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Systematic Review

# Effect of Emergency Department Crowding on Patient Mortality: A Systematic Review

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**Abstract**

**Introduction:** Emergency department (ED) overcrowding may damage patient outcomes in various settings. This systematic review investigated the association between ED crowding and patient mortality.

**Methods:** A search of three electronic databases, namely Medline, EMBASE, and Web of Science websites, was done to identify all original English language published studies concerning mortalities caused by ED crowding between January 1999 and January 2020.

**Results:** A total of 45 studies were included in the full-text review. After excluding 17 studies because of poor quality, 28 articles were included in the final review. Twenty articles reported a direct association between ED crowding and emergency patient mortality. With the increase in ED overcrowding, mortality also increased. Nevertheless, eight studies reported no association between ED crowding and mortality.

**Conclusion:** ED overcrowding significantly increased patient mortality regardless of the amount of ED overcrowding and type of diseases in most studies were assessed in this study. Additional studies are required to comprehensively assess the relationship between ED overcrowding and patients' mortality.

## Introduction

Crowding in the ED has been described as a significant public health problem threatening the appropriate function of the health systems in many countries worldwide [1-4]. Many institutions and studies have developed definitions for ED crowding and overcrowding. In a simple form, when there is a delay in providing timely care by providers due to congestion, crowding exists [4-6].

ED crowding causes problems for patients, staff, health systems, and society. Thus, many studies aimed to identify its cause, consequences, and possible solutions to avoid its adverse effects. Crowding in ED can cause problems including deteriorating healthcare delivery process [7-10], poor quality care [1,11] and efficiency [12-14], increased medical errors[15-17], low satisfaction and high compliance [11, 18, 19], high morbidity [20], increasing patient mortalities [9, 21-23], etc., which all deteriorate the effective and appropriate provision of healthcare services and safe healthcare network.

Among those adverse effects, patient mortalities also have been identified as an adverse outcome of crowding, which indicates the quality of care. Thus, several studies have looked at available databases that compare mortality rates in patients presenting during crowding versus no crowding times. Most of these studies found correlations between increased mortality and crowding in EDs and have concluded that the death rate is higher during crowding. Some systematic reviews which aimed to assess the effects of crowding on patient outcomes covered the impact of crowding on patient mortalities [4,10,24-27]. They included a few published studies concerning this correlation in their reviews, which do not give us complete results, and they have significant limitations.

Thus, this article aimed to describe the effects of crowding on mortality by assessing all published articles in peer review journals.

## Methods

### Search Strategy

In this review, the American College of Emergency Physicians defined crowding as a situation where emergency services exceed available healthcare resources. For this study, we followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines[28]. We performed the search on three electronic databases, including Medline, EMBASE, and Web of Science. The search keywords and phrases used in this review are shown in Table 1. We have included all English-language published studies between January 1999 and January 2020 for twenty years. We had no limitation on the types of studies and methods applied for the reviews. All articles concerned with mortality caused by ED crowding and satisfied the inclusion criteria of being original studies and published in peer-review journals were included in the study.

### Study selection, quality assessment, and data extraction

Two reviewers followed the procedure of searching in databases independently, and then they reviewed the abstracts and titles of studies to identify the relevant articles. Discussing with another reviewer was used in the case of any disagreement. A total of 45 articles were eligible for the full-text review. Then, the reviewers assessed the quality of the studies using standardized Critical Appraisal Skills Programme (CASP) tools designed for different types of studies[29]. In this process, 17 studies were excluded because of poor quality. For the included studies, reviewers using a standardized form, extracted data about the design, setting, sample size, outcomes, and main findings of the studies.

Table 1: Keywords utilized for search from databases.

| Emergency department-related keywords | Crowding-related keywords | Mortality-related keywords |
|---|---|---|
| emergency medicine, hospital emergency service, emergency health services, emergency medical services, emergency department, ED, emergency room, ER, emergency ward | crowding, crowded, overcrowding, overcrowded, hospital bed utilization, diversion, divert, crises, crisis, surging, surged, congestion, capacity, occupancy | mortality, mortalities, mortality rate, excess mortality, mortality decline, fatality rate, fatality excess, case fatality rates death rate, age-specific death |

## Studies characteristics

We found 1269 records from the search of MEDLINE, EMBASE, and Web of Science databases. Also, we found 15 records through the Google Scholar search (Fig. 1). After removing duplicates and abstract screening, 45 records were eligible for full-text screening. The full-text screening resulted in 28 articles eligible for the final review. The summary of the included articles in the final review is presented in Table 2.

Out of the 28 articles included in the final review, the designs of 19 articles were retrospective cohort studies, two retrospective cross-sectional studies, two retrospective observational studies, two prospective cohort studies, one prospective observational study, one quasi-experimental, and another longitudinal time-series regression analysis. Also, studies used various measures of crowding, such as boarding time, ED length of stay, ambulance diversion, mean ED occupancy, relative ED occupancy, and patient volume (Table 2).

Again, 13 articles were from studies in North America, eight were from Asian countries, four were from European countries, and the remaining three were from Australia. Besides, 12 articles were published during 2013-2019, 13 during 006-2012, and the rest three during 1999-2005 (Table 2).

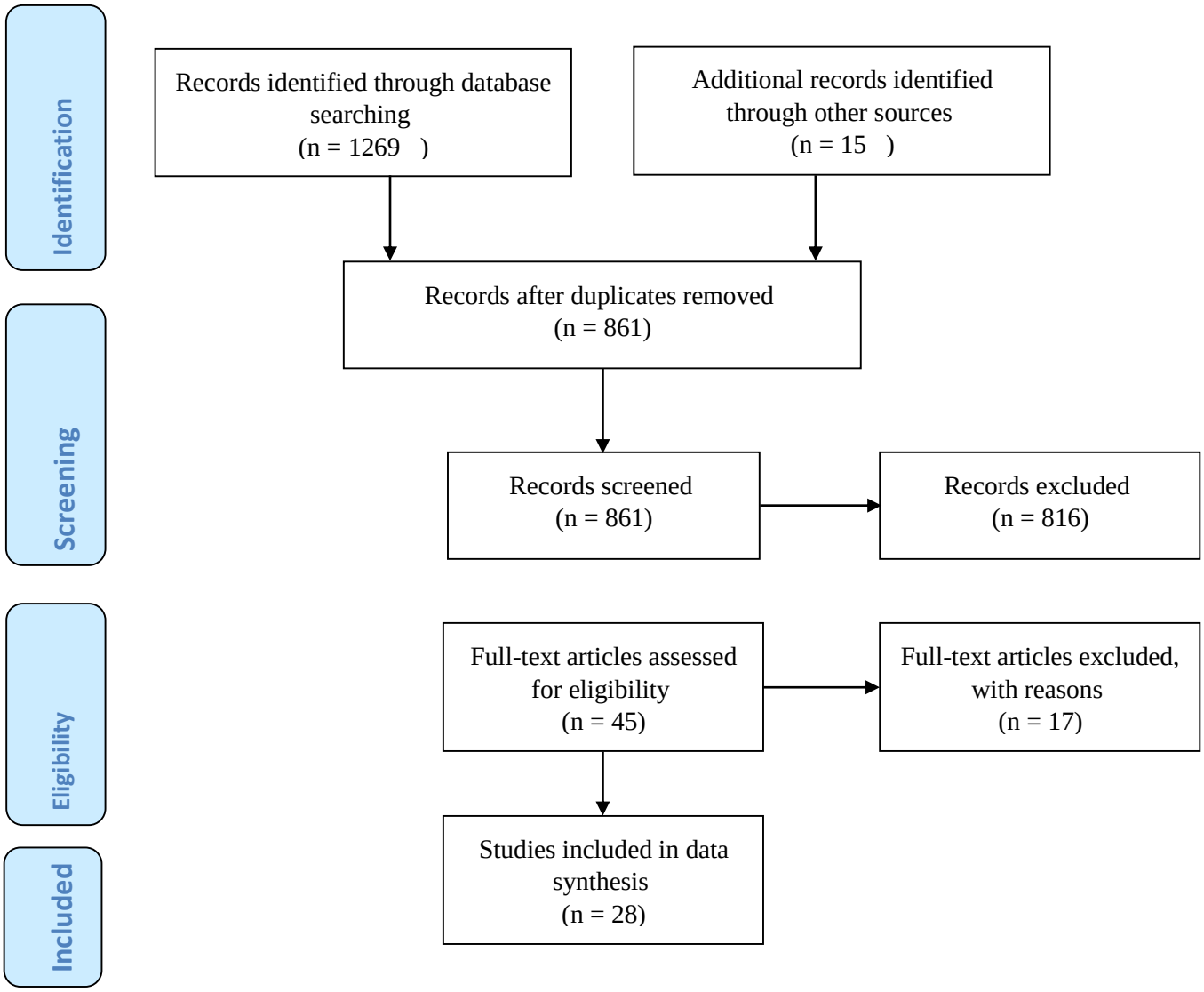


Figure 1: PRISMA flow diagram.

Twenty articles reported a direct association between ED crowding and emergency patient mortality. With the increase in ED crowding, emergency patient mortality also increased. Nevertheless, eight studies reported no correlation between ED crowding and mortality[20, 22, 30-35]. Regardless of the type of patients, three studies reported an association between an increased boarding time and emergency patient mortality. For example, Singer et al. reported an emergency patient mortality rate of nearly twice (4.5%) among patients with a boarding time of greater than 12 hours compared with those with a boarding time of fewer than 2 hours (2.5%). Their study also revealed a significant association between an increased ED boarding time and a higher inpatient mortality rate [36]. Similarly, Hong and colleagues found an association between ED boarding times of above 8 hours and increased mortality in necrotizing fasciitis patients [37]. Another study reported a significantly higher ICU and in-hospital patient death and increased hospital LOS among those patients who experienced a delay in being transferred for more than 6 hours from the ED [21].

The findings of a quasi-experimental study reported that tertiary hospitals which implemented the 4-hour rule in serving emergency patients revealed a significant reduction in patient mortality rate, while not

following the 4-hour rule did not [38]. A higher risk of 7-day death among patients who visited the ED during shifts with a mean length of stay ≥ 6 hours was reported compared to those with a mean LOS of less than six hours [39]. Similarly, delays in resuscitation efforts (DREs) to emergency patients resulted in more than three times increased the risk of in-hospital mortality [40]. In contrast, others found no association between patient transit times and ED LOS with inpatient mortality [22]. Gilligan et al. reported no association between the volume of emergency patients and the likelihood of patient death[32]. A study that analyzed ED LOS due to guideline-recommended therapies revealed no association with patient mortality. However, an increased ED LOS was associated with decreased use of guideline-recommended therapies [30].

A study conducted in Houston among trauma patients found slightly higher admitted patient mortality with the diversion of more than 8 hours than in patients with the diversion of fewer than 8 hours[41]. Exposure to more than 12 hours of diversion was also associated with higher 30-day, 90-day, 9-month, and 1-year mortalities[42]. Others found a significant association between ambulance diversion and increased inpatient mortality [10, 43]. In contrast, a study in the US found no association between ambulance diversion and inpatient pediatric mortality [33].

Ten studies reported an association between ED occupancy and patient mortality. The results of a study in Australia revealed significantly higher rates of mortality during overcrowded shifts than not overcrowded shifts [23]. Similarly, a study of CAP patients showed an association between ED occupancy and higher 28-day mortality[44]. Sprivulis and colleagues found a relationship between the Overcrowding Hazard Scale and increased mortality rates. Another study found an association between ED occupancy rates and 1, 2, and 3-day mortalities, while no association was found between EDOR with 4- to 7-day mortalities [45]. A study of critically ill patients admitted to an ED showed that as the ED occupancy ratio increases, mortality rates also increase [46]. Similarly, McCusker et al. found that a 10% increase in ED bed relative occupancy ratio was related to a 3% increase in ED death and a stronger association between bed crowding and mortality among more significant EDs [47]. In contrast, the results of a study showed no differences in patient mortality during crowding versus non-crowding time [34]. Also, a study of patients with severe sepsis revealed that ED crowding would not significantly increase the mortality rate[31]. Others found no associations between ED occupancy rate and patient mortalities [20, 35].

The results of a study showed that with the increase in triage level, the risk of patient mortality is increased [48]. Also, a study that assessed the correlation between the number of patients per hour and patient mortality rate found that ED crowding deteriorated the treatment process of patients with critical conditions[49]. Measuring patients per minute revealed a significantly higher mortality rate among pediatric patients who visited ED [9]. Another study by Miro et al. found a significant relationship between higher mortality rates and weekly visits [50].

Table 2. Studies assessed the association of ED crowding and patients mortality (n = 28).

| Author (year) | Sample size | Design | Aim | Outcome variable/measure | Findings |
|---|---|---|---|---|---|
| Ala et al. (2017) | 583 critically ill patients referred to the ED of Imam Reza Hospital, Iran, | Retrospective cross-sectional | To assess the relationship between crowding and clinical outcome of referred critical patients from other hospitals | Mortality rate | Majority of death were during the peak hour of emergency referrals. Crowding in the emergency department worsened the treatment process of patients with a critical condition. |
| Begley et al. (2004) | 18,888 trauma patients in seven trauma hospitals in Houston | retrospective cohort | To evaluate the correlation between trauma death rates and hospital diversion | Death rates for trauma patients | Mortality of patients on significant diversion days was higher than among patients on day when hospitals diversion was fewer than 8 hr (3.9% vs. 3.3%) |
| Cha et al. (2011) | 125,031 pediatric patients; 35,924 patients in crowded group; 89,107 patients in noncrowded group; in 34 EDs | Retrospective cohort | To analyze the effect of crowding on the hospital mortality of pediatric patients | 30-day mortality | Hazard ratio of 30-day mortality among crowded group compared to non-crowded group was 1.26 (95% CI 1.02–1.59) |
| Chalfin et al. (2007) | 50,322 adults from 120 hospital ICUs | Retrospective. Cross-sectional. | To study the association of ED boarding and outcomes | Mortality of patients transferred to ICU | Mortality rates of more than 6 hr was 17.4% vs. 12.9% for patients transferred less than 6 hr (OR = 0.71; 95% CI = 0.56–0.89) |
| Derose et al. (2014) | 136,740 adults with visit 13 health system EDs | Retrospective cohort | To assess the relationship between ED system crowding measures and outcomes | Individual inpatient mortality | Inpatient mortality was not associated with patient transit times or ED LOS was unrelated to inpatient mortality |
| Diercks et al. (2007) | 42,780 adults from 550 hospitals | Retrospective cohort | To analyze the association of ED LOS with the use of guideline-recommended therapies and clinical outcomes | Rate of Mortality | Risk adjusted mortality was similar among groups Rate if MI increased in patients with long ED stays (OR = 1.23; 95% CI = 1.01–1.48) |
| Fatovich et al. (2005) | 51,885 adults from a hospital ED | Retrospective cohort | To assess a higher mortality rate of ED patients if present during periods of ambulance diversion | Death in ED or IP | 28% reduction in patients mortality for patients during periods of ambulance diversion (OR = 1.13; 95% CI = 1.13–1.46) |
| Gaieski et al. (2017) | 2913 severe sepsis patients | Retrospective cohort | To assess the hypothesize that ED crowding would increase mortality for patients with severe sepsis | Inpatient mortality | ED crowding did not impact in-hospital mortality Patient hours odd ratios 0.99 (0.70-1.39) 95% CI |
| Geelhoed et al (2012) | 297,043 admissions during 4 years | Quasi-experimental intervention | To measure whether any changes in overcrowding were associated with mortality rates. | Mortality rates; overcrowding rates. | Mortality rate fell significantly from 1.12% to 0.98(by 13%; 95% CI, 7%–18%; $P < 0.001$). Monthly mortality rates decreased in two of the three tertiary hospitals. |
| Gilligan et al. (2008) | 73,305 adults in a ED 690-bed academic urban tertiary | Retrospective Cohort | To study the impact of crowing on mortality | Mortality | Boarders was not significantly associated with mortality (OR = 1.001; 95% CI = 0.993–1.009, $p$ = .690) |
| Guttmann et al. (2011) | 13,934,542 patients discharged from | Retrospective cohort | To determine the correlation between patients | 7-day mortality | OR of 7-day mortality among group that presented to the ED during shifts with mean LOS ≥ 6 hr |

| | | | | | |
|---|---|---|---|---|---|
| | 125 EDs in Ontario, Canada | | who are not admitted to hospital after attending an ED during long waiting times shifts and risk of adverse events | | vs. <1 hr was 1.79 (95% CI 1.24–2.59) |
| Hong et al. (2009) | 195 patients with necrotizing fasciitis | Retrospective cohort | To assess the association between prolonged ED boarding stay and mortality | Patient mortality | Prolonged ED boarding stay (OR, 3.4; 95% CI 1.3-8.6) was associated with higher mortality |
| Hong et al. (2013) | 1296 patients underwent resuscitative procedures in the resuscitation room in a single urban tertiary ED | Retrospective observational | To evaluate whether ED crowding is associated with delayed resuscitation efforts (DREs) that resulted in hospital mortality. | Mortality because of delayed resuscitation efforts | Mortality during the ED stay or during the total hospital stay was significantly higher in the DRE group (OR, 3.39; 95% CI, 1.22-9.45 and OR, 3.96; 95% CI, 2.28-6.88, respectively) compared with the non-DRE group. |
| Iversen et al. (2019) | 6383 patients in a ED | Prospective cohort | To determine the association between triage level and 30-day mortality; relation between triage level and 48-hour mortality | 30-day mortality; 48-hour mortality | The hazard ratio for 48-hour mortality for patients was 0.9 (95% CI 0.4 to 1.9). For 30-day mortality the HR for patients was 1.7 (95% CI 1.2 to 2.4). |
| Jo et al. (2012) | 477 CAP patients | Retrospective observational | To measure the relationship between emergency department crowding and 28-day mortality | 28-day mortality | High crowding condition was associated with a higher 28-day mortality (OR = 9.48, 95% CI 1.53-58.90). |
| Jo et al. (2014) | 54,410 adult patients visited ED of an urban tertiary academic hospital in Korea | Retrospective cohort | To determine whether the EDOR is associated with mortality | Mortality | The fourth quartile of the EDOR was associated with 1-day mortality (OR = 1.42; 95% CI= 1.08-1.88), 2-day mortality (OR = 1.31; 95% CI 1.04-1.67), and 3-day mortality (OR = 1.27; 95% CI 1.02-1.58). |
| Jo et al. (2015) | 1801 critically ill patients admitted via a ED | Retrospective cohort | To analyze the correlation between ED crowding and inpatient mortality | Inpatient mortality | ORs of 1.95, 2.51, and 1.93; CI=1.23 - 3.12, 1.58 - 3.99, and 1.21 - 3.09 for the second, third, and fourth quartiles, respectively, in compare with the first quartile. |
| McCusker et al. (2014) | 677,475 patients who visited hospital EDs | Retrospective cohort | To assess the effect of ED occupancy on patient outcomes | 30-day mortality | A10% increase in ED bed relative occupancy ratio was associated with 3% increases in death. There was a strong correlation between crowding and mortality among larger EDs 1.06 (1.05–1.07) 99% CI |
| Miro et al. (1999); | 81,301 adults from an urban hospital | Prospective cohort | To assess the effect of crowding on mortality | Mortality | mortality rate was correlated with ED weekly visit volume ($p < .05$) |
| Richardson (2006) | 34,377 crowded group patients; 32,231 noncrowded group patients from a Australian hospital | Retrospective stratified cohort | To evaluate the effect of crowding on mortality | 10-day in- hospital mortality | Inpatient mortality was higher during crowding OR=1.34 (95% CI = 1.04–1.72) |

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|---|---|---|---|---|---|
| Shen et al. (2011) | 13 860 Medicare patients with AMI within 4 California counties | longitudinal time-series | To evaluate whether diversion is associated with increased mortality | 7, 30, 90 days, and 9 months, and 1 year mortalities | Exposure to more than 12 hr of diversion was associated with higher 30-day mortality 3.24 percentage points; 95% CI, 0.60-5.88.Higher 90-day mortality (2.89 percentage points; 95% CI, 0.13-5.64); higher 9-month mortality (2.93 percentage points; 95% CI, 0.15-5.71); and higher 1-year mortality (3.04 percentage points; 95% CI, 0.33-5.75). |
| Shenoi et al. (2009) | 4,095 children admitted to ED during ambulance diversion | Retrospective Descriptive | To assess the prevalence of ED ambulance diversion and association with mortality | ED or IP Mortality | Fewer severely ill patients admitted during diversion (OR = 0.72; 95% CI = 0.66–0.78). Diversion was not associated with mortality |
| Singer et al. (2011) | 41,256 admissions from a suburban academic ED | Retrospective cohort | To analyze the association between length of ED boarding and outcomes | In-hospital mortality | Increase in Mortality with increase boarding time, from 2.5% in patients boarded less than 2 hr to 4.5% in patients boarding 12 hr or more. Hospital mortality was associate with length of ED boarding. ED boarding between 6-12 was OR=1.24 (1.00–1.54). OR of 12-24 = 1.43 (1.13–1.82) and more than 24 hr OR was 1.23 (0.73–2.09) |
| Sprivulis, et al. (2006) | 62,495 admitted adults to 3 EDs | Retrospective Descriptive. | To assess the association between hospital and ED occupancy and mortality | Death on days 2,7, and 30 against crowding Hazard Scale | HRs for mortality at 2, 7, and 30 days were 1.3, 1.3, and 1.2 for patients admitted during periods of greater ED and hospital occupancy |
| Sun et al. (2013) | 995,379 ED visits | Retrospective cohort | To examine the association of ED crowding with subsequent outcomes | Inpatient mortality | Patients admitted in high EDC days experienced 5% greater odds of inpatient death (95% CI 2% to 8%). Periods of high EDC were associated with increased inpatient mortality. OR=1.05 1.02–1.08 |
| Van der Linden et al. (2016) | 39,110 patients of an inner-city ED in the Netherlands | Retrospective cohort | To evaluate the relationship of ED crowding with 24-h mortality | 24-h and 10-day mortalities | No differences in mortality between patients arriving during crowding versus those arriving during noncrowding. EDC with 24-h mortality and 10-day mortality was, respectively 1.16 (0.91–1.47), 0.23 1.07 (0.94–1.21), 0.34 |
| Verelst et al. (2015) | 32,866 admissions of an academic teaching hospital in Leuven, Belgium | Prospective observational cohort | To assess the association of ED crowding and risk of in-hospital death | In-hospital death | ED crowding was not associated with mortality (OR=0.94, 95% CI 0.74-1.19) |
| Wu et al. (2015) | 852 hemorrhagic shock trauma patients in an urban tertiary hospital | Retrospective cohort | To assess the association between EDC and poor performance | 30-day mortality | No clear relationship was found between ED crowding and 30-day mortality, OR: 1.15 (0.79–1.47); 95% CI |

## Discussion

After a full assessment of the eligible articles, twenty of the articles reported a direct association between ED crowding and emergency patient mortality. In this regard, emergency patient mortality also increased with the increase in ED crowding. Nevertheless, eight studies reported no significant correlation between ED crowding and mortality [20,22,30-35]. The significance was different based on the measure of crowding. When crowding was measured using boarding times, all studies revealed an association between ED crowding and patient mortalities. However, measuring ED crowding using ED LOS did not show a clear relationship between ED crowding and mortality [22, 30, 32, 38-40].

Similarly, three studies showed an association between crowding and higher diversion, while in a study with a specific population group, this association deteriorated. Measuring crowding using ED occupancy was complicated. In some studies, the association was identified; in others, no association was discovered. Finally, using triage-level visits number as crowding measures revealed a significant association between crowding and patient mortalities.

In the past, some systematic reviews aimed to assess the association between ED crowding and health outcomes such as patient mortality. However, this review did not include all relevant articles in this relation and needed to be more comprehensive. At the same time, the majority of the studies covered by these reviews reported a negative association between crowding in EDs and patient mortalities, some covered studies which did not show any association. Johnson and Winkelman, in their review, assessed the relationship between ED crowding and patient mortality in eight studies [21, 23, 30, 32, 33, 43, 50, 51] and found in almost all of these studies a clear correlation between ED crowding and increased mortality [25]. In another review, Sun et al. showed that comparing mortalities during crowding versus non-crowding by different authors in different studies revealed that the mortality rate is higher in times of increased crowding[10]. Moreover, another review investigated the association between ED crowding and patient outcomes. They found an association between ED crowding and higher inpatient mortality rates [52].

The most comprehensive systematic review in this relation was operated by George et al., in which their systematic review 12 articles were included to include twelve articles assessing the association between ED crowding and mortality [24]. In our study, we covered all these works too. Hoot et al. found four articles concentrated on the association of patient mortality and crowding and concluded that patient mortality is an adverse outcome of crowding[4]. Similarly, in a recent systematic review by Morley, seven studies [10,23,36,39,46,47,51] were included regarding the mentioned association, and the results showed that finding the exact impact of ED crowding on patient mortalities is controversial [26].

In most studies, crowding was associated with patient mortalities, increasing the risk of adverse outcomes [53-56]. According to a comprehensive investigation of this systematic review, the increase in ED crowding levels was significantly associated with higher mortalities in most studies. Although because of the difference in the measure of ED crowding and specific group patients, the association between crowding and mortalities is not directly comparable across studies, the results of this study emphasize the negative impact of ED crowding on patient mortalities.

This study has some significant limitations. Our review is limited only to English-published articles. We used the different databases to minimize the bias of not selecting relevant articles. Second, various measures of crowding and outcomes and population groups result in the inability to generalize. To address this issue, we categorized all articles based on the outcome and crowding measures and analyzed each subgroup separately, making the comparison more accurate.

## Conclusion

ED crowding is a primary concern associated with adverse clinical outcomes such as mortality. Some studies have demonstrated that crowding correlates with increased mortality. So in this systematic review, twenty-eight articles specifically examined the association between ED crowding and mortality. The results of these studies are mixed. Although there was not a significant association between ED crowding and patient mortality in some studies, the majority of studies revealed a clear and significant association between ED crowding and patient mortality. Given the significance and magnitude of ED crowding and its role in deteriorating patient safety, policies must address this concern.

## List of abbreviations

ED: Emergency Department
MeSH: Medical Subject Headings
CASP: Critical Appraisal Skills Programme
JBI-MAStARI: Joanna Briggs Institute Meta-Analysis of Statistics Assessment and Review Instrument

LWBS: Left without Being Seen
LOS: Length of Stay

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## Ethical considerations
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## References
1. Pines JM, Hilton JA, Weber EJ, Alkemade AJ, Al Shabanah H, Anderson PD, et al. International perspectives on emergency department crowding. 2011;18(12):1358-70.

2. Di Somma S, Paladino L, Vaughan L, Lalle I, Magrini L, Magnanti MJI, et al. Overcrowding in emergency department: an international issue. 2015;10(2):171-5.

3. Bernstein SL, Aronsky D, Duseja R, Epstein S, Handel D, Hwang U, et al. The effect of emergency department crowding on clinically oriented outcomes. 2009;16(1):1-10.

4. Hoot NR, Aronsky DJAoem. Systematic review of emergency department crowding: causes, effects, and solutions. 2008;52(2):126-36. e1.

5. Asplin BR, Magid DJ, Rhodes KV, Solberg LI, Lurie N, Camargo Jr CAJAoem. A conceptual model of emergency department crowding. 2003;42(2):173-80.

6. Forero R, Man N, Ngo H, Mountain D, Mohsin M, Fatovich D, et al. Impact of the four-hour National Emergency Access Target on 30-day mortality, access block and chronic emergency department overcrowding in Australian emergency departments. 2019;31(1):58-66.

7. Michelson KA, Monuteaux MC, Stack AM, Bachur RGJAEM. Pediatric emergency department crowding is associated with a lower likelihood of hospital admission. 2012;19(7):816-20.

8. Chiu I-M, Lin Y-R, Syue Y-J, Kung C-T, Wu K-H, Li C-JJTAjoem. The influence of crowding on clinical practice in the emergency department. 2018;36(1):56-60.

9. Cha WC, Shin SD, Cho JS, Song KJ, Singer AJ, Kwak YH. The association between crowding and mortality in admitted pediatric patients from mixed adult-pediatric emergency departments in Korea. Pediatric emergency care. 2011;27(12):1136-41.

10. Sun BC, Hsia RY, Weiss RE, Zingmond D, Liang LJ, Han W, et al. Effect of emergency department crowding on outcomes of admitted patients. Annals of Emergency Medicine. 2013;61(6):605-11. e6.

11. Mullins PM, Pines JMJTAjoem. National ED crowding and hospital quality: results from the 2013 Hospital Compare data. 2014;32(6):634-9.

12. Cremonesi P, di Bella E, Montefiori M, Persico LJAhe, policy h. The robustness and effectiveness of the triage system at times of overcrowding and the extra costs due to inappropriate use of emergency departments. 2015;13(5):507-14.

13. Depinet HE, Iyer SB, Hornung R, Timm NL, Byczkowski TLJAEM. The effect of emergency department crowding on reassessment of children with critically abnormal vital signs. 2014;21(10):1116-20.

14. Reznek MA, Murray E, Youngren MN, Durham NT, Michael SSJS. Door-to-imaging time for acute stroke patients is adversely affected by emergency department crowding. 2017;48(1):49-54.

15. Dubin J, Blumenthal J, Milzman DJAoEM. Emergency Department Crowding and Physician Inexperience Are Synergistically Associated with Increased Physician Errors. 2013;62(4): S49.

16. Epstein SK, Huckins DS, Liu SW, Pallin DJ, Sullivan AF, Lipton RI, et al. Emergency department crowding and risk of preventable medical errors. 2012;7(2):173-80.

17. Kulstad EB, Sikka R, Sweis RT, Kelley KM, Rzechula KHJTAjoem. ED overcrowding is associated with an increased frequency of medication errors. 2010;28(3):304-9.

18. Tekwani KL, Kerem Y, Mistry CD, Sayger BM, Kulstad EBJWJoEM. Emergency department crowding is associated with reduced satisfaction scores in patients discharged from the emergency department. 2013;14(1):11.

19. Pines JM, Iyer S, Disbot M, Hollander JE, Shofer FS, Datner EMJAEM. The effect of emergency department crowding on patient satisfaction for admitted patients. 2008;15(9):825-31.

20. Verelst S, Wouters P, Gillet JB, Van Den Berghe G. Emergency department crowding in relation to in-hospital adverse medical events: A large prospective observational cohort study. Journal of Emergency Medicine. 2015;49(6):949-61.

21. Chalfin DB, Trzeciak S, Likourezos A, Baumann BM, Dellinger RP, group D-Es. Impact of delayed transfer of critically ill patients from the emergency department to the intensive care unit. Critical care medicine. 2007;35(6):1477-83.

22. Derose SF, Gabayan GZ, Chiu VY, Yiu SC, Sun BC. Emergency department crowding predicts admission length-of-stay but not mortality in a large health system. Medical Care. 2014;52(7):602-11.

23. Richardson DBJMjoA. Increase in patient mortality at 10 days associated with emergency department overcrowding. 2006;184(5):213-6.

24. George F, Evridiki KJHSJ. The effect of emergency department crowding on patient outcomes. 2015;9(1):1.

25. Johnson KD, Winkelman CJAenj. The effect of emergency department crowding on patient outcomes: a literature review. 2011;33(1):39-54.

26. Morley C, Unwin M, Peterson GM, Stankovich J, Kinsman LJPo. Emergency department crowding: A systematic review of causes, consequences and solutions. 2018;13(8): e0203316.

27. Carter EJ, Pouch SM, Larson ELJJoNS. The relationship between emergency department crowding and patient outcomes: a systematic review. 2014;46(2):106-15.

28. Shamseer L, Moher D, Clarke M, Ghersi D, Liberati A, Petticrew M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. 2015;349: g7647.

29. evidence CASPJCASPMso. CASP checklists. 2014.

30. Diercks DB, Roe MT, Chen AY, Peacock WF, Kirk JD, Pollack Jr CV, et al. Prolonged emergency department stays of non–ST-segment-elevation myocardial infarction patients are associated with worse adherence to the American College of Cardiology/American Heart Association guidelines for management and increased adverse events. 2007;50(5):489-96.

31. Gaieski DF, Agarwal AK, Mikkelsen ME, Drumheller B, Cham Sante S, Shofer FS, et al. The impact of ED crowding on early interventions and mortality in patients with severe sepsis. The American journal of emergency medicine. 2017;35(7):953-60.

32. Gilligan P, Winder S, Singh I, Gupta V, Kelly P, Hegarty DJEMJ. The boarders in the emergency department (BED) study. 2008;25(5):265-9.

33. Shenoi RP, Ma L, Jones J, Frost M, Seo M, Begley CE. Ambulance diversion as a proxy for emergency department crowding: The effect on pediatric mortality in a metropolitan area. Academic Emergency Medicine. 2009;16(2):116-23.

34. Van Der Linden N, Van Der Linden MC, Richards JR, Derlet RW, Grootendorst DC, Van Den Brand CL. Effects of emergency department crowding on the delivery of timely care in an inner-city hospital in the Netherlands. European Journal of Emergency Medicine. 2016;23(5):337-43.

35. Wu D, Zhou X, Ye L, Gan J, Zhang M. Emergency Department Crowding and the Performance of Damage Control Resuscitation in Major Trauma Patients with Hemorrhagic Shock. Academic Emergency Medicine. 2015;22(8):915-21.

36. Singer AJ, Thode Jr HC, Viccellio P, Pines JM. The association between length of emergency department boarding and mortality. Academic Emergency Medicine. 2011;18(12):1324-9.

37. Hong YC, Chou MH, Liu EH, Hsiao CT, Kuan JT, Lin JC, et al. The effect of prolonged ED stays on outcome in patients with necrotizing fasciitis. The American journal of emergency medicine. 2009;27(4):385-90.

38. Geelhoed GC, de Klerk NH. Emergency department overcrowding, mortality and the 4-hour rule in Western Australia. The Medical journal of Australia. 2012; 196:122-6.

39. Guttmann A, Schull MJ, Vermeulen MJ, Stukel TAJB. Association between waiting times and short term mortality and hospital admission after departure from emergency department: population based cohort study from Ontario, Canada. BMJ. 2011;342: d2983.

40. Hong KJ, Shin SD, Song KJ, Cha WC, Cho JS. Association between ED crowding and delay in resuscitation effort. American Journal of Emergency Medicine. 2013;31(3):509-15.

41. Begley CE, Chang Y, Wood RC, Weltge AJJoT, Surgery AC. Emergency department diversion and trauma mortality: evidence from Houston, Texas. 2004;57(6):1260-5.

42. Shen Y-C, Hsia RY. Association between ambulance diversion and survival among patients with acute myocardial infarction. Jama. 2011;305(23):2440-7.

43. Fatovich DMJMJoA. Effect of ambulance diversion on patient mortality: how access block can save your life. 2005;183(11/12):672.

44. Jo S, Kim K, Lee JH, Rhee JE, Kim YJ, Suh GJ, et al. Emergency department crowding is associated with 28-day mortality in community-acquired pneumonia patients. Journal of Infection. 2012;64(3):268-75.

45. Jo S, Jin YH, Lee JB, Jeong T, Yoon J, Park B. Emergency department occupancy ratio is associated with increased early mortality. Journal of Emergency Medicine. 2014;46(2):241-9.

46. Jo S, Jeong T, Jin YH, Lee JB, Yoon J, Park B. ED crowding is associated with inpatient mortality among critically ill patients admitted via the ED: Post hoc analysis from a retrospective study. American Journal of Emergency Medicine. 2015;33(12):1725-31.

47. McCusker J, Vadeboncoeur A, Lйvesque JF, Ciampi A, Belzile E. Increases in emergency department occupancy are associated with adverse 30-day outcomes. Academic Emergency Medicine. 2014;21(10):1092-100.

48. Iversen AKS, Kristensen M, ШstervigRM, Kшber L, Sцlйtormos G, Forberg JL, et al. A simple clinical assessment is superior to systematic triage in prediction of mortality in the emergency department. 2019;36(2):66-71.

49. Ala A, Shams-Vahdati S, Fahimi RJJoARiCM. The relationship between emergency department crowding and outcome of referred critical patients from other hospitals. 2017;5(4):118-21.

50. Miro O, Antonio M, Jimenez S, De AD, Sanchez M, Borras A, et al. Decreased health care quality associated with emergency department overcrowding. 1999;6(2):105-7.

51. Sprivulis PC, Da Silva JA, Jacobs IG, Jelinek GA, Frazer ARJMJoA. The association between hospital overcrowding and mortality among patients admitted via Western Australian emergency departments. 2006;184(5):208-12.

52. Carter EJ, Pouch SM, Larson EL. The relationship between emergency department crowding and patient outcomes: a systematic review. Journal of Nursing Scholarship. 2014;46(2):106-15.

53. Rasouli HR, Esfahani AA, Nobakht M, Eskandari M, Mahmoodi S, Goodarzi H, Farajzadeh MA. Outcomes of crowding in emergency departments; a systematic review. Archives of academic emergency medicine. 2019;7(1).

54. Rasouli HR, Ahmadpour F, Khoshmohabat H, Abbasi Farajzadeh M. Health concepts regarding Arbaeen's foot-pilgrimage. Trauma Monthly. 2019 Mar 1;24(2):1-.

55. Rasouli HR, Aliakbar Esfahani A, Abbasi Farajzadeh M. Challenges, consequences, and lessons for way–outs to emergencies at hospitals: a systematic review study. BMC Emergency Medicine. 2019 Dec;19(1):1-0.

56. Rasouli HR, Tireh H, Ahmadpour M, Kalantar Motamedi MH, Khoshmohabat H, Ahmadpour F, Hasani Z, Ahmadpour F. The Trauma Challenges in the Arbaeen Ceremony. Trauma Monthly. 2023 Feb 1;28(1):687-93.