White Paper from the Emergency Department Crowding and Access Block Task Force

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Executive Summary

Lang E, Hansen K, Javidan A, Lewis D

Emergency Department (ED) crowding and access block represent potentially the greatest threats to the core mission of emergency care across the world. The problem is pervasive, massive in scale, and amounts to a public health emergency with potentially lethal consequences. At its core, crowding and access block overwhelm ED resources and prevent the delivery of timely and effective care for patients. These are patients in need of necessary and immediate attention for the whole range of medical, trauma and behavioral emergencies that can impact a person or community. COVID-19 represents a prime example of how ED crowding and access block can serve as dangerous accelerants for pandemic infections. The causes of ED crowding and access block are complex and multifactorial and can vary considerably not only between hospitals, jurisdictions, and countries, but also within the same setting during different periods of time. As a 'wicked problem' for health care systems internationally, experts and thought leaders around the world have invested a remarkable amount of resources to understand the problem and formulate solutions. This report is designed to leverage that vast international experience and serve as a comprehensive global resource for EDs facing the challenge of crowding and access block.

This project was born during a discussion over breakfast at the Emirates Society of Emergency Medicine conference in 2018. An ED chief in the Middle East lamented the tragic outcome of a young man in his forties, a father of four, who died due to a fat embolus from a femoral fracture as he waited in the ED for 48 hours for an in-hospital bed that was required for operative intervention. The challenges faced by that member of our global EM community exemplify why we need an urgent, coordinated, and multifaceted response.

The International Federation of Emergency Medicine (IFEM) realized early on that there was both an extreme need and a unique opportunity to provide EDs around the world with expert and evidence-based guidance. Recognizing that this was not a situation where one size fits all, the plan to develop a resource that could be adapted to local circumstances was endorsed by the IFEM Board and launched at the International Conference on Emergency Medicine (ICEM) conference in South Korea in 2019. Since that time, the ED Crowding and Access Block Task Force Terms of Reference were approved, and the task force has seen involvement from all

IFEM regions. Over thirty Emergency Medicine (EM) physician experts and thought leaders, with a broad range of expertise, have been joining monthly video conferences and contributing to fourteen distinct dossiers and well-referenced synopses which constitute the basis for this report.

This report examines the wickedness and complexity of ED Crowding and Access Block through multiple important lenses. These range from an accounting of the impacts of the problem through to tactical and strategic solutions including policy, advocacy, operational, and "on-the-floor" initiatives. One overwhelmingly common theme that emerged through Task Force deliberations is that the problem may be misnamed. ED Crowding and Access Block is not an issue isolated to the Emergency Department, but fundamentally a health-systems issue. Emergency Departments are well-prepared to serve as the "safety net" for a wide range of medical, traumatic and behavioral emergencies, however EDs cannot fulfill this mission if they are also forced to become the "safety valve" for dysfunction and limited capacity within the community and the hospital. Despite this, the Task Force would also share the view that EDs that are not contributing to solutions for healthcare system dysfunction are also part of the problem; hence the vital importance of emergency care providers who are well-versed in system issues to infiltrate decision-making and public awareness realms at multiple levels.

This document is meant to be used as a toolbox with each section acting as a tool to diagnose and treat an unsafe and overwhelmed ED. Leaders in emergency care will be able to realize what instruments are required to address their local circumstances both on a short-term and long-term basis. This report is also meant to be shared in portion, or in its entirety, with all of the stakeholders that can be impacted by ED Crowding and Access Block as well as the partners necessary to mitigate and distribute risk and allow emergency care to fulfill its core mission.

The various dossiers have been summarized in Tables 1-4. These tables provide a broad overview of the content in this report. For a more nuanced and comprehensive explanation, each corresponding section has been linked.

Table 1. Summary of background information related to ED crowding

Effects of crowding	Description
Input	
Delays to Treatment	High numbers of arrivals can result in delayed treatment and worsened outcomes for critically ill patients.
Throughput	
Mortality	Mortality is worse at times of high ED occupancy. However for certain conditions, longer ED length of stay is associated with better outcomes.
Output	
Routine Medications	There is evidence of delayed administration of routine medications for admitted patients boarded in the ED.
Mortality	Increased mortality has been associated with delays to admission both for delayed patients and other patients in the ED at the time when delays occur.
Hospital Length of Stay	Delays to admission are also associated with longer hospital stays.
Equality	
Low Resource Settings	Vulnerable and disadvantaged groups are more exposed to the negative effects of crowding.
International Experience	**Description**
Causes and Solutions	There are similarities in the causes of crowding worldwide. It is most commonly related to output and access block specifically. Various input, throughput, and output solutions have been adopted and studied internationally.

Research	There is a paucity of high-quality patient outcome research on the effects of crowding.
Case studies and patient voices	**Description**
Importance of stories	Data has not been, and likely will not be, enough to mobilize action from policymakers and stakeholders. The power of narrative and patient stories must also be leveraged to illustrate the impact that crowding has.

Table 2. Summary of measurements and metrics related to ED crowding

Metrics	**Description**
No consistent standards for measurement. Various metrics have been proposed but none are without limitations.	
Time-based	
ED length of stay, time to be seen, boarded time, etc.	ED length of stay most persuasive and impactful. Preferably collected electronically. 90th percentile reporting better for capturing outliers.
Volume-based	
Number of patients boarded	May have different implications in different settings.
Occupancy-based	
Total number of beds available	May have different implications in different settings. Also need to consider staffing ratios.
Cost	**Description**
Human Cost	
Quality of care	Lower in the setting of crowding (ambulance diversion, inappropriate patient placement).

Patient satisfaction	Increased risk of patient elopement, lower satisfaction, ED reputation impacted, increased risk of violence.
Staff satisfaction	Increased staff stress, impacts recruitment and retention, impacts education and research.
Financial Cost	
Delays to admission	Associated with significantly higher costs and opportunity loss.
Long waits for assessment	Weakly associated with increased financial costs.

Table 3. Summary of patient flow strategies related to ED crowding

Strategy	**Description**
Prehospital Services	
Offload Delay and Turnaround Time	Offload delay time is difficult to measure reliably. Total time spent at hospital (turnaround time) is a useful proxy.
Impact of Crowding	Impact on community EMS availability, increased financial costs (overtime).
Ambulance Diversion	Mixed effects; impact on response times, no benefit to patient volumes.
Alternative Care Destination	Algorithms, training and physician triage guide redirection to alternative destinations.
Hospital-based Solutions	Offload zones, shared responsibility for waiting ambulance patients, fast-track, observation area and overcapacity protocols.
Input	

Patient Education and Public Awareness Campaigns	National and local strategies to educate public and streamline ED utilization. Right time, right place. Behavior change is difficult.
Improved Access to Primary Care	ED utilization is highest amongst those without access to primary care.
Patient Redirection Strategies	Redirection at Triage to an appropriate service (remote or co-located) e.g. primary care, urgent care facility, fast-track streams.
Alternative Models of Care	Low acuity walk-in clinics, telemedicine, admission avoidance pathways.
Throughput	
Process Improvement	Simplify and improve hospital and ED processes.
ED Staffing	Volume-based staffing of Eds. Scheduling existing resources to match demand.
ED Information Systems	Patient tracking systems to capture real-time information.
Fast Track and Medical Directives	Expedite care for certain presenting complaints using designated areas, pathways and medical directives.
Satellite Labs / Point of Care Diagnostics	Reduce wait times attributed to waiting for laboratory results.
Rapid Assessment Zones	Stream / cohort intermediate acuity patients to reduce resource demand and improve flow
Short-Stay Units	Rapid turnover, frequent reassessments, alternative to patient hospitalization

Formalize Intake / Admission Policies	Stream patients with easily defined conditions to rapid assessment and admission pathways
Output and Boarding	
Bed Management	Active bed management strategy can reduce ED LOS.
Admission Policies	ED Observation Units, Short-stay units and Hospital in the Home and optimizing discharge strategies have improved output metrics.
Time-based Targets	Associated with reduction in access-block and ED LOS, but may have negative effects e.g. returns, readmissions and inpatient LOS.
System-based Solutions	Alternative level of care patients that occupy hospital beds are a significant contributor to access block. Solutions to ED crowding must target the system as a whole.

Table 4. Summary of management strategies and principles related to ED crowding

Leadership	**Description**
Defining the problem	ED crowding meets the criteria for a wicked problem and traditional leadership styles will likely be insufficient in addressing it holistically.
The need for complex systems leadership	Principles of complex systems leadership can be applied at a broad level to target the issue. These principles include creating coherence, influencing conditions, and encouraging connections.
Leading a crowded ED on the ground	Traditional leadership skills play a more central role here. Recommendations include clearly framing the issue, advocacy across the board, clear communication of risks, direction of attention at the right priorities, and the use of an emergency physician in charge.
Legal Risks	**Description**

Key considerations (to be interpreted in the context of local legal systems)	Scarcity of resources or a crowded ED would likely not be a stand-alone defense to allegations of negligence; hospitals do have an independent legal duty to provide safe systems and courts may consider the facilities available to physicians at the time of care delivery.
Policy	**Description**
Principles of effective policy	Many organizations have created policies and guidelines for ED crowding. Effective policies explicitly describe goals, outline key performance indicators, inform key stakeholders, and clarify, instead of contribute to, misperceptions.
Advocacy	**Description**
Principles of effective advocacy	Advocacy for ED crowding has been long-standing, but has often been limited by various factors: a lack of a systems-approach, misdirection at goals not supported by evidence, and not involving multidisciplinary stakeholders.
Lessons from COVID-19 and Disaster Medicine	**Description**
Key takeaways	Various organizations have released guidelines of how to apply principles of disaster medicine to crowding and addressing surge capacity. COVID-19 has identified the importance of how crowding places patients and staff at risk, the utility of telemedicine in providing care, the importance of forward deployment of resources to prevent crowding, and the need for sustained systems-level change.

Introduction

Javidan A

Delays to the provision of timely and effective care undermine the mission of emergency medicine and have been associated with an extensive range of adverse outcomes, including worsened patient morbidity and mortality.[1-5] Emergency department (ED) crowding is the most common cause of delayed emergency care and represents potentially the greatest threat to patient safety in the provision of emergency care around the world.[6,7] Fundamentally, ED crowding refers to a situation where the demand for ED clinical care exceeds available supply.[6-8] Although the causes of ED crowding are multifactorial, access block has often been described as the most significant contributor.[6,9] Access block refers to the delay that occurs when a patient is admitted but is awaiting an inpatient bed, also known as 'boarding' in some parts of the world (Appendix I describes different terms used around the world to describe the same concept related to crowding or access block).[6, 8-10] Fundamentally, ED crowding and access block are issues that affect emergency care systems of all scales around the world. Worldwide, efforts have been directed at reducing crowding or its effects, but these initiatives have often been specific to sites, regions, or countries as a whole.[6, 7, 9, 11, 12]

Recognizing the global scope of the issue as well as the need for both systems-level and tailored local strategies, our objective was to harness international expertise in order to create a resource library addressing different elements of crowding, as well as identify strategies that on-the-ground clinicians and policymakers could implement around the world. To our knowledge, this is the first collaborative project of this scale that has championed an international response to ED crowding and access block.

Methods

Javidan A

The ED Crowding and Access Block Task Force was conceptualized in March 2018 and subsequently proposed to the leadership of the International Federation of Emergency Medicine (IFEM). In January 2019, the initiative was approved and sanctioned under IFEM's Quality and Safety Special Interest Group. We identified and invited international experts and thought-leaders in emergency medicine whose areas of expertise pertained to various aspects of crowding and access block to the Task Force.

We held our inaugural meeting in June 2019 during the 18th International Conference on Emergency Medicine. The final task force consisted of over 30 emergency physicians representing all six IFEM regions across 15 countries. Full details, including the terms of reference, are available on the IFEM website.

Initially, the Task Force determined fourteen topic areas most relevant to ED crowding and access block (e.g., evidence for effects of crowding, input, throughput, output, etc.). Each topic area was made into a dossier using an online file-sharing platform (Google Drive). Task Force content experts were assigned a specific dossier to develop in a team. Each dossier consisted of a resource library, a brief summary of the topic capturing the most relevant literature, and key messages and recommendations. Task force members met monthly via video-conferencing software and discussed each dossier and its contents. The dossiers were iteratively refined until consensus was achieved.

Background

Evidence Base for Effects of Crowding

Jones P

There is a vast evidence base that examines the association between ED crowding and worse quality of care. As randomized trials of crowding are not feasible, most studies on crowding are observational and much of the evidence is low or very low quality as a result. However, due to the strength of effect and 'dose-response' observed, some of the evidence is considered to be of moderate quality, including for the important outcome of mortality. Appendix II describes a brief explanation of quality grading for these studies.

The phases of a patient's journey through and out of the ED overlap, and crowding can be measured using occupancy, time, or workload measures at each phase. These inter-relate, so measuring one partly reflects the others. However, the evidence for associations with effects of crowding differs across the various measures.

Input measures include the number of patients arriving and their acuity (urgency to be seen). Low quality evidence from a small number of studies suggests that when the number of patient arrivals is high, there are delays to assessment, resuscitation of critically ill patients,[1] treatment for pain[2] and for asthma.[3] There is very low quality and inconsistent evidence of delays to treatment for infections[4] and no association with time to treatment for acute coronary syndromes.[4, 5] There is mostly consistent but very low quality evidence from several studies that ED throughput may be delayed when arrivals are high,[6-9] and that patient acuity does not significantly impact throughput.[7, 10, 11]

ED throughput measures include the time spent in the ED and ED occupancy. Compared to input measures, these throughput measures show a more strong inverse association with the timeliness of care, also across a wider range of conditions, although there is some inconsistency in the literature with this association.[3, 4, 12-24] There is low-quality, inconsistent evidence that mortality is worse at times of high ED occupancy[25-33] and when there are longer ED stays on average.[22, 34-37] Conversely, longer stays in ED for individual patients with some conditions in some settings is associated with better care and improved mortality.[38, 39]

Output measures include the number of patients requiring admission to hospital waiting in the ED (boarded patients), and the time they spend in ED after care is complete. There is moderate quality evidence that greater volumes of boarded patients is associated with delays in care for most conditions,[12, 14, 21, 22, 40-42] but quicker investigations for acute coronary syndromes.[40, 42] There is inconsistent and very low quality evidence of impacts on other conditions with respect to receiving appropriate care.[12, 13, 22, 23, 41]

Importantly, there is moderate quality evidence of an association between delays to admission after ED care is complete and mortality in high acuity settings, both for the boarded patients as well as for other patients in the ED at the time when delays occur.[43-48] Delays to admission are also associated with longer hospital stays overall.[43, 47, 49, 50]

There is a paucity of research around whether crowding impacted equity of care as defined by the World Health Organization, [51, 52] although it is known that minority patients have worse access block in the USA[53] and that crowding may worsen implicit racial bias in providers.[54] Crowding is also higher in larger public safety net hospitals and in less well-resourced settings.[55] This means vulnerable groups and disadvantaged groups will likely be more exposed to the negative effects of crowding, as these groups are more likely to present to the ED in these hospitals.[56-58]

Financial and Human Costs of Crowding

Jones P

Human Costs of Crowding

A variety of studies have examined the costs associated with crowding, and Appendix II describes a brief explanation of quality grading for these studies. Current measures of the input phase of emergency department (ED) care include the number of patients arriving and their urgency to be seen (acuity). There is sufficient moderate quality evidence suggesting that when the number of arrivals are high, patients are less likely to wait to be seen (i.e., patient elopement - a patient leaves without being seen).[1-7] There is evidence of lower quality that in the setting of crowding, ambulances are more likely to be diverted away from the ED[8-10] and that patients are more likely to be placed into inappropriate hallway spaces during their stay.[3] Conversely, there is questionable evidence of the association between patient acuity and not waiting to be seen.[2, 5, 7, 11] There is also a weak association with ambulance diversion[12] and staff perception that the ED is crowded.[13, 14] There is a negligible association between input measures of crowding and staff ability to teach trainees.[15]

There is moderate quality evidence that ED throughput measures (time and occupancy in the ED) are associated with patient elopement,[2, 7, 8, 11, 16-18] and lower quality evidence of an association with ambulance diversion,[8, 16, 18, 19] not recommending the ED to others,[17, 20-22] and lower patient satisfaction.[20, 23-28] There is low quality evidence that these measures are strongly associated with violence towards staff,[29, 30] and inconsistent evidence of associations with other aspects of staff experience, such as perception of a crowded[13, 14, 31, 32] or dangerous ED[31] depending on which phase of throughput is measured. There is very low quality evidence from a limited number of studies of no impact on staff stress[33] or quality of education[34] and of improved staff experience when ED length of stay was longer.[35]

Output measures include occupancy by patients waiting for hospital beds after care in ED is complete, and the length of stay in ED for boarding inpatients. There is very low quality evidence that these measures are weakly associated with patient satisfaction[17, 20, 22] and not recommending the ED to others.[20] Additionally, there is very low quality evidence that staff

perceive these measures to compromise care[31, 36, 37] or endanger patients[31] and there is very low quality evidence of no association of these measures with staff education.[34]

Qualitative data suggest that staff believe crowding contributes to stress and negatively impacts on teaching and research, although these results are not consistent with quantitative studies.[38, 39]

Financial Cost of Crowding, Evidence from Quantitative Research

Few studies have explored the financial cost of crowding, but these studies provide moderate quality evidence that long stays, especially delays to admission for inpatients, were associated with significantly higher costs and a 'lost opportunity' to see new patients.[22, 40, 41] There is also very low quality evidence that long waits for initial assessment were also weakly associated with increased financial costs.[22]

Metrics

Lang E, Bertuzzi B

Emergency department (ED) crowding is recognized to be a major international concern that affects patients and providers, but there are no consistent standards for measurement.[1,2] Various metrics have been proposed as a gold-standard means of quantification, but none are without their limitations.[1] Peter Drucker said that you cannot improve what you cannot measure, an idea prevalent in the realm of quality improvement.[3] As such, measuring crowding and access block is a crucial step towards identifying specific areas of improvement and tracking them forward.[4] There is a consensus of the need for quantitative, objective measures that are not site-specific, but are feasible and reproducible.[2,5,6] In general, subjective measures should be avoided due to a lack of standardization across sites and providers.[2]

A number of metrics have been proposed in the literature as a means of providing concrete insights into the severity of ED crowding.[5,6] Many of these are time-based, (e.g., ED length of stay (LOS)), volume-based (e.g. number of boarded patients at a particular moment in time), or occupancy-based (e.g. total number of beds available).[5,6]

Metrics can measure specific components of the input, throughput and output model of ED operations. A broad range of metrics have been proposed and studied. ED input measurements include time to see a clinician from arrival and number of patients waiting to be seen.[5,6] ED throughput can be linked to ED LOS and also to duration of treatment.[5,6] Output challenges can be captured by measuring, LOS for boarded patients (i.e., admitted patients not yet transferred to another unit), the number of boarded patients, the percentage of beds occupied by boarded patients, and overall hospital occupancy.[5,6] These measures may be stratified by patient age or illness severity to factor in potential harms due to delay. These measures may have different implications in different settings. For example, an ED LOS with a maximum stipulated value may distress some departments, but not others, due to differences in ED structures and processes.

Selecting the ideal ED measures may be a pragmatic matter dependent on the reliability of captured data. It is preferable that automated data, collected electronically, be the primary source of data, such as automated electronic time stamps. However there is a risk that this drives us to measure what we can, rather than what we should. The net effect is that process measures are the most commonly selected proxy measures of crowding. An additional consideration is the utility

of metrics in evaluating and guiding quality of care compared to their utility as the focus of empirical research.[7]

Significant debate exists over the optimal reporting of time-based metrics, such as ED LOS. Median LOS can be deceiving if there are significant outliers that contribute disproportionately to ED gridlock through bed block and access to new patients.[8] Some authors have noted that 90th percentile reporting effectively communicates the severe delays experienced by 10% of patients but is often difficult for public stakeholders to understand.[8]

ED LOS can likely be considered as both the most pervasive and clinically impactful measure of crowding and throughput, but a specific definition is warranted as the precise time interval can be subject to debate and requires a means of accurate time capture. Nevertheless, studies have established a clear correlation between ED LOS and the risk of mortality among discharged patients and their quality of care.[9,10]

International Experience

Ho P, Hansen K

The relationship between access block and emergency department (ED) crowding has been well described in studies from the US, UK, Canada and Australia in the last 30 years.[1-5] Amongst the many causes (input-throughput-output model) of ED crowding, access block or hospital overcrowding is identified as the primary and most definitive cause.[3,5-6] Of 15 countries surveyed in a 2011 article,[7] only four European countries (Denmark, Finland, Sweden and The Netherlands) did not have crowding in their EDs at the time, and crowding in Hong Kong was relatively less of a concern. Nonetheless, subsequent reports have revealed that ED overcrowding has now become increasingly problematic in The Netherlands,[8] Sweden,[9] Denmark,[10] and Hong Kong.[11] In the 2011 survey,[7] EDs of Asia and Middle East, countries like India, Saudi Arabia and Iran were overcrowded, and Taiwan, as early as 1999, reported ED overcrowding.[12] In Thailand, a retrospective study[13] conducted in a University-based hospital found that ED crowding was related to the number of laboratory tests requested and/or the type of health insurance the patient had, and these two factors were indirectly linked to "bed block". In Singapore, the total ED attendance had grown at a disproportionately higher rate of 6.8% per year between 2005 and 2011, as compared to the total population annual growth rate of 1.3%.[14] Again, in this example, high hospital bed occupancy and access block were linked to ED overcrowding, as patients are unable to be transferred to inpatient care due to insufficient capacity. Crowding is also being reported in West Africa, though mainly due to a lack of access to resources.[15]

Globally, there are remarkable similarities in the causes of ED crowding. Those potential causes are listed in table 5. Unsurprisingly, there are multiple causes that account for ED crowding in most countries. However, the most common and significant cause is related to output, i.e. access block.

A systems-level problem is implied when there are multiple causes of ED crowding. Therefore, interventions need to involve more than just the ED. Strategies that target only the input and throughput factors have had some positive effects, but the impact on ED crowding is limited in effect and not sustainable over extended periods of time.[4] For those countries in which output

factors are the main reasons for ED crowding, interventions that focus within the ED will have a particularly limited effect. Currently, evidence supporting the most effective solutions is limited, and additional work needs to be done in this area of research.[5] In table 6, solutions adopted and studied in various countries are categorized according to the input-throughput-output model.

Table 5. Potential causes of ED crowding in different countries[7, 8, 9, 10, 11, 12, 14, 15, 16, 17]

Causes	Countries affected
Input ● Increasing ED attendance ● Temporal patterns in ED visits ● Increase in ED urgent and complex cases ● Increase in elderly presentations to ED ● Lack of primary care access leading to increase in low acuity cases to ED	Australia Canada Denmark Germany Ghana Hong Kong India Italy New Zealand Saudi Arabia Turkey UK USA
Throughput ● Shortage of ED staff (nurses, doctors, etc.) ● Long turnaround times of diagnostic tests (laboratory, radiology, etc.) leading to delay in disposition decisions ● Development of subspecialty service in ED (e.g. Geriatric EM)	Australia Canada Ghana* Hong Kong Japan Singapore The Netherlands Thailand Turkey
Output ● Access block	Australia* Canada* France* Hong Kong* India*

	Iran New Zealand* Saudi Arabia* Singapore* Sweden Taiwan Thailand The Netherlands* Turkey* USA*

*denotes the more significant factor if the country has more than one potential cause

Table 6. Potential solutions to ED crowding[3, 7, 11, 16, 17, 18]

Solutions	Countries
Input ● Co-locate primary care service within ED ● Extended GP work hours ● Stand-alone urgent care centres ● Physicians in ambulance ● Hospital at home (end-of-life patients) ● Telemedicine call hotline ● Social interventions such as education, redirection, and financial disincentives ● Ambulance diversion	Australia Canada Denmark Finland France Hong Kong India New Zealand Singapore* Sweden* The Netherlands Turkey UK USA
Throughput ● Fast-track clinic ● Nurse and nurse practitioner-initiated interventions ● Waiting room nurse ● Patient streaming (e.g. senior physician at triage) ● Rapid assessment teams ● Short stay observation units ● Care coordination teams ● Improved laboratory turnaround time / ED satellite laboratory ● Increased ED bed numbers ● Increased ED staff ● Utilize better teaching practice	Australia* Canada* France Hong Kong* India* Italy* New Zealand Singapore Sweden Turkey UK USA
Output	Australia

● Active discharge plan for in-patient	Canada
● Discharge lounge to improve discharge process	Hong Kong
● Inter-hospital transfer to stepdown facilities	India
● ED staff direct admission rights	Italy
● Bed manager and care coordinators	New Zealand*
● National mandated timed patient disposition targets	Spain
● Systems-level leadership interventions and support (e.g. hospital LOS committee, overcapacity protocols, etc.)	Turkey
● Leadership, management/support (Hospital LOS Committee, overcapacity protocols, etc.)	UK*
	USA*

*denotes the more significant factor if the country has more than one potential solution

Case Studies and Patient Voices

Hansen K, Maharjan R

While the literature as a whole and evidence speaks to the significant patient harm that occurs with crowding and access block, it is through hearing patients' stories of suffering that we can understand the individual human impact. Patients come to the Emergency Department with their illness or injury at a time of great stress and uncertainty, and delays in their treatment journey can compound the emotional and physical distress that they are already experiencing.

It can be hypothesized that access block causes disjointed and lower quality care as EDs are not set up as inpatient areas. Access block has been shown to be associated with delays in delivery of analgesia and antibiotics, greater risk of medical error, pressure sores, disturbed sleep, delayed treatment of serious conditions, length of stay, and increased mortality.[1-9] The three patient stories below are real cases in which access block contributed to a poor outcome. It is case stories like these, based on both personal anecdotes from the members of this Task Force, as well based in the literature, that leaders must highlight to stakeholders, policy-makers, and the media in order to capture attention with not only facts, but narrative.

Case 1

A 79 year old male presented to an Emergency Department somewhere in Australia mid-afternoon. He had been referred to his general practitioner for his increasing breathlessness due to congestive cardiac failure. He spent two hours waiting on the ambulance trolley in a large area with many other patients. After two hours, he was moved to a monitored area on an ED trolley and was seen by an Emergency Doctor who agreed with the diagnosis. He was referred to the General Medicine Registrar (admitting doctor) for admission to a ward bed. It was six hours before he was seen by the registrar, and in the meantime the patient had become more confused and agitated on the trolley. He had not received his usual evening medications and did not receive a meal. After the review, the staff heard a thud as the patient fell to the floor while trying to get over the trolley rails to go to the toilet. The patient landed on his side, causing a fracture of the neck of his femur. He was now referred to orthopaedics. As there were no beds in the hospital, the patient spent the night

in the ED on the trolley, with increasing delirium. His cardiac failure worsened. He was taken to the operating theatre the next afternoon but did not survive the procedure.

Case 2

A 20 year old female patient presented with shortness of breath to a hospital somewhere in Nepal. She was diagnosed with community acquired pneumonia and treated with antibiotics. She was then referred from this first hospital (a cardiac specialty hospital) to a general hospital for respiratory involvement. She didn't improve and was referred onto a third hospital. All three hospitals were within a six kilometer distance of each other. On arrival at the third hospital, the patient felt very unwell, was tachycardic, had decreased air entry in her right chest and had an increasing oxygen requirement. She now had severe pneumonia with pulmonary hypertension and right sided pleural effusion.

The duty admitting consultant was asked to review and antibiotics were increased to piperacillin and tazobactam. It was planned to admit the patient once a ward bed became available but this was delayed for over 48 hours as the patient became more hypotensive. There was delayed access to ICU care at this time as well for the patient. On the third day of Emergency Department boarding, the patient began having seizures. Her vitals deteriorated and despite treatment she unfortunately died in ED from sepsis. Her family were devastated by her death and the disjointed care leading up to her demise. The staff felt that the delay to intensive care contributed to the patient's death.

Case 3[10]

A 69 year old female in good health presented to a large, academic ED somewhere in the USA with a fast, irregular heartbeat. She was diagnosed with atrial fibrillation and started on anticoagulation. Due to the access block, she spent the night in the emergency department. The patient was eventually admitted to cardiology ward the following afternoon, but was told that due to the delay, she would not be able to have echocardiography or defibrillation until the next business day, which was three days ahead. Two days after arrival at the hospital, she suffered a large stroke with hemorrhage and subsequently died. Her family have concerns around the dosage and monitoring of anticoagulation in the chaotic ED and the impact of the delay to definitive

treatment. They felt that had she been able to be defibrillated earlier, her anticoagulation could have been reduced or stopped and she may have survived.

Patient Flow

Emergency Medical Services (prehospital services) offload

Carter A

Examining pre-hospital services specifically, emergency department (ED) crowding causes offload delay for Emergency Medical Services (EMS) when patient handover is delayed due to a lack of availability of a bed for the new patient.[1-5] Although offload delay represents a prolongation of the prehospital delivery interval, this can be challenging to reliably measure. Instead, the total turnaround time - the amount of time spent at the hospital, including both delivery (handover) and recovery (restocking, etc.) - is often used as a proxy.[6-8] Because turnaround incorporates both paramedic and hospital factors, accountability to any individual stakeholder or factors remains challenging.

Impacts of ED crowding can include longer ED time to triage and length of stay[9,10] decreased EMS availability to the community, increased financial costs (overtime), and legal impacts which will differ between regulatory jurisdictions.[3, 11-13] Less is known about impacts on paramedic education and morale.

A number of solutions to reduce offload delay have been tested and evaluated. Diversion of ambulances was an early approach, whereby the ED was closed to incoming ambulances which are instead redirected elsewhere. Research has shown mixed effects; there may or may not be impact on response times, but there is likely no benefit to patient volumes.[14,15] Diversion may also create negative consequences for patients and for paramedic services.[16-24]

Interventions examining alternate care destinations have also been investigated. This is a process whereby prehospital services, guided through algorithms, training, or physician triage, could transport patients to destinations other than the ED. However, research is mixed for this intervention as well.[19, 25-27]

Hospital-based solutions have also been examined, including offload ‘zones’, addition of ED capacity, and ED throughput interventions. Offloading could use hospital staff to wait with

multiple ambulance patients to allow paramedics to return to service in the field. This has mixed impact on offload times versus the quality of patient care.[12] Addition of extra beds in high-utilization EDs may improve offload delay, or may be filled by an unmet need.[10, 11, 28, 29] Fast-track and observation areas, as well as overcapacity protocols, can optimize throughput and may have benefit in improving EMS offload.[11, 30, 31]

Overall, a systems-based approach is needed. Ultimately, the ability of paramedics to transfer patient care to an ED is determined by the status of the ED, which is directly related to the availability of inpatient beds. Solutions in one aspect of the system will have unintended consequences on other aspects.

Input and Demand Management

Revue E, Javidan A

Emergency department (ED) overcrowding is frequently described in terms of the input-throughput-output model by Asplin et al.[1] A systematic review by Morley et al.[2] found that factors related to input that have been correlated with ED crowding include poor access to primary care[3-6] resulting in an increase in low acuity presentations,[3,6] increased ED use by the elderly and those with complex conditions,[3, 4, 8-11] and an overall increase in demand for ED services.[2] Many input-based solutions have been proposed targeting these factors, each of varying effectiveness and based on studies of heterogeneous quality. Their effectiveness and/or likelihood of usefulness in implementation should be gauged within these limitations.

Increased access to primary care and general practitioners

Appropriate redirection of low acuity patients and increasing access to primary care have been explored as methods to reduce ED crowding and have also been summarized in the review by Morley et al.[2] A co-located general practitioner office was correlated with lower wait times in an Australian study[12] and a reduction in low acuity presentations in a UK study,[13] although these findings were not replicated in a study based in Singapore.[14] Increasing the hours that general practitioner services are available to patients has been found to have positive effects on ED crowding,[15-18] although this does seem to vary across studies as well.

Alternative models of care

Alternative models of care, such as the Discharge to Medical Home model routes low-acuity, ambulatory, ED patients to a primary care clinic, which provides a connection to primary care the patient may not already have. During clinic hours, walk-in patients to the ED are assessed and if they are determined to be low risk, scheduled for a same-day primary care appointment.[19] These models of care generally aim to reduce the use of the ED for low acuity presentations.

Computer Simulation and Patient Flow Modelling

Crowding and access block are issues modulated by local factors, and a one-size-fits-all solution is unlikely to be effective. An understanding and appreciation of local circumstances thus

facilitates implementation of strategies that are more likely to be effective, although trialing these strategies may pose an administrative and financial burden. Computer simulations which involve patient flow modeling can allow ED leaders to better impediments to patient flow and test delivery of care changes in more efficient ways before implementation in real time. This may be applicable not only to causes and interventions related to input, but to throughput and output as well.[20]

Throughput

Cohen E, Javidan A

In the input-throughput-output model of emergency department crowding described by Asplin et al., throughput is defined as the patient length of stay in the emergency department (ED), consisting of two phases: 1) triage to room placement to initial provider evaluation and 2) diagnostic testing and ED treatment.[1]

Optimizing throughput is dependent on improving process and patient flow. In their 2013 position statement on ED crowding and access block, the Canadian Association of Emergency Physicians (CAEP) compiled 11 possible throughput solutions,[2] including the implementation of LEAN process improvement strategies,[3] adjustments in the roles of physicians – for example assisting with triage to expedite the care of patients subject to unpredictable wait times[4] - and the use of fast track areas or rapid assessment zones.[5] (Table 7) These solutions are multi-disciplinary and can involve fundamental structural changes to the organization, processes, and staffing of an ED.

Various authors have also synthesized reviews on potential solutions that may optimize throughput in the ED.[6-8] These address various factors that influence throughput time – for example, the use of scribes has been proposed to reduce the burden of administrative tasks on emergency physicians while expediting throughput times. Similarly, analyses of factors affecting throughput time and length of stay (LOS) have been conducted, which offer insight into important factors that may be modulated and provide a model by which to measure and evaluate the effectiveness of throughput interventions.[9-11] Additionally, as technologies in the ED continue to advance, machine learning and artificial intelligence methods may hold promise in optimizing throughput times.[12] Reverse triage and early safe discharges from ED may also have a role in improving ED flow but require further evaluation.[13]

Strategies have been evaluated that seek to improve the triage process specifically. These include adding a physician or other primary care professionals to triage, expansion in scope of practice by allowing triage nurses to order tests, addition of fast-track service lines, and primary triage, whereby a nurse practitioner evaluates patients and either refers them to primary care or

discharges them home, depending on the acuity of their complaint.[14-22] A review by Morley et al. found that the introduction of a physician at triage was generally effective at improving metrics related to crowding (e.g., ED length of stay), although this was not always consistent across all of the studies they examined.[23]

Overall, partially attributed to variation in the strength of study designs, it has been noted that there is significant heterogeneity in the quality of the literature for throughput interventions. [2,4] As there may be variation in the systems in EDs across jurisdictions or different settings (e.g., rural vs. urban), we recommend that throughput interventions be piloted in accordance with iterative quality improvement principles, such as PDSA cycles.

Throughput interventions should ideally optimize patient LOS in the ED and increase efficiency without compromising patient safety. Excessive emphasis on the LOS metric may worsen other important metrics, and a well-balanced approach is needed.[24]

Table 7. Throughput strategies proposed in the Canadian Association of Emergency Physicians Position Statement on emergency department crowding and access block

Strategy	**Brief description**
Process improvement	Use of LEAN techniques to simplify and improve hospital and ED processes
Improved ED staffing	Volume-based staffing of EDs to adjust for patient loads
Matching staffing to patient demand	Scheduling existing resources based on patterns of patient use and employing staff on administrative functions to optimize efficiency
Improved ED information systems	Optimization of patient tracking systems to capture real-time information
Use of medical directives	Implementing medical directives, with appropriate support, to expedite care for select groups of patients

Use of Fast Track Areas	Using designated areas that expedite care for certain presenting complaints
Use of Rapid Assessment Zones	Use of these zones for intermediate acuity patients that may be cared for in spaces taking up less ED resources
Establishment of formalized intake policies and processes	Streamlining particular groups of patients to rapid assessment areas to expedite care
Establishing short-stay units	Establishing areas in the hospital that appropriately serve as an alternative to hospitalization of patients
Establishing dedicated ED satellite labs	Use of a satellite lab to reduce wait times attributed to waiting for laboratory results
Using better teaching practices	Use of innovative ways to optimize teaching and patient care

Output and Boarding

Revue E, Javidan A

Crowding is multifactorial and various models have been proposed for its characterization, including the input-throughput-output model by Asplin et al. Access block, the inability to transfer a patient from the ED following a decision to admit, has often been cited to be the predominant contributor to crowding in the output process.[1,2]

Output measures that reflect crowding include boarding time (the time that a patient waits until they are transferred following an admission decision), number of ED admissions, number of patients awaiting discharge, and wait time after a decision or discharge. Integrated scores which measure crowding overall, such as the Emergency Department Work Index Score (EDWIN), and National Emergency Department Overcrowding Scale (NEDOCS) can also measure output, although with less specificity as they include metrics beyond output.[3-5] A number of strategies have been tested and evaluated to improve output. These strategies should be interpreted in the context of their settings and the strength of the underlying evidence.

Bed management

One review identified three studies that showed that an active strategy involving the assessment of bed availability and appropriate allocation by a dedicated bed manager could reduce total ED length of stay, with a reduction in boarding time as well.[2, 6-8]

Changing admission destinations and policies

Some studies have noted that incorporating alternative admission destinations, including ED observation units, short-stay units, ED-staffed inpatient unit, and care models like Hospital in the Home (intended to reduce low acuity admissions) have resulted in improvement in output metrics as well as an improvement in patient satisfaction and financial costs.[2, 9-13] Capacity protocols, wherein additional resources are diverted to the ED in times of crowding, have been met with both improvements and worsening of output measures in different settings.[2, 15, 16] Policies and models which optimize patient discharge times ahead of surges in ED demands can also improve crowding output metrics.[17]

Time-based targets

Time-based targets, such as the UK 4-hour rule, the Australian National Emergency Access Target (NEAT), and New Zealand's Shorter-stays-in-emergency-departments target, have been introduced and met with differing levels of impact. The implementation of these targets have been associated with a reduction in access block and ED length of stay; however, some studies have reported negative outcomes, including an increase in repeat patient visits, readmissions, inappropriate admissions, and inpatient length of stay.[2, 18-23]

Systems-based solutions

A significant contributor to access block are inpatients who no longer require hospital-level care, but are unable to be transferred to an alternative care location (e.g., outpatient rehabilitation, elderly care centres, long-term care, etc.) due to a shortage of beds or other resources in the community. These are often referred to as alternative level of care (ALC) patients, or more colloquially, bed-blockers. Solutions addressing this challenge must intrinsically target the system as a whole, and further demonstrate that ED crowding is not an issue isolated to the ED.[24-26]

Management

Leadership

Higginson I, Petrie D

Crowding meets the criteria for a wicked problem; as such, it is important to recognize that there is not a single solution, and that each time improvements are implemented, there will be second and third-order impacts identified, some of which are anticipated, local and positive, and others unanticipated, distant, and negative.[1] Wicked or complex problems require less directive, or command-and-control, leadership.[2] Solutions to these issues call for styles based in complex systems leadership, requiring more emphasis on contextual thinking, perspective coordination, collaborative skills, and comfort with uncertainty.[3]

High-level leadership is necessary to tackle emergency department (ED) crowding. Fortunately, there are several levels at which EM leaders may be engaging with the issue. At the national level leaders may engage with people or organizations involved in healthcare and social care management. Regionally or locally, clinicians can engage with the management structure of their local healthcare organisations, or can be leading EDs or subsections within EDs.

Systems leadership requires patience, consistent messaging, and an understanding of where the leverage points are in a complex system.[4] These can be grouped into three themes of leadership: creating coherence, influencing conditions, and encouraging connections, described in Table 8. These principles apply regardless of the level of ED crowding or the surrounding circumstances.

Table 8. Themes, context, and recommendations for complex systems leadership styles addressing ED crowding

Systems leadership theme	Context and recommendations
Creating coherence	Describe and frame the issue to create a shared mental model

	that will help guide problem-solving. For example: ● Crowding is not an ED-only issue, and EDs alone cannot solve it ● Crowding causes harm to patients and staff, and therefore there is a moral imperative to act ● Crowding is the visible representation of systemic failures to meet the demands placed on health and social care systems ● Crowding is not inevitable ● High performing systems have improved access and flow in their EDs, i.e. *how* you do things is more important than *what* you do[5]
Influencing conditions	Improve boundary conditions and reduce constraints in the system to enable positive deviance, service delivery innovations, and the emergence of bottom-up solutions. Advocate for policies, incentives, and sanctions that help hold organisational and system leaders accountable especially in cases where potential solutions lie outside of the power of emergency care systems.[6] Make every effort to mitigate effects of crowding on both ED patients and staff. This may be done by collaborating with colleagues and building coalitions across disciplines, departments, and organizations towards the shared goal of better access and flow.
Encouraging connections	Be clear, consistent, honest, and advocate on behalf of both

	patients and staff. Use both data and stories - data creates focus and the use of stories inspires action. Using both is particularly powerful. Implement Plan, Do, Study, Act cycles. Scale successful interventions across the system, but stop (and learn from) failures

Looking beyond systems leadership, leading an ED in the face of crowding has unique considerations that must be taken into account. Managing and leading an Emergency Department suffering from crowding makes an already complex job all the more complicated. Above all, crowding is a system problem which cannot be "'fixed" at local level in the ED and regular communication with your team about this issue is central. As a leader, you set the tone and culture of the organization, and can fundamentally influence morale, and guiding principles can help you in this process, described in Table 9.

Table 9. Recommendations and considerations for leading a crowded ED

Recommendations for leading a crowded ED	Considerations
Clearly describe and frame the problem	The term "ED crowding" is now widely accepted; problems should be framed around this Understand the phenomenon, be able to describe its causes, effects, and use best practices to reinforce your source of influence as an expert within the hospital to enact change Use data - there is not a perfect measure of crowding but

	two appropriate ones may be ED occupancy and boarding time Narrative can help where data fails to paint the full picture
Advocate on behalf of your patients confidently, consistently, and clearly	Get to the right meetings. This might be within your organization or within your wider health community. Invite hospital leadership or other senior leaders to walk in your shoes and meet your staff and patients Ask your board leaders when crowding was last discussed and be clear that board level leadership is required
Ensure that the risks of crowding are clearly described in your organisation's risk management system and that incidents related to crowding are reported	Have you examined your demand for services and matched your capacity as much as possible? Have you made the case for any extra staff or resources you may require? Are your ED's processes as efficient as they can be where that is within your control? What are you doing to mitigate risks in your department? Are you following accepted best practices?
Direct your attention to the right people and priorities	Pay attention to, and actively invest in, the wellbeing of your staff Pay attention to how you are training your trainees and developing your staff. This aspect of your work should not stop even when crowding is present.

	Look after yourself. Moral injury and distress associated with leading crowded departments is a real occupational hazard.

Finally, on-the-ground leadership must be discussed. There is a lack of evidence supporting best practice in this realm of leadership, but a wealth of experience and expertise that can be mobilized. In the UK, the model of the Emergency Physician In Charge (EPIC) has evolved.[7] This role has similarities to the tactical command role that is defined for major incidents and Hosking et. al. have described the problem-solving approaches adopted by EPIC. The responsibilities of the EPIC might consist of:

1. Being the identifiable leader of the medical staff in the emergency department
2. Maintaining situational awareness of the state of the emergency department
3. Setting the tone, culture and standards of the shift
4. Ensuring safe handover of patients between shifts
5. Contributing to the effective operational management of the department, for instance by prioritising care and deploying resources
6. Acting as a source of advice for more junior clinicians
7. Acting as a senior arbitrator where there is conflict
8. Supporting education
9. Acting as the main “interruptible” person, in order to minimise interruptions of others. This may have a role in reducing errors [8]

An EPIC would not be expected to have an individual case load. The nature of the role mandates that a senior clinician should undertake it as well. Given that EDs are intrinsically busy and error prone environments, the EPIC role becomes even more important when a department is crowded, as this has been associated with increased stress in staff and an increased risk of harm to patients.[9,10]

Addressing ED crowding can be frustrating and difficult when utilizing conventional approaches. Leadership at different levels is required to effectively tackle the issue. Concepts from complex

systems leadership, effective ED management, and effective on-the-ground leadership skills must be applied appropriately. Leaders operating within this space therefore need to be appropriately prepared and supported for the challenges they face.

Legal Risks and Regulatory Violations

Lee S

Crowding and a lack of clinical resources is a consistent problem plaguing emergency departments (ED) across Canada and most other countries with publicly funded health care systems.[1] While physicians and healthcare providers continue to find creative ways of dealing with crowding, they must also be mindful of the unique medical-legal issues that can arise, including waitlist management, treating patients in hallways or waiting rooms, and frustrated patients who leave without being seen (LWBS).[2]

The issue of ED crowding has not yet been specifically addressed by Canadian courts in the context of medical malpractice claims. In such a situation, the court's analysis would start with whether the physician owes a duty of care to the patient, such as reviewing the chart or triaging the patient in a certain amount of time. If the physician is found to owe a duty of care to the patient, the next question is whether the physician acted in accordance with an accepted standard of practice during the relevant time period. A standard ED concern, scarcity of resources, is currently not a stand-alone defence to allegations of negligence, as a crowded ED does not relieve emergency physicians from their duty of care or ethical obligations. Courts also generally disapprove of treatment decisions that prioritize costs over the best interests of the patient.[3]

That said, physicians are not to be held to a standard of perfection. Rather, they are expected to do their best with the limited resources at their disposal. When determining the standard of care, courts can take into account the facilities, equipment, and personnel reasonably available to the physician at the time care was provided.[4] Courts have also confirmed that hospitals have an independent legal duty to patients to provide "safe systems", which broadly includes coordinating medical personnel, as well as maintaining and operating facilities and equipment necessary for reasonable patient care.[5]

Policy

Holroyd BR, Lang E, Petrie D

The World Health Organization (WHO) describes health policy as "decisions, plans, and actions that are undertaken to achieve specific health care goals within a society".[1] The WHO also describes health policy as achieving several goals: "it defines a vision for the future which in turn helps to establish targets and points of reference for the short and medium term. It outlines priorities and the expected roles of different groups; and it builds consensus and informs people".[1] These goals have significant relevance to health policy as it relates to access to timely emergency care, and issues of emergency department (ED) crowding and access block.

Health policy may influence many dimensions of emergency care including creating standards for equipment and staffing, establishing training and qualification standards for healthcare providers, and defining the ED and role of emergency care and its relationships with other aspects of the health system.[2] Health policy related to ED access block and crowding may originate from governmental bodies, regulatory agencies, or professional organizations. Examples of governmental policy related to access block and ED throughput include the UK " 4-hour access standard"[3], and the Australian Emergency Treatment Performance (ETP) target.[4] An example of a regulatory body implementing ED-related policy is the United States Joint Commission and its mandates regarding ED throughput.[5]

Health policy may also influence other aspects of the medical system[6] that have an impact on ED access and flow, such as mandating same-day/next-day access to primary care, establishing non-ED alternatives to help manage social services crises, setting number of beds per thousand population expectations, and supporting appropriate community/home care and long-term care efficiency and capacity targets.

Many emergency medicine professional organizations have developed policies and guidelines related to emergency department crowding. These include the American College of Emergency Physicians,[7] the UK Royal College of Emergency Medicine,[8] the Canadian Association of Emergency Physicians,[9] and the Australasian College for Emergency Medicine.[10] The "vision for

the future" in an organizations' policy related to emergency care, should describe the goals of the emergency care system,[8] with explicit attributes of the quality of patient care inherent in those goals.

The policy should designate "targets and points of reference" with defining metrics and/or key process and performance indicators that are applicable to the local emergency care context and are realistically able to be collected and reported.[9] It is essential that the goals of emergency care delivery, and the metrics used to define and evaluate the performance of emergency care delivery reflect the patients' perspective so that they are relevant to the individuals being cared for.

Effective health policy also plays a significant role in development of a consensus on key issues related to emergency department access block, informing key stakeholders on the impact to patients when access to emergency care is compromised. It is also essential to address misperceptions about factors contributing to ED access block,[11] which may potentially contribute to ineffective or counterproductive interventions being promoted. Emergency Medicine professional organizations are able to use effective health policy related to ED crowding to inform and support consistent advocacy efforts that address ED crowding and promote goals of timely, safe, and quality emergency care.[12]

Advocacy

Judkins S, Hansen K, Bonning J

Advocacy efforts focusing on the impacts of access block have been escalating on an international scale for over a decade. In the Australasian context, the National Access Block Summit in 2008 highlighted the perils of the issue for clinicians and patients alike and pointed to solutions focused at the level of health systems.[1] In the UK, The Royal College of Emergency Medicine have been vocal in their calls for hospital and ED capacity to ensure EDs are able to operate safely. The UK introduced the four hour emergency care standard in 2000 which drove significant improvements, although there was some concern around whether it also generated perverse incentives. Elsewhere, such as in New Zealand, time-based targets were also met with initial performance improvements. However, in both systems these gains have been limited by increases in healthcare demand without commensurate system investment.[2,3]

Deficiencies in the health system to provide adequate emergency care are increasingly coming to light, partially attributable to pressure on resource availability and financial strains.[3] At one end of the spectrum, reports from around the world describe patients waiting excessive amounts of time in the ED.[4] Similarly, member countries across IFEM describe ED crowding and hospitals working at and over capacity.

Given limited resources and the scale of the issue, it is particularly important that advocacy efforts should be evidence-based and avoid perpetuating myths regarding the causes of access block and crowding. A number of myths exist that must be dispelled in order to direct advocacy efforts, and are outlined in table 10.

Table 10. Common myths related to ED crowding and access block

ED Crowding and Access Block Myth	**Evidence to the contrary**
Patients with minor conditions who visit the	Low-complexity patients have a notable but

ED are thought to be among the most significant contributor to crowding and access block.	small effect on measures related to ED crowding, including ED length of stay and time to first physician contact.[5]
System capacity is not the cause	Access block has been consistently identified as a major contributor to ED crowding. Access block can be addressed via systems-level solution that increase hospital capacity or optimize functions.[6, 7]
Even if crowded, the ED is the best place for sick patients to be	Crowding, through various mechanisms, has been shown to have negative patient outcomes, including increased patient morbidity and mortality, for both acute and non-acute patients.[6]

Advocacy is essential for solutions that are evidence-based. These solutions address different components of the Input-Throughput-Output model and have been met with improvements in different crowding metrics. The evidence for some of these interventions is sometimes equivocal. For example, one study found that a GP-led walk-in-clinic was successful in reducing GP-type visits to the ED, while another study found that this, in another setting, had no impact.[8,9] As such, the results of these studies should be interpreted within their context and applied judiciously.

Although many advocacy efforts have been focused on the impacts of crowding and access block on patient mortality and increased risk of medical error, this has not driven a change in the political will and leadership needed to support the required system interventions. Ultimately, crowding and access block is a systems-based issue, and focusing purely on EDs where the problem is manifest will not be adequate to address the issue.

In this process of advocacy, it is vital that a multidisciplinary community, consisting of politicians, health executives, EM professional bodies, and EM clinicians, collaborate to engage

with stakeholders in the health sector, other specialist bodies, unions, media, and of course, patients. Media teams should coordinate information and advocacy with these stakeholders in order to capitalize on news events or political cycles.

Early lessons from COVID-19 and Disaster Medicine

Mazurik L, Javidan A, Higginson I, Judkins S, Petrie D, Graham C, Bonning J, Hansen K, Lang E

Medical disasters such as the COVID-19 pandemic can produce rapid unexpected surges in patient volumes that emergency care systems may not be able to immediately accommodate. At various levels, emergency systems can take steps to prepare and react effectively to the consequences, including the effects on crowding and access block.

In response to the 2015 Ebola epidemic, the World Health Organization released a global report outlining ten government-level and systems-level recommendations that should be implemented in managing disease outbreaks.[1] At the level of individual emergency departments, guidelines have been published which suggest how clinicians should respond to surges in demand. The Australasian College for Emergency Medicine Disaster Medicine Subcommittee has outlined eight sets of recommendations directed towards clinicians.[2] Similarly, the Surge Capacity topic panel affiliated with the American College of Chest Physicians produced a series of 10 recommendations targeted towards clinicians, hospital administrators, and governments.[3]

In addition, in response to the COVID-19 pandemic, the Canadian Association of Emergency Physicians released surge capacity guidelines, and this Task Force on behalf of IFEM has also released critical guidance recommendations pertaining to COVID-19.[4, 5]

Examining COVID-19 specifically, some systems that have responded to the pandemic have seen an acceleration in innovation around strategies that may be used post-outbreak to significantly improve ED crowding. However, the response has also flagged key issues and accentuated the need for system-levels change.

EM patients and staff at risk

It has long been known that EM patients and staff in crowded departments are at increased risk of additional hazards. The COVID-19 pandemic has highlighted the risk of nosocomial infection. There is a pressing need to ensure that ED design and processes are engineered to protect both

patients and staff. This must include being able to consistently and reliably undertake basic infection control and protective measures, and enabling staff to work safely both in terms of distancing from patients, and creating physical space around patients if they are not isolated in cubicles.[6] During ED redesign, consideration should also be given to installing negative pressure cubicles, including at least one negative pressure resuscitation area.

Telemedicine

Much of the telemedicine infrastructure mobilized during the COVID-19 pandemic has existed for years, but healthcare has historically been delivered face-to-face.[7-11] The COVID-19 pandemic significantly disrupted this to bring virtual care to the forefront. COVID-19 also saw an increasing number of self-care applications that were released that enabled patients to receive automated guided medical assistance (e.g. online COVID-19 self-assessment tools).[12] Tiered telemedicine services became increasingly available as well, whereby a contact nurse, paramedic, physician assistant, etc., would further triage complaints to a general practitioner or a specialist depending on clinician suspicion and acuity. Collectively, these strategies may be more broadly applied at a systems-level to reduce ED crowding by reducing or diverting input.[7-11]

Forward deployment of resources and re-consideration of hospital admission

A significant portion of the population seriously affected by COVID-19 were elderly patients with chronic comorbidities, many of whom came from assisted living homes, or who were experiencing palliative care at home.[13] The pandemic forced clinicians to now consider that they may not be able to provide care in hospital for these patients and it must be delivered *in situ*.[7]

There are certain populations of patients who present to the ED where care delivered *in situ* via forward deployment of resources, and supported by telemedicine, can similarly reduce crowding by diverting input.[7, 8]

In further groups it could be argued that with increased attention to discussions around treatment escalation and end of life care, patients could be allowed to die with dignity in more appropriate settings than acute hospitals, if culturally appropriate.

An important comparison can be drawn between COVID-19 and seasonal influenza. The death rate from COVID 19 has yet to be conclusively determined, but a conservative estimate for the annual death rate from seasonal influenza worldwide is thought to be ~ 500,000 and causes a predictable ED surge and hospital burden.[15] The establishment of fever management systems for outbreaks, even if only used for influenza, could significantly reduce this burden on the ED.

Establishing self-care apps, phone tracking of patients with influenza-like illness (ILI) symptoms, passive ED ILI tracking systems, tiered system telemedicine screening, testing, strict isolation, housing mild-moderate cases in non-hospital settings (people in shelters or high-risk housing conditions) and strictly separated wards that are created during these periods, would likely reduce the impact, and would remain scalable measures for pandemics.[16-20]

Systems change and the need for a new normal

The COVID-19 pandemic has demonstrated to the world that when a common goal must be urgently met, emergency care systems can rapidly adapt, with the NHS response to COVID-19 serving as one of many clear examples.[21] The pandemic has also provided additional validity for the input-throughput-output model described by Asplin et al. and throughout this white paper. In departments not at the centre of major surges, input has reduced, and reduced hospital occupancy has meant that access block has improved. Staffing levels have been boosted and departments have been granted more floor space. Despite the challenges of reconfigured departments, the need to work in high levels of PPE, and the need to redesign clinical pathways, many EM teams have been able to do their job better, delivering better quality care, and avoiding more admissions. This begs the question as to why it has been such a battle for health system leaders to believe, and act upon, what has in past been obvious to those working in EM, well evidenced in the literature, and which has now been shown to be true during a natural experiment. ED crowding has not generated the same urgency as the pandemic, although it has been attributed with a wide range of negative outcomes, including significant mortality.[22,23] Returning to the previous state of crowded EDs will inevitably result in worsened patient outcomes and avoidable deaths, necessitating the need for a reset of expectations following COVID-19.[6]

Access block and crowding are not insolvable problems. The same systems-wide collective leverage that was applied to the COVID-19 response can and should be applied to our emergency departments and emergency care systems. High-performing EDs exhibit fundamental system-level differences that we should aim to apply broadly.[24] Recommendations to reduce ED and hospital occupancies have also been put forth by EM colleges to facilitate ED redesign.[6] Unless a 'new normal' in emergency care comes after COVID-19, one that is re-engineered for resilience, ED crowding will continue to take its toll on patients and providers. We are at the crux of this transition, and health systems leaders, policy-makers, on-the-ground clinicians, and other stakeholders must act now.

Conclusion

ED crowding and access block is a multifactorial issue whose impact is felt globally. We have described an international collaborative that sought to understand the universal causes of ED crowding and access block, unify expertise to address the fundamental issues, and provide the much-needed stepping stones for sustainable and effective solutions. Ultimately, this collaborative and associated white paper are the first of many steps in tackling ED crowding and access block. We envision that other experts around the world will build on our work with the IFEM Task Force continuing to provide ongoing support to participant countries.

Appendix

Appendix I - Glossary of international terms used around crowding in North America, the UK, and Australasia

Higginson I

Region	USA[1]	CANADA[2]	UK[3]	AUSTRALASIA[4]
Definition of crowding / overcrowding and indication of term most commonly used in relevant country	Crowding occurs when the identified need for emergency services exceeds available resources for patient care in the emergency department (ED), hospital, or both.	Emergency department overcrowding (EDOC) is defined as a situation where the demand for emergency services exceeds the ability of an emergency department (ED) to provide quality care within appropriate time frames.	Crowding: This is the situation where the number of patients occupying the emergency department is beyond the capacity for which the emergency department is designed and resourced to manage at any one time.	Overcrowding (previously) or Crowding (more used now to fit in with USA and UK) ACEM: the situation "…where Emergency Department function is impeded primarily because the number of patients waiting to be seen, undergoing assessment and treatment or waiting for departure exceeds either the physical or staffing capacity of the Emergency Department"
Key metrics used to measure crowding /	None	90th centile for Physician Initial Assessment in hours - CIHI	Time to initial assessment (triage)	The 4 hour National Emergency Access Target (NEAT) standard is still used in

proxy measures used		90th centile for admitted patient LOS in ED – CIHI Alberta / HQCA / 16 largest hospitals: ● Patient time to see an emergency doctor ● Patient emergency department total length of stay (LOS) ● Length of time emergency department patients wait for a hospital bed after a decision to admit ● Time for X-ray completion ● Time waiting for specialist/admitting doctor opinion	Time to senior decision maker (clinician) 4-hour emergency access standard Aggregated patient delay 12 hour trolley waits	most states/territories in Australia with different thresholds Access Block is the proportion of admitted patients with ED LOS >8hr; versions of this have been used in some states in Australia previously, unsure now. It is the College preferred metric The 6 hour Target with a 95% threshold is still used in NZ (Shorter Stays in ED)
Term used to describe the state when patients cannot be transferred from EMS to the hospital	**Offload delay**	**Off Load Delay** - is a state when an ambulance transports a patient to a hospital and paramedics must wait with the patient until hospital staff assumes responsibility for care of the patient.	**Delayed ambulance offloads**. Metric: ambulance handover time OR minutes lost in each hospital	**Ambulance ramping**. Also called off-stretcher time delays, Patient Off Stretcher Time, or ambulance turnaround delays Queensland metric is 90% of patients are to be off-loaded within 30 minutes of arrival.

Term used to describe the state when patients cannot be placed in an inpatient bed	**Boarding** / a "boarded patient" is defined as a patient who remains in the emergency department after the patient has been admitted or placed into observation status at the facility but has not been transferred to an inpatient or observation unit.	**Access Block** - refers to the situation where patients in the emergency department (ED) requiring inpatient care are unable to gain access to appropriate hospital beds within a reasonable time frame, or anywhere else patients needing care are unable to obtain it in a timely fashion appropriate to their need.	**Exit block**	**Access block**

Appendix II - Assessing Quality of Evidence

Studies included in the chapters on the Evidence Base and Human and Financial Costs of crowding were critically appraised using the Graphic Appraisal Tool for Epidemiology (GATE)[1] in order to assign a Level of Evidence based on the 'Oxford 2011 Levels of Evidence'.[2] The Grading of Recommendations Assessment, Development and Evaluation (GRADE) process was then used to appraise the quality of the body of evidence for the association of each metric with effect measures.[3] All studies were observational so began as low-quality evidence. Where there was a strong association or a dose response effect the evidence was upgraded. Where there was a high risk of bias (Level 4 studies), the association was imprecise, or the evidence was inconsistent the quality of evidence quality was downgraded. Level 5 evidence was not included due to a very high risk of bias.

References

Introduction

1. Innes G, Sivilotti M, Ovens H, et al. Emergency overcrowding and access block: A smaller problem than we think. CJEM. 2018;21(2):177-185.

2. Sprivulis P, Da Silva J, Jacobs I, et al. The association between hospital overcrowding and mortality among patients admitted via Western Australian emergency departments. Med J Aust. 2006;184(12):616-616.

3. Pines J, Pollack C, Diercks D, et al. The Association Between Emergency Department Crowding and Adverse Cardiovascular Outcomes in Patients with Chest Pain. Acad Emerg Med. 2009;16(7):617-625.

4. Bernstein S, Aronsky D, Duseja R, et al. The Effect of Emergency Department Crowding on Clinically Oriented Outcomes. Acad Emerg Med. 2009;16(1):1-10.

5. Boudi Z, Lauque D, Alsabri M, et al. Association between boarding in the emergency department and in-hospital mortality: A systematic review. PLoS ONE. 2020;15(4):e0231253.

6. Fatovich D. Access block causes emergency department overcrowding and ambulance diversion in Perth, Western Australia. Emerg Med J. 2005;22(5):351-354.

7. Geelhoed G, Klerk N. Emergency department overcrowding, mortality and the 4-hour rule in Western Australia. Med J Aust. 2012;196(2):122-126.

8. Forero R, McCarthy S, Hillman K. Access block and emergency department overcrowding. Crit Care. 2011;15(2):216.

9. Khanna S, Boyle J, Good N, et al. Unravelling relationships: Hospital occupancy levels, discharge timing and emergency department access block. Emerg Med Australas. 2012;24(5):510-517.

10. FitzGerald G, Jelinek G, Scott D, et al. Emergency department triage revisited. Emerg Med J. 2010;27(2):86-92.

11. Affleck A, Parks P, Drummond A, et al. Emergency department overcrowding and access block. CJEM. 2013;15(06):359-370.

12. Crawford K, Morphet J, Jones T, et al. Initiatives to reduce overcrowding and access block in Australian emergency departments: A literature review. Collegian. 2014;21(4):359-366.

Evidence base for effects of crowding

1. Hong KJ, Shin SD, Song KJ, et al. Association between ED crowding and delay in resuscitation effort. Am J Emerg Med. 2013;31(3):509-15.

2. Forero R, Mohsin M, McCarthy S, et al. Prevalence of morphine use and time to initial analgesia in an Australian emergency department. Emerg Med Australas. 2008;20(2):136-43.

3. Sills MR, Fairclough D, Ranade D, et al. Emergency department crowding is associated with decreased quality of care for children. Pediatr Emerg Care. 2011;27(9):837-45.

4. Pines JM, Hollander JE, Localio AR, et al. The association between emergency department crowding and hospital performance on antibiotic timing for pneumonia and percutaneous intervention for myocardial infarction. Acad Emerg Med. 2006;13(8):873-8.

5. Weiss SJ, Ernst AA, Derlet R, et al. Relationship between the National ED Overcrowding Scale and the number of patients who leave without being seen in an academic ED. Am J Emerg Med. 2005;23(3):288-94.

6. Gorelick MH, Yen K, Yun HJ. The effect of in-room registration on emergency department length of stay. Ann Emerg Med. 2005;45(2):128-33.

7. Rathlev NK, Chessare J, Olshaker J, et al. Time series analysis of variables associated with daily mean emergency department length of stay. Ann Emerg Med. 2007;49(3):265-271.

8. Timm NL, Ho ML, Luria JW. Pediatric emergency department overcrowding and impact on patient flow outcomes. Acad Emerg Med. 2008;15(9):832-837.

9. Asaro PV, Lewis LM, Boxerman SB. The impact of input and output factors on emergency department throughput. Acad Emerg Med. 2007;14(3):235-242.

10. Fatovich DM, Nagree Y, Sprivulis P. Access block causes emergency department overcrowding and ambulance diversion in Perth, Western Australia. Emerg Med J. 2005;22(5):351-354.

11. Schull MJ, Kiss A, Szalai JP. The effect of low-complexity patients on emergency department waiting times. Ann Emerg Med. 2007;49(3):257-264, 64 e1.

12. Pines JM, Shofer FS, Isserman JA, et al. The effect of emergency department crowding on analgesia in patients with back pain in two hospitals. Acad Emerg Med. 2010;17(3):276-283.

13. Pines JM, Pollack Jr CV, Diercks DB, et al. The association between emergency department crowding and adverse cardiovascular outcomes in patients with chest pain. Acad Emerg Med. 2009;16(7):617-625.

14. Pines JM, Prabhu A, Hilton JA, et al. The effect of emergency department crowding on length of stay and medication treatment times in discharged patients with acute asthma. Acad Emerg Med. 2010;17(8):834-839.

15. Kennebeck SS, Timm NL, Kurowski EM, et al. The association of emergency department crowding and time to antibiotics in febrile neonates. Acad Emerg Med. 2011;18(12):1380-1385.

16. Fee C, Weber EJ, Maak CA, et al. Effect of emergency department crowding on time to antibiotics in patients admitted with community-acquired pneumonia. Ann Emerg Med. 2007;50(5):501.

17. Fee C, Weber EJ, Bacchetti P, et al. Effect of emergency department crowding on pneumonia admission care components. Am J Manag Care. 2011;17(4):269-278.

18. Chatterjee P, Cucchiara BL, Lazarciuc N, et al. Emergency department crowding and time to care in patients with acute stroke. Stroke. 2011;42(4):1074-80.

19. Reznek MA, Murray E, Youngren MN, et al. Door-to-imaging time for acute stroke patients is adversely affected by emergency department crowding. Stroke. 2017;48(1):49-54.

20. Hwang U, Baumlin K, Berman J, et al. Emergency department patient volume and troponin laboratory turnaround time. Acad Emerg Med. 2010;17(5):501-507.

21. Depinet HE, Iyer SB, Hornung R, et al. The effect of emergency department crowding on reassessment of children with critically abnormal vital signs. Acad Emerg Med. 2014;21(10):1116-1120.

22. Gaieski DF, Agarwal AK, Mikkelsen ME, et al. The impact of ED crowding on early interventions and mortality in patients with severe sepsis. Am J Emerg Med. 2017;35(7):953-960.

23. Mills AM, Shofer FS, Chen EH, et al. The association between emergency department

crowding and analgesia administration in acute abdominal pain patients. Acad Emerg Med. 2009;16(7):603-608.

24. Chang AM, Lin A, Fu R, et al. Associations of emergency department length of stay with publicly reported quality-of-care measures. Acad Emerg Med. 2017;24(2):246-250.

25. Miro O, Antonio MT, Jimenez S, et al. Decreased health care quality associated with emergency department overcrowding. Eur J Emerg Med. 1999;6(2):105-107.

26. McCusker J, Vadeboncoeur A, Levesque JF, et al. Increases in emergency department occupancy are associated with adverse 30-day outcomes. Acad Emerg Med. 2014;21(10):1092-1100.

27. Jo S, Jeong T, Jin YH, et al. 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(12):1725-1731.

28. Jo S, Jin YH, Lee JB, et al. Emergency department occupancy ratio is associated with increased early mortality. J Emerg Med. 2014;46(2):241-249.

29. Jo S, Kim K, Lee JH, et al. Emergency department crowding is associated with 28-day mortality in community-acquired pneumonia patients. J Infection. 2012;64(3):268-275.

30. Cha WC, Shin SD, Cho JS, et al. The association between crowding and mortality in admitted pediatric patients from mixed adult-pediatric emergency departments in Korea. Pediatr Emerg Care. 2011;27(12):1136-1141.

31. van der Linden N, van der Linden MC, Richards JR, et al. Effects of emergency department crowding on the delivery of timely care in an inner-city hospital in the Netherlands. Eur J Emerg Med. 2016;23(5):337-343.

32. Chiu IM, Lin Y-R, Syue Y-J, et al. The influence of crowding on clinical practice in the emergency department. Am J Emerg Med. 2018;36(1):56-60.

33. Verelst S, Wouters P, Gillet J-B, et al. Emergency Department crowding in relation to in-hospital adverse medical events: A large prospective observational cohort study. J Emerg Med. 2015;49(6):949-961.

34. Richardson DB. Increase in patient mortality at 10 days associated with emergency department overcrowding. Med J Aust. 2006;184(5):213-216.

35. Geelhoed GC, de Klerk NH. Emergency department overcrowding, mortality and the 4-hour rule in Western Australia. Med J Aust. 2012;196:122-126.

36. Guttmann A, Schull MJ, Vermeulen MJ, et al. 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.

37. Mullins PM, Pines JM. National ED crowding and hospital quality: results from the 2013 Hospital Compare data. Am J Emerg Med 2014;32(6):634-639.

38. Yergens DW, Ghali WA, Faris PD, et al. Assessing the association between occupancy and outcome in critically ill hospitalized patients with sepsis. BMC Emerg Med. 2015;15:31.

39. Conway R, O'Riordan D, Silke B. Targets and the emergency medical system - Intended and unintended consequences. Eur J Emerg Med. 2015;22(4):235-240.

40. Liu SW, Chang Y, Weissman JS, et al. An empirical assessment of boarding and quality of care: delays in care among chest pain, pneumonia, and cellulitis patients. Acad Emerg Med 2011;18(12):1339-1348. doi: 10.1111/j.1553-2712.2011.01082.x [published Online First: 2011/06/23]

41. Hwang UR, L.; Livote, E.; Harris, B.; Spencer, N.; Morrison, R. S. Emergency department crowding and decreased quality of pain care. Acad Emerg Med. 2008;15(12):1248-1255. doi: 10.1111/j.1553-2712.2008.00267.x

42. Sri-On J, Chang Y, Curley DP, et al. Boarding is associated with higher rates of medication delays and adverse events but fewer laboratory-related delays. Am J Emerg Med. 2014;32(9):1033-1036.

43. Chalfin DB, Trzeciak S, Likourezos A, et al. Impact of delayed transfer of critically ill patients from the emergency department to the intensive care unit. Crit Care Med. 2007;35(6):1477-1483.

44. Clark K, Normile L. Influence of time-to-interventions for emergency department critical care patients on hospital mortality. J Emerg Nurs. 2007;33(1):6-13.

45. Plunkett PK, Byrne DG, Breslin T, et al. Increasing wait times predict increasing mortality for emergency medical admissions. Eur J Emerg Med. 2011;18(4):192-196.

46. Reznek MA, Upatising B, Kennedy SJ, et al. Mortality associated with emergency department boarding exposure: Are there differences between patients admitted to ICU and non-ICU settings? Med Care. 2018;56(5):436-440.

47. Singer AJ, Thode Jr, HC, Viccellio P, et al. The association between length of emergency department boarding and mortality. Acad Emerg Med. 2011;18(12):1324-1329.

48. Hong YC, Chou MH, Liu EH, et al. The effect of prolonged ED stay on outcome in patients with necrotizing fasciitis. Am J Emerg Med. 2009;27(4):385-390.

49. Bekmezian A, Chung PJ. Boarding admitted children in the emergency department impacts inpatient outcomes. Pediatr Emerg Care. 2012;28(3):236-242.

50. Derose SF, Gabayan GZ, Chiu VY, et al. Emergency department crowding predicts admission length-of-stay but not mortality in a large health system. Med Care. 2014;52(7):602-611.

51. WHO | Equity [Internet]. Who.int. 2020 [cited 4 May 2020]. Available from: https://www.who.int/healthsystems/topics/equity/en/

52. Hwang U, Weber EJ, Richardson LD, et al. A research agenda to assure equity during periods of emergency department crowding. Acad Emerg Med. 2011;18(12):1318-1323.

53. Pines JM, Russell Localio A, Hollander JE. Racial disparities in emergency department length of stay for admitted patients in the United States. Acad Emerg Med. 2009;16(5):403-410.

54. Johnson TJ, Hickey RW, Switzer GE, et al. The impact of cognitive stressors in the emergency department on physician implicit racial bias. Acad Emerg Med. 2016;23(3):297-305.

55. Pines JM, Decker SL, Hu T. Exogenous predictors of national performance measures for emergency department crowding. Ann Emerg Med. 2012;60(3):293-298.

56. Hanchate AD, Paasche-Orlow MK, Baker WE, et al. Association of race/ethnicity with emergency department destination of emergency medical services transport. JAMA Netw Open. 2019 Sep 4;2(9):e1910816.

57. Greenwood-Ericksen MB, Kocher K. Trends in emergency department use by rural and urban populations in the United States. JAMA Netw Open. 2019 Apr 5;2(4):e191919.

58. Tang N, Stein J, Hsia RY, et al. Trends and characteristics of US emergency department visits, 1997-2007. JAMA. 2010 Aug 11;304(6):664-670.

Financial and human costs of crowding

1. Timm NL, Ho ML, Luria JW. Pediatric emergency department overcrowding and impact on patient flow outcomes. Acad Emerg Med. 2008;15(9):832-837.

2. Stang AS, McCusker J, Ciampi A. Emergency department conditions associated with the number of patients who leave a pediatric emergency department before physician assessment. Pediatr Emerg Care. 2013;29(10):1082-1090.

3. Hillier DF, Parry GJ, Shannon MW. The effect of hospital bed occupancy on throughput in the pediatric emergency department. Ann Emerg Med. 2009;53(6):767-776.

4. Asaro PV, Lewis LM, Boxerman SB. Emergency department overcrowding: analysis of the factors of renege rate. Acad Emerg Med. 2007;14(2):157-162.

5. Handel DA, Fu R, Vu E, et al. Association of emergency department and hospital characteristics with elopements and length of stay. J Emerg Med. 2014;46(6):839-846.

6. Van Der Linden MC, Lindeboom R, Van Der Linden N, et al. Walkouts from the emergency department: Characteristics, reasons and medical care needs. Eur J Emerg Med. 2014;21(5):354-359.

7. Anderson D, Pimentel L, Golden B, et al. Drivers of ED efficiency: a statistical and cluster analysis of volume, staffing, and operations. Am J Emerg Med. 2016;34(2):155-161.

8. Weiss SJ, Ernst AA, Derlet R, et al. Relationship between the national ED overcrowding scale and the number of patients who leave without being seen in an academic ED. Am J Emerg Med. 2005;23(3):288-294.

9. Fatovich DM, Hirsch RL. Entry overload, emergency department overcrowding, and ambulance bypass. Emerg Med J. 2003;20(5):406-409.

10. Fatovich DM, Nagree Y, Sprivulis P. Access block causes emergency department overcrowding and ambulance diversion in Perth, Western Australia. Emerg Med J. 2005;22(5):351-354.

11. Polevoi SK, Quinn JV, Kramer NR. Factors associated with patients who leave without being seen. Acad Emerg Med. 2005;12(3):232-236.

12. Epstein SK, Tian L. Development of an emergency department work score to predict ambulance diversion. Acad Emerg Med. 2006;13(4):421-426.

13. Weiss SJ, Arndahl J, Ernst AA, et al. Development of a site sampling form for evaluation of ED overcrowding. Med Sci Monit. 2002;8(8):CR549-553.

14. Weiss SJ, Derlet R, Arndahl J, et al. Estimating the degree of emergency department overcrowding in academic medical centers: Results of the national ED overcrowding study (NEDOCS). Acad Emerg Med. 2004;11(1):38-50.

15. Kelly SP, Shapiro N, Woodruff M, et al. The effects of clinical workload on teaching in the emergency department. Acad Emerg Med. 2007;14(6):526-531.

16. McCarthy ML, Aronsky D, Jones ID, et al. The emergency department occupancy rate: a simple measure of emergency department crowding? Ann Emerg Med. 2008;51(1):15.

17. Chang AM, Lin A, Fu R, et al. Associations of emergency department length of stay with publicly reported quality-of-care measures. Acad Emerg Med. 2017;24(2):246-250.

18. Henneman PL, Nathanson BH, Li HP, et al. Emergency department patients who stay more than 6 hours contribute to crowding. J Emerg Med. 2010;39(1):105-112.

19. Hoot NR, Zhou C, Jones I, et al. Measuring and forecasting emergency department crowding in real time. Ann Emerg Med. 2007;49(6):747-755.

20. Pines JM, Iyer S, Disbot M, et al. The effect of emergency department crowding on patient satisfaction for admitted Patients. Acad Emerg Med. 2008;15(9):825-831.

21. Nichol JR, Fu R, French K, et al. Association between patient and emergency department operational characteristics and patient satisfaction scores in a pediatric population. Pediatr Emerg Care. 2016;32(3):139-141.

22. Mullins PM, Pines JM. National ED crowding and hospital quality: results from the 2013 Hospital Compare data. Am J Emerg Med. 2014;32(6):634-639.

23. Thompson DA, Yarnold PR, Williams DR, et al. Effects of actual waiting time, perceived waiting time, information delivery, and expressive quality on patient satisfaction in the emergency department. Ann Emerg Med. 1996;28(6):657-665.

24. Hedges JR, Trout A, Magnusson AR. Patients exiting the emergency department (SPEED) study. Acad Emerg Med. 2002;9(1):15-21.

25. Pitrou I, Lecourt AC, Bailly L, et al. Waiting time and assessment of patient satisfaction in a large reference emergency department: A prospective cohort study, France. Eur J Emerg Med. 2009;16(4):177-182.

26. Goloback M, McCarthy DM, Schmidt M, et al. ED operational factors associated with patient satisfaction. Am J Emerg Med. 2015;33(1):111-112.

27. Booth AJ, Harrison CJ, Gardener GJ, et al. Waiting times and patient satisfaction in the accident and emergency department. Arch Emerg Med. 1992;9(2):162-168.

28. Tekwani KL, Kerem Y, Mistry CD, et al. Emergency department crowding is associated with reduced satisfaction scores in patients discharged from the emergency department. West J Emerg Med. 2013;14(1):11-5.

29. Medley DB, Morris JE, Stone CK, et al. An Association Between Occupancy Rates in the Emergency Department and Rates of Violence Toward Staff. J Emerg Med. 2012;43(4):736-744.

30. Ogundipe KO, Etonyeaku AC, Adigun I, et al. Violence in the emergency department: a multicentre survey of nurses' perceptions in Nigeria. Emerg Med J. 2013;30(9):758-762.

31. Boyle A, Coleman J, Sultan Y, et al. Initial validation of the international crowding measure in emergency departments (ICMED) to measure emergency department crowding. Emerg Med J. 2015;32(2):105-118.

32. Weiss SJ, Rogers DB, Maas F, et al. Evaluating community ED crowding: the community ED overcrowding scale study. Am J Emerg Med. 2014;32(11):1357-1363.

33. Wrenn K, Lorenzen B, Jones I, et al. Factors affecting stress in emergency medicine residents while working in the ED. Am J Emerg Med. 2010;28(8):897-902.

34. Pines JM, Prabhu A, McCusker CM, et al. The effect of ED crowding on education. Am J Emerg Med. 2010;28(2):217-220.

35. von Thiele Schwarz U, Hasson H, Muntlin Athlin A. Efficiency in the emergency department - A complex relationship between throughput rates and staff perceptions. Int Emerg Nurs. 2016;29:15-20.

36. Pines JM, Garson C, Baxt WG. ED crowding is associated with variable perceptions of care compromise. Acad Emerg Med. 2007;14(12):1176-1181.

37. Husain N, Bein KJ, Green TC, et al. Real time shift reporting by emergency physicians predicts overall ED performance. Emerg Med J. 2015;32(2):130-133.

38. Bond K, Ospina MB, Blitz S, et al. Frequency, determinants and impact of overcrowding in emergency departments in Canada: a national survey. Healthc Q. 2007;10(4):32-40.

39. Crook HD, Taylor DM, Pallant JF, et al. Workplace factors leading to planned reduction of clinical work among emergency physicians. Emerg Med Australas. 2009;16(1):28-34.

40. Lucas R, Farley H, Twanmoh J, et al. Measuring the opportunity loss of time spent boarding admitted patients in the emergency department: a multihospital analysis. Journal of Healthcare Management. 2009;54(2):117-124; discussion 24-25.

41. Bekmezian A, Chung PJ. Boarding admitted children in the emergency department impacts inpatient outcomes. Pediatr Emerg Care. 2012;28(3):236-242.

Metrics

1. Hoot NR, Zhou C, Jones I, et al. Measuring and forecasting emergency department crowding in real time. Ann Emerg Med. 2007;49:747-755.

2. Ospina MB, Bond K, Schull M, et al. Measuring overcrowding in emergency departments: a call for standardization [Technology report no 67.1]. Ottawa: Canadian Agency for Drugs and Technologies in Health; 2006 [cited 2020 May 6]. Available from: https://www.cadth.ca/media/pdf/320a_overcrowding_tr_e_no-appendices.pdf

3. Blumenthal D, McGinnis JM. Measuring vital signs: An IOM report on core metrics for health and health care progress. JAMA. 2015;313(19):1901-1902.

4. Scheck, A. Special Report: The standardized ED: Performance metrics improve ED efficiency. Emergency Medicine News. Jan 2020;34(1):16-17.

5. Hwang U, McCarthy ML, Aronsky D, et al. Measures of crowding in the emergency department: A systematic review. Acad Emerg Med. 2011; 18:527–538.

6. Stang AS, Crotts J, Johnson DW, et al. Crowding measures associated with the quality of emergency department care: A systematic review. Acad Emerg Med. 2015;22:643–656.

7. McRae A, Innes G, Schull M, et al. Associations between ED crowding metrics and 72h-hour ED re-visits: Which crowding metrics are most highly associated with patient-oriented adverse outcomes? CJEM. May 2019;21 Suppl 1. p. S10.

8. Ovens H, Affleck A, Letovsky E. On posting wait times: an alternative view. CJEM. 2014;16(01), 1-3.

9. Guttmann A, Schull MJ, Vermeulen MJ, et al. 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.

10. Vermeulen MJ, Guttmann A, Stukel TA, et al. Are reductions in emergency department length of stay associated with improvements in quality of care? A difference-in-differences analysis. BMJ Qual Saf. 2016;25:489–498.

International experience

1. Moskop JC, Sklar DP, Geiderman JM, et al. Emergency Department crowding, part 1 – concepts, causes, and moral consequences. Ann Emerg Med. 2009; 53:605-611.
2. Moskop JC, Sklar DP, Geiderman JM, et al. Emergency Department crowding, part 2 – barriers of reform and strategies to overcome them. Ann Emerg Med. 2009;53:612-617.
3. Affleck A, Parks P, Drummond A, et al. CAEP position statement on Emergency department overcrowding and access block. CJEM. 2013;15(6):359-370
4. Forero R, McCarthy S, Hillman K. Access block and emergency department overcrowding. Crit Care. 2011;15:216
5. Higginson I. Emergency Department crowding. Emerg Med J. 2012;29:437-443
6. Harris A, Sharma A. Access block and overcrowding in emergency department: an empirical analysis. Emerg Med J. 2010;27:508-511.
7. Pines JM, Hilston JA, Weber EJ, et al. International Perspectives on Emergency Department Crowding. Acad Emerg Med. 2011;18(12):1358-1370.
8. van der Linden CM, Reijnen R, Derlet R, et al. Emergency department crowding in The Netherlands: managers' experiences. Int J Emerg Med. 2013;6:41.
9. Berd LM, Ehrenberg A, Florin J, et al. Significant changes in emergency department length of stay and case mix over eight years at a large Swedish University Hospital. Int J Emerg Med. 2019;43:50-55.
10. Hertzum Morten. Patterns in emergency-department arrivals and length of stay: Input for visualizations of crowing. The Ergonomics Open J. 2016;9:1-14.
11. Chan SSW, Cheung NK, Graham C. Strategies and solutions to alleviate access block and

overcrowding in emergency departments. Hong Kong Med J. 2015;21(4):345-352.
12. Shih FY, Ma MH, Chen SC, et al. ED overcrowding in Taiwan: facts and strategies. Am J Emerg Med. 1999 Mar;17(2):198-202.
13. Wibulpolprasert A, Sittichanbuncha Y, Sricharoen P, et al. Factors associated with overcrowded emergency rooms in Thailand: A Medical School setting. Emerg Med Int. 2014;576249.
14. Schoenenberger LK, Bayer S, Ansah JP, et al. Emergency department crowding in Singapore: Insights from a systems thinking approach. SAGE Open Med. 2016;4:1-10.
15. Quao NS, Bonney J, Forson PK, et al. Overcrowding in a low resources emergency setting in West Africa: Perceptions by health workers in the Accident and Emergency Center, Komfo Anokye Teaching Hospital (Kath) Kumasi, Ghana. Prehosp Disaster Med. 2017 April.
16. Morley C, Unwin M, Peterson GM, et al. ED Crowding: A systematic review of causes, consequences and solutions. PLoS ONE. 2018 Aug 30;13(8):00203316.
17. Akoglu, Haldun. Acil servis kalabalığına etki eden faktörler ve Önleme yöntemleri: Yurtdışı tecrübelerinin ülkemizde uygulanabilirliği. May 2014. doi:10.5281/zenodo.3757741 [In Turkish].
18. Crawford K, Morphet J, Jones T, et al. Initiatives to reduce overcrowding and access block in Australian emergency departments: A literature review. Collegian. 2014;21:359-366.

Case studies and patient voices

1. Mills AM, Shofer FS, Chen EH, et al. The association between emergency department crowding and analgesia administration in acute abdominal pain patients. Acad Emerg Med. 2009 Jul;16(7):603-608.
2. Pines JM, Locallo AR, Hollander JE, et al. The impact of emergency department crowding measures on time to antibiotics for patients with community-acquired pneumonia. Ann Emerg Med. 2007 Nov;50(5):510-516.
3. Kulstad EB, Sikka R, Sweis RT, et al. ED overcrowding is associated with an increased frequency of medication errors. Am J Emerg Med. 2010 Mar; 28(3):304-309.

4. Hospital's 'gross failings lead to pressure sores death. BBC News [Internet]. 2020 Feb 14 [cited April 2020]. Available from: https://www.bbc.com/news/uk-england-nottinghamshire-51503977
5. Rapaport L. It really is hard to sleep in the ER. Reuters [Internet]. 2019 Sept 16 [cited April 2020]. Available from: https://www.reuters.com/article/us-health-emergency-dept-sleep/it-really-is-hard-to-sleep-in-the-er-idUSKBN1W12R2
6. Kulstad EB, Kelley KM. Overcrowding is associated with delays in percutaneous coronary intervention for acute myocardial infarction. Int J Emerg Med. 2009 Jun;2(3):149-154.
7. Singer AJ, Thode Jr HC, Viccellio P, et al. The association between length of emergency department boarding and mortality. Acad Emerg Med. 2011 Dec;18(12):1324-1329.
8. Salehi L, Phalpher P, Valani R, et al. Emergency department boarding: A descriptive analysis and measurement of impact on outcomes. CJEM. 2018 Nov;20(6):929-937.
9. Richardson DB. Increase in patient mortality at 10 days associated with emergency department overcrowding. MJA. 2006 Mar;184(5):213-216.
10. Maa J. The waits that matter. NEJM. 2011 Jun 16; 364: 2279-2281.

Emergency medical service (prehospital services) offload

1. Creemers S, Lambrecht M, Vandaele N. Queueing models in healthcare. Comput Ind Eng 2007;3:471-497.
2. Aboueljinane L, Sahin E, Jemai Z. A review on simulation models applied to emergency medical service operations. Comput Ind Eng. 2013;66(4):734-750.
3. Almehdawe E, Jewkes B, He QM. A Markovian queueing model for ambulance offload delays. Eur J Oper Res. 2013;226(3):602–614.
4. Takeda RA, Widmer JA, Morabito R. Analysis of ambulance decentralization in an urban emergency medical service using extra hypercube queueing model. Comput Oper Res. 2007;34(3):727–741.
5. Singer M, Donoso P. Assessing an ambulance service with queuing theory. Comput Oper Res. 2008;35(8):2549-2560.
6. Spaite D, Benoit R, Brown D, et al. Uniform prehospital data elements and definitions: A report from the uniform pre-hospital emergency medical services data conference. 1995;25(4):525-345.

7. Carter AJ, Overton J, Terashima M, et al. Can emergency medical services use turnaround time as a proxy for measuring ambulance offload time? J Emerg Med. 2013:47(1):30–35.
8. Cone DC, Davidson SJ, Nguyen Q. A time-motion study of the emergency medical services turnaround interval. Ann Emerg Med. 1998 Feb;31(2):241-246.
9. Hitchcock M, Crilly J, Gillespie B, et al. The effects of ambulance ramping on emergency department length of stay and in-patient mortality. Australas Emerg Nurs J. 2010 May;13(1-2):17–24.
10. Crilly J, Keijzers G, Tippett V, et al. Improved outcomes for emergency department patients whose ambulance off-stretcher time is not delayed. Emerg Med Australas. 2015 Jun;27(3):216-224.
11. Majedi M. A queueing model to study ambulance offload delays [dissertation]. University of Waterloo, Canada;. 2008. Available from: https://uwspace.uwaterloo.ca/handle/10012/4019
12. Carter AJ, Gould JB, Vanberkel P, et al. Offload zones to mitigate emergency medical services (EMS) offload delay in the emergency department: a process map and hazard analysis. CJEM. 2015 Nov;17(6):670–678.
13. Smith L. Modelling Emerg Med Serv [Dissertation]. Cardiff University.
14. Scheulen JJ, Li G, Kelen GD. Impact of ambulance diversion policies in urban, suburban, and rural areas of Central Maryland. Acad Emerg Med. 2001 Jan;8(1):36–40.
15. Carter AJ, Grierson R. The impact of ambulance diversion on EMS resource availability. Prehosp Emerg Care. 2007;11(4):421–426.
16. Asplin BR. Does ambulance diversion matter? Ann Emerg Med. 2003 Apr;41(4):477–480.
17. Redd JM, Bair AE, Jayaraman S. Implications of ambulance diversion. Ann Emerg Med. 2003;42:S93.
18. Nakajima Y, Vilke GM. Editorial: ambulance diversion: the con perspective. Am J Emerg Med. 2015 June;33(6):818–819.
19. Eckstein M, Isaacs SM, Slovis CM, et al. Facilitating EMS turnaround intervals at hospitals in the face of receiving facility overcrowding. Prehosp Emerg Care. 2005;9(3)267–275.
20. Redelmeier DA, Blair PJ, Collins WE. No place to unload: A preliminary analysis of the prevalence, risk factors, and consequences of ambulance diversion. Ann Emerg Med. 1994 Jan;23(1):43-47.

21. Mund E. Ending ambulance diversion. Eighteen hospitals in King County,Wash., work toward a perpetual zero-divert status. EMS World. 2011 Apr;40(4):31-8.
22. Cooney DR, Millin MG, Carter A, et al. Ambulance diversion and emergency department offload delay: Resource document for the National Association of EMS physicians position statement. Prehosp Emerg Care. 2011 Oct-Dec;15(4):555– 561.
23. Vilke GM, Brown L, Skogland P, et al. (2004) Approach to decreasing emergency department ambulance diversion hours. J Emerg Med. 2004 Feb;26(2):189–192.
24. Shealy RM, Sorrell JF, French DM. Ambulance diversion by cooperation: a positive experience with a physician-directed ambulance diversion policy in Charleston County, South Carolina. Ann Emerg Med. 2014 July;64(1):97-98.
25. Clawson JJ. Principles of emergency medical dispatch. Englewood Cliffs, N.J.: Prentice-Hall, Englewood Cliffs, N.J; 1988.
26. Millin MG, Brown LH, Schwartz B. EMS provider determinations of necessity for transport and reimbursement for EMS response, medical care, and transport: combined resource document for the National Association of EMS physicians position statements. Prehosp Emerg Care. 2011;15(4):562–569.
27. Snooks HA, Dale J, Hartley-Sharpe C, et al. On-scene alternatives for emergency ambulance crews attending patients who do not need to travel to the accident and emergency department: a review of the literature. Emerg Med J. 2004;21(2):212–215.
28. Silvestri S, Ralls GA, Papa L, et al. Impact of emergency department bed capacity on emergency medical services unit off-load time. Acad Emerg Med. 2006 April; 13:S70.
29. Almehdawe E Queueing network models of ambulance offload delays [dissertation]. 2012. University of Waterloo.
30. Lee IH, Chen CT, Lee YT, et al. A new strategy for emergency department crowding: High-turnover utility bed intervention. J Chin Med Assoc. 2017;80(5):297–302.
31. McRae A, Wang D, Blanchard IE, et al. Benefits on EMS offload delay of a provincial ED overcapacity protocol aimed at reducing ED boarding. Tech. rep. 2012.

Input and demand management

1. Asplin BR, Magid, DJ, Rhodes KV, et al. A conceptual model of emergency department crowding. Ann Emerg Med. 2003 Aug; 42(2): 173-180.
2. Morley C, Unwin M, Kinsman L. Emergency department crowding: A systematic review of causes, consequences and solutions. PLoS One. 2018; 13(8): e0203316.
3. Bond K, Ospina MB, Blitz S, et al. Frequency, determinants and impact of overcrowding in emergency departments in Canada. Healthc Q. 2007;10(4):32–40
4. Estey A, Ness K, Saunders DL, et al. Understanding the causes of overcrowding in emergency departments in the Capital Health Region in Alberta: a focus group study. CJEM. 2003;5(2):87–94
5. Cowling TE, Cecil EV, Soljak MA, et al. Access to primary care and visits to emergency departments in England: a cross-sectional, population-based study. PLoS One. 2013;8(6):e66699
6. Moineddin R, Meaney C, Agha M, et al. Modeling factors influencing the demand for emergency department services in Ontario: a comparison of methods. BMC Emerg Med. 2011;11:13
7. Bond K, Ospina MB, Blitz S, et al. Frequency, determinants and impact of overcrowding in emergency departments in Canada. Healthc Q. 2007;10(4):32–40.
8. van der Linden MC, Khursheed M, Hooda K, et al. Two emergency departments, 6000 km apart: Differences in patient flow and staff perceptions about crowding. Int Emerg Nurs. 2017;35:30–6.
9. Aboagye-Sarfo P, Mai Q, Sanfilippo FM, et al. Growth in Western Australian emergency department demand during 2007–2013 is due to people with urgent and complex care needs. Emerg Med Australas. 2015;27(3):202–9.
10. Knapman M, Bonner A. Overcrowding in medium-volume emergency departments: effects of aged patients in emergency departments on wait times for non-emergent triage-level patients. Int J Nurs Pract. 2010;16(3):310–7.
11. Kawano T, Nishiyama K, Anan H, et al. Direct relationship between aging and overcrowding in the ED, and a calculation formula for demand projection: a cross-sectional study. Emerg Med J. 2014;31(1):19–23.
12. Sharma A, Inder B. Impact of co-located general practitioner (GP) clinics and patient choice on duration of wait in the emergency department. Emerg Med J. 2011;28:658–61.

13. Arain M, Campbell MJ, Nicholl JP. Impact of a GP-led walk-in centre on NHS emergency departments. Emerg Med J. 2015;32(4):295–300.
14. Anantharaman V. Impact of health care system interventions on emergency department utilization and overcrowding in Singapore. Int J Emerg Med. 2008;1(1):11–20.
15.Dolton P, Pathania V. Can increased primary care access reduce demand for emergency care? Evidence from England's 7-day GP opening. J Health Econ. 2016;49:193–208.
16. Whittaker W, Anselmi L, Kristensen SR, et al. Associations between extending access to primary care and emergency department visits: a difference-in-differences analysis. PLoS Med. 2016;13(9):e1002113
17. Buckley DJ, Curtis PW, McGirr JG. The effect of a general practice after-hours clinic on emergency department presentations: a regression time series analysis. Med J Aust. 2010;192(8):448–51.
18. Nagree Y, Ercleve TNO, Sprivulis PC. After-hours general practice clinics are unlikely to reduce low acuity patient attendances to metropolitan Perth emergency departments. Aust Health Rev. 2004;28(3):285–91.
19. Zager K. Discharge to medical home: A new care delivery model to treat non-urgent cases in a rural emergency department. Health (Amst). 2019 Mar;7(1):7-12.
20.Mohiuddin S, Busby J, Savovic J, et al. Patient flow within UK emergency departments: A systematic review of the use of computer simulation modelling methods. BMJ Open. 2017;7:e015007.

Throughput

1. Asplin BR, Magid DJ, Rhodes KV, et al. A conceptual model of emergency department crowding. Ann Emerg Med. 2003 Aug;42(2):173–180.
2. Affleck A, Parks P, Drummond A, et al. Emergency department overcrowding and access block. CJEM. 2013 Nov;15(06):359–370.
3. Dickson EW, Anguelov Z, Vetterick D, et al. Use of lean in the emergency department: A case series of 4 hospitals. Ann Emerg Med. 2009 Oct;54(4):504–510.
4. Rowe BH, Guo X, Villa-Roel C, et al. The role of triage liaison physicians on mitigating overcrowding in emergency departments: A systematic review. Acad Emerg Med. 2011;18(2):111–120.

5. Bullard MJ, Villa-Roel C, Guo X, et al. The role of a rapid assessment zone/pod on reducing overcrowding in emergency departments: A systematic review. Emerg Med J. 2012 May;29(5):372–378.
6. Crawford K, Morphet J, Jones T, et al. Initiatives to reduce overcrowding and access block in Australian emergency departments: A literature review. Collegian. 2014 Dec;21(4):359–366.
7. Wiler JL, Gentle C, Halfpenny JM, et al. Optimizing emergency department front-end operations. Ann Emerg Med. 2010 Feb;55(2):142-160.e1.
8. Yarmohammadian MH, Rezaei F, Haghshenas A, et al. Overcrowding in emergency departments: A review of strategies to decrease future challenges. J Res Med Sci; 2017:22:23.
9. Yoon P, Steiner I, Reinhardt G. Analysis of factors influencing length of stay in the emergency department. CJEM. 2003 May;5(03):155–161.
10. Rathlev NK, Chessare J, Olshaker J, et al. Time series analysis of variables associated with daily mean emergency department length of stay. Ann Emerg Med. 2007 Mar;49(3):265–271.
11. Chan L, Reilly KM, Salluzzo RF. Variables that affect patient throughput times in an academic emergency department. Am J Med Qual. 1997 Dec;12(4):183–186.
12. Levin S, Toerper M, Hamrock E, et al. Machine-learning-based electronic triage more accurately differentiates patients with respect to clinical outcomes compared with the emergency severity index. Ann Emerg Med. 2018;71:565-574.
13. Chan S, Cheung NK, Graham CA, et al. Strategies and solutions to alleviate access block and overcrowding in emergency departments. Hong Kong Med J. 2015;21:345–352.
14. Blom M, Erwander K, Gustafsson L, et al. Primary triage nurses do not divert patients away from the emergency department at times of high in-hospital bed occupancy - A retrospective cohort study. BMC Emerg Med. 2016;16(39).
15. Wiler J, Gentle C, Halfpenny J, et al. Optimizing emergency department front-end operations. Ann Emerg Med. 2010;55(2):142–160.
16. Oredsson S, Jonsson H, Rognes J, et al. A systematic review of triage-related interventions to improve patient flow in emergency departments. SJTREM. 2011;19(43).
17. Rowe B, Xiaoyan G, Villa-Roel C, et al. The role of triage liaison physicians on mitigating overcrowding in emergency departments: A systematic review. Acad Emerg Med. 2011;18(2):111–120.

18. Holroyd B, Bullard M, Latoszek K, et al. Impact of a triage liaison physician on emergency department overcrowding and throughput: A randomized controlled trial. Acad Emerg Med. 2007;14(8):702–708.
19. Choi Y, Wong T, Lau C. Triage rapid initial assessment by doctor (TRIAD) improves waiting time and processing time of the emergency department. Emerg Med J. 2006;23(4):262–265.
20. Rowe B, Villa-Roel C, Guo X, et al. The role of triage nurse ordering on mitigating overcrowding in emergency departments: A systematic review. Acad Emerg Med. 2011;18(12):1349–1357.
21. Fry M. Triage nurses order x-rays for patients with isolated distal limb injuries: A12-month ED study. J Emerg Nurs. 2011;27(1):17–22
22. Hangura JK, Flodgren G, Perera R, et al. Primary care professionals providing non-urgent care in hospital emergency departments. Cochrane Database Syst Rev. 2012;11:75.
23. Morley C, Unwin M, Kinsman L. Emergency department crowding: A systematic review of causes, consequences and solutions. PLoS One. 2018; 13(8): e0203316.
24. Eitel D, Rudkin S, Malvehy M, Killeen J, Pines J. Improving Service Quality by Understanding Emergency Department Flow: A White Paper and Position Statement Prepared For the American Academy of Emergency Medicine. J Emerg Med. 2010;38(1):70-79.

Output

1. Innes GD, Sivilotti ML, Ovens H, et al. Emergency overcrowding and access block: A smaller problem than we think. CJEM. March 2019; 21(2): 177-185.
2. Morley C, Unwin M, Peterson G, et al. Emergency department crowding: A systematic review of causes, consequences, and solutions. PLOS One. August 30 2018; 13(8):e0203316.
3. Weiss SJ, Derlet R, Arndahl J, et al. Estimating the degree of emergency department overcrowding in academic medical centers: Results of the national emergency medicine department overcrowding study (NEDOCS). Acad Emerg Med. 2004;11:38-50.
4. Bernstein SL, Verghese V, Leung W, et al. Development and validation of new index to measure emergency department crowding. Acad Emerg Med. 2003; 10:938–942.

5. Hoot NR, Zhou C, Jones ID, et al. Measuring and forecasting emergency department crowding in real time. Ann Emerg Med. 2007; 49:747–755
6. Barrett L, Ford S, Ward-Smith P. A bed management strategy for overcrowding in the emergency department. Nurs Econ. 2012;30(2):82–5.
7. Burley G, Bendyk H, Whelchel C. Managing the storm: an emergency department capacity strategy. J Healthc Qual. 2007;29(1):19–28.
8. Howell E, Bessman E, Kravet S, et al. Active bed management by hospitalists and emergency department throughput. Ann Intern Med. 2008;149(11):804–810.
9. Gonnah R, Hegazi MO, Hmdy I, et al. Can a change in policy reduce emergency hospital admissions? Effect of admission avoidance team, guideline implementation and maximising the observation unit. Emerg Med J. 2008;25:575–578.
10. Lateef F, Anantharaman V. The short-stay emergency observation ward is here to stay. Am J Emerg Med. 2000;18:629–634.
11. Kelen GD, Scheulen JJ, Hill PM. Effect of an emergency department (ED) managed acute care unit on ED overcrowding and emergency medical services diversion. Acad Emerg Med. 2001;8(11):1095–1100.
12. Lee IH, Chen CT, Lee YT, et al. A new strategy for emergency department crowding: high-turnover utility bed intervention. J Chin Med Assoc. 2017;80(5):297–302.
13. van der Linden C, Lucas C, van der Linden N, et al. Evaluation of a flexible acute admission unit: effects on transfers to other hospitals and patient throughput times. J Emerg Nurs. 2013;39(4):340–345.
14. Varney J, Weiland TJ, Jelinek G. Efficacy of Hospital in the Home Services Providing Care for Patients Admitted from Emergency Departments: An Integrative Review. Int J Evid Based Healthc. 2014 Jun;12(2):128-141.
15. Cha WC, Song KJ, Cho JS, et al. The long-term effect of an independent capacity protocol on emergency department length of stay: A before and after study. Yonsei Med J. 2015;56(5):1428–1436.
16. Willard E, Carlton EF, Moffat L, et al. A full-capacity protocol allows for increased emergency patient volume and hospital admissions. J Emerg Nurs. 2017;43(5):413–418.
17. Powell E, Khare RK, Venkatesh AK, et al. The relationship between inpatient discharge timing and emergency department boarding. J Emerg Med. 2012;42(2): 186–196.

18. Jones P, Wells S, Harper A, et al. Impact of a national time target for ED length of stay on patient outcomes. N Z Med J. 2017;130(1455):15–34.
19. Mason S, Weber EJ, Coster J, et al. Time patients spend in the emergency department: England's 4-hour rule-a case of hitting the target but missing the point? Ann Emerg Med. 2012;59(5):341–349.
20. Ngo H, Forero R, Mountain D, et al. Impact of the four-hour rule in Western Australian hospitals: trend analysis of a large record linkage study 2002–2013. Plos One. 2018;13(3).
21. Perera ML, Davies AW, Gnaneswaran N, et al. Clearing emergency departments and clogging wards: National Emergency Access Target and the law of unintended consequences. Emerg Med Australas. 2014;26:549–55.
22. Sullivan CM, Staib A, Flores J, et al. Aiming to be NEAT: safely improving and sustaining access to emergency care in a tertiary referral hospital. Aust Health Rev. 2014;38(5):564–574.
23. Tenbensel T, Chalmers L, Jones P, et al. New Zealand's emergency department target—did it reduce ED length of stay, and if so, how and when? BMC Health Serv Res. 2017;17.
24. Affleck A, Drummond A, Rowe BH, et al. Emergency department overcrowding and access block. CJEM. 2013;15(6):359-370.
25. Costa AP, Hirdes JP. Clinical characteristics and service needs of alternate-level-of-care patients waiting for long-term care in Ontario hospitals. Healthc Policy. 2010 Aug; 6(1):32-46.
26. Di Somma S, Paladino L, Vaughan L, et al. Overcrowding in emergency department: an international issue. Intern Emerg Med. 2014; 10(2): 171-175.

Leadership

1. Rittel HW, Webber MM. Dilemmas in a general theory of planning. Policy Sci. 1973;4(2), 155-169.
2. Braithwaite J, Churruca K, Long JC et al. When complexity science meets implementation science: a theoretical and empirical analysis of systems change. BMC Med. 2018 Apr;16(1):63.
3. Dawson T. Leader decisions part 1: How good are leaders' VUCA skills? [Internet]. Medium. 2018 [cited 6 May 2020]. Available from: https://medium.com/@theo_dawson/leaders-vuca-skills-how-good-are-they-85f69d5c8eac

4. Meadows D. Leverage points places to intervene in a system [Internet]. Donellameadows.org. 2020 [cited 6 May 2020]. Available from: http://www.donellameadows.org/wp-content/userfiles/Leverage_Points.pdf
5. Chang AM, Cohen DJ, Lin A, et al. Hospital strategies for reducing emergency department crowding: A mixed-methods study. Ann Emerg Med. 2018 Apr;71(4):497-505.
6. Innes, G. Sorry-we're full! Access block and accountability failure in the health care system. CJEM. 2015 Mar;17(2):171-179.
7. Hosking I, Boyle A, Ahmed V, et al. What do emergency physicians in charge do? A qualitative observational study. Emerg Med J. 2018;35(3):186–188.
8. Westbrook JI, Raban MZ, Walter SR, et al. Task errors by emergency physicians are associated with interruptions, multitasking, fatigue and working memory capacity: A prospective, direct observation study. BMJ Qual Saf. 2018;27:655-663.
9. Schnapp B, Sun JE, Kim JL, et al. Cognitive error in an academic emergency department. Diagnosis. 2018 Sep;5(3):135–142.
10. Howlett M, Doody K, Murray J, et al. Burnout in emergency department healthcare professionals is associated with coping style: a cross-sectional survey. Emerg Med J. 2015 Sep;32(9):722-727.

Other Useful Reading

Glouberman and Zimmerman (2002). Commission on the Future of Health Care In Canada. Saskatoon – Saskatchewan: Privy Council. Complicated and Complex Systems: What Would Successful Reform Look Like?. 2002 [cited 7/2/20]. Available at https://www.alnap.org/system/files/content/resource/files/main/complicatedandcomplexsystems-zimmermanreport-medicare-reform.pdf.

Grint K. The British Association of Medical Managers. Wicked Problems and Clumsy Solutions: the role of leadership. 2008 [cited 7/2/20]. Available at http://leadershipforchange.org.uk/wp-content/uploads/Keith-Grint-Wicked-Problems-handout.pdf

Wicked problems: : Wicked Problems. Wikipedia. Available at https://en.wikipedia.org/wiki/Wicked_problem

The Kings Fund. The practice of system leadership. Being comfortable with chaos. 2015 [cited 7/2/20]. Available at https://www.kingsfund.org.uk/publications/practice-system-leadership

Legal risks and regulatory violations

1. Jayaprakash N, O'Sullivan R, Bey T, Ahmed SS, Loftpour S. Crowding and delivery of healthcare in emergency departments: The European perspective. West J Emerg Med. 2009;10(4):233-239.
2. For more information, see CMPA, "Medico-legal risks in busy and overcrowded emergency departments" (September 2010); "Limited healthcare resources: The difficult balancing act" (December 2018); "Being on call when resources are limited" (revised November 2018).
3. See, for example, *Egedebo v Windermre District Hospital Assn*., 1991 CanLll 1921 (BC SC); St. Joseph's Hospital v Lahey Estate, 1993 CanLII (NB CA); *Law Estate v Simice*, 1994 CanLll 3068 (BC SC), aff'd 1995 CanLll 3251 (BC CA).
4. See, for example, *Bateman v Doiron et al*., 1991 CanLll 8051 (NB QB), aff'd 1993 CanLll (NB CA); *Mathura v Scarborough General Hospital*, 1999 CarswellOnt 43, (199) O.J. No. 47 (Gen Div.).
5. See, for example, *Yepremian v Scarborough General Hospital et al*., 1980 CanLll 1906 (ON CA).

Policy

1. WHO | Health policy [Internet]. Who.int. 2020 [cited 7 May 2020]. Available from: https://www.who.int/topics/health_policy/en/
2. Heisler EJ, Tyler NL. Hospital-based emergency departments: background and policy considerations. [internet]. [Place unknown]: Congressional Research Service; 08 Dec 2014 [cited 05 Feb 2020]. Available from: https://fas.org/sgp/crs/misc/R43812.pdf
3. Boyle A, Mason S. What has the 4-hour access standard achieved? Br J Hosp Med. 2014 Nov;75(11):620-622.
4. Emergency Care Institute New South Wales [Internet]. [Place unknown]: Agency for Clinical Innovation; c2020. Emergency treatment performance (ETP). 10 Oct 2017 [cited 05 Feb 2020]; Available from: https://www.aci.health.nsw.gov.au/networks/eci/administration/neat

5. The Joint Commission. Managing patient flow: a shared responsibility. The Source. [Internet]. 2019 May;17(5):1-21. Available from: https://store.jcrinc.com/assets/1/14/ts_17_2019_05.pdf
6. Association Québécoise d'établissements de santé et de services sociaux. Guide de gestion de l'urgence. [Internet]. [Place unknown]: La Direction des communications du ministère de la Santé et des Services sociaux Government du Québec; 2000 [updated Sep 2006; cited 05 Feb 2020]. Available from: https://publications.msss.gouv.qc.ca/msss/fichiers/2006/06-905-01.pdf
7. American College of Emergency Physicians. Policy statement: crowding. [Internet]. Dallas, TX: American College of Emergency Physicians; Jan 2006 [updated Feb 2013, Apr 2019; cited 05 Feb 2020]. Available from: https://www.acep.org/globalassets/new-pdfs/policy-statements/crowding.pdf
8. Boyle A, Higginson I, Smith S, et al. Crowding in Emergency Departments. London, UK: The College of Emergency Medicine; Feb 2012 [revised Aug 2012, May 2014; cited 05 Feb 2020]. Available from: https://www.rcem.ac.uk/docs/Service%20Design%20+%20Delivery/52b.%20RCEM%20Crowding%20Guideline%20(2015).pdf
9. Affleck A, Parks P, Drummond A, et al. Emergency department overcrowding and access block. CJEM. 2013 Nov;15(6):359-370.
10. Australasian College for Emergency Medicine. Position statement: ED overcrowding. [Internet]. West Melbourne, VIC: Australasian College for Emergency Medicine; Mar 2006 [revised Jul 2011, Nov 2018, June 2019; cited 05 Feb 2020]. Available from: https://acem.org.au/getmedia/dd609f9a-9ead-473d-9786-d5518cc58298/S57-Statement-on-ED-Overcrowding-Jul-11-v02.aspx
11. Canadian Foundation for Healthcare Improvement [Internet]. [Place unknown]: Canadian Health Services Research Foundation; c2020. Myth: emergency room overcrowding is caused by non-urgent cases. 01 Oct 2009 [cited 05 Feb 2020]. Available from: https://www.cfhi-fcass.ca/SearchResultsNews/09-10-01/73a17f86-f6ea-4d82-b59e-d2305ff99a80.aspx
12. Petrie DA. Crowding, Karenina and complexity: patient flow in evolving health care ecosystems. CJEM. 2018 Jan;20(1):12-15.

Advocacy

1. Fatovich DM, Hughes G, McCarthy SM. Access block: it's all about available beds. Med J Aust. 2009;190(7):362-363.

2. Campbell P, Boyle A, Higginson I. Should we scrap the target of a maximum four hour wait in emergency departments? BMJ. 2017; 359 :j4857.

3. Tenbensel T, Chalmers L, Jones P, et al. New Zealand's emergency department target – did it reduce ED length of stay, and if so, how and when?. BMC Health Services Research. 2017;17(1).

4. Ontario's hospital logjam brings record wait times, before arrival of COVID-19 | CBC News [Internet]. CBC. 2020 [cited 3 April 2020]. Available from: https://www.cbc.ca/news/canada/toronto/ontario-hospital-hallway-medicine-january-emergency-wait-1.5493740

5. Schull M, Kiss A, Szalai J. The effect of low-complexity patients on emergency department waiting times. Ann Emerg Med. 2007;49(3):257-264.

6. Morley C, Unwin M, Peterson G, et al. Emergency department crowding: A systematic review of causes, consequences and solutions. PLoS ONE. 2018;13(8):e0203316.

7. Innes G, Sivilotti M, Ovens H, et al. Emergency overcrowding and access block: A smaller problem than we think. CJEM. 2018;21(2):177-185.

8. Anantharaman V. Impact of health care system interventions on emergency department utilization and overcrowding in Singapore. Int J Emerg Med. 2008;1(1):11–20.

9 .Arain M, Campbell MJ, Nicholl JP. Impact of a GP-led walk-in centre on NHS emergency departments. Emerg Med J. 2015;32(4):295–300.

Early lessons from COVID-19 and Disaster Medicine to reduce ED crowding

1. Moon S, Sridhar D, Pate M, et al. Will Ebola change the game? Ten essential reforms before the next pandemic. The report of the Harvard-LSHTM Independent Panel on the Global Response to Ebola. Lancet. 2015;386(10009):2204-2221.

2. Bradt D, Aitken P, FitzGerald G, et al. Emergency Department Surge Capacity: Recommendations of the Australasian Surge Strategy Working Group. Acad Emerg Med. 2009;16(12):1350-1358.

3. Hick JL, Einav S, Hanfling D, et al; Task Force for Mass Critical Care. Surge capacity principles: care of the critically ill and injured during pandemics and disasters: CHEST consensus statement. Chest. 2014 Oct;146(4 Suppl):e1S-e16S.

4. Canadian Association for Emergency Physicians. Surge Capacity and the Canadian Emergency Department [Internet]. Mar 24, 2020 [Cited May 7 2020] Available at: https://caep.ca/wp-content/uploads/2020/03/Surge-Capacity-and-the-Canadian-Emergency-Department-CLEAN-March23PP.pdf

5. Lang E, Hansen K, Javidan A, Mazurik L. Critical guidance for mitigating the impact of the COVID-19 pandemic on the safety and integrity of EDs around the world [Internet]. Mar 24, 2020 [Cited May 7 2020]. Available at: https://www.ifem.cc/critical-guidance-for-mitigating-the-impact-of-the-covid-19-pandemic-on-the-safety-and-integrity-of-emergency-departments-around-the-globe/

6. Royal College of Emergency Medicine. Covid-19: Resetting emergency department care [Internet]. 6 May 2020 [cited 7 May 2020]. Available from: https://www.rcem.ac.uk/docs/Policy/RCEM_Position_statement_Resetting_Emergency_Care_200506.pdf

7. Hollander J, Carr B. Virtually Perfect? Telemedicine for Covid-19. N Eng J Med. 2020;382(18):1679-1681.

8. Heneghan J. Physician Response Unit Expansion Supports London's Covid-19 Response – Ambulance Today – Official Website [Internet]. Ambulancetoday.co.uk. 2020 [cited 10 May 2020]. Available from: https://ambulancetoday.co.uk/uncategorized/physician-response-unit-expansion-supports-londons-covid-19-response/

9. Ohannessian R, Duong T, Odone A. Global Telemedicine Implementation and Integration Within Health Systems to Fight the COVID-19 Pandemic: A Call to Action. JMIR Public Health Surveill. 2020;6(2):e18810.

10. Mann D, Chen J, Chunara R, et al. COVID-19 transforms health care through telemedicine: evidence from the field. J Am Med Inform Assoc. 2020 Apr 23;ocaa072.

11. Moazzami B, Razavi-Khorasani N, Dooghaie Moghadam A, et al. COVID-19 and telemedicine: Immediate action required for maintaining healthcare providers well-being. J Clin Virol. 2020;126:104345.

12. Smith A, Thomas E, Snoswell C, et al. Telehealth for global emergencies: Implications for coronavirus disease 2019 (COVID-19). J Telemed Telecare. 2020;:1357633X2091656.
13. Coronavirus (COVID-19) self-assessment [Internet]. Covid-19.ontario.ca. 2020 [cited 7 May 2020]. Available from: https://covid-19.ontario.ca/self-assessment/
14. COVID-19 Epidemiology [Internet]. CIDRAP. 2020 [cited 7 May 2020]. Available from: https://www.cidrap.umn.edu/covid-19/epidemiology
15. Up to 650 000 people die of respiratory diseases linked to seasonal flu each year [Internet]. Who.int. 2020 [cited 7 May 2020]. Available from: https://www.who.int/news-room/detail/14-12-2017-up-to-650-000-people-die-of-respiratory-diseases-linked-to-seasonal-flu-each-year
16. Wang C, Ng C, Brook R. Response to COVID-19 in Taiwan. JAMA. 2020;323(14):1341.
17. Bedford J, Enria D, Giesecke J, et al. COVID-19: towards controlling of a pandemic. Lancet. 2020;395(10229):1015-1018.
19. Kwon K, Ko J, Shin H, et al. Drive-through screening center for COVID-19: A safe and efficient screening system against massive community outbreak. J Korean Med Sci. 2020 Mar 23;35(11):e123.
19. Parodi S, Liu V. From containment to mitigation of COVID-19 in the US. JAMA. 2020;323(15):1441.
20. Tanne J, Hayasaki E, Zastrow M, et al. Covid-19: how doctors and healthcare systems are tackling coronavirus worldwide. BMJ. 2020;m1090.
21. O'Dowd A. Emergency departments must not return to pre-covid days of overcrowding and lack of safety, says college. BMJ. 2020;m1848.
22. Schneider S. Just Another Crowding Paper. Acad Emerg Med. 2014;21(10):1158-1159.
23. McCusker J, Vadeboncoeur A, Lévesque J, et al. Increases in Emergency Department Occupancy Are Associated With Adverse 30-day Outcomes. Acad Emerg Med. 2014;21(10):1092-1100.
24. Chang A, Cohen D, Lin A, et al. Hospital Strategies for Reducing Emergency Department Crowding: A Mixed-Methods Study. Ann Emerg Med. 2018;71(4):497-505.e4.

Appendix I - Glossary of international terms used around crowding in North America, the UK, and Australasia.

1. American College of Emergency Physicians. Crowding. American College of Emergency Physicians, 2006 [Revised April 2019, cited 7/2/20]. Available from: https://www.acep.org/patient-care/policy-statements/crowding/
2. Affleck A, Parks P, Drummond A, et al.. Canadian Association of Emergency Physicians Position Statement: Emergency Department Overcrowding and Access Block, 2013. CJEM; 15(6) 359-370.
3. Royal College of Emergency Medicine. Tackling Emergency Department Crowding, 2015 [cited 7/2/20]. Available from https://www.rcem.ac.uk/docs/Service%20Design%20+%20Delivery/52a.%20ED%20crowding%20overview%20and%20toolkit%20-%20Dec%202015.pdf
4. Australasian College of Emergency Medicine: Position Statement: ED Overcrowding, 2019 [cited 7/2/20]. Available from: https://acem.org.au/getmedia/dd609f9a-9ead-473d-9786-d5518cc58298/S57-Statement-on-ED-Overcrowding-Jul-11-v02.aspx

Appendix II - Assessing quality of evidence

1. Jackson R, Ameratunga S, Broad J, et al. The GATE frame: critical appraisal with pictures. Evid Based Med. 2006;11(2):35-38.

2. OCEBM Levels of Evidence Working Group [Internet]. The Oxford 2011 Levels of Evidence. 2020 [cited 10 May 2020]. Oxford Centre for Evidence-Based Medicine. Available from: http://www.cebm.net/index.aspx?o=5653

3. Schünemann H, Brożek J, Guyatt G, et al. GRADE handbook for grading quality of evidence and recommendations. The GRADE Working Group, 2013 [cited 10 May 2020]. Available from: https://gdt.gradepro.org/app/handbook/handbook.html.