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Public Health Impact of ED Crowding and Boarding of Inpatients

an Information Paper

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Introduction

Emergency department (ED) crowding and the boarding of admitted patients for excessive lengths of time, one of the key determinants of crowding, has been addressed at the highest levels of academic medicine, public health, and the government. The United States (US) Congress requested that the Institute of Medicine (IOM) study the emergency care system in the US. The IOM presented their findings before Congress in 2006. They found that EDs were seriously overcrowded with problems of boarding admitted patients for excessive time periods. The combination of more patients, fewer functioning EDs, and far fewer inpatient beds was to blame. The IOM reported reduced quality of care, increased ambulance diversion, and lack of preparedness for disaster. However, the IOM did not specifically address adverse population-level and individual health outcomes caused by these problems with the emergency care system.[1]

This paper will explore the available evidence of the public health impact of ED crowding and boarding related to the following issues:

1. Epidemiology
2. As a risk factor for poor health outcomes
3. Health impact of ambulance diversion
4. Risk associated with patients who leave without evaluation and treatment
5. Infectious disease implications
6. Surge capacity and disaster preparedness
7. Screening and prevention efforts

Epidemiology of ED Crowding/Boarding

Key Points

1) The boarding of inpatients for excessive periods of time secondary to a lack of inpatient beds is the key driver of crowding in the ED.

2) More than half of all EDs in the US are at or over capacity at least some of the time.

Once popularized by mainstream culture such as the television show "ER," EDs used to be glorified as havens for the critically ill, the stage for traumatic injuries and dramatic resuscitations. More recently, however, EDs have been better known for overflowing waiting rooms, stretcher filled hallways and overwhelmed medical providers.

This paradigm shift is hardly unexpected and is reflective of a combination of factors over the last two decades. Medical literature addressing ED crowding dates back to the early 1990s.[2] At the time, however, attention was diverted to other issues such as surging health care costs. Meanwhile, EDs coped as they moved closer to their eventual breaking point. In 2001, the issue of ED crowding was popularized with the US News and World Report article "Code blue crisis in the ER."[3] The public finally was exposed to what emergency physicians and leaders had been experiencing for years. Since then, emergency physicians and their representative societies, the American College of Emergency Physicians (ACEP) and the Society for Academic Emergency Medicine (SAEM), have fought to keep the issue of ED crowding in the spotlight.

The problem of ED crowding is closely associated to boarding – a term used to describe the practice of holding admitted patients in the ED because of a lack of available inpatient beds. In fact, many hospitals cite boarding as the leading culprit in ED crowding.[4,5] Boarding is particularly a problem for large volume EDs and those in metropolitan areas. As CDC data released in May 2009 highlights, over 85% of those EDs with annual visit volumes over 50,000 report boarding patients for more than two hours in the ED while waiting for an inpatient bed. The same was true of 77% of hospitals with metropolitan status.

Table 1. Percent distribution of emergency departments and corresponding standard errors, by whether admitted ED patients ever "boarded" for more than 2 hours in the ED while waiting for an inpatient bed, according to emergency department visit volume and metropolitan status: United States, 2007

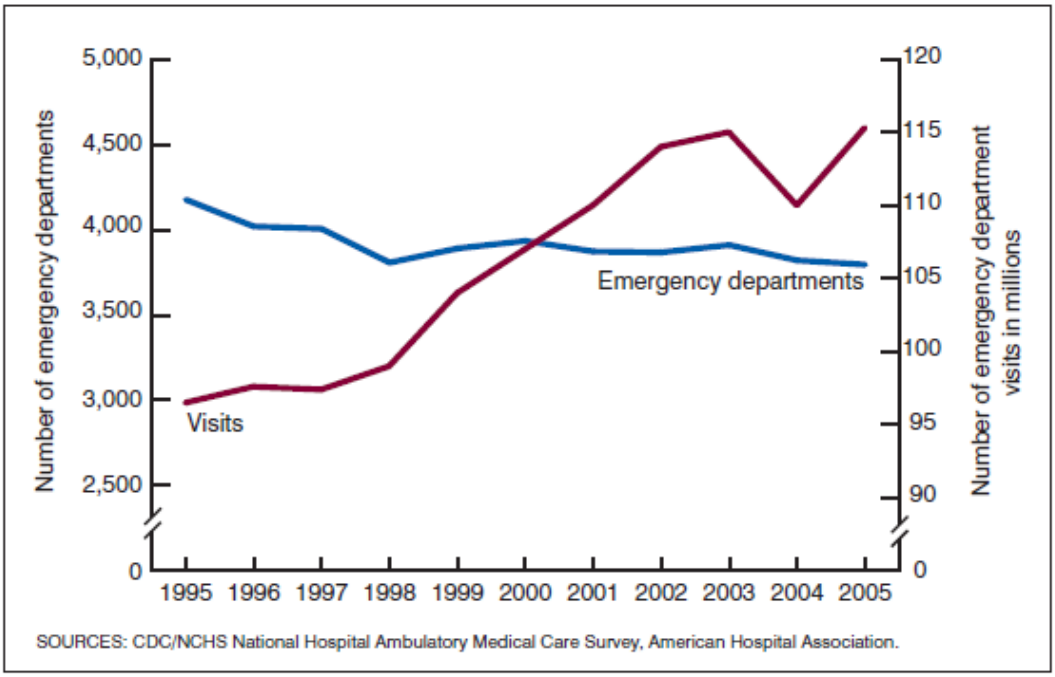
			ED annual visit volume						Metropolitan status			
	Total[1]		Less than 20,000		20,000 to 50,000		50,000 or more		MSA		Non-MSA	
Admitted ED patients ever "boarded" for more than 2 hours in the ED while waiting for an inpatient bed	All EDs	SE	Percent distribution	SE	Percent distribution	SE	Percent distribution	SE	Percent distribution	SE	Percent distribution	SE
Yes	62.5	4.5	39.0	7.7	83.3	3.5	86.5	4.6	77.4	3.8	32.8	9.1
No	34.8	4.5	61.0	7.7	11.9	3.1	*7.6	3.8	18.6	3.8	67.2	9.1
Unknown or blank	*2.7	0.9	*0	...	*4.8	2.0	*5.9	2.6	*4.0	1.3	*0	...

Source: McCaig LF, Xu J, Niska RW. Estimates of emergency department capacity: United States, 2007. NCHS E-Stats. CDC.

As EDs become gridlocked with admitted patients, less space remains to evaluate and treat new patients. Consequently, EDs are increasingly forced to go on "diversion" – a policy that has ambulances bypass crowded EDs and take patients to other facilities with more adequate resources. Diversion, in turn, increases patient transport time which can be detrimental in urgent cases where time sensitive treatment is essential. More than half of urban and teaching hospitals reported being on diversion at one time or another. One in eight urban hospitals reported being on diversion 20 percent or more of the time.[6]

Several other factors are commonly cited as contributors to ED crowding. As a result of policy and health care philosophy in the 1990s, like the Balanced Budget Act of 1997, many health care systems closed hospitals, inpatients beds and EDs.[7] Ongoing closures have left existing emergency facilities stressed and overcrowded. In 1995, there were 4,176 hospitals with EDs while in 2005, only 3,795 remained.[8] During this same time period, annual ED visits increased by 20% from 96.5 million in 1995 to 115.3 million in 2005. On average in 2005 there were 219 visits to U.S. EDs every minute.

Figure 1: Trends in numbers of emergency departments and related visits: United States, 1995-2005.[8]



In June 2006, the IOM released a series of three reports entitled "Hospital-Based Emergency Care: At the Breaking Point" highlighting that the US emergency medical system is overburdened, underfunded, and highly fragmented. These disturbing trends are reflected in the day to day reality of hospitals and EDs. A 2007 survey of hospital leaders revealed that the majority of hospitals felt they were at or over capacity. While 48% of all hospital EDs reported being at or over capacity, urban and teaching hospitals were most affected with 65% and 73% respectively reporting at or over capacity.

The effect on patients is also seen by increased waiting times, as shown in the following table. More than 60% of metropolitan patients triaged as urgent, meaning they should ideally be seen in fifteen minutes, will wait thirty minutes or more to be seen.

Characteristic	Total		Metropolitan area		Not metropolitan area	
	Percent distribution	Standard error	Percent distribution	Standard error	Percent distribution	Standard error
Throughput measures—Con.						
Average waiting time for urgent cases[1]:						
Less than 15 minutes	27.3	2.9	16.5	3.0	44.6	5.4
15–29 minutes	25.1	2.8	20.0	2.4	33.3	5.9
30–44 minutes	27.3	2.4	31.8	2.7	20.1	3.9
45–59 minutes	12.5	1.5	18.9	2.3	*2.0	1.1
60 minutes or more	7.9	1.0	12.8	1.6	*0.1	0.0

. . . Category not applicable.
* Figure does not meet standard of reliability or precision.
0.0 Quantity more than zero but less than 0.05.
[1]Urgent cases are defined as those that must be seen within 15–60 minutes.

Source: National Hospital Ambulatory Medical Care Survey. CDC. September 2006.

ED Crowding/Boarding as a Risk Factor for Poor Health Outcomes at Individual and Population Levels

Key Points

1) Admitted patients held in the ED for longer periods of time die more frequently than those moved to the floor or ICU more quickly.
2) Admitted patients with longer ED lengths of stay have longer hospital stays, wasting billions at the population level.
3) Patients seen and treated in crowded ED conditions receive delayed care.

Individual Level Health Effects of Crowding/Boarding

An extensive review of the effect of ED crowding/boarding on patient health outcomes has been performed and recently published.[9] Summarized here are the key findings from eight of the health outcome studies, most amenable to an estimate of population-level effects, out of the 41 reviewed in the article cited above. We will attempt to extrapolate some of these findings to the US population to provide a model for evaluating the public health impact of varying levels of crowding.

Increased mortality due to ED crowding

Spirivulis et al[10] studied 3 hospitals in Australia and found that periods of the greatest ED and hospital occupancy (eg, when hospital occupancy exceeded 99th percentile or when >20% of ED bays were occupied by patients waiting >8hours for an inpatient bed), were associated with hazard ratios of 1.3, 1.3, and 1.2 for mortality at 2, 7, and 30 days.

Increased mortality for ICU patients boarded in ED more than 6 hours and associated with ED crowding

Chalfin et al[11] evaluated mortality rates for patients admitted to the ICU through the ED in a consortium of 120 hospitals. They found in-hospital mortality of 17.4% for patients held in the ED more than 6 hours compared to a rate of 12.9% for patients moved to the ICU in less than 6 hours, with similar demographics and illness severity between the groups, but more sepsis patients in delayed transfer group and more multi-trauma and cardiac patients in non-delayed group. This yields an absolute mortality risk of 4.5% for extended ED boarding of ICU patients, a number needed to cause one death of 22.

Delayed antibiotic administration in ED pneumonia patients

Pines et al[12] studied 694 patients admitted for pneumonia from one ED. They found that 69% of patients seen during the lowest quartile of ED crowding received antibiotics within the recommended 4-hour time standard, compared to only 28% seen during the highest quartile of ED crowding.

Increased hospital length of stay for admitted patients held in ED

Liew, et al[13] compared average hospital length of stay (LOS) for patients in four categories of ED LOS, <4 hours, 4-8 hours, 8-12 hours, and >12 hours. They found that compared to the shortest ED LOS, patients in ED 4-8 hours spent 1.3 more days in the hospital, patients in ED 8-12 hours spent 1.96 more days, and patients in ED >12 hours spent 2.35 more days.

Bernstein et al[14] reported a similar study in abstract form. They studied hospital LOS for patients admitted during quartiles of ED crowding. Exclusive of the extra ED hours, they found that compared to the lowest quartile of crowding, patients in second quartile had hospital LOS 0.67 days longer, third quartile 0.81 days longer, and fourth quartile 0.85 days longer.

Delays in analgesic administration for patients in pain

Pines et al[15] studied 13,758 patients from one ED with severe pain. Using regression analysis, they found that the odds ratio for not receiving analgesia despite severe pain was 1.03 for each additional waiting room patient.

Extrapolation of Individual Health Effects of Crowding/Boarding to US Population

No population-based studies have been performed to directly measure the public health impact of ED crowding. Several methodological issues limit the ability to estimate public health impact of crowding. First, the nationally-representative surveys of ED care, specifically the National Hospital and Ambulatory Medical Care Survey (NHAMCS), is available years after the ED visits studied. For example, full data from the 2006 is now available[8], with the data for 2007 expected later this year. Next, no accepted measure of ED crowding, or counting method for boarded inpatients, exists. So, until ED data on a population level, including description of patient and facility characteristics, such as crowding measures, and patient-oriented health outcomes is available, we are left with some preliminary extrapolation from individual health outcomes at single sites to estimate the public health impact of ED crowding/boarding.

Using NHAMCS 2006 estimates of total ED visits, ED admissions, ED ICU admissions, and ED pneumonia patients, and a review of ED literature on ED patients with pain, we will use the findings from the studies described above to extrapolate the population-level health effects of ED crowding/boarding related to extended LOS for admitted patients, increased mortality for ICU patients boarded in the ED more than 6 hours, delays in analgesic administration for patients in pain, delays in antibiotic administration beyond 4 hours for patients with pneumonia, and morbidity in patients who leave without being seen.

Increased mortality due to ED crowding

In 2006 NHAMCS estimates that 15,207,497 patients were admitted through US EDs. If the crowding conditions associated with increased risk of short-term death (HR 1.3), described by Spirivulis et al[10], occur 1% of the time in US EDs, we can estimate that about 45,000 excess deaths occur due to extreme ED crowding. Future research should evaluate other levels of crowding in a broader array of hospitals to more precisely define the effect of crowding/boarding on mortality.

Increased mortality for ICU patients boarded in ED more than 6 hours and associated with ED crowding

In 2006 NHAMCS estimates that 2,242,547 patients were admitted to critical care units from the ED. If 10% of these patients remain in the ED over 6 hours and the mortality difference found by Chalfin et al[11] exists for matched groups differing only by ED LOS > or <6 hours, we can estimate that about 10,200 excess deaths would occur among the delayed admit group. If 20% of ED ICU admits stay more than 6 hours, the estimate of excess deaths would double.

Delayed antibiotic administration in ED pneumonia patients

In 2006 NHAMCS estimates that 1,385,246 ED patients had a principal diagnosis of pneumonia. Even though the evidence for harm from delayed antibiotic administration in pneumonia patients is far from settled, and the regulatory and accreditation standards are in flux, it is accepted that much attention

is paid to time to antibiotic administration among payers, regulators, and accrediting agencies, resulting in a financial effect of delayed care due to crowding.

Increased hospital LOS for admitted patients held in ED

In 2006 NHAMCS estimates that 15,207,497 patients were admitted from US EDs. From the studies by Liew, et al[13] and Bernstein et al[14] we find excess hospital LOS related to ED boarding, resulting in millions of days of excess hospital stays, and billions of dollars in preventable costs.

Delays in analgesic administration for patients in pain

Todd et al[16] prospectively studied the pain experiences of 2841 patients. 35% presented with no or mild pain only and were not included in the study. Others were excluded for other reasons. Of the study cohort, over half reported a pain score of 8 or more (consistent with severe pain) on the 11-point verbal pain scale used most commonly in US EDs. If we assume that about 1/3 of EDs patients report severe pain, and in 2006 NHAMCS estimates that there were 119,191,528 ED visits, we can estimate that almost 40 million patients per year are in the pool potentially at risk for poor analgesic treatment caused by crowding as found by Pines et al.[15]

Health Impact of Ambulance Diversion and Patients Leaving Without Evaluation and Treatment Due to ED Crowding/Boarding

Key Points

1) Crowding increases the likelihood that patients will leave without being seen, placing them at risk for adverse health outcomes.
2) Ambulance diversion increases with crowding and exposes diverted patients to delays and disruption of continuity in care.

Background

Two of the most frequently used measures of ED crowding are patient's leaving without being seen (LWBS) and ambulance diversion. Published research has examined these measures for several years. However, these studies have a number of limitations. We will review the available information, examine the relation of other measures of crowding with LWBS and ambulance diversion, and describe current knowledge about the health effects of LWBS and ambulance diversion.

Patients Who Leave Without Evaluation and/or Treatment (LWBS)

CDC estimates from 2007 report that approximately 2% of ED patients leave an ED without being seen by a health care provider.[8] Of course this number is very difficult to quantitate because of the problem of capturing those patients who leave before triage. In terms of the patients who leave after triage, studies have found that there are a number of factors associated with LWBS. While many reasonably assume that the patients who are less sick are the ones to walk out, this, too is hard to evaluate. Triage assessments can be inaccurate at times, and this is typically the only record remaining of the patient's status after leaving. Baker et al found that 46% of patients who left prior to physician evaluation were in need of immediate medical attention. Ding et al[17], found that a history of a prior "walk out" was a strong predictor of future leaving without being seen. In addition, they found other predictors to be lack of insurance and Medicaid coverage. When patients have been asked why they walked out of an ED, the most common reason was they felt the wait was too long. Other common reasons cited were that the patient's felt their symptoms were stable or improving, they were mistreated by hospital staff or they didn't feel well enough to wait any longer.[18]

Various hospital factors have also been associated with higher LWBS rates including increasing hospital size, higher ED volume, increasing length of ED waiting time, and teaching hospital status.[19,20] Interestingly, the study by Stock et al[19] showed that public hospital status had lower LWBS rates. As suggested by the authors, this may have to do with public expectation of longer wait times at public hospitals.[19] The characteristics of the providers within that hospital have also been shown by Polevoi et al[21] to be significant, wherein older physician age and lack of EM residency completion were shown to be significantly related to increased rates of patient walkouts.[21]

Most literature on the health impact of LWBS is over 10 years old or from international sources. Baker et al[22] showed that half of the patients who LWBS saw another provider within 1 week of that

encounter. Of those, 11% were hospitalized. Approximately 41% of those who left did not seek further care within the study period of 1 week. The overwhelming reason for not seeking follow up care was concern over health care costs. Other factors were that patient no longer felt they needed medical attention and they did not know where else to seek medical care. The evidence suggests and it is intuitive that ED crowding increases the LWBS rate. Not counting the missed financial opportunities of LWBS, estimates of the population health effects of LWBS has not yet been determined adequately. Certainly costs at the society level are reduced by ED visits foregone by leaving before being seen. However, in light of the morbidity described by Baker et al[22] the effects of delayed care of potentially treatable conditions may exceed the savings. In addition, these studies say nothing about the costs of delayed care for people who do not even try to come to the ED because of a perception that the wait will be too long.

Ambulance Diversion

A significant proportion of ED patients are brought by ambulance. Roughly 15.5 % patients arrive by ambulance, which is up 25% from 1997.[8] A recent study by McConnell et al[23] found that sicker patients, who are more likely to be admitted, and Medicare insured patients, are those most likely to be transported by ambulance.[23] Almost half of all EDs experience at least one episode of ambulance diversion within a year.[24] Diversion is most likely to happen if that hospital is in a metropolitan area, inpatient beds are not available, the ED census is high, and that census has high average acuity.[24]

It is well known that delays in treatment for various critical medical insults from trauma to sepsis lead to worse patient outcomes. Schull et al[25] showed that chest pain patients experience increased transport times during periods of high ED crowding and ambulance diversion. If patients are experiencing longer transport times from ambulance diversion, this could lead to increased patient morbidity and mortality. It may in turn increase the transport times of patients awaiting ambulances due to EMS having to transport patients further distances. As patients are diverted away from their primary hospitals, they are being diverted away from their regular health care providers and medical records, which could also lead to a decrease in patient satisfaction as well.

Possible Solutions

As both LWBS and ambulance diversion are related to crowding, any intervention that reduces ED crowding will likely reduce LWBS rates and ambulance diversion time. Specific interventions to reduce LWBS and ambulance diversion directly have been investigated.

When patients were asked what could be done to increase their likelihood of waiting longer to be seen in the ED, a few simple ideas emerged. More frequent updates on wait times and more immediate temporary treatment like bandages and ice packs were cited most often.[18]

One interesting method, noted in the literature, to decrease hospital ambulance diversion rates is for neighboring hospitals to go on diversion less frequently. Vilke et al[26] describe a “reciprocating effect” in neighboring hospital facilities in that when one hospital goes on diversion, the shift in load to the neighboring facility causes that facility also to go on diversion. In the same way, when a facility is able to have decreased it’s time in diversion by means of increased staffing, efficiency, etc, the neighboring facility experiences a decrease in diversion hours without making any changes to its daily functioning.[26]

Infectious Disease Implications of ED Crowding and Boarding

Key points

1) Crowding and boarding place a burden on appropriate infection control of both community and nosocomial pathogens (eg, MRSA, influenza, SARS, tuberculosis).
2) Overburdened EDs are at higher risk for rendering delayed diagnoses and definitive care to patients with life-threatening infectious illnesses.

The ED is a vital portal to the hospital for the community and plays a sentinel role in public health response to infectious diseases. Accurate diagnosis and timely care of illness remains the hallmark of emergency medicine. Crowding and boarding of admitted patients in the ED pose significant barriers to this mission, particularly with regard to the early identification, containment and definitive management of infectious illnesses.

Infection control in the fluid and unpredictable environment of the ED remains a challenge even under the best circumstances. The challenge is multiplied several-fold when crowding and boarding place

stressors on limited available resources. The national spread of community-acquired methicillin-resistant *Staphylococcus aureus* (MRSA) illustrates some of the potential public health implications of ED crowding and boarding. In a study involving 11 cities across the US in 2004, MRSA was identified as the most common cause of skin and soft tissue infections presenting to the ED.[27] While no studies specifically address ED crowding and MRSA to the best of our knowledge, there is a growing body of evidence linking hospital crowding and increased MRSA transmission. In the United Kingdom, high bed occupancy and turnover rates of acute beds have been associated with a higher incidence of MRSA infections.[28,29] Elsewhere, specific periods of severe crowding on general medicine wards have been found to coincide with increases in incidence of MRSA infections.[30] Crowded wards place patients in closer vicinity with one another, increasing the chance of cross-transmission of resistant organisms, particularly during procedures, personal hygiene and wound care. Additionally, greater patient density and higher turnover likely contribute to greater contamination of inanimate objects in the healthcare environment and less rigorous decontamination practices as a result of cleaning time constraints. Higher patient volume may translate into greater clinician workload, thus competing with a healthcare worker's time to comply with proper hand hygiene and eliminating an important means of reducing transmission of MRSA and other hospital-acquired organisms. Overall physician compliance with hand hygiene has been reported to be as low as 57%, with busy workload, involvement in activities that could result in cross-transmission of organisms, and certain technical medical specialties (including emergency medicine) frequently cited as risk factors for non-adherence.[31] Similar trends have also been observed for overburdened nurses.[32] Use of alcohol-based hand sanitizers placed outside of patient rooms has improved compliance to a degree. While these studies focus predominantly on inpatient settings where factors such as LOS, prevalence of hospital acquired infections, and nature of patient contact may vary from that of the ED, they raise interesting public health questions about the nosocomial transmission of MRSA and other infections in the ED that warrant further investigation.

Crowded EDs represent an obstacle to controlling the spread of rapidly transmissible respiratory infections, particularly during epidemics and community outbreaks. Influenza season has been associated with increased ED ambulance diversion, a surrogate marker for ED crowding.[33] Transmitted by air, droplet and contact, influenza can disseminate quickly in closed areas, including healthcare facilities.[34]

Similarly, waiting rooms are likely to be congested during influenza season and place uninfected patients, friends and family members at greater risk of illness. During the spring of 2003, severe acute respiratory syndrome (SARS) highlighted how ED crowding and boarding could lead to disease transmission during an epidemic.[35] A 78 year-old woman, later identified as the index case for SARS in Toronto, Canada, had returned from a trip to Hong Kong and died at home after developing fever, cough, and dyspnea. Her 43 year-old son presented with similar symptoms to a Toronto ED several days later and was admitted to the hospital for suspected community-acquired pneumonia. As no hospital beds were available, the son boarded overnight in the ED, where he received nebulizer treatments. He died of SARS several days later in his hospital stay. In the ED, just 1.5 meters away from the son on the next gurney and separated by a curtain, a 78 year-old man was being evaluated and observed for rapid atrial fibrillation. This patient was discharged home the next morning and returned two days later with symptoms consistent with SARS. He died five days later. A second patient in the ED that night, located three beds away from the son, also subsequently developed and died of SARS. Together, these three patients would mark the beginning of a large nosocomial outbreak of SARS in this hospital that would sicken more than a hundred people, almost one-third of whom were healthcare workers, and kill more than a dozen.[36]

As part of a larger global epidemic that began in Asia, SARS would come to be viewed as an illness that was significantly amplified by nosocomial transmission to healthcare workers and other non-infected patients in hospital settings such as the ED.[37-39] It is likely that ED crowding, lack of ED isolation facilities, and inadequate infection control contributed to this transmission. While respiratory infection control practices such as patient masking and separation, hand hygiene and personal protective equipment, were highlighted as effective infection control countermeasures that later helped end the SARS epidemic, adherence generally remains a challenge in the busy ED setting and is likely more problematic during periods of crowding.[40]

Inner-city EDs frequently provide care for populations at high risk for tuberculosis.[41] Prolonged waiting times and lack of airborne isolation facilities have historically been identified as contributing factors to the potential spread of tuberculosis in the ED.[42] Unrecognized cases and atypical presentations of tuberculosis have been shown to lead to delays in initiating appropriate infection control measures and frequently result in multiple patient visits to the ED prior to diagnosis of non-specific symptoms as

tuberculosis.[43,44] Healthcare workers in urban EDs frequently have an elevated risk of exposure to tuberculosis and have been shown to have higher tuberculosis conversion rates compared with that of other hospital employees when rigorous infection control measures are not implemented.[45] Furthermore, emergency procedures such as intubation and airway suctioning may create aerosols from infected patients leading to nosocomial transmission of disease not only to healthcare providers but to other patients in overcrowded settings.

ED crowding and boarding may serve as an obstacle to timely management of infectious diseases. It is widely believed that early administration of antibiotics for the treatment of community-acquired pneumonia decreases mortality.[46,47] A large retrospective study based on national data from the Centers for Medicare & Medicaid Services from 1998 to 1999 demonstrated improved in-hospital and 30-day mortality for patients 65 years or older admitted with pneumonia particularly when antibiotic therapy was initiated within four hours of hospital arrival.[48] This study has since become the backbone for a core measure for quality of care by The Joint Commission, mandating the first dose of antibiotic for treatment of community-acquired pneumonia for all patients within six hours of arrival to a hospital in its most recent iteration.

Several recent studies looking at ED crowding have shown that higher ED volume and increased overall length of ED stay are associated with delayed administration of antibiotics for pneumonia.[12,49,50] While these studies do not comment specifically on mortality from pneumonia diagnosed in the ED, they do confirm that crowding likely contributes to a delay in definitive care for a common and treatable infectious illness. Increased waiting room times likely also contribute to a delay in initial diagnosis of pneumonia, though many ED triage protocols have instituted early chest radiography for patients with chief complaints and objective vital signs concerning for pneumonia in order to expedite care.

As a frontline medical provider and gatekeeper to the hospital, the ED remains a vulnerable setting for the spread of infectious diseases. Emergency departments are tasked with the rapid diagnosis and initiation of care of life-threatening illness. As admitted patients board in the ED more frequently while larger volumes of patients wait to be seen, this mission may be increasingly compromised as limited resources, stemming from adequate infection control facilities to adequate staff, are stretched dangerously thin. The public health implications are unfortunate as patients may be placed at greater risk of contracting a nosocomial infection or experiencing a delay in definitive care as a consequence of an overburdened emergency care system.

Effect of ED Crowding/Boarding on Surge Capacity and Disaster Preparedness

Key Point

1) ED crowding limits surge capacity and impairs the ability to mount an effective response to natural or man-made disasters.

Background

Surge capacity and disaster preparedness are areas of intense activity in emergency medicine. SAEM and its journal *Academic Emergency Medicine* hosted a consensus conference on these topics and published the results in 2006. However, specific research on the effects of ED crowding on surge capacity and disaster preparedness has not been published. This section will review the theoretical foundations of ED surge capacity and disaster preparedness, propose some specific research hypotheses, and speculate on the impact of ED crowding on these two components of public health readiness.

Surge Capacity

Surge capacity has a number of definitions employed by different organizations. In general, surge capacity refers to the facilities, material, and people available to be utilized on a temporary basis to contend with health care demand in excess of usual operational capacity. Epidemics, natural disasters, and mass-casualty events due to transportation crashes, terrorist attacks, and other human-mediated acts are the source of excess demand for health care. Surge capacity may involve all aspects of the health care system including out-of-hospital emergency medical services, in-hospital capacity including EDs, out-of-hospital facilities and people, and community resources such as communications, power, water, etc. [51,52]

have developed models of normal variations in ED patient flow to provide a baseline to describe daily surge and surge capacity as the foundation for other investigations of events that may inject measurable increased demand for ED care into a dynamic system. As expected, ED crowding reduces daily surge capacity in the ED as well as surge capacity available for increased demands on ED services.

In separate reviews McCarthy et al[53] and Stratton and Tyler[54] describe ED surge capacity and its relevance to the needs for health care in a disaster. Stratton and Tyler[54] found that the ED was the primary access point for care during a sudden-impact disaster, with the peak demand occurring within 24 hours. Often resources from outside the local area were delayed by as much as 4 days, so local ED surge capacity had to be self-sustaining for up to 4 days. McCarthy et al[53] describe the many dimensions of ED surge capacity that must be measured to provide an accurate picture of surge capacity and the effect of various types of disasters.

Disaster Preparedness

In addition to the literature reviews of surge capacity and disaster preparedness described above, Kaji and Lewis[55] conducted a cross-sectional survey of disaster preparedness and surge capacity, verified by on-site inspections, among a cohort of 45 hospitals in Los Angeles County, California. Almost all of the hospital plans had standard protocols for handling a disaster, but there was little inter-hospital cooperation or training documented. In addition, surge capacity was extremely limited at most hospitals, with only 29% of hospitals capable of providing more than 20 beds to manage surge. Only 42% had 10 or more isolation rooms, and the majority (60%) were on ambulance diversion more than 20% of the time, suggesting that there was no excess ED or hospital capacity.

Impact of ED Crowding on Surge Capacity and Disaster Preparedness

Crowded conditions and over-burdened ED staffs do not provide much capacity to accommodate any surge, especially the large-scale surge of a disaster. Even though this is intuitive, the methods for objectively measuring surge capacity are not well developed. Along with a standard measure of crowding, a standard method of determining surge capacity from analysis of facilities, resources, and disaster plans must be developed to quantify the impact of crowding on surge capacity and disaster preparedness. Actual disaster situations allow natural experiments in measuring capacity to care for ill or injured people and can be compared to these a priori assessments.

Impact of Boarding and Crowding in Emergency Department Preventive and Public Health Measures

Key Points

1) Implementation of preventive and public health care measures is difficult in a crowded ED due to the lack of resources and privacy.

2) The main opportunities for delivering public health interventions in EDs are to devise simple and effective brief interventions in the ED to identify and counsel on risky behaviors, to provide early detection and prevention for patients with chronic disease, and to develop appropriate systems for follow-up.

The EDs across the country have become not only a place for acute emergency care but also a place for primary health care and public health measures. Many services such as basic screening to identify risky behaviors, preventive services for early detection as well as prevention of chronic disease have become more important in the ED. There is sufficient evidence to support public health measures in the ED[56] such as alcohol screening and intervention,[57] smoke cessation counseling,[58] HIV screening and referral (in high risk, high prevalence populations),[56] hypertension screening and referral,[59] adult pneumococcal vaccination,[60] youth violence counseling programs,[61] safe firearm storage counseling,[56] and domestic violence screening.[62] The research looking at the effect of boarding and crowding in the performance of these public health measures in the ED is lacking. In general, the identification and

referral for some of these risky behaviors and chronic illness is lacking in the ED as a generalized practice and a quality of care issue. The ED is overextended and crowding has become a significant issue.[1]

Crowding has many untoward consequences regarding patient care and affects the ability of physicians to deliver prompt and effective treatment of life-threatening illnesses and injuries.[1] In addition, one may deduce that crowding interferes with the physicians' ability to interact with patients in a private fashion by forcing physicians to take care of patients in hallways, waiting areas and other open and shared spaces. The lack of privacy interferes with the physician's ability to obtain information that may be embarrassing or of a sensitive and personal nature. Under these conditions it will be even more difficult to identify risky behaviors or domestic violence, since it puts the patients at risk of the information being overheard by others. This crowded environment compromises the ability of patients to exchange such critical information in a protected environment. Additionally, the ED resources are being utilized for acute care and important screening and counseling regarding alcohol, smoking cessation, HIV screening are not taking place. Identification of youth at risk of violence and the safety of firearm storage are not being discussed and addressed with our patients. Important preventive measures such hypertension and adult vaccination are not being carried on.

Some suggestions to improve the ability to address some of the public health measures have been to provide the opportunity in the waiting room for patients to self administer computer health risk assessments and then tailor health advice and referrals.[63] Placement of check boxes or prompts to improve screening and detection of substance abuse, domestic violence,[64] as well as risk factors for HIV, youth violence and fire arm storage safety. In addition, the presence of someone in the ED similar to a "discharge planner" as used on the inpatient wards that could arrange follow-up and provide the continuity of care needed by those patients.[65]

Future directions in a research agenda should be driven by the desire to improve the health system to provide excellent patient care. Research into effective brief ED interventions that can help identify and counsel on risky behaviors and programs that will be effective in providing follow-up for these patients. In addition, study the impact of the ED interventions in the actual health outcomes.

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