ORIGINAL RESEARCH

Counting Crises: US Hospital Evacuations, 1971–1999

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Keywords: benefits; cost; evacuations; events; hazards; hospitals; planning; risk

Abbreviavions:
AHA = American Hospital Association
HazMat = hazardous materials
NFPA = National Fire Protection Association
US = United States

Research was supported by a grant from the Earthquake Education Research Centers Program of the National Science Foundation to the Multi-disciplinary Center for Earthquake Engineering Research (Grant EEC-9701471).

Web publication: 13 August 2004

Abstract

Objectives: To investigate the relative distribution of hazards causing hospital evacuations, thereby to provide rudimentary risk information for hospital disaster planning.

Methods: Cases of hospital evacuations were retrieved from newspaper and publication databases and classified according to hazard type, proximate and original cause, duration, and casualties. Both partial and full evacuations were included. The total number of evacuation incidents for all hazards were compared to the total number of hospital incidents for the one hazard, fire, for which national data is available.

Results: There were 275 reported evacuation incidents from 1971–1999, with an annual average of 21 in the 1990s, the period for which databases were more reliable. The most, 33, were recorded in 1994, the year of the Northridge Earthquake. Of all incidents, 63 (23%) were attributable primarily to internal fire, followed by internal hazardous materials (HazMat) events (18%), hurricane (14%), human threat (13%), earthquake (9%), external fire (6%), flood (6%), utility failure (5%), and external HazMat (4%).

Conclusions: More than 50% of the hospital evacuations occurred because of hazards originating in the hospital facility itself or from human intruders. While natural disasters were not the preponderant causes of evacuations, they caused severe problems when multiple hospitals in the same urban area were incapacitated simultaneously. Clearly, as hospitals are vulnerable to many hazards, mitigation investments should be assessed not in terms of single-hazard risk-cost-benefit analysis, but in terms of capacity to mitigate multiple hazards. In view of the many qualifications and limitations of the dataset used here, but value of such data for disaster planning, hospitals should be asked to submit standardized incident reports to permit national data gathering on major disruptions.

Sternberg E, Lee GC, Huard D: Counting crises: US hospital evacuations, 1971–1999. *Prehosp Disast Med* 2004;19(2):150–157.

Introduction

This article uses academic and newspaper databases to compile a provisional list of hospital evacuations in the United States (US) to identify the range of hazards that cause them. Then, it compares this limited dataset to more extensive data obtained just for hospital fires by the US Fire Administration. Results should assist hospital administrators and facility designers in the assessment of the frequencies and types of internal disruptions that hospitals are likely to face.

Results should have value to disaster planners, since hospital crises are of broad interest in community-wide disaster management. Like a police station or emergency operations center, the hospital is an *essential facility*—the

https://doi.org/10.1017/S1049023X00001667 Published online by Cambridge University Press

Evacuees	Incidents
1,000+	3
500–999	2
100–499	51
50–99	27
1–49	60
Total Reported	143

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Table 1—Reported number of evacuees (n = 143)

Duration (hours)	Incidents
24 hours or over	12
12–23:59 hours	5
2–11:59 hours	19
up to 1:59 hours	7

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Table 2—Reported durations of evacuations (n = 43)

facility is itself necessary for disaster response on behalf of the community. Simultaneously, like a school or nursing home, it is a *vulnerable facility*, with occupants more likely to need help than occupants of other buildings. Being both essential and vulnerable, a hospital that is unable function and needs to evacuate is indeed a serious matters for the community at large.

It need hardly be said that those responsible for hospital operations must be concerned about hazardous events severe enough to warrant evacuation. Whether fires, earthquakes, utility outages, or hazardous waste spills, these events can cause injury and death. They disrupt essential hospital services, undermine patient care and harm the hospital's financial condition. And, if these reasons are not enough, then healthcare practitioners and managers should be concerned at least because US accreditation (by the Joint Committee on the Accreditation of Healthcare Organizations) and licensure (by some states) require hospitals to conduct at least nominal disaster planning, including planning for the possibility of evacuation.

These responsible officials may well resist investments in disaster preparedness, in light of the many other pressures impinging on contemporary hospitals. They may ask: "How high is the likelihood of the kind of crisis (the kind that can lead to an internal disaster) that precipitates an evacuation?" And, "What kinds of hazards generate such crises?" To the best of the authors' knowledge, the evacuations dataset to be provided here—despite all the qualifications and limitations that it must be recognized to have—offers the first quantitative answers to the second question. As is shown, however, it is not yet possible to estimate a reasonable answer to the first question.

By way of definition, an *internal crisis* should be understood as an event that disrupts or poses the immediate danger of disrupting hospital operations and patient care sufficiently to endanger patients, visitors, or staff. Internal crisis may, but need not necessarily, turn into an *internal disaster*, in which casualties and extensive suspension of services occur. The rationale for this distinction—not normally made in the disaster management literature—between crisis and disaster is that the crisis provides important opportunities for averting a full-blown disaster.[1]

Causes of an internal crisis may include utility failures or armed intruders inside the facility or by outside events (earthquake, fire in a neighboring building, or a railway accident spilling hazardous materials (HazMat)) affecting the facility. What makes it an internal crisis (with the possibility of becoming an internal disaster) is *not* that it is internally caused, but that it is internally disruptive. To qualify as an internal crisis, the event should threaten disruption past some threshold that is difficult to define in the abstract—it should threaten all or a significant portion of the facility. Therefore, the crisis should be distinguished from a routine internal mishap, such as a disruptive patient posing a limited threat, a materials spill isolated to one enclosed space, or an elevator malfunction.

Quite contrary to expectations, severe internal disruptions seem to be more common in hospitals than are community disasters affecting hospital function through patient surge (according to Milsten,[2] though the evidence for the assertion is unclear). The worst scenario, however, takes place when an external disaster, say an ice storm or a wildfire, undermines hospital operations while simultaneously straining hospital resources through patient surge. Hospitals better prepared for internal crisis also will be better prepared for the rarer, but more formidable task of responding when patient surge coincides with internal disruption.

Though there are several compilations of advice on how hospitals should prepare for internal disasters,[3–7] the subject has received relatively little research attention.[8] Moreover, the effectiveness of preparations at many hospitals is in doubt. Hospitals are required to prepare internal disaster plans, but these—in Erik Auf der Heide's words—reflect a "paper plan syndrome."[9] Though formally prepared, they often are done as a matter of rote, are insufficiently practiced through drills and exercises, and, in the event of an actual crisis, often are not even consulted. Research on Japan has shown similarly low commitment to hospital disaster planning, especially for crises within the facility.[10] Auf der Heide described this inattention to internal disaster as "apathy," due to the perceived low probability of the event. However, the reluctance to address the problem may have had a deeper foundation. Our impression—from anecdotal evidence—is that, whereas plans for external disaster confirm healthcare practitioners' self-perceptions as solvers of medical crises, the internal disaster put the hospital and its staff in the position of victims, a prospect that many practitioners may prefer to think of as quite remote. The therapy for this attitude should be not alarmism, but better data.

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Year	All Reported Evacuations	Specific Natural Events	Evacuations Attributable to Specified Event
1989	19	Loma Prieta Earthquake	6
1992	26	Hurricane Andrew	15
1994	33	Northridge Earthquake	14
1998	23	Hurricanes Bonnie & George	8
1999	28	Hurricane Floyd	10

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Table 3—Number of hospital evacuations associated with specific natural events

AK	1	IN	4	NE	2	RI	1
AZ	7	KY	4	NH	1	SC	10
CA	77	LA	14	NJ	10	SD	1
CO	4	MA	12	NM	2	TN	1
CT	1	MD	3	NV	1	TX	15
DC	4	MI	1	NY	7	UT	1
FL	29	MN	3	OH	6	VA	6
GA	3	MO	4	OK	5	WA	10
IA	2	NC	3	OR	3	WI	1
IL	6	ND	1	PA	8	WV	1

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Table 4—Hospital evacuations by state, 1971-1999 (States not appearing had no reported evacuations.)

Since 11 September 2001, the interest in hospital readiness for disaster has increased dramatically, as sources have warned of shortfalls in medical preparedness for catastrophic terrorism.[11] Disruptions that a terrorist incident would cause within medical facilities themselves would greatly exacerbate the shortfall. The data for this study, which precede 2001, serve as a baseline on the range of causes of internal disaster even when domestic security is not a primary concern.

This article uses academic and newspaper databases to compile a provisional list of hospital evacuations in the United States (US) to inquire into the range of hazards that cause them. Then, it compares this limited dataset to more extensive data obtained just for hospital fires by the United States (US) Fire Administration. Results should assist hospital administrators and facility designers assessing the frequencies and types of internal disruptions that hospitals are likely to face.

Methods

The dataset abstracted below is about evacuations, which only are one type of response to an internal crisis. Depending on many conditions, including the acuteness of the onset of the hazard, a hospital can engage in a range of responses to severe internal disruption. These may include: (1) continued intensified operations with call-in of staff and volunteers; (2) curtailed service; and (3) postponement of elective procedures, in addition to evacuation. Evacuations then, are only some of the possible responses to an internal crisis. Yet, they do constitute and important kind of response, ones that clearly can be enumerated from textual mentions.

The terms "evacuation" and "evacuate" are effective keywords for identifying and enumerating cases from secondary sources. Using Boolean operators to combine these keywords with "hospital" or "medical center" (and likely variations of these), a search was conducted to identify cases in standard databases: Dow-Jones, HazLit, HealthStar, LexisNexis, and Quakeline, as well as sources obtained through citations. From each case description, the following types of information, if available were abstracted: (1) hospital name; (2) location; (3) event date; (4) hazard type; (5) duration of evacuation; (6) number evacuated; (7) fatalities; (8) injuries; and (9) causes of the hazards. Newspaper sources were the most productive, but of variable quality.

Graduate students in urban planning and civil engineering at the University at Buffalo read and classified all the articles under a faculty member's supervision. The data were inserted into an Excel database (Microsoft, Inc, Redmond, Washington USA, 2001) with hyperlinks from almost all entries to the descriptions of the event—whether summaries prepared by the students or direct copies of the articles.

The search began with the year 1971, the year of the partial collapse of the Veterans Administration Hospital in Sylmar, California during the San Fernando earthquake that caused 49 fatalities, the largest number in a hospital disaster within the last 30 years. Overall, 275 cases of hospital evacuations were found, ranging from minor ones affecting a handful of people and lasting a few minutes, to enormous evacuations of hundreds of patients and staff for several days. All hospital evacuations were included: horizontal (within the same floor), vertical (between floors), building evacuations of a ward or wing, and total hospital evacuations.

The following hazard classification turned was the most informative: (1) earthquake; (2) fire (external); (3) external HazMat; (4) fire (internal); (5) flood; (6) HazMat (internal); (7) human threat; (8) hurricane; (9) utility failure; (10) weather; and (11) miscellaneous.

Evacuations attributed to fire alarm, smoke or actual fire within a hospital building or within a medical campus

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	CA	FL	TX	LA
Earthquake	26	0	0	0
Fire (External)	7	2	1	0
HazMat (External)	1	1	0	1
Fire (Internal)	10	2	5	4
Flood	2	0	2	1
HazMat (Internal)	21	2	3	0
Human Threat	7	4	0	4
Hurricane	0	18	0	4
Miscellaneous	1	0	0	0
Utility Failure	1	0	2	0
Weather	1	0	2	0
Total Reported Evacuations	77	29	15	14

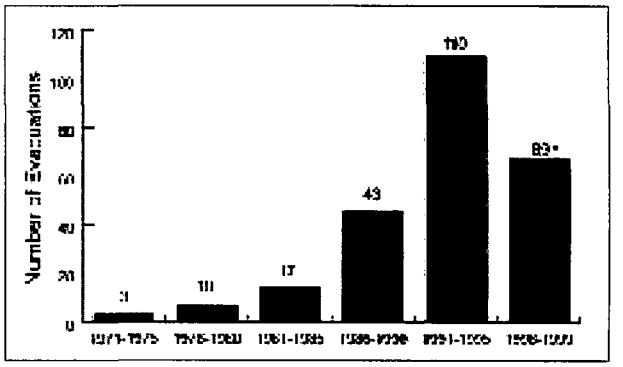
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Table 5—Number of incidents involving evacuation of a hospital by cause for the four states with the largest frequency of evacuation (HazMat = hazardous materials; CA = California; FL = Florida; TX = Texas; LA = Louisiana)

(unless it was in a nursing home, which was excluded from the list), were all classified under "fire". Those due to fumes or spills suspected as hazardous were listed as "HazMat" along with actually hazardous leaks or spills. Flooding accompanying hurricane was classified under "hurricane". "External fire" consisted of wildfire or fire in nearby buildings or a combination of both. Similarly, "external hazmat" referred to hazardous materials releases outside the facility, but causing a crisis inside the facility. "Utility failure" included failures of electrical, medical gas, natural gas, sewer, and water systems. "Weather" included severe windstorms, rainstorms, and snowstorms, but excluded hurricanes.

Since a natural disaster often creates crises indirectly, by damaging utilities (such as electrical or water systems on which the hospital operations depend), evacuations occurring in such cases were placed under the primary classification, namely the earthquake, flood, hurricane, etc. as appropriate. Evacuations were classified under the primary category "utility failure" when the failure was not attributable to fire or natural disaster.

Where the information was available, two causal attributions were included for each case of evacuation: immediate (proximate) cause and original cause. In cases of earthquake, the original cause of evacuation is a named temblor (such as "Northridge"), while the immediate cause may be fear of structural failure, actual structural failure, water failure, elec-



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Figure 1—Reported US Hospital evacuations by five-year intervals (*Data limited to four years)

trical failure, or multiple failures. Under the category "fire", the immediate cause of evacuation is alarm, false alarm, smoke, or actual fire, while the original cause could be smoking in bed, misuse of a welding torch, or combustion in a kitchen or electrical switchbox. For evacuations due to human threat, immediate causes included bomb threat, actual bombs, armed intruders and hostage events, while original causes would have been psychological states or social conditions on which no information was available.

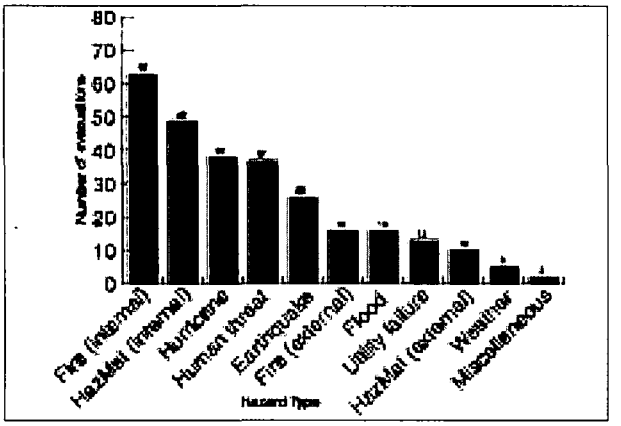
Users of the quantitative result should understand its limitations. The most general limitation is that published reports of variable quality were used. The reporters who filed their stories were not trained investigators. Some of the stories may have been erroneous. Moreover, only reported evacuations were included. Those that were not reported in a newspaper and article were missed. Though the result is a severe undercount, it allows us to estimate the distribution of evacuations by hazard type.

The results show increasing numbers of evacuations from decade to decade. This can be attributed primarily to the increasing coverage by periodicals around the country. Data for the 1990s was more robust than was that for the 1970s. Nonetheless, some of the increase is attributable to the greater number of natural events that resulted in disasters in the 1990s.

There were relatively few hospital evacuations reported in large cities, such as Chicago and New York City. This result probably is related to the fact the tendency of large metro newspapers to be less likely to report relatively minor evacuations than are rural or small town newspapers. Users also should be aware that, because of the investigators' affiliation with the Multidisciplinary Center for Earthquake Engineering Research, there was very good access to data about earthquakes, so the enumeration unintentionally may be biased toward inclusion of earthquake-induced evacuations relative to other causes. Finally, evacuations should be understood as providing limited representations of hospital internal crises, since hospitals also have other ways of responding to potential disaster, as by curtailing services.

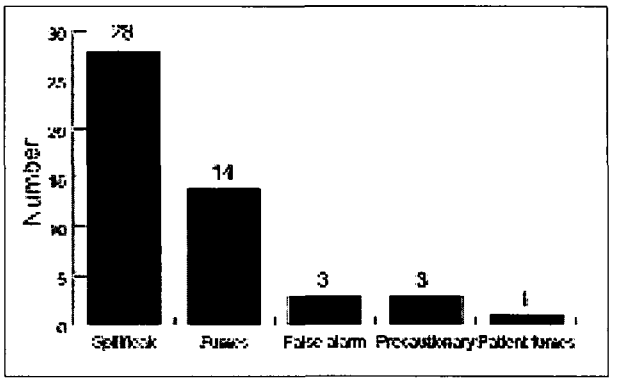
These data are interesting for the range of hazards they reveal, and cannot be said to estimate total number of hospital internal crises. Better data are available from the

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Figure 2—Reported US hospital evacuations by hazard type, 1971–1999



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Figure 3—US hospital evacuations resulting from internal hazardous material events, 1971–1999

National Fire Protection Association, but many of these were minor (may not have imminently threatened disruption amounting to disaster) and were limited to internal fires. For estimating the distribution of hazards in hospital internal crises, this report presents the only available compilation of data. There were no attempts to independently verify the data found in the published sources.

Why is there such a large discrepancy between the evacuation data and fire data? One reason is that the first dataset was limited by its origin in published descriptions of evacuation incidents, while the latter reflects reports submitted by municipal fire departments after fires. Moreover, the two sets measure different kinds of incidents: the first measures incidents serious enough to warrant evacuation while the latter measures any fire, no matter how minor, whether or not there was an evacuation, and includes infirmary buildings.

Results

Overall Evacuations

As shown in Figure 1, the numbers of reported evacuations increased per year from a mere handful in the 1970s and early 1980s, to as many as 33 in one year, 1994—the year of the Northridge earthquake. Indeed, the results show that US hospitals averaged just under one per year in the 1970s, 5.7 in the 1980s, and 20.8 in the 1990s (Table 1). The data from the 1990s were the most accurate, therefore, 20.8 or 21 was selected as the lower bound for reported evacuations per year in the US. This result is compared with the far larger number of annually reported fires in healthcare facilities, giving a range for estimating the risks for internal crisis. In the meantime, the evacuation data allows for an estimate of the distribution of internal crises by type of hazard.

Severity of Incidents

To find out how about the seriousness of the evacuation, sources were searched for information on the number of people evacuated, the durations of the evacuation, and the number of fatalities and the number of persons injured. As could be expected, many of the published sources omitted such information, gave rough verbal estimates ("a few hours"), or offered data ranges. Mostly they were "ballpark" figures; they did not result from rigorous inquiry.

In the incidents in which numbers of evacuees were reported, the top one showed 1,491 persons were evacuated from St. John's Hospital in Santa Monica in 1994 after the Northridge earthquake. Two other incidents (University of California-San Diego Medical Center, 1992, from external fire; and Children's Hospital in Oklahoma City in 1995, from a bomb scare) were estimated to have had 1,000 evacuees each. Of the 143 incidents for which numbers of evacuees were reported, only these three had 1,000 or more evacuees. In 51 incidents, the evacuees were reported to number from 100–499 each. Incidents with ≤49 evacuees were the most numerous—60 were reported. The smallest number of persons reported in an "evacuation" was three in each of two incidents. Results are shown in Table 1.

Durations of the incidents also varied widely. Of 43 incidents for which duration was reported, 12 were hospital evacuations of ≥24 hours; five lasted from 12 to just under 24 hours; 19 lasted from 2 to just under 12 hours; and seven lasted under two hours (Table 2).

Of the 275 incidents identified, 30 reported injuries and/or fatalities. In the most severe, domestic, hospital disaster, the partial collapse in 1971 of the Veterans Administration Hospital (Sylmar, California) took 49 lives. The second most severe event, a fire at Southside Regional Medical Center in Petersburg, Virginia in 1995 is reported to have led to four deaths and five injuries. Among events reported to have persons injured but not killed, the most severe was a fire at Lincoln Hospital in New York City with 70 reported injuries. Overall, of 275 listed hospital evacuations, 11% listed at least one casualty.

Evacuations by Hazard Type

Despite the extensive precautions taken around the US, of the 275 incidents of hospital evacuation, 63 (23%) were attributable primarily to internal fire. Fourty-nine incidents were attributable primarily to internal HazMat events. In addition, 13 incidents were utility failures occurring within the facility (they were not failures caused by natural events—those were classified under the specific

https://doi.org/10.1017/S1049023X00001667 Published online by Cambridge University Press

hazard, such as hurricane or earthquake). Forty-five percent of cases, not counting incidents of human threat, originated within the hospital facility (Figure 2).

Of other hazard types, the most common were hurricane in 38, varied human threats in 37, earthquake in 26, flood in 16, external HazMat event in 10, and weather events other than flood or hurricane in five (Figure 2). Listed under the "miscellaneous" heading, only one case was found in which patients were evacuated because of a transmissible disease—the City of Hope Medical Center in Duarte, California reported to have been evacuated in 1986 because of Legionnaire's Disease.

Natural Disaster

Though we attribute the decade-to-decade increase in evacuations mainly to the improved coverage by the periodical sources, there also was an increased number of incidents arising from the especially destructive natural disasters experienced since 1989. Several annual peaks in the number of evacuations are attributable to these natural disasters. Of the 26 reported evacuations in 1992, fully 15 were attributable to Hurricane Andrew; of the 33 in 1994, 14 were attributed to the Northridge Earthquake. Similar effects were seen following the Loma Prieta earthquake in 1989, Hurricanes Bonnie and George in 1998, and Hurricane Floyd in 1999 (Table 3). A disturbing conclusion from these data is that, in a large proportion of incidents, hospitals face evacuation at the same time that other hospitals in the region face a similar decision. They must undertake this dangerous action when emergency services already are strained, and there are reduced options for patient transfer.

Evacuations by State

For the 1971–1999 period, evacuations were reported in 29 states and the District of Columbia. California tops the list with 77 hospital evacuations, followed by Florida with 29, Texas with 15, Louisiana with 14, Massachusetts with 12, and New Jersey, South Carolina, and Washington State with 10 each (Table 4). Coastal states are disproportionately represented, as is California, which is coastal, has earthquakes and wildfires, and is the most populous. However, New York State reports relatively few hospitals evacuations (seven) for its population. Explanations may include low coverage of minor evacuations in the metropolitan New York City press (hence a limitation of the data), few natural disasters during the time period studied, and the state's relatively stringent fire codes.

As one would expect, California's reported evacuations are heavily weighted by earthquake disasters (26 of 77), though evacuations attributable to internal plus external HazMat incidents are almost as common (22 of 77). Of Florida's 29 reported evacuations, 18 were attributable to hurricanes, with human threat trailing as the second major cause (4 of 29). In Texas, internal fire was the top cause (5 of 15 reported incidents), while in Louisiana the top causes were evenly distributed among internal fire, human threat, and hurricane (4 each of 14 reported evacuations). As summarized in Table 5, the data suggest that hospitals in different regions ought to have different priorities for preparedness for internal crises.

Fire, Internal and External

While enumerating fires in our published sources, further details also were sought, including attributions of cause. Of the 63 evacuation incidents reported that were associated with internal fire as the primary hazard, 46 included attributions of cause. Common causes were electrical malfunctions, "torch" events (from cutting, welding, and roofing torches, especially on roofs), arson or suspected arson, and mattress fire, often presumed to be from a patient smoking. A number of descriptions of mattress fires spoke of patients who denied they had been smoking. Note, however, that data from the US Fire Administration and the National Fire Protection Association, discussed below, provide far superior data on causes of fire in health care facilities.

Of the 16 reported external fires—occurring outside the hospital building or medical campus—that led to evacuation within the hospital, nine were wildfires, and the rest were other urban fires that threatened or affected the hospital. Three external fires were associated with welding, roofing, or cutting torches.

Other Hazards

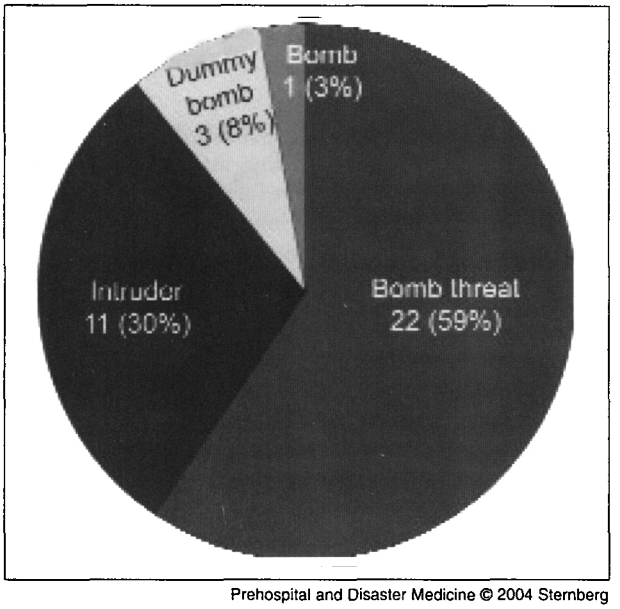
Of the 49 incidents attributed to internal HazMat events, 28 were associated with a "spill" or "leak," 14 with fumes, and six appeared to be precautionary or to result from what were reported to be false alarms (Figure 3). Many of the reports stressed the great uncertainty that hospital staff faced in deciding whether spilled or leaking material, or the fumes, were indeed hazardous.

After internal fire, internal hazmat event, and hurricane, human threat was the next most important reason for hospital evacuation. This proved to be an especially difficult kind of event to classify. The 37 incidents that were attributed to "human threat" encompassed 22 bomb threats, 11 intruders deemed dangerous, three dummy bombs, and one actual bomb (Figure 4).

Comparison with National Fire Data

From the inventory of reports on hospital evacuations, a working figure of 21 hospital evacuations per year in the 1990s was derived. Data assembled by the US Fire Administration[12] and by the National Fire Protection Association (NFPA)[13] show far higher numbers of incidents just for fires. For the years 1994–1998, the NFPA estimates an annual average of 1,900 fires in a US hospitals and "hospital-type" infirmaries. Of these, about 20% are caused by electronic equipment, motors, or generators; 18% by cooking equipment; 15.6% by appliances, tools, or air conditioners; and 12% by electrical distribution systems. Also, 10.5% are listed as "suspicious", 7.6% as due to smoking (a decrease from previous years), and 7.4% as due to open flames or torches. The NFPA analysis also indicates a nationwide, annual average of five civilian deaths in hospitals from fires, along with an annual average of 107 persons injured.

https://doi.org/10.1017/S1049023X00001667 Published online by Cambridge University Press



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Figure 4—Reported US hospital evacuations resulting from human threat, 1971–1999

Hospital Crisis Risk per Year

According to the American Hospital Association (AHA), the number of hospitals in the US stood at 6,649 in 1990, and dropped to 6,021 by 1998.[14] No doubt the meaning of "hospital" as defined in the evacuation reports and in national fire data corresponds imperfectly with the definition used by the AHA. Nonetheless, when the two datasets are compared to the AHA information, they reveal the enormous discrepancy in potential estimates of internal crisis risk.

From the evacuation data obtained in this study, it is estimated that (average reported evacuations per year in the 1990s divided by the average annual number of hospitals) a US hospital in the 1990s had a 0.33% annual probability of undergoing a reported evacuation per year. However, from the NFPA data, the likelihood differs by two orders of magnitude. If all hospitals had equal chances of experiencing a fire, then hospitals faced a 31% chance of having an average of one fire per year. Moreover, the NFPA data exclude other hazards, such as HazMat events, which would raise considerably the number of serious internal incidents that hospitals face.

For perspective, compare these results to the 1% annual likelihood (100 year return) conventionally used by as the standard in community planning against flood hazards. By the very limited results of the all-hazard evacuations dataset, hospitals face a lesser 0.33% annual likelihood of an evacuation. However, by the rather complete NFPA results, hospitals on the average face an annual 31% chance of fire only; HazMat, earthquake, utility failure, etc., would be additional hazards for each facility.

Discussion

In general, hospitals are exposed to varied hazards capable of causing crisis in the facility—the data reinforce the long-understood need for multi-hazard disaster planning. Despite the overt limitations of the data, those responsible for hospital disaster planning can draw some lessons from this study.

First, in at least 275 instances from 1970–1999, US hospitals indeed have faced the painful but urgent decision about evacuation. Relatively few of these turned into disasters; there were only nine instances in which there was at least one reported fatality. The NFPA fire analysis shows larger numbers of fatalities and persons injured, but these still constituted small percentages of all hospital fires. In many of the cases without a fatality, it may have been the rapidity and efficiency of response, sometimes including evacuation, that prevented the crisis from turning into disaster.

Second, while natural events are not the preponderant cause of evacuations, they do cause particularly difficult problems: several hospitals can be incapacitated simultaneously. At the very moment when the hospital is needed, first responders may be otherwise occupied, and the hospitals to which patients could have been transferred may be disrupted themselves. Therefore, hospitals located in regions subject to hurricanes and earthquakes should engage in extraordinary mitigation investments to remain operational. A reasonable additional precaution would be mutual-aid across regions, to enable long-distance patient and staff transfer during emergencies, though such agreements call for complex and time-consuming negotiations.

Third, despite the continuing impacts of natural event, the primary source of crisis in hospitals continues to be events that occur within the hospital. Of the 275 incidents studied, 162 (56%) were attributable to internal fire, internal HazMat, human threat, and utility failure not caused by an external event. As the number of hospitals in the US declines while the facilities themselves become larger, and as the facilities incorporate ever more elaborate utility systems and equipment, while maintaining high occupancy and intense activity 24 hours each day, hospitals increasingly are finding that the source of their greatest risk is the increasing complexity of the facilities themselves. Though hospitals must be aware of new threats, like terrorism and future "super-hurricanes", they also should be aware that seriously disruptive events still are most likely to emanate from their own facilities.

Fourth, there is reason to maintain a distinction between "crisis" and "disaster". The vast majority of the incidents did not produce casualties. Of the 275 reported cases, only nine had at least one fatality and only seven had >10 injuries. Of the 143 incidents that reported the numbers of evacuees, just over half had <99 evacuees. Of incidents for which duration was reported, the majority lasted <12 hours. Most of the incidents could not be reasonably described by the usual terminology as "internal disasters". It is more accurate to refer to them—as we have done in this paper—as internal crises, during which critical decisions are made about how to preserve patient care, protect occupants, and avert disaster. This crisis opportunity to avoid disaster merits more specific study than it has received so far.

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Fifth, it is clear that hospitals are exposed to multiple hazards. Some building features, such as the design of corridors, stairs, and doorways for egress, are protective across multiple hazard types. Cabinet restraints that help against earthquakes also may protect against accidental spillage of hazardous materials. Back-up communications systems could help under multiple dangerous conditions. Therefore, engineered structural and nonstructural mitigation efforts should be assessed not just with respect to the risk-adjusted, benefit:cost ratio of the particular hazard, but also with respect to complementary benefits across multiple hazards. Hospitals benefit from multi-hazard design and planning.

Conclusion

Finally, in light of enormous discrepancies revealed in comparing these evacuation data to the fire data, hospital crises clearly deserve more thorough empirical research. This research should include incident investigations, such as fire investigations, to ensure that, when there are etiological patterns—such as chemical storage practices that lead to HazMat incidents, or welding and cutting torches as important causes of fires—healthcare administrators are warned. Indeed, hospitals should be required to submit an investigative report on each internal crisis, even if it resulted from a false alarm. Since one should expect that a hospital, just as a matter of good management, would conduct an investigation after a disruptive incident, it should not add a heavy reporting burden to require that such an investigation result in a written report submitted to a national data center in a standard format. With more accurate data, hospitals professionals should be better prepared to overcome their reluctance to recognize their own facilities' vulnerability.

Acknowledgment

We appreciate research assistance by Lisa Kuligowski, Daniel McMullan, Sal Militello, Jason Powers, Eric Simeone, Scott Stefano, Allita Steward, and Paul Twyman.

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https://doi.org/10.1017/S1049023X00001667 Published online by Cambridge University Press