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Overcrowding in the Emergency Department: A Bed Management Strategy

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Abstract:
Overcrowding in emergency departments (EDs) is a global phenomenon that has a substantial detrimental impact that spreads throughout the hospital. This has a number of ramifications that can affect both the number of available resources and the quality of service. Overcrowding is caused by a variety of variables that, in most circumstances, result in an increase in the number of individuals in the ED, an increase in mortality and morbidity, and a loss in the ability to offer crucial services to patients suffering from medical emergencies in a timely way. As a result of this phenomena, the Emergency Department reaches, and in some circumstances exceeds, its optimal capacity. The main causes and effects of this phenomena were compiled in this review, including the effect induced by the SARS-CoV-2 virus in recent years. Finally, special emphasis was made to the primary operational strategies that have been established over the years, strategies that can be utilized both at the ED level (microlevel strategies) and at the hospital level (hospital level strategies) (macrolevel strategies).

Keywords: overcrowding; emergency department; hospital admission

I. Introduction

The Emergency Department (ED) is one of the busiest hospital units, with many patients admitted with diverse medical conditions, including high-risk patients [1]. The primary goal of the ED is to treat emergency and urgent situations that require immediate assistance by performing a quick diagnosis and administering medicinal or surgical therapy in a short period of time. It has now been demonstrated that the failure of community health services leads to incorrect entry to the ED, particularly in the geriatric and pediatric age groups [1–3]. Since the 1980s, ED congestion, sometimes known as overcrowding, has been recognized as an issue for prompt and efficient help [4].

Overcrowding is characterized as a condition in which the emergency department's function is jeopardized, primarily due to an excessive number of patients waiting for consultation, diagnosis, treatment, transfer, or release [2,5]; Overcrowding is characterized by a supply-demand imbalance [2].

Although numerous factors contribute to overcrowding, the latter is primarily determined by three elements: the volume of patients arriving (input), the time it takes to process and treat patients (throughput), and the volume of patients leaving the ED (output) [6].

Patient boarding was discovered to be one of the most significant among the several criteria [7]. Boarding is the practice of retaining patients admitted to the ED for extended periods of time due to insufficient inpatient ward capacity [7,8]. Overcrowding in general, as well as boarding, has a detrimental impact on patient care, mortality, morbidity, patient satisfaction, and quality of care. [4,9,10]. These factors also contribute to greater LOS in the ED, an increased rate of patients leaving the ED without being seen (LWBS, left without being seen), and increased medical mistakes [11–13].

Overcrowding in emergency departments has become a severe health issue, as the number of EDs is decreasing while the number of people requiring emergency care is increasing [11,13].Overcrowding has been described in the literature to occur most frequently in EDs with an annual volume of more than 40,000 visits [11,14].

Before attempting to identify remedies, an accurate measurement of crowding in the ED and an evidence-based understanding of its impact are required [6]. Although there are several scores for determining the various degrees of overcrowding, there is no gold standard for measuring this problem to yet [4,15]. Overcrowding is defined by three estimation indices, according to a review of the literature: National Emergency Department Overcrowding Score (NEDOCS), Community Emergency Department Overcrowding Score (CEDOCS), and Severely-overcrowded Overcrowded and Not-overcrowded Estimation Tool (SONET). The NEDOCS, developed by Weiss and colleagues, is the most commonly used score [15]; NEDOCS translates a set of variables into a score that is proportional to the level of overcrowding observed by the professionals conducting their tasks at the time. The measure has a 0 to 200 point scale, with a grade of 101 or more indicating overcrowding [16].

Finally, we have ED occupancy, ED length of stay, ED volume, ED boarding time, number of boarders, waiting room number, and the Emergency Department Work Index (EDWIN) score among the measuring systems that can be examined to predict overcrowding. To design effective solutions to overcrowding, it is necessary to not only comprehend its different origins and effects, but also to quantify its actual impact on the health-care system [4]. This work intends to contribute to a better understanding of ED overcrowding by presenting an analytical overview of the causes, effects, and remedies to the problem; to our knowledge, there aren't many papers that approach the subject with this organic perspective.

II. Materials and Methods

A comprehensive search was conducted on PubMed.gov, Scopus, ISI Web of Science, Science Direct, and Google Scholar using the keywords "Overcrowding", "Emergency Department", "Hospital admission", "Length of Stay", "Waiting time", and "inpatient boarding" up to June 2022 using Medical Subject Headings (MeSH) terms as vocabulary. The following inclusion criteria were considered: (1) research articles with quantitative details and information on the relationship between the causes of overcrowding in Emergency Departments and the consequences of this phenomenon; and (2) articles describing possible strategies already implemented or that could be implemented in the future to address the effect that overcrowding has on the Emergency Department. Exclusion criteria included articles that were not directly relevant to the query string or articles that lacked sufficient information about the relationship between overcrowding and Emergency Departments. (Table 1).

During the screening of the literature, two authors were involved. Articles were first chosen based on their title and abstract. The complete text of pertinent study was then obtained and evaluated. Each reference in the chosen articles was reviewed to ensure that no relevant article was overlooked. All of the papers were read separately by the writers. For the materials included in this study, debate resulted in total agreement.

Table 1. Search strategy.

Search Strategy	Details
Search string	(Emergency Department [MeSH Terms]) AND (Overcrowding) OR (Crowding)(Overcrowding) AND (ED) OR (Emergency Department)
Databases	PubMed/MEDLINE, Scopus, Cochrane, and Google Scholar
Inclusion criteria	(1) research articles with quantitative details and information on the relationship between the causes that lead to overcrowding in Emergency Departments and the consequences that this phenomenon entails; (2) articles describing possible strategies already adopted or adoptable in the future to address the effect that overcrowding has on the Emergency Department were considered; (3) all kinds of study designs and reviews
Exclusion criteria	Items not directly pertinent to the query string and articles not containing sufficient information on the relationship between Overcrowding and Emergency Department Study design: editorial, commentaries, expert opinions, letters to editor, and abstracts
Time filter	None (from inception)
Language filter	Only Italian and English articles

III. Results

After duplicate items were removed, the resultant list had 113 nonredundant articles, of which 61 were eventually examined in our narrative review.

3.1. Causes of ED Overcrowding

As expected, congestion in EDs can be caused by a variety of causes, which can be described by the input-throughput-output model (Table 2). Overcrowding is a multifaceted and complicated issue; these various causes are independent of one another but are strongly linked and influenced by other factors. [10,17,18].

Table 2. Main causes of overcrowding.

Factors	Causes
Input *due to the volume of patients arriving and waiting to be seen*	Presentations with more urgent and complex care needs • Emergencies Increase in presentations by the elderly High volume of low-acuity presentations (LAPs) Access to primary care • The poor and uninsured who lack primary care Limited access to diagnostic services in community • The malfunctioning of health care services in the community Inappropriate use of emergency services • Unnecessary visits • "Frequent flyer" patients • Nonurgent visits • The majority of ED incomings resulted from self-referral process The number of escorts accompanying a patient

Table 2. *Cont.*

Factors	Causes
Throughput *due to the time to process and/or treat patients*	ED nursing staff shortages Low staffing and resource levels Presence of junior medical staff in ED Delays in receiving test results and delayed disposition decisions Number of tests (blood test and urinalysis) required to be performed per patient Too long a consultation time Patient degree of gravity Bed availability (both in the ED and in the hospital)
Output *due to the volume of patients leaving the ED*	Boarding Exit block Lack of available hospital beds Inefficient planning of discharging patients
Others	An increase in closures of a significant number of EDs Time of the year • Influenza season • Seasonal illness Weekend, holiday periods COVID-19

3.1.1. Input Factors

Input factors are those that contribute to an increase in ED admissions [10,19]. These include the emergence of new or unmet care needs in appropriate areas of community care, the population's progressive aging, an increase in the number of complex patients, the introduction of new diagnostic and treatment technologies, and an increase in admissions for diseases related to seasonal epidemiology (e.g., flu epidemics and heat waves) or related to time of year/week. The ED has no control over input factors [10,20].

The number of escorts has been found to have a negative impact on ED workflow. Although they have no active role in the procedure, they may unintentionally anger the personnel, increasing the stress and pressure in the ED. As a result, some Israeli hospitals have limited the number of escorts per patient to one [18].Another important input factor is avoidable accesses, which can be categorized as "conditions susceptible to ambulatory treatment," such as major chronic diseases, double accesses due to poor performance of the territorial emergency network, more broadly repeated accesses (e.g., frequent flyers), and all improper accesses due to territorial organizational patterns (e.g., schedules) and patient habits [20,21].

Some studies have discovered a positive relationship between ED overcrowding and patient admission rates, and this effect is amplified for less severe patients. These data imply that ED overcrowding may be creating a variety of issues, including wasteful medical resource use owing to unwarranted hospitalizations [22,23].

3.1.2. Throughput Factors

Internal to the ED, throughput issues determine the time from patient admission to discharge, hospitalization, or transfer (LOS) [10].

Among the throughput factors, the need for specialistic consultations and/or additional instrumental diagnostic investigations has the greatest influence on a patient's LOS, procedures that are becoming increasingly necessary due to the increasing average age of patients and comorbidities, as well as to ensure appropriate hospitalizations and safe discharges [20]. Overcrowding, delayed radiographic and laboratory test findings, delayed and unsuitable consultations, and an insufficient number of inpatient beds may all contribute to prolonged inpatient stays [21].

The work efficiency of hospital staff also has an impact on ED productivity. It is critical that the demand for assistance and actual operating capacity are balanced in order to ensure that the flow continues correctly, especially in emergency situations [20]. Anything that disrupts the flow of patients through the emergency

department might lead to overpopulation [19]; If the demand for a resource (e.g., medical personnel, consultant, diagnostic service, or bed slot) exceeds its capacity, the system will be blocked; thus, the flow will be regular if available resources balance the demand at all points of the path [6,20].

3.1.3. Output Factors

Failure to move patients out of the ED after all necessary treatment is an example of an output factor. Among these variables are the availability of beds and the delay in transporting patients to free up space in the ED, causing patients to wait both to be transferred to the proper department and to be discharged. As a result, it is obvious how significant the impact of these factors on overcrowding is, given that they burden not only the availability of space and beds, but also other health care resources [10].

As previously stated, one of the most major issues contributing to overpopulation is a lack of available beds and the inability to receive proper home care. These have an impact not just on EDs locally, but also internationally, and this influences other phenomena such as exit block and boarding [10,20].

Exit block is a phenomena that occurs when patients in the ED are unable to obtain beds in a timely manner. As a result, there will be more overcrowding because the hospital, particularly the ED, has already surpassed its maximum admittance capacity, and additional arrivals will cause them to wait longer than necessary.

Exit blockage has serious effects for patient health, increased waiting time, boarding, and overall treatment quality. Many studies have focused on the harmful effects of exit block, not only on low-risk patients but also on those who require immediate surgery, such as in an emergency. Finally, this phenomena and congestion have been seen to influence a patient's decision to leave the ED without first getting a proper medical assessment, perhaps leading to a worse outcome [10].

Due to a paucity of beds, the practice of keeping patients in the ED might result in the phenomena of boarding, which is directly dependent on the exit block. Indeed, boarding, like the latter, has the principal consequence of exceeding the standards of care that the hospital can promise. According to studies, at least 40% of health care professionals in certain big EDs spend their time on patients who have previously had a medical consultation but are unable to leave the ED due to the aforementioned phenomenon, rather than taking care of patients in the wards [10].

3.1.4. The Impact of SARS-CoV-2 on ED Overcrowding

Over the last two years, hospitals have encountered challenges brought on by the SARS-CoV-2 epidemic, and the latter's impacts on the availability of emergency services and ED overcrowding are still being assessed [24].

The pandemic has proven difficult on the emergency department [1,25] in a variety of ways, and this has resulted in changes in the administration of personnel, patients, and wards. Potentially contaminated patients must, indeed, be isolated from others; workers must wear protective garb that reduces productivity; and key metrics must be evaluated more regularly. There is a strong chance that the ED may become overcrowded as a result of the increasing workload [26,27].

The waiting time for hospitalization has increased, partially due to the requirement to screen all patients before assigning them to a "clean" ward or a COVID unit, to ensure that positive patients, even if asymptomatic, were not sent to clean wards, adding to the virus's spread [10]

The increased crowding during the pandemic is thought to be caused mostly by three factors: a mismatch between the requirement for intensive care unit beds and the number of available beds, a significant number of weak patients who require stabilization before admission, and a lack of available beds to hospital wards, as well as a change in how all patients are managed [24]. As a result, ED overpopulation has been a direct result of hospital overcrowding in general [10].

As a result of these two years, it has been determined that actions are required to ease crowding and eliminate exit blockage, so that hospitals are fully equipped to respond to any future pandemics [24].

3.2. Effects and Consequences of Overcrowding in EDs

The most visible effect of overcrowding on the performance of an ED is an increase in patient waiting time; this increase causes an increase in the number of patients leaving the ED without being seen by a physician, which is defined as left without being seen (LWBS); however, it has been observed that this group of patients complains of progressive worsening of health conditions and returns shortly afterwards to be hospitalized (return visit).

Several studies have found that the quality of treatment deteriorates significantly in overcrowded situations; it has been demonstrated that in patients with myocardial infarction, an increase in door-to-needle time, or the time between patient evaluation and drug administration, was significantly longer in overcrowded situations compared to normal timing [2]. An Australian retrospective study found that patients admitted to the ED during an overcrowded shift had a higher mortality rate than those treated during a typical shift. According to the authors of this study, there are 13 deaths per year in their hospital owing to ED overcrowding [28].
Overcrowding diminishes ED capacity, degrades care quality, raises the risk of unfavorable outcomes for patients, particularly cardiac and intubated patients, and raises the risk of hospital-acquired infections and the chance of patient management errors [29,30].
Overcrowding affects ED employees as well; job satisfaction is reduced by these stressful situations, and overcrowding has been highlighted as a primary factor for staff decrease [2,31].

Overcrowding has a substantial financial impact; in fact, the increased reconsultations and hospitalizations, poorer treatment quality, discontent with health care workers, and morbidity all lead to greater treatment costs [2,32]. According to one study, boarding costs USD 6.8 million over three years. A one-hour reduction in boarding time would improve income by USD 13,298 per day, or USD 4.9 million per year [4,33,34].
Return visits (RV) are frequently used as a quality indicator for emergency departments (EDs) since they might be caused by premature discharge, missed diagnoses, or failures in treatment or discharge planning [35].RVs not only postpone adequate patient treatment, but they also increase resource utilization and medical costs [35,36]. Other elements that contribute to this problem include disease progression, a lack of improvement, and patient concern and fear about their health. Overcrowding is a global health issue that contributes to an increase in misdiagnoses and medical blunders [35,37]. Because ED staff must constantly offer timely care to urgent patients, when the ED is overloaded, physicians speed up the patient discharge procedure to make room for new patients [2].

3.3. Solution to Overcrowding

Several efforts are required to address overpopulation, not only at the medical level but also at the bureaucratic level. These are separated into two layers that work in tandem: Strategies at the micro- and macro-levels [4,10] as seen schematically in Table 3.

Table 3. Microlevel and macrolevel strategies.

Strategies	Solutions
Microlevel strategies *applied at the level of the Emergency Department*	Acceleration of diagnostic pathways Fast track Outpatient services outside the EDSetting home care Observation unit Team triage Artificial intelligence (AI) and machine learning
Macrolevel strategies *applied at the hospital and/or care system level*	Simplifying the admission process Reverse triage Smoothing elective admissions Early discharge Weekend discharge Full capacity protocol or action plan Legislation and guidelines

3.3.1. Microlevel Strategies

Microlevel tactics are intended to combat the problem of overcrowding and boarding and involve modifications that can be implemented at the ED level [4].

Acceleration of Diagnostic Pathways

Standardized diagnostic routes can be immensely beneficial in standardizing the care process, diagnosis, and treatment in order to reduce waiting times, the possibility of error, and, in some cases, hospitalization rates. They are also important in improving outcomes by lowering adverse events and death [4,10].

One viable strategy is to implement point-of-care procedures (POCTs) in EDs. Internal POCTs in emergency departments have various advantages over determining laboratory parameters in a central laboratory. This shortens sample transport times and results communication from the central laboratory to the receiver. [2,5]. There is promising data in this area; a recent U.S. study found that using point-of-care laboratory testing in triage reduced average treatment time by 1 hour [38].

Fast Track

An alternate method, known as the "fast track," has already been implemented in several EDs to expedite the treatment of nonurgent patients with less serious symptoms or illnesses (green and white codes). The expedited route entails a straight transfer from triage to a specialist physician. Numerous studies have demonstrated that the implementation of this accelerated pathway has resulted in various benefits, not only in terms of lowering patient waiting time and treatment, but also in reducing the number of patients who left the ED without being seen by a physician (LWBS) [2,3,39].

Outpatient Services outside the ED

Another microlevel method is to steer patients who come to the ED to alternative health care resources by emphasizing outpatient services; in fact, some patients come to the ED because they are unable to navigate the health care system. This phenomena is particularly common in specific social groups, such as those from lower socioeconomic backgrounds, those with low literacy skills, and patients who are afraid of the stigma and shame associated with certain disorders [5,40,41]. Other appropriate facilities could take over imaging techniques for noncritical patients in order to prioritize and ensure access to emergency diagnostic procedures for essential patients.

Setting Home Care

Home care is another option for reducing overcrowding in EDs. Home care can play an important role in the continuation of care for people who do not require hospitalization after an adequate initial diagnosis and stabilization of the patient.

Thus, home care benefits patients not just in terms of minimizing overcrowding, but also in terms of quality of care and patient satisfaction. These advantages have been underlined in particular for the elderly, who believe that being able to continue therapy in a familiar and comfortable setting enhances their health [4,10].

Team Triage

Team triage refers to patient triage performed by nurses in collaboration with physicians. However, some research have produced contradictory results to date [2]; Some of these studies discovered a mortality benefit but no effect on waiting time or treatment duration [2]. Other trials, on the other hand, revealed much shorter treatment times[42].

Another promising intervention in triage is to give nurses additional authority, such as the ability to request diagnostic tests such as X-rays before the physician has evaluated the patient [5,39,43]. However, it is strongly advised that nurses have proper training before taking on this extra job [26].

Furthermore, in a study by Debono et al. [44], It was shown that medical or nursing staff trained to operate a telephone triage system might reduce the number of visits to a pediatric emergency department, and this prospective solution could be expanded to other age groups as well.

Machine Learning and Artificial Intelligence (AI) AI and machine learning represent a novel approach to implementing the most effective anti-overcrowding strategies. Cabezuelo investigated the best collection of variables that explain the phenomena of patients returning to a hospital's emergency department in less than 72 hours. He discovered that a neural network is the best machine learning algorithm [45]. Arnaud et al. used data analytics to study the early prediction of patient hospitalization at the triage stage [46].

3.3.2. Macrolevel Strategies

Macrolevel techniques, like microlevel strategies, can be used to combat congestion, but unlike the latter, they are implemented at the hospital and/or care system level [4,10].

Simplifying the Admission Process

Simplifying admission protocols could improve patient flow control by reducing wait times and assuring better management of ED overcrowding [10,47].

The most effective approach of ensuring safe and smooth transitions is still verbal handover between two attending physicians; however, this can be challenging in moments of high patient influx or in academic institutions where students serve as the major workforce. The goal would be for all inpatient services to follow a standardized admission process in order to eliminate delays and potentially maximize hospital service performance.

A unified electronic signing method in hospitals with the capabilities could allow for more efficient and asynchronous admission [4,48].

Reverse Triage

Reverse triage is a method of identifying hospitalized patients who are stable and do not require additional care and may thus be discharged safely [10,49].

Cooperation with external facilities, such as hospices, nursing homes, rehabilitation centers, and the patients' own homes, as well as an appropriate support program, facilitates and supports early discharge from the hospital [10,49]. The addition of a 24-48 hour post discharge telemedicine follow-up period, in conjunction with reverse triage and early discharge processes, has the potential to benefit both caregivers and patients by increasing the availability of hospital beds for new admissions. [4,50].

Smoothing Elective Admissions

Although the frequency of hospitalizations in emergency medicine cannot be regulated, studies have shown that it is highly predictable based on weather, season, and epidemiology across time [51,52]. The remaining hospital admissions are scheduled elective admissions, which are often booked at the start of each week and have been demonstrated to have a significant detrimental influence on overall flow and boarding.

The issue is that elective hospitalizations frequently compete with urgent hospitalizations related to ED admissions.

Much research has been conducted on the elective scheduling of surgical hospitalizations, which has resulted in a significant reduction in boarding and better bed availability in the inpatient and intensive care units. Because elective hospitalizations peak at the beginning of the week, dispersing them evenly throughout the week would increase the hospital's bed capacity. [51,53,54].

Early Discharge

Without the early discharge of hospitalized patients, new patients admitted to the ED face boarding. To contrast, early discharge before midday has been found in a research by Powell et al. to enhance ED flow, reducing boarding by 96% [51,55]. It was also discovered at New York University that increasing the number of patients discharged before noon resulted in a reduction in overall duration of stay. Their efforts were led by the discovery that hospitalized patients who arrived at the inpatient unit before noon spent 0.6 days less than those who arrived after noon [17].

Weekend Discharge

The number of discharges on weekends is often about 50% lower than the number of discharges on weekdays [51]. Increased weekend discharges can significantly boost bed availability early in the week and lower the hospital's overall LOS. Although this may need the use of resources that are frequently unavailable on weekends, such as echographies, MRIs, and stress tests, increased weekend availability results in less demand for them during the week. As a result, it is not required to increase staffing, but rather to redistribute some of it on weekends [17,56].

Full Capacity Protocol or Action Plan

Financial constraints force hospitals to operate at nearly full capacity, but when that capacity is reached, hospitals should implement a program to manage excess hospitalized patients and reduce ED boarding, such as the full capacity protocol (FCP), which involves transferring patients from ED hallways to inpatient ward hallways.

The implementation of an FCP has been thoroughly researched in several contexts and has been demonstrated to minimize waiting time and boarding, improve productivity, decrease overall length of stay, and improve patient satisfaction [17,51,57].

Legislation and Guidelines

The understanding of the overcrowding situation by hospital administration is a critical factor that must be addressed in order to alleviate the problem [10,49].

If there is no improvement, despite the possibility of making structural and organizational changes that could alleviate the problem, it is necessary to strengthen regulations and draft stronger legislation to regulate overcrowding, using effective and precise guidelines, in order to solve the problem at a higher level [7,10].

3.3.3. Observation Unit

Other techniques that could reduce hospital admissions include observation units (OBIs—units of short and intensive observation), which serve as a link between microlevel and macrolevel determinants because they are placed at the junction of ED and hospital care [4,10,58,59].

Patients who benefit from the presence of an observation unit are those who, after getting a diagnosis or beginning therapy, do not require prolonged hospitalization but must be monitored for a short period of time. Thus, the implementation of OBIs could lessen ED overcrowding while allowing for continuous patient monitoring and treatment.

An Italian research group found that, despite an increase in the number of ED admissions and the requirement for patients to be hospitalized, the phenomenon of "boarding" and "exit block" stabilized over the years of operation of an OBI team. There was also a reduction in the length of stay and an improvement in the outcomes of some patient groups [10]; These findings are consistent with findings from other European and American study organizations [10,60,61].

IV. Discussion

Given the growing importance of ED congestion and its potential implications on patient and employee welfare, it is clear that methods to deal with or minimize the situation are required [2]. As previously stated, the causes of ED overpopulation are numerous, beginning with input factors and ending with output ones. Only knowledge and understanding of the issue can lead to the implementation of the most effective measures to counteract and control the problem. This review was undertaken in this respect, beginning with a study of the origins and implications, and then focused primarily on the measures that can be utilized to counteract this phenomenon.

To the best of our knowledge, this evaluation provides a detailed examination of prospective solutions to overcrowding that has not been documented in other reviews. It also provides an overview of the primary signs of overpopulation, despite the fact that there is no gold standard at the moment.

This narrative review has significant limitations. Because this is a global topic, only articles in English were included. As a result, vital information published in other languages may be omitted. In other circumstances, pediatric EDs with their special concerns were included in other Emergency Departments geared at the broader population.

V. Conclusions

Numerous solutions have been collected and offered in this regard, with the goal of being applied both in the ED (microlevel strategies) and at the hospital level (macrolevel strategies). The goal should be to implement a strategy that considers not only the ED but also the hospital, the health care system as a whole, and the community.

References

[1] Babatabar-Darzi, H.; Jafari-Iraqi, I.; Mahmoudi, H.; Ebadi, A. Overcrowding Management and Patient Safety: An Application of the Stabilization Model. *Iran. J. Nurs. Midwifery Res.* **2020**, *25*, 382. [CrossRef] [PubMed]

[2] Lindner, G.; Woitok, B.K. Emergency Department Overcrowding: Analysis and Strategies to Manage an International Phe- nomenon. *Wien. Klin. Wochenschr.* **2021**, *133*, 229–233. [CrossRef] [PubMed]

[3] Adriani, L.; Dall'Oglio, I.; Brusco, C.; Gawronski, O.; Piga, S.; Reale, A.; Buonomo, E.; Cerone, G.; Palombi, L.; Raponi, M. Reduction of Waiting Times and Patients Leaving Without Being Seen in the Tertiary Pediatric Emergency Department: A Comparative Observational Study. *Pediatr. Emerg. Care* **2022**, *38*, 219–223. [CrossRef] [PubMed]

[4] Kenny, J.F.; Chang, B.C.; Hemmert, K.C. Factors Affecting Emergency Department Crowding. *Emerg. Med. Clin. N. Am.* **2020**, *38*, 573–587. [CrossRef] [PubMed]

[5] Yarmohammadian, M.; Rezaei, F.; Haghshenas, A.; Tavakoli, N. Overcrowding in Emergency Departments: A Review of Strategies to Decrease Future Challenges. *J. Res. Med. Sci.* **2017**, *22*, 23. [CrossRef]

[6] Badr, S.; Nyce, A.; Awan, T.; Cortes, D.; Mowdawalla, C.; Rachoin, J.-S. Measures of Emergency Department Crowding, a Systematic Review. How to Make Sense of a Long List. *Open Access Emerg. Med.* **2022**, *14*, 5–14. [CrossRef] [PubMed]

[7] Rabin, E.; Kocher, K.; McClelland, M.; Pines, J.; Hwang, U.; Rathlev, N.; Asplin, B.; Trueger, N.S.; Weber, E. Solutions To Emergency Department 'Boarding' And Crowding Are Underused And May Need To Be Legislated. *Health Aff.* **2012**, *31*, 1757–1766. [CrossRef]

[8] American College of Emergency Physicians. Practice Guideline. Definition of Boarded Patient. *Ann. Emerg. Med.* **2011**, *57*, 548.[CrossRef]

[9] Emergency Medicine Practice Committee. Emergency Department Crowding: High Impact Solutions. 2016. Available online: https://www.acep.org/globalassets/sites/acep/media/crowding/empc_crowding-ip_092016.pdf (accessed on 31 May 2022).

[10] Savioli, G.; Ceresa, I.F.; Gri, N.; Bavestrello Piccini, G.; Longhitano, Y.; Zanza, C.; Piccioni, A.; Esposito, C.; Ricevuti, G.; Bressan, M.A. Emergency Department Overcrowding: Understanding the Factors to Find Corresponding Solutions. *J. Pers. Med.* **2022**, *12*, 279. [CrossRef]

[11] Phillips, J.L.; Jackson, B.E.; Fagan, E.L.; Arze, S.E.; Major, B.; Zenarosa, N.R.; Wang, H. Overcrowding and Its Association With Patient Outcomes in a Median-Low Volume Emergency Department. *J. Clin. Med. Res.* **2017**, *9*, 911–916. [CrossRef]

[12] Epstein, S.K.; Huckins, D.S.; Liu, S.W.; Pallin, D.J.; Sullivan, A.F.; Lipton, R.I.; Camargo, C.A. Emergency Department Crowdingand Risk of Preventable Medical Errors. *Intern. Emerg. Med.* **2012**, *7*, 173–180. [CrossRef]

[13] Carter, E.J.; Pouch, S.M.; Larson, E.L. The Relationship Between Emergency Department Crowding and Patient Outcomes: ASystematic Review: Emergency Department Crowding and Patient Outcomes. *J. Nurs. Scholarsh.* **2014**, *46*, 106–115. [CrossRef]

[14] Welch, S.J.; Augustine, J.J.; Dong, L.; Savitz, L.A.; Snow, G.; James, B.C. Volume-Related Differences in Emergency Department Performance. *Jt. Comm. J. Qual. Patient Saf.* **2012**, *38*, 395-AP1. [CrossRef]

[15] Asaro, P.V.; Lewis, L.M.; Boxerman, S.B. Emergency Department Overcrowding: Analysis of the Factors of Renege Rate. *Acad.Emerg. Med.* **2007**, *14*, 157–162. [CrossRef] [PubMed]

[16] Boldori, H.M.; Ciconet, R.M.; Viegas, K.; Schaefer, R.; dos Santos, M.N. Cross-Cultural Adaptation of the Scale National Emergency Department Overcrowding Score (NEDOCS) for Use in Brazil. *Rev. Gaúcha De Enferm.* **2021**, *42*, e20200185. [CrossRef] [PubMed]

[17] Salway, R.; Valenzuela, R.; Shoenberger, J.; Mallon, W.; Viccellio, A. Emergency department (ed) overcrowding: Evidence-basedanswers to frequently asked questions. *Rev. Médica Clínica Las*

Condes **2017**, *28*, 213–219. [CrossRef]

[18] Wachtel, G.; Elalouf, A. Addressing Overcrowding in an Emergency Department: An Approach for Identifying and Treating Influential Factors and a Real-Life Application. *Isr. J. Health Policy Res.* **2020**, *9*, 37. [CrossRef]

[19] Affleck, A.; Parks, P.; Drummond, A.; Rowe, B.H.; Ovens, H.J. Emergency Department Overcrowding and Access Block. *CJEM* **2013**, *15*, 359–370. [CrossRef]

[20] Ministero Della Salute. Linee di Indirizzo Nazionali per lo Sviluppo del Piano di Gestione del Sovraffollamento in Pronto soccorso. Available online: https://www.salute.gov.it/imgs/C_17_pubblicazioni_3143_allegato.pdf (accessed on 31 May 2022).

[21] Erenler, A.K.; Akbulut, S.; Guzel, M.; Cetinkaya, H.; Karaca, A.; Turkoz, B.; Baydin, A. Reasons for Overcrowding in the Emergency Department: Experiences and Suggestions of an Education and Research Hospital. *Turk. J. Emerg. Med.* **2014**, *14*, 59–63. [CrossRef] [PubMed]

[22] Jung, H.M.; Kim, M.J.; Kim, J.H.; Park, Y.S.; Chung, H.S.; Chung, S.P.; Lee, J.H. The Effect of Overcrowding in Emergency Departments on the Admission Rate According to the Emergency Triage Level. *PLoS ONE* **2021**, *16*, e0247042. [CrossRef]

[23] Chen, W.; Linthicum, B.; Argon, N.T.; Bohrmann, T.; Lopiano, K.; Mehrotra, A.; Travers, D.; Ziya, S. The Effects of Emergency Department Crowding on Triage and Hospital Admission Decisions. *Am. J. Emerg. Med.* **2020**, *38*, 774–779. [CrossRef] [PubMed]

[24] Savioli, G.; Ceresa, I.F.; Novelli, V.; Ricevuti, G.; Bressan, M.A.; Oddone, E. How the Coronavirus Disease 2019 Pandemic Changedthe Patterns of Healthcare Utilization by Geriatric Patients and the Crowding: A Call to Action for Effective Solutions to the Access Block. *Intern. Emerg. Med.* **2022**, *17*, 503–514. [CrossRef] [PubMed]

[25] Al-Surimi, K.; Yenugadhati, N.; Shaheen, N.; Althagafi, M.; Alsalamah, M. Epidemiology of Frequent Visits to the Emergency Department at a Tertiary Care Hospital in Saudi Arabia: Rate, Visitors' Characteristics, and Associated Factors. *Int. J. Gen. Med.***2021**, *14*, 909–921. [CrossRef] [PubMed]

[26] Bittencourt, R.J.; Stevanato, A.D.M.; Bragança, C.T.N.M.; Gottems, L.B.D.; O'Dwyer, G. Interventions in Overcrowding of Emergency Departments: An Overview of Systematic Reviews. *Rev. De Saúde Pública* **2020**, *54*, 66. [CrossRef].

[27] af Ugglas, B.; Skyttberg, N.; Wladis, A.; Djärv, T.; Holzmann, M.J. Emergency Department Crowding and Hospital Transformationduring COVID-19, a Retrospective, Descriptive Study of a University Hospital in Stockholm, Sweden. *Scand. J. Trauma Resusc. Emerg. Med.* **2020**, *28*, 107. [CrossRef]

[28] Richardson, D.B. Increase in Patient Mortality at 10 Days Associated with Emergency Department Overcrowding. *Med. J. Aust.* **2006**, *184*, 213–216. [CrossRef]

[29] Menon, N.V.B.; Jayashree, M.; Nallasamy, K.; Angurana, S.K.; Bansal, A. Bed Utilization and Overcrowding in a High-VolumeTertiary Level Pediatric Emergency Department. *Indian Pediatr.* **2021**, *58*, 723–725. [CrossRef]

[30] Jo, S.; Jeong, T.; Jin, Y.H.; Lee, J.B.; 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. *Am. J. Emerg. Med.* **2015**, *33*, 1725–1731. [CrossRef]

[31] Crook, H.D.; Taylor, D.M.; Pallant, J.F.; Cameron, P.A. Workplace Factors Leading to Planned Reduction of Clinical Work among Emergency Physicians. *Emerg. Med.* **2004**, *16*, 28–34. [CrossRef]

[32] Green, D.; Ruel, J. Impact of Advanced Practice Prehospital Programs on Health Care Costs and ED Overcrowding: A Literature Review. *Adv. Emerg. Nurs. J.* **2020**, *42*, 128–136. [CrossRef]

[33] Krochmal, P.; Riley, T.A. Increased Health Care Costs Associated with ED Overcrowding. *Am. J. Emerg. Med.* **1994**, *12*, 265–266.[CrossRef]

[34] Pines, J.M.; Batt, R.J.; Hilton, J.A.; Terwiesch, C. The Financial Consequences of Lost Demand

and Reducing Boarding in Hospital Emergency Departments. *Ann. Emerg. Med.* **2011**, *58*, 331–340. [CrossRef] [PubMed]

[35] Kim, D.; Park, Y.S.; Park, J.M.; Brown, N.J.; Chu, K.; Lee, J.H.; Kim, J.H.; Kim, M.J. Influence of Overcrowding in the Emergency Department on Return Visit within 72 H. *J. Clin. Med.* **2020**, *9*, 1406. [CrossRef] [PubMed]

[36] Duseja, R.; Bardach, N.S.; Lin, G.A.; Yazdany, J.; Dean, M.L.; Clay, T.H.; Boscardin, W.J.; Dudley, R.A. Revisit Rates and Associated Costs After an Emergency Department Encounter: A Multistate Analysis. *Ann. Intern. Med.* **2015**, *162*, 750–756. [CrossRef]

[37] Di Somma, S.; Paladino, L.; Vaughan, L.; Lalle, I.; Magrini, L.; Magnanti, M. Overcrowding in Emergency Department: An International Issue. *Intern. Emerg. Med.* **2015**, *10*, 171–175. [CrossRef]

[38] Singer, A.J.; Taylor, M.; LeBlanc, D.; Meyers, K.; Perez, K.; Thode, H.C.; Pines, J.M. Early Point-of-Care Testing at Triage Reduces Care Time in Stable Adult Emergency Department Patients. *J. Emerg. Med.* **2018**, *55*, 172–178. [CrossRef]

[39] Oredsson, S.; Jonsson, H.; Rognes, J.; Lind, L.; Göransson, K.E.; Ehrenberg, A.; Asplund, K.; Castrén, M.; Farrohknia, N. A Systematic Review of Triage-Related Interventions to Improve Patient Flow in Emergency Departments. *Scand. J. Trauma Resusc. Emerg. Med.* **2011**, *19*, 43. [CrossRef]

[40] Savioli, G.; Ceresa, I.F.; Maggioni, P.; Lava, M.; Ricevuti, G.; Manzoni, F.; Oddone, E.; Bressan, M.A. Impact of ED Organization with a Holding Area and a Dedicated Team on the Adherence to International Guidelines for Patients with Acute Pulmonary Embolism: Experience of an Emergency Department Organized in Areas of Intensity of Care. *Medicines* **2020**, *7*, 60. [CrossRef]

[41] Lee, I.-H.; Chen, C.-T.; Lee, Y.-T.; Hsu, Y.-S.; Lu, C.-L.; Huang, H.-H.; Hsu, T.-F.; How, C.-K.; Yen, D.H.-T.; Yang, U.-C. A New Strategy for Emergency Department Crowding: High-Turnover Utility Bed Intervention. *J. Chin. Med. Assoc.* **2017**, *80*, 297–302.[CrossRef]

[42] Burström, L.; Nordberg, M.; Örnung, G.; Castrén, M.; Wiklund, T.; Engström, M.-L.; Enlund, M. Physician-Led Team Triage Basedon Lean Principles May Be Superior for Efficiency and Quality? A Comparison of Three Emergency Departments with DifferentTriage Models. *Scand. J. Trauma Resusc. Emerg. Med.* **2012**, *20*, 57. [CrossRef]

[43] Jeyaraman, M.M.; Copstein, L.; Al-Yousif, N.; Alder, R.N.; Kirkland, S.W.; Al-Yousif, Y.; Suss, R.; Zarychanski, R.; Doupe, M.B.; Berthelot, S.; et al. Interventions and Strategies Involving Primary Healthcare Professionals to Manage Emergency Department Overcrowding: A Scoping Review. *BMJ Open* **2021**, *11*, e048613. [CrossRef] [PubMed]

[44] Debono, P.; Debattista, J.; Attard-Montalto, S.; Pace, D. Adequacy of Pediatric Triage. *Disaster Med. Public Health Prep.* **2012**, *6*, 151–154. [CrossRef] [PubMed]

[45] Sarasa Cabezuelo, A. Application of Machine Learning Techniques to Analyze Patient Returns to the Emergency Department. *J. Pers. Med.* **2020**, *10*, 81. [CrossRef]

[46] Arnaud, E.; Elbattah, M.; Gignon, M.; Dequen, G. Deep Learning to Predict Hospitalization at Triage: Integration of Structured Data and Unstructured Text. In Proceedings of the 2020 IEEE International Conference on Big Data (Big Data), Atlanta, GA, USA, 10–13 December 2020; pp. 4836–4841.

[47] Lovett, P.B.; Illg, M.L.; Sweeney, B.E. A Successful Model for a Comprehensive Patient Flow Management Center at an Academic Health System. *Am. J. Med. Qual.* **2016**, *31*, 246–255. [CrossRef] [PubMed]

[48] Kelen, G.D.; Wolfe, R.; D'Onofrio, G.; Mills, A.M.; Diercks, D.; Stern, S.A.; Wadman, M.C.; Sokolove, P.E. Emergency Department Crowding: The Canary in the Health Care System. *NEJM Catal. Innov. Care Deliv.* **2021**, 1–26. [CrossRef]

[49] Pollaris, G.; Sabbe, M. Reverse Triage: More than Just Another Method. *Eur. J. Emerg. Med.* **2016**, *23*, 240–247. [CrossRef]

[50] Syed, S.T.; Gerber, B.S.; Sharp, L.K. Traveling Towards Disease: Transportation Barriers to Health Care Access. *J. CommunityHealth* **2013**, *38*, 976–993. [CrossRef]

[51] McKenna, P.; Heslin, S.M.; Viccellio, P.; Mallon, W.K.; Hernandez, C.; Morley, E.J. Emergency Department and Hospital Crowding: Causes, Consequences, and Cures. *Clin. Exp. Emerg. Med.* **2019**, *6*, 189–195. [CrossRef]

[52] Boyle, J.; Jessup, M.; Crilly, J.; Green, D.; Lind, J.; Wallis, M.; Miller, P.; Fitzgerald, G. Predicting Emergency Department Admissions. *Emerg. Med. J.* **2012**, *29*, 358–365. [CrossRef].

[53] McManus, M.L.; Long, M.C.; Cooper, A.; Mandell, J.; Berwick, D.M.; Pagano, M.; Litvak, E. Variability in Surgical Caseload and Access to Intensive Care Services. *Anesthesiology* **2003**, *98*, 1491–1496. [CrossRef]

[54] Litvak, E.; Fineberg, H.V. Smoothing the Way to High Quality, Safety, and Economy. *N. Engl. J. Med.* **2013**, *369*, 1581–1583. [CrossRef] [PubMed]

[55] Powell, E.S.; Khare, R.K.; Venkatesh, A.K.; Van Roo, B.D.; Adams, J.G.; Reinhardt, G. The Relationship between Inpatient Discharge Timing and Emergency Department Boarding. *J. Emerg. Med.* **2012**, *42*, 186–196. [CrossRef] [PubMed]

[56] Wong, H.J.; Wu, R.C.; Caesar, M.; Abrams, H.; Morra, D. Smoothing Inpatient Discharges Decreases Emergency Department Congestion: A System Dynamics Simulation Model. *Emerg. Med. J.* **2010**, *27*, 593–598. [CrossRef] [PubMed]

[57] Garson, C.; Hollander, J.E.; Rhodes, K.V.; Shofer, F.S.; Baxt, W.G.; Pines, J.M. Emergency Department Patient Preferences forBoarding Locations When Hospitals Are at Full Capacity. *Ann. Emerg. Med.* **2008**, *51*, 9–12.e3. [CrossRef]

[58] Aaronson, E.L.; Yun, B.J. Emergency Department Shifts and Decision to Admit: Is There a Lever to Pull to Address Crowding? *BMJ Qual. Saf.* **2020**, *29*, 443–445. [CrossRef]

[59] Ross, M.A.; Hockenberry, J.M.; Mutter, R.; Barrett, M.; Wheatley, M.; Pitts, S.R. Protocol-Driven Emergency Department Observation Units Offer Savings, Shorter Stays, And Reduced Admissions. *Health Aff.* **2013**, *32*, 2149–2156. [CrossRef]

[60] Al-Kuwaiti, A.; Hefny, A.F.; Bellou, A.; Eid, H.O.; Abu-Zidan, F.M. Epidemiology of Head Injury in the United Arab Emirates. Turk. J. *Trauma Emerg. Surg.* **2012**, *18*, 213–218. [CrossRef]

[61] Lim, A.G.; Kivlehan, S.; Losonczy, L.I.; Murthy, S.; Dippenaar, E.; Lowsby, R.; Yang, M.L.C.L.C.; Jaung, M.S.; Stephens, P.A.; Benzoni, N.; et al. Critical Care Service Delivery across Healthcare Systems in Low-Income and Low-Middle-Income Countries: Protocol for a Systematic Review. *BMJ Open* **2021**, *11*, e048423. [CrossRef] [PubMed]