Hospital infectious disease emergency preparedness: A survey of infection control professionals

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Background: Hospital preparedness for infectious disease emergencies is imperative for local, regional, and national response planning.
Methods: A secondary data analysis was conducted of a survey administered to Infection Control Professionals (ICPs) in May, 2005.
Results: Most hospitals have ICP representation on their disaster committee, around-the-clock infection control support, a plan to prioritize health care workers to receive vaccine or antivirals, and non-health care facility surge beds. Almost 20% lack a surge capacity plan. Some lack negative pressure rooms for current patient loads or any surge capacity. Less than half have a plan for rapid set-up of negative pressure, and Midwest hospitals are less likely than other areas to have such plans. Smaller hospitals have less negative pressure surge capacity than do larger hospitals. About half have enough health care workers to respond to a surge that involves ≤50 patients; few can handle ≥100 patients. Many do not have sufficient ventilators or can handle ≤10 additional ventilated patients. Most do not have enough National Institute for Occupational Safety and Health–approved respirators, and less than half have sufficient surgical masks to handle a significant surge.
Conclusions: United States hospitals lack negative pressure, health care worker, and medical equipment/supplies surge capacity. Hospitals must continue to address gaps in infectious disease emergency planning. (Am J Infect Control 2007;35:25-32.)

BACKGROUND

Bioterrorism attacks or outbreaks of emerging infections pose a substantial threat to the safety, health, and security of United States (U.S.) citizens and could result in financial devastation. Total costs from the 2001 U.S. bioterrorism attack that used anthrax and involved only 22 cases and 5 deaths has yet to be determined, but early estimates put the total cost at more than $2.5 billion;[1] the severe acute respiratory syndrome (SARS) outbreak that lasted less than a year in Canada was estimated to have cost between $1.5 billion and $2.1 billion.[2] The potential consequences of being unprepared for such events are staggering.[3]

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The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, nor the U.S. Government.

0196-6553/$32.00

doi:10.1016/j.ajic.2006.07.002

Hospitals will face the challenge of caring for a large influx of patients following a bioterrorism attack or emerging infectious disease outbreak, and these patients may be contagious. Because of this, hospital surge capacity (having adequate resources for managing a sudden, unexpected increase in patients requiring acute medical care) and surge capability (having adequate specialized resources to treat specific patient groups, such as burned or highly contagious patients) must be addressed.[4] The first step in this process is to assess U.S. hospitals' preparedness for infectious disease emergencies and current surge capacity and capability. This will identify gaps that hospitals can begin to address to become better prepared for an infectious disease emergency. For the purposes of this study, the collective term "surge capacity" is used.

Some researchers have measured aspects of hospital preparedness for mass casualty events. Treat et al[5] measured hospital preparedness for all types of weapons of mass destruction. Higgins and colleagues[6] assessed Kentucky hospitals' preparedness to respond to a bioterrorism event using components of the Mass Casualty Disaster Plan Checklist as indicators of readiness. Braun and colleagues[7] examined a national sample of hospitals undergoing Joint Commission on Accreditation of Healthcare Organizations accreditation survey and used a variety of hospital preparedness indicators. Most recently, Trust For America's Health (TFAH) conducted a national survey of infection control professionals (ICP) representing U.S. hospitals in 2005 to examine infectious disease emergency preparedness.[8] All of the previously published studies provide a broad view of hospital preparedness and discuss readiness indicators in relation to whether a hospital has a plan for surge capacity issues. Rarely are the hospital readiness indicators quantified in relation to the number/amount of beds and equipment available for disaster response. In addition, previously published studies have grouped hospital preparedness by region,[5] state,[6,8] or as an aggregate sample.[7] No published articles report hospital preparedness in relation to bed size.

In the past, bioterrorism preparedness funding, such as the Metropolitan Medical Response System (MMRS), has concentrated on major U.S. cities that tend to have larger-sized hospitals with more licensed beds. Previous research has indicated that non-MMRS areas (i.e., smaller sized cities with smaller hospitals) have not benefited as much from past bioterrorism funding; this has resulted in significant differences in bioterrorism preparedness between MMRS and non-MMRS areas.[6] It is important to examine surge capacity in relation to hospital bed size to highlight gaps in preparedness and to provide initial recommendations of ways to fill these gaps. In addition, hospital preparedness indicators must be quantified in terms of the number/amount of beds and the supplies/equipment available for disaster response.

PURPOSE AND AIMS

The purpose of this study is to evaluate U.S. hospitals' current readiness to respond to a bioterrorism attack or outbreak of an emerging or reemerging infectious disease. The aims of the study include the following: (1) describe the proportion of hospitals that have ICPs as members of their disaster planning committee; (2) identify hospitals' capacity to care for an influx of 50 to 100 potentially infectious patients; (3) identify hospitals' current surge capacity in relation to existence of a response plan, coordination of the plan with other local/regional plans, existence of a strategy to convert non-health care facility to one that can house medical patients, incentives to get health care workers to come to work, negative pressure, staffing levels, and medical equipment (i.e., ventilators, surgical masks, and N-95 respirators); (4) describe the proportion of U.S. hospitals with 24 hour a day/7 day a week infection control support; and (5) describe U.S. hospitals' participation in different types of disaster drills/exercises. It was hypothesized that larger-sized hospitals (in terms of the number of beds in a facility, as reported by the ICP) would report the ability to care for a larger influx of patients more readily than would smaller-sized hospitals. It also was hypothesized that most U.S. hospitals do not have the surge capacity needed to care for an influx of potentially infectious patients in terms of staff to care for the patients or medical equipment/supplies needed.

METHODS

This study was a secondary data analysis of a national hospital emergency preparedness survey that was conducted by TFAH and the Association for Professionals in Infection Control and Epidemiology, Inc. (APIC) in June 2005 at the APIC 32nd Annual Education Conference and International Meeting in Baltimore, Maryland. The ICPs completed the survey as representatives from their hospital. The methodology and results from the primary survey have been reported previously.[8] The Institutional Review Boards of Saint Louis University, the University of Louisville, and the National Naval Medical Center (protocol B06-072) approved this study.

SAMPLE

The original database contained data from 1897 hospitals. The ICPs from all U.S. hospitals, regardless of size, location, or for-profit status were invited to complete a survey; therefore, the sample was non-random. The only exclusion criterion was hospital location outside of the U.S. respondents who completed multiple surveys (as defined by having the same APIC identification number) were deleted from the database; this was done by TFAH before sending the data to the authors. In addition, respondents who identified multiple states were excluded. The final database contained 1745 subjects. All data were anonymous and there were no identifiers within the database that could link an ICP or hospital to the data.

Responses were received from participants in all 50 U.S. states. There was a higher response rate in the South (37.4%) and Midwest (25.3%) than in the West (18.2%) or Northeast (19.1%) ($\chi^2 = 162.77$, $P < .001$; Table 1). This is likely due to the larger number of hospitals in those regions.[9] This sample contained a disproportionately higher number of respondents from hospitals located in Northeastern states than would be expected ($\chi^2 = 22.38$, $P < .001$).[9] There also was a higher proportion of respondents from smaller-sized hospitals (≤250 beds) than from hospitals with 251 or more beds ($\chi^2 = 228.03$, $P < .001$; Table 1). This is consistent with the higher number of hospitals in that size range across the U.S; however, there was a higher proportion of respondents from the largest-sized hospitals (≥501 beds) than would be expected ($\chi^2 = 219.9$, $P < .001$).[9]

SURVEY QUESTIONNAIRE

The survey consisted of 17 items that measure components of hospital preparedness for infectious disease emergencies (surge capacity and other infectious disease emergency planning issues). In addition, two demographic questions (hospital location by state and hospital bed size) were included. A list of the survey questions, not including demographic items, is outlined in Table 2. Respondents were asked to list the state in which their hospital is located. Hospital bed size was divided into four categories: ≤100 beds, 101 to 250 beds, 251 to 500 beds, and ≥501 beds. The three surge capacity items (having enough staff to care for the increased patient load, sufficient numbers of negative pressure rooms, and sufficient numbers of ventilators) and hospital bed size provided ordinal level data because the answer options indicated incremental differences in preparedness. For instance, answers to the health care worker surge capacity question consisted of the following: (a) sufficient for fewer than 50 patients, (b) sufficient for 50 to 100 patients, and (c) sufficient for more than 100 patients. These options were considered ordinal because they indicate incremental improvements in a facility's ability to respond to an infectious disease emergency. All other items provided nominal level data. The National APIC Emergency Preparedness Committee (of which the authors are members) and TFAH developed the survey. Internal consistency testing could not be conducted because all of the items were single-item measures.[10]

Data analysis

The Statistical Package for the Social Sciences (SPSS) 14.0 was used for all analyses. All items were dummy coded because they consisted of nominal data.[11] Hospital locations were categorized into four regions (Midwest, Northeast, South, and West) based on U.S. census divisions.[9,12] Descriptive statistics were computed for each question and used to describe surge capacity and other infectious disease emergency preparedness issues (ICP participation in a hospital disaster preparedness committee, around-the-clock infection control support, participation in disaster exercises, and plan for health care worker prioritization plan). A series of Kruskal-Wallis one-way analysis of variance tests were used to evaluate the relationship between a hospital's bed size and geographic region (independent variables) and its ability to care for an influx of potentially infectious patients in relation to various surge capacity and infectious disease emergency preparedness measures (dependent variables); nonparametric tests were conducted because the questions provided nominal level data.[11] Significant findings were followed by Mann-Whitney *U* post hoc tests. Items that were answered "I don't know" were coded as missing data and excluded from analysis for the Kruskal-Wallis and Mann-Whitney *U* tests. A series of χ^2 Goodness of Fit tests was used to evaluate whether there were significant differences between the proportion of respondents from the U.S. Census regions and those from varying sized hospitals.[13]

Table 1. Respondents' hospital location by U.S. Census region and number of hospital beds

Hospital Location and Bed Size	n (%)
States grouped by U.S. Census regions	
South	652 (37.4)
Midwest	441 (25.3)
Northeast	334 (18.2)
West	318 (19.1)
Hospital beds	
≤100 beds	578 (33.6)
101–250 beds	572 (33.2)
251–500 beds	370 (21.5)
≥501 beds	201 (11.7)

RESULTS

Infectious disease emergency preparedness

Almost all respondents reported that their facility has an ICP as a member of their hospital disaster preparedness committee (89.7%, n = 1565), with no difference between hospital bed size or geographic location and having ICP representation on this committee. Most facilities also reported that they have around-the-clock infection control support in the form of an ICP who can be reached within 15 minutes for verbal consultation (by way of phone or face-to-face) (80.1%, n = 1397). There was no difference between the hospital's geographic location and having around-the-clock infection control support; however, the smallest hospitals (those with ≤100 beds) were significantly less likely to have around-the-clock infection control support (Kruskal-Wallis χ^2 (3) = 55.12, $P < .001$) than were hospitals with 101 to 250 beds (U = 146825.5, $P < .001$), 251 to 500 beds (U = 87022.5, $P < .001$), or ≥501 beds (U = 46543.5, $P < .001$). In addition, smaller-sized hospitals (those with 101-250 beds) were significantly less likely to have around-the-clock infection control support than were hospitals with 251 to 500 beds (U = 96109.5, $P < .01$) or ≥501 beds (U = 51430.5, P = .001). There was no difference between larger-sized hospitals (those with 251-500 beds or those with ≥501 beds) and having around-the-clock infection control support. Most hospitals (69.6%, n = 1214) reported that they have worked with their local or state health department to plan for prioritizing health care workers to receive vaccine or antiviral medications in the event of an infectious disease emergency. There was no difference between hospital size or geographic location and having such a prioritization plan. Almost all hospitals reported having

Table 2. List of questions included on the survey questionnaire

Answer options: (a) yes, (b) no, (c) don't know
Does your facility have Infection Control Professional representation on the Emergency Preparedness Planning Committee that includes bioterrorism response planning?
Does your hospital have plans/provisions for the rapid set-up of a negative pressure area in or near the hospital as a surge capacity measure?
Does your hospital have a plan/incentives/provisions to encourage health care workers to continue coming to work in the event of a major infectious disease outbreak?
Does your hospital have enough supplies (in the form of NIOSH-approved respirators for airborne isolation patients) for staff and a surge of 500 patients/visitors that will require extra safety measures for the next 3 days?
Does your hospital have enough supplies (in the form of surgical masks for droplet precautions) for staff and a surge of 500 patients/visitors that will require extra safety measures for the next 3 days?
In the past 3 years, has your facility participated in a bioterrorism/infectious disease exercise?
In the past 3 years, has your facility participated in a chemical agent exercise?
In the past 3 years, has your facility participated in a nuclear/radiologic exercise?
In the past 3 years, has your facility participated in a mass casualty exercise?
In the event of a major health emergency, has your hospital established plans or been involved in state/local planning efforts to care for patients at a non-health care facility, such as a community center, sports arena, or hotel?
Has your hospital worked with the state or local health department to plan for prioritizing hospital workers to receive health agency–managed vaccine or antivirals in the event of an infectious disease emergency?
Does your hospital have a surge capacity plan?
Is your hospital plan coordinated with local/regional emergency response plan(s)?
Can an infection control professional from your hospital be available for an immediate (within 15 minutes) verbal consultation (by way of phone or face-to-face) on a 24-hour/7-day basis with the hospital or public health personnel?
Answer options: (a) sufficient for <50 patients, (b) sufficient for 50 to 100 patients, (c) sufficient for >100 patients
Would your hospital have sufficient levels of health care workers, such as nurses, physicians, pharmacists, radiology technicians, and respiratory therapists, to respond to a major infectious disease outbreak?
Answer options: (a) for current isolation needs, (b) for ≤10 patients, (c) for 11 to 50 patients, (d) for >50 patients
Does your facility have sufficient numbers of negative pressure rooms to accommodate a surge of the following:
Answer options: (a) for 10 additional ventilated patients, (b) for 100 additional ventilated patients, (c) for 500 additional ventilated patients
Does your hospital currently have sufficient medical equipment and supplies for surge capacity needs for patients requiring mechanical ventilation?

participated in a disaster exercise involving a bioterrorism (89.5%, n = 1562), chemical terrorism (75.2%, n = 1312), or mass casualty (83.6%, n = 1458) scenario during the past 3 years. In contrast, only 26.5% (n = 463) reported having participated in a disaster exercise using a nuclear or radiological incident scenario in the past 3 years.

SURGE CAPACITY

Although most ICPs reported that their hospital has a surge capacity plan (68.4%, n = 1194), almost 20% of ICPs reported that their hospital does not have such a plan (18.6%, n = 324), and 11% (n = 192) were unsure. Of those hospitals that do have a surge capacity plan, 82.2% (n = 981) reported that it is coordinated with their local/regional emergency response plan(s). There was no difference between hospital size or geographic location and having a surge capacity plan or having the plan be coordinated with local response plans. Many ICPs reported that their hospital has surge capacity plans to care for patients at a non-health care facility, such as a community center, sports arena, or hotel (63.3%, n = 1104); however, almost a quarter (23.3%, n = 406) reported that their facility does not have such plans and 12.6% (n = 219) do not know if such plans exist. There was no difference between hospital size or geographic location and having plans for off-site surge capacity.

NEGATIVE PRESSURE SURGE CAPACITY

Approximately 10% of ICPs (n = 182) reported that their hospital does not have sufficient numbers of negative pressure rooms to accommodate their current isolation needs, and approximately a third (33.7%, n = 588) have no negative pressure surge capacity. About 40% reported hospital negative pressure surge capacity for ≤10 patients (41.4%, n = 722), 21.8% (n = 381) can accommodate 11 to 50 patients, and only 3% (n = 52) have negative pressure surge capacity for ≥50 patients. There was no significant difference between hospitals' geographic location and their negative pressure surge capacity; however, there were significant differences between all hospital sizes and negative pressure surge capacity. Smaller hospitals (those with ≤100 beds or 101-250 beds) have less ability to accommodate a surge in patients who require negative pressure than do larger hospitals (251-500 beds or ≥501 beds; Kruskal-Wallis χ^2 (3) = 533.2, $P < .001$) (Table 3).

Less than half of the ICPs reported that their hospital has plans for the rapid set-up of a negative pressure

Table 3. Negative pressure, health care worker, ventilator, National Institute for Occupational Safety and Health–approved respirator, and surgical mask surge capacity by number of hospital beds

	Mean	SD	N	Kruskal-Wallis
Negative pressure surge capacity[†,a-f]				
≤100 beds	1.22	.79	578	
101-250 beds	1.82	.83	572	533.2*
251-500 beds	2.44	.82	370	
≥501 beds	2.62	.88	201	
Health care worker surge capacity[§,a-f]				
≤100 beds	0.81	.67	570	
101-250 beds	1.14	.76	556	290.8*
251-500 beds	1.61	.85	360	
≥ 501 beds	1.78	.89	196	
Ventilator surge capacity[¶,a-f]				
≤100 beds	0.19	.40	573	
101-250 beds	0.62	.52	554	513.4*
251-500 beds	0.90	.48	361	
≥501 beds	1.00	.54	188	
Surgical mask surge capacity[Ψ,b,c,d,e]				
≤100 beds	1.74	.61	559	
101-250 beds	1.68	.69	554	25.97*
251-500 beds	1.58	.74	362	
≥501 beds	1.58	.77	196	
NIOSH-approved respirator surge capacity[Ψ,b,c,e]				
≤100 beds	1.95	.45	573	
101-250 beds	1.93	.57	565	21.23*
251-500 beds	1.87	.67	363	
≥501 beds	1.77	.73	197	

NIOSH, National Institute for Occupational Safety and Health.
*$P < .001$.
[§]4-point health care worker surge capacity score (1 = no surge capacity, 2 = sufficient for ≤50 patients, 3 = sufficient for 50-100 patients, 4 = sufficient for ≥101 patients).
[¶]3-point ventilator surge capacity score (1 = surge for ≤10 patients, 2 = surge for ≤100 patients, 3 = surge for ≤1000 patients).
[†]4-point negative pressure surge capacity score (1 = sufficient for current isolation needs, 2 = surge for ≤ 10 patients, 3 = surge for 11-50 patients, 4 = surge for ≥51 patients).
[Ψ]1 = yes, 2 = no.
[a]Significant difference between ≤100 beds and 101-250 beds.
[b]Significant difference between ≤100 beds and 251-500 beds.
[c]Significant difference between ≤100 beds and ≥501 beds.
[d]Significant difference between 101-250 beds and 251-500 beds.
[e]Significant difference between 101-250 beds and ≥501 beds.
[f]Significant difference between 251-500 beds and ≥501 beds.

area in or near their facility as a surge capacity measure (43.7%, n = 763). The smallest-sized hospitals (those with ≤100 beds) were significantly less likely to have such than were hospitals with 101 to 250 beds (U = 146332, P = .01), 251 to 500 beds (U = 87728, $P < .001$), or ≥501 beds (U = 50096, $P < .01$) (Kruskal-Wallis χ^2 (3) = 19.92, $P < .001$). There were no significant differences between the other sized hospitals and their plans for rapid set-up of a negative pressure area. In addition, there were geographic differences; ICPs in the Midwest were significantly less likely than were those in the West or Northeast to report that their hospital has plans for the rapid set-up of negative pressure in or near the facility (Kruskal-Wallis χ^2 (3) = 10.78, $P < .05$) (Table 4).

Table 4. Rapid set-up of negative pressure, health care worker incentives, and ventilator surge capacity by hospital geographic location

	Mean	SD	N	Kruskal-Wallis
Rapid set-up of negative pressure[Ψ,a,c]				
Midwest	1.57	.63	434	
Northeast	1.67	.63	324	10.78*
South	1.66	.67	639	
West	1.73	.65	310	
Health care worker incentives[Ψ,b-e]				
Midwest	1.84	.68	439	
Northeast	1.85	.66	329	20.25**
South	1.69	.67	642	
West	1.74	.66	317	
Ventilator surge capacity[¶,a]				
Midwest	0.53	.56	429	
Northeast	0.64	.57	325	8.03*
South	0.58	.57	630	
West	0.58	.57	314	

*$P < .05$.
[¶]3-point ventilator surge capacity score (1 = surge for ≤10 patients, 2 = surge for ≤100 patients, 3 = surge for ≤1000 patients).
[Ψ]1 = yes, 2 = no.
**$P < .001$.
[a]Significant difference between Midwest and Northeast.
[b]Significant difference between Midwest and South.
[c]Significant difference between Midwest and West.
[d]Significant difference between Northeast and South.
[e]Significant difference between Northeast and West.

Health care worker surge capacity

Approximately half of the ICPs reported that their hospital has sufficient numbers of health care workers (nurses, physicians, pharmacists, radiology technicians, and respiratory therapists) to respond to an infectious disease outbreak involving a surge of ≤50 patients (49.1%, n = 856). Less than a quarter (21.4%, n = 374) reported that their hospital has sufficient health care workers to accommodate a surge of 50 to 100 patients, and only 8.4% (n = 147) can handle an influx of ≥100 patients. Almost 20% (18.7%, n = 327) reported that their hospital does not have enough health care workers to accommodate an influx of any number of patients. There were significant differences between all hospital sizes and their health care worker surge capacity, with smaller hospitals (those with ≤100 beds or 101-250 beds) having less ability to accommodate a surge in patients than larger hospitals (251-500 beds or ≥501 beds; Kruskal-Wallis χ^2 (3) = 290.8, $P < .001$; Table 3). There were no differences between hospitals' geographic location and health care worker surge capacity.

Almost half of the ICPs reported that their hospital's disaster plan does not include incentives for encouraging health care workers to continue working during an infectious disease emergency (48.9%, n = 854); 36.6% (n = 638) of hospitals' disaster plans do include such provisions; 13.5% (n = 235) of ICPs did not know if such plans exist. There were no significant differences between hospital size and the existence of health care worker incentives, but there were differences between hospitals' geographic location and the existence of such incentives (Kruskal-Wallis χ^2 (3) = 20.25, $P < .001$). Hospitals in the South and West were less likely than hospitals in the Midwest or Northeast to include health care worker incentives in their disaster plan (Table 4).

Medical equipment/supplies surge capacity

Three types of medical equipment/supplies were assessed by this survey: ventilators, National Institute for Occupational Safety and Health (NIOSH)–approved respirators for airborne precautions, and surgical masks for droplet precautions. Almost all of the ICPs reported that their hospital either does not have the supplies needed to care for an influx of patients who require mechanical ventilation (44.9%, n = 783) or they have surge capacity for ≤10 artificially-ventilated patients (48.7%, n = 849). Only 3.8% (n = 66) reported that their hospital can accommodate an influx of up to 100 ventilated patients; no hospital could provide for up to 500 such patients. There were significant differences between hospital size and ventilator surge capacity; smaller hospitals (those with ≤100 beds or 101-250 beds) reported less ability to accommodate a surge in patients who require ventilators than did larger hospitals (251-500 beds or ≥501 beds; Kruskal-Wallis χ^2 (3) = 513.4, $P < .001$; Table 3). In addition, there were differences between hospitals' geographic location and the ability to accommodate an influx of ventilated patients. Hospitals in the Northeast were more likely than were those in the Midwest to report being able to accommodate a surge in patients who require ventilators (Table 4).

Most ICPs (64.6%, n = 1128) reported that their hospital does not have enough NIOSH-approved respirators to handle a surge of 500 patients/visitors for 3 days; 21.5% (n = 375) reported that they would have enough respirators; 12.3% (n = 215) were not sure. In contrast, almost half of the ICPs (44.4%, n = 775) reported that their hospital would have enough surgical masks to handle a surge of 500 patients/visitors for 3 days; 40.3% (n = 704) indicated that they would not have enough masks; 12.2% (n = 213) did not know. There were significant differences between hospital size and availability of NIOSH-approved respirators and masks for surge capacity (Table 3). There were no differences between hospitals' geographic location and respirator or mask surge capacity.

DISCUSSION

The findings of this study indicate that U.S. hospitals are beginning to address some infectious disease emergency planning issues. Similar to previously published research, this study indicates that most U.S. hospitals have a disaster plan that is coordinated with other agencies, have appropriate infection control representation on their disaster planning committee, have around-the-clock access to infection control consultation, and are participating in various types of disaster exercises.[6,7] Although many ICPs report that their hospital has a plan for surge capacity and that this plan is coordinated with local/regional plans, a significant proportion of hospitals (approximately 20%) do not have a plan for surge capacity. This identified lack of a surge capacity plan is similar to previously published literature.[6,7] In addition, almost a quarter of U.S. hospitals do not have plans to care for patients at an off-site/non-health care facility, such as a community center, sports arena, or hotel; this is a necessary component of surge capacity planning as evidenced by the nation's response to Hurricane Katrina in 2005.[14]

A large proportion of health care facilities report that they do not have enough health care providers to accommodate an influx of any number of patients, and of those that can handle a surge, they can only manage ≤50 patients. This may be a reflection of the general shortage of health care providers that not only affects routine patient care, but also disaster planning. Smaller-sized hospitals report less health care worker surge capacity than do larger facilities, which is logical given that smaller hospitals have fewer staff from which to draw during a disaster. It is critical, however, that hospitals of all sizes continue to develop plans for obtaining extra staff to respond during an infectious disease emergency, because this will affect a hospital's ability to care for patients. One way to accomplish this is for hospitals to include provisions for health care worker incentives to encourage them to come to work during an infectious disease emergency, something that less than half of U.S. hospitals report including in their disaster plan.

The results from this study indicate that a fair proportion (10%) of hospitals do not have enough negative pressure rooms to care for their current patient load, a finding that is different from that reported by other researchers.[15] Although researchers have indicated that the number of negative pressure rooms is increasing,[15,16] the findings from this study indicate that this does not translate into negative pressure surge capacity. Another unique finding from this study is that smaller-sized hospitals have less negative pressure surge capacity and are less likely to have developed plans for the rapid set-up of negative pressure than are larger-sized hospitals. Local/regional planning efforts that aim to spread out the burden of potentially contagious patients among several hospitals by way of a coalition or in nearby facilities may aid smaller-sized hospitals in handling an infectious disease outbreak. A bioterrorism attack or outbreak of an emerging infection involving an agent that is transmitted by way of the airborne route would require the use of negative pressure rooms and would be expected to exceed hospitals' current capacity to house potentially contagious patients. It is important that U.S. hospitals of all sizes continue to develop plans for negative pressure surge capacity.

A significant finding from this study is the lack of ventilator surge capacity in most U.S. hospitals. Almost all ICPs report that their hospital cannot accommodate an influx of any patients who require mechanical ventilation or that their facility can handle fewer than 10 such patients. Smaller-sized hospitals have less ventilator surge capacity than do larger-sized hospitals; this is likely related to the decreased ability of many small hospitals to provide large volume intensive care. Many potential bioterrorism agents and emerging infections cause diseases that result in severe respiratory distress or failure that would require prolonged intensive care for patients, including the use of mechanical ventilation. Without ventilator surge capacity, patient care could be compromised severely and result in increased morbidity and mortality. Most U.S. hospitals also report a lack of NIOSH-approved respirators, and half do not have sufficient numbers of surgical masks to handle a 3-day influx of patients. Although ventilators, respirators, and masks will have some availability through the Centers for Disease Control and Prevention's Strategic National Stockpile, there will be a delay before such resources are made available at the local level and the amount available might not meet the demand. The U.S. hospitals need to plan for surge capacity for ventilators, respiratory protection equipment, and other essential medical supplies until federal resources are made available. If not, significant ongoing discussion regarding altering or adjusting standards of care should become a more predominant theme.

For many of the hospital preparedness issues that were assessed by this survey (infection control representation on the hospital disaster planning committee, around-the-clock access to infection control consultation, and some surge capacity indicators), there are no significant differences in the level of preparedness across hospitals in relation to bed size or geographic location. Smaller-sized hospitals have less surge capacity than do larger-sized hospitals in relation to health care worker and medical equipment/supplies surge capacity, however. In addition, this study indicates that Midwest hospitals are less likely than are those in the West or Northeast to have plans for negative pressure surge capacity, and have less ventilator surge capacity. Hospitals in the South are less likely to have plans/provisions for health care worker incentives. These regional differences pose unique challenges to disaster planning because there is less ability for a hospital to rely on neighboring facilities to fill the gaps in resources and staff needed to respond to an infectious disease emergency.

A few limitations of this study must be noted. One limitation is the potential issue of non-responder bias. Characteristics of the non-responders or their facility could not be assessed directly, which is a common issue in survey research. It also is possible that some respondents provided information about the same hospital, which may decrease data validity and reduce sample size. There was a higher than expected response rate from ICPs in Northeastern hospitals and those in larger-sized facilities based on the American Hospital Association hospital demographics.[9] This likely is due to the increased interest and awareness surrounding infectious disease emergency preparedness in the Northeast (due to the 2001 terrorist events) and in larger-sized hospitals (due to the employment of more ICPs which leads to oversampling and the possible perception that these facilities will bear the largest responsibility for treating victims). Another limitation is that all ICPs were invited to participate in this survey, regardless of whether they were a member of their hospital's disaster planning committee or had any knowledge of their facility's disaster plan. The answer option, "I don't know," was chosen a fair amount of the time. It is not known whether the survey question items assess issues that hospital disaster planning committees are not addressing or whether the ICP who answered the survey was not a member of their disaster planning committee or was not familiar with the details of their facility's surge capacity plan. If multiple ICPs in a given hospital are collectively unfamiliar with the emergency response plans for their facility, this could indicate a further area of concern.

CONCLUSION

Hospital preparedness for infectious disease emergencies has become essential. This study identifies gaps in U.S. hospital preparedness and highlights the areas that are most in need of being addressed: negative pressure, health care worker, and medical equipment/supplies surge capacity. Differences between hospitals of various sizes and gaps in regional planning are outlined. The U.S. hospitals must continue to address gaps in infectious disease emergency planning.

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