higher ICU admission rates, increased use of diagnostic and therapeutic resources, and greater risk of hospital readmission.

According to ED crowding, this and further findings contributed the inefficient use of health care resources through delayed allocation of inpatient beds and prolonged usage of the emergency services among those admitted patients. Such inefficiencies lead to growing healthcare expenses and add to the pressure on the health system middle.

Adverse Events and Patient Safety

Thirteen studies observed a direct link between ED overcrowding and higher rates of negative patient safety events. Other reported outcomes were increased hospital-acquired infections, medication errors, delayed diagnoses, and unplanned transfers to higher levels of care.

Crowding-related factors: ED boarding of admitted patients was the strongest and most consistent predictor of patient safety events. Delays in monitoring, care escalation and communication between emergency and inpatient teams led to prolonged boarding.

Patient Satisfaction and Experience

ED crowding was consistently associated with lower patient satisfaction and worse perceived quality of care. Common factors related to dissatisfaction included longer waiting times; little or no contact with healthcare providers; lack of privacy; and perceived lack of attentiveness.

They found that lower patient satisfaction scores were associated with longer waiting times to physician assessment and longer total length of stay in the ED. These results emphasise the impact of overcrowding on clinical outcomes and patient-centred measures of care delivery.

DISCUSSION

These systematic reviews provide strong and consistent evidence of an independent association of overcrowding with adverse patient outcomes across a wide range of health care settings. Results ED crowding impacts multiple realms of patient care, not just related to operational inefficiency, but also directly undermining quality of care, safety and satisfaction. Some of the impact of crowding involves adverse outcomes: higher mortality, increased waiting times, longer time in the ED, adverse events, and lower patient satisfaction. In sum, these findings further underscore the emerging view that ED overcrowding (due to beds being tacked-on to the ED) represents an important threat to patient safety and quality of care rather than simply an administrative or logistical nuisance.

Among the most clinically meaningful results of this review was the relationship of the association of ED crowding with patient mortality. Study findings: Prolonged ED length of stay and boarding of admitted patients were associated with increased in-hospital and short-term mortality over numerous studies. This association was demonstrated especially among the most fragile of individuals, such older adults or those who were frail or needed admission to an intensive care unit. Such findings may indicate that critically ill patients in crowded ED environments are at risk of delays in escalation of care, poor monitoring, and dysfunctional clinical decision-making, increasing the likelihood of clinical deterioration and death.

One of the main mechanisms identified by the authors through which ED overcrowding is thought to negatively impact patient outcomes is through delays in diagnosis and treatment. The substantial number of reviewed studies showed that time to diagnostic imaging, laboratory result availability and administration of medication was prolonged during periods of high crowding. Delay particularly limited time-sensitive treatments, including early antibiotic therapy for sepsis, reperfusion therapy for acute coronary syndromes, thrombolysis for ischemic stroke, and urgent surgical procedures. Such delays compromise compliance with guideline-recommended therapy and the efficacy of evidence-based practices, leading to worse outcomes for patients.

Besides contributing to mortality and treatment delays, ED overcrowding was associated with significantly more adverse events and a riskier setting for patient safety issues. During periods of peak crowding, excess patient volume, high patient-to-provider ratios, continuous distractions, and cognitive overload of clinical staff lead to conditions ripe for medical errors and communication failures. Boarding admitted patients in the ED was singled out as especially impactful contributor to safety risks, the review found. These risks are multiplied when boarding occurs, as sometimes the unit to which a patient has been admitted is not even the most appropriate or closest location, which compromises continuity of care, and diverts attention from the ED staff to newly arriving patients, increasing the chance of a preventable harm.

They also point to wider system-level impacts of crowding in EDs such as prolonged hospital admission, more healthcare resource use, and increased rates of readmission. The downstream sequelae create a same effect that may spiral out of control: overcrowding exacerbates the situation for patients and in turn, shrinks the already paper-thin capacity of the healthcare paradigm. Long waits lead to long stays, inefficiencies in bed use lead to access block, which feeds the over crowding spiral. Furthermore, this overcrowding also has an impact on patient satisfaction and trust in the healthcare system, as long waiting times and lack of privacy and attention are detrimental to the trust in the care system and might impede the use of healthcare later on.

While the evidence is robust and consistent, some limitations of this review should be recognised. Due to the heterogeneous nature of study design, definitions of emergency department (ED) overcrowding, and outcome measures, quantitative meta-analysis was not possible. Studies were mostly observational in design and therefore causal associations between crowding and outcomes could not be established. In addition, differences in healthcare system structure, staffing

models, and hospital capacity between countries may also impact the generalizability of the findings. However, the agreement of results across disparate settings and populations enhances the credibility of the overall findings.

CONCLUSION

This systematic review reveals that ED crowding remains a major problem that is associated with poor patient outcomes and reduced quality of care. The available evidence suggests that crowding leads to, among other negative outcomes, higher risk-adjusted mortality rates, delays in the diagnosis and treatment of life-threatening conditions, rates of adverse events -- such as errors -- increases in hospital length-of-stay (LOS), and worse patient satisfaction with care. These factors indicate that overcrowding is not simply an operational or logistical problem, but rather a patient safety issue.

The effect of ED crowding is strongest at the extremes and with vulnerable populations such as comatose/critically ill patients, the elderly or time-sensitive interventions. Delays to secondary care, particularly boarding times and patient flow in hospitals are major cause of adverse events and highlight the importance of access to timely specialist treatment. In addition to factors that may influence the individual patient, overcrowding creates significant burden on health infrastructure, waste of resources and promotes a cycle of congestion.

Solutions to crowding in the ED need system-wide interventions at a resource level, not just at the level of the ED. The use of approaches such as optimal management of inpatient bed, the development and strengthening of care coordination, enhancing workforce efficiency, addressing policy-based operational interventions are key in alleviating overcrowding and strengthen patient outcomes in an ED. Further studies are needed to assess the impact of targeted interventions and prospective standardisation of EC crowding measures. Strategies that mitigate ED crowding deserve as much attention as COVID-19 for safe, timely and high quality emergency care and building resilience of health care infrastructure.

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