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# How to Evacuate When Disaster Strikes: A Literature Review of Hospital Evacuations

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Emergency Preparedness

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*Abstract*

Hospitals are an essential component of any community's infrastructure, and due to the nature of their services they are vulnerable when a disaster strikes. If a disaster is severe enough to warrant a hospital evacuation, both hospital and community leaders must decide how to proceed with the resources at their disposal. Organizations such as the World Health Organization, the United Nations, and the United States Department of Health and Human Services offer general guidance, but specifics as to how a hospital should proceed with an evacuation are left to individual hospital leaders and emergency management teams. This capstone project will review the existing literature surrounding hospital evacuations as well as recommendations from international authorities, identify gaps in current literature and official recommendations, and pinpoint opportunities for improvement in future hospital evacuations. As an attempt to address gaps in the literature, a four-step framework that can be utilized to provide structure to a hospital undertaking an evacuation will be recommended.

*Introduction*

The primary research questions that this capstone project will attempt to answer are: "How does a hospital evacuate when a disaster necessitates it?" and "How can the evacuation process of a hospital be improved?"

I attempted to answer these research questions by reviewing the available literature in three primary areas. First, I reviewed existing recommendations for hospital evacuations from the World Health Organization, the United Nations, and the United States Department of Health and Human Services. While no specific, standardized protocols for hospital evacuations exist, each of these organizations offers general advice and recommendations that hospitals around the world can utilize when developing preparedness programs and responding to disasters.

Second, I reviewed real-world examples of hospital evacuations that have taken place in recent years around the world in response to a multitude of natural and man-made disasters. A literature review yielded numerous individual case studies and systematic reviews of hospital evacuations; these reports offer valuable insights into how individual hospitals and leaders approached evacuation, as well as what went well and what presents an opportunity for improvement in future evacuations.

Finally, I reviewed current recommendations in the literature for how to improve future hospital evacuations. This area of the literature is robust, with numerous preparedness professionals identifying best practices and novel techniques that hospitals can utilize during an evacuation event.

The rationale for this literature review is driven by several factors: first, existing guidelines and recommendations for hospital evacuations by international bodies are broad in

scope. While these guidelines are likely intended to be broad so that they can be applied to a wide variety of hospitals, they are not sufficient for a hospital to be fully prepared for a disaster and subsequent evacuation. Individual hospitals will have unique experiences with disasters and evacuations depending on their location, size, community partnerships, staff training, level of government support, and other factors; because of the wide variety of factors that can impact an individual hospital's disaster response, it is useful to examine how individual hospitals have adapted best practices to meet their specific needs.

Additionally, advances in the quality of health care provided in many parts of the world have allowed more people to live longer and manage chronic illnesses. As a result, hospitals around the world are caring for more medically complex patients than they were even twenty years ago; on average, hospitalized patients are older and have more comorbidities than ever before (Naik et al., 2024). Special considerations will need to be made for hospitals that are caring for a large number of medically complex patients; if an evacuation is necessary, it will take more time and will require more resources to safely evacuate all patients.

Finally, a changing climate is contributing to an increase in natural disasters worldwide, often impacting large population centers (World Meteorological Association, 2024). As a result, hospitals in these communities are becoming increasingly vulnerable to wildfires, hurricanes, flooding, and other natural disasters; by reviewing situations in which hospitals have responded to these events, crucial lessons can be learned to improve hospital preparedness and patient safety.

*Background and Description of the Problem*

Hospitals are the foundation of a community's health care infrastructure, providing care at all times to patients experiencing illness and injury. During a disaster, however, hospitals take on additional roles within the communities they serve: the World Health Organization describes hospitals as "the last shelter for disaster victims seeking refuge and the care they desperately need" as well as "an icon of social well-being" (2017, p. 15). A hospital not only continues to care for ill patients who were at the facility before the disaster occurred, but it also takes in patients who were injured as a result of the disaster. A functioning hospital can serve as a safe place to seek temporary shelter during or after a disaster, as well as a gathering point for emergency services that are serving the community. A hospital also serves an important psychological purpose for community residents during and after a disaster: "losing a hospital may result in a loss of security, connectivity and trust in local authorities" (World Health Organization, 2017, p. 15). For all of these reasons, it is crucial to safeguard a community's hospital services in the context of a natural or man-made disaster.

If a disaster is severe enough, safeguarding a hospital may actually mean evacuating it so as to ensure that safe and appropriate care can be continuously provided for patients. This concept is supported by numerous reports of hospital evacuations: in the wake of the Japanese nuclear plant disaster in 2011, a prolonged evacuation effort left too few staff members in the hospital to provide necessary care for ill patients. As a result of low staffing levels during the evacuation and a significant delay in obtaining beds for patients at outside hospitals, four patients died from potentially preventable complications due to interruptions in care (Sawano et al., 2021; Yoshida et al., 2023). Conversely, an efficient evacuation effort by a hospital can

result in patients safely transferred to a receiving hospital with no adverse outcome or interruption in care; examples of these successful evacuations are present in literature from the United States, Israel, India, and Germany (Kaliamoorthy et al., 2016; Nitschke et al., 2006; Hick, 2022; Ma et al., 2021; Lino et al., 2015).

The natural question that arises, then, is *how* a community can best protect its hospital and safely evacuate it if necessary. Various resources published by the World Health Organization, the United Nations, and the United States' Department of Health and Human Services provide useful tools to enhance the preparedness of hospitals and health care systems. While these tools are undoubtedly a good start for hospitals seeking to improve their preparedness programs and evacuation plans, significant gaps exist.

The World Health Organization offers a Hospital Safety Index as a tool for hospitals worldwide; this 176-page document is easily accessible via its website and is completely free. The Hospital Safety Index discusses how to assess the safety of a hospital in four key areas: external hazards that might impact the hospital, structural safety, nonstructural safety, and competencies of emergency management staff. The index offers highly specific criteria that a hospital can use to assess its physical building, staff knowledge, and overall preparedness program. The document includes a checklist that hospitals can use to rate themselves on their level of preparedness; this is useful because it provides objective data to governments and health systems regarding which hospitals are most prepared for a disaster, and which hospitals are most vulnerable and in need of additional funding and support (WHO, 2017).

The Hospital Safety Index emphasizes that each hospital should employ emergency preparedness staff, have an incident management system, and an emergency operations center;

the index does not, however, offer specific advice on what a disaster or evacuation plan should entail. No specific guidance is given regarding what to do if a disaster overwhelms a hospital, when the decision to evacuate a hospital should be made, or how to proceed with an evacuation if it is deemed necessary. These important specifics are left for an individual hospital's emergency management staff to determine (WHO, 2017).

In addition to recommendations from the World Health Organization, hospital preparedness guidance exists from the United Nations. The Sendai Framework for Disaster Risk Reduction was developed by UN member states in response to an increase in natural disasters worldwide impacting areas of high population. The framework is intended to help governments and health systems build and strengthen preparedness infrastructure, thus improving emergency response and recovery following disasters. The document describes goals to decrease the human and economic impact of disasters, improve communication and coordination both within and between national governments, and identify nongovernmental stakeholders in disaster preparedness and response. Four overarching priorities are identified: "understanding disaster risk, strengthening disaster risk governance to manage disaster risk, investing in disaster risk reduction for resilience, and enhancing disaster preparedness for effective response and to 'Build Back Better' in recovery, rehabilitation and reconstruction" (United Nations Office for Disaster Risk Reduction, 2015, p. 14).

While this UN document succeeds in stressing the importance of disaster preparedness and setting goals toward which a community should work, the language utilized in the framework is vague in nature. The Sendai Framework does not offer specific information as to how a community can prioritize its hospitals or health care infrastructure, or how hospitals can

establish and improve their preparedness programs. No specific information is provided in this framework as to how a hospital should respond to a disaster or how an evacuation should occur if a hospital is overwhelmed (United Nations, 2015).

In contrast to often broad guidelines from international authorities, the United States' Department of Health and Human Services offers more specific information regarding hospital preparedness. A quick internet search directs one to the Administration for Strategic Preparedness and Response (or ASPR), which is the preparedness division of the Department of Health and Human Services. Several frameworks are discussed that can help a hospital develop its emergency response plan, though they do not include concrete steps that a hospital should take in response to specific disasters. ASPR does, however, offer helpful guidance regarding how to develop a health care coalition; the organization defines this as an agreement between local hospitals, health departments, and emergency medical service providers to share resources during an emergency (Administration for Strategic Preparedness and Response, 2024).

Perhaps most helpful to a hospital that is building its evacuation plan is the TRACIE (Technical Resources, Assistance Center, and Information Exchange) division of the ASPR website. This section of the ASPR website offers in-depth interviews with hospital emergency management staff regarding their experiences with specific hospital evacuations. Hospital preparedness professionals who are developing their evacuation plans can read about the successes and failures of prior responses to wildfires, floods, and hurricanes. While these resources are undoubtedly beneficial to hospital emergency management professionals, they fail to outline a concrete and comprehensive process for hospital evacuation in response to a major threat. In addition, the resources are geared toward hospitals operating in the US health

care system, leaving doubt as to whether they are generalizable to hospitals operating in different countries, economies, and health care systems (ASPR TRACIE, 2024).

Finally, a search for information regarding hospital preparedness, response, and evacuation on the website of the American Hospital Association showed that while information from this organization is available regarding clinical quality data, patient safety initiatives, infectious diseases, and cybersecurity, no information is readily available concerning best practices for hospitals in the context of a disaster or evacuation (American Hospital Association, 2024).

As no comprehensive hospital evacuation plan or framework exists from authorities including the World Health Organization, the United Nations, the US Department of Health and Human Services, and the American Hospital Association, decisions regarding evacuation procedures fall to emergency management officials at individual hospitals and health systems. The degree to which these professionals are able to develop and practice disaster response and evacuation plans is often dependent on the number of resources that they are given from their hospital as well as the willingness of community partners to share knowledge and resources. Given the critical nature of hospitals during disasters and the highly variable nature of individual hospitals' preparedness/evacuation procedures, a literature review was necessary to identify best practices and opportunities for improvement in recent real-world hospital evacuations.

*Methods*

A preliminary literature review surrounding hospital evacuation began by developing search criteria for Embase. Upon review of the databases' terminology on Emtree, the term "hospital" was converted to "hospital/exp"; the term "evacuation" was converted to

“emergency evacuation” to align with the database vocabulary. Combining these terms into a single search (“hospital/exp” AND “emergency evacuation”) yielded 195 results; after review of these initial results, 65 results were found to be research articles with full-text articles available. Titles and abstracts of these 65 results were then reviewed to determine relevance to the capstone topic.

In addition to Embase, CINAHL was used to identify additional relevant sources. After a review of CINAHL’s terminology, a search method was developed: “Hospitals” AND “Emergency Evacuation”. This search yielded 27 article results; titles and abstracts of these results were then assessed for relevance to the research topic.

Finally, a review of PubMed’s vocabulary (MESH) was conducted; while “Hospitals”[Mesh] was identified as a helpful search term, there was no available synonym for “evacuation”. The closest synonym to “evacuation” that was identified was “Disasters”[Mesh]; when combined with “hospitals” as “Hospitals”[Mesh] AND “Disasters”[Mesh], 3,860 results were found. These results were briefly reviewed and many were not relevant to the topic of hospital evacuation in response to disasters. The next closest synonym to “evacuation” was “Emergency Shelter”[Mesh]; when this search term was combined with “Hospitals”[Mesh], 20 results were found; upon review of these results, none were identified that were relevant to the topic of hospital evacuation. As a result, the decision was made to focus on literature results from Embase and CINAHL, as these databases yielded 92 results with potential relevance to the capstone topic.

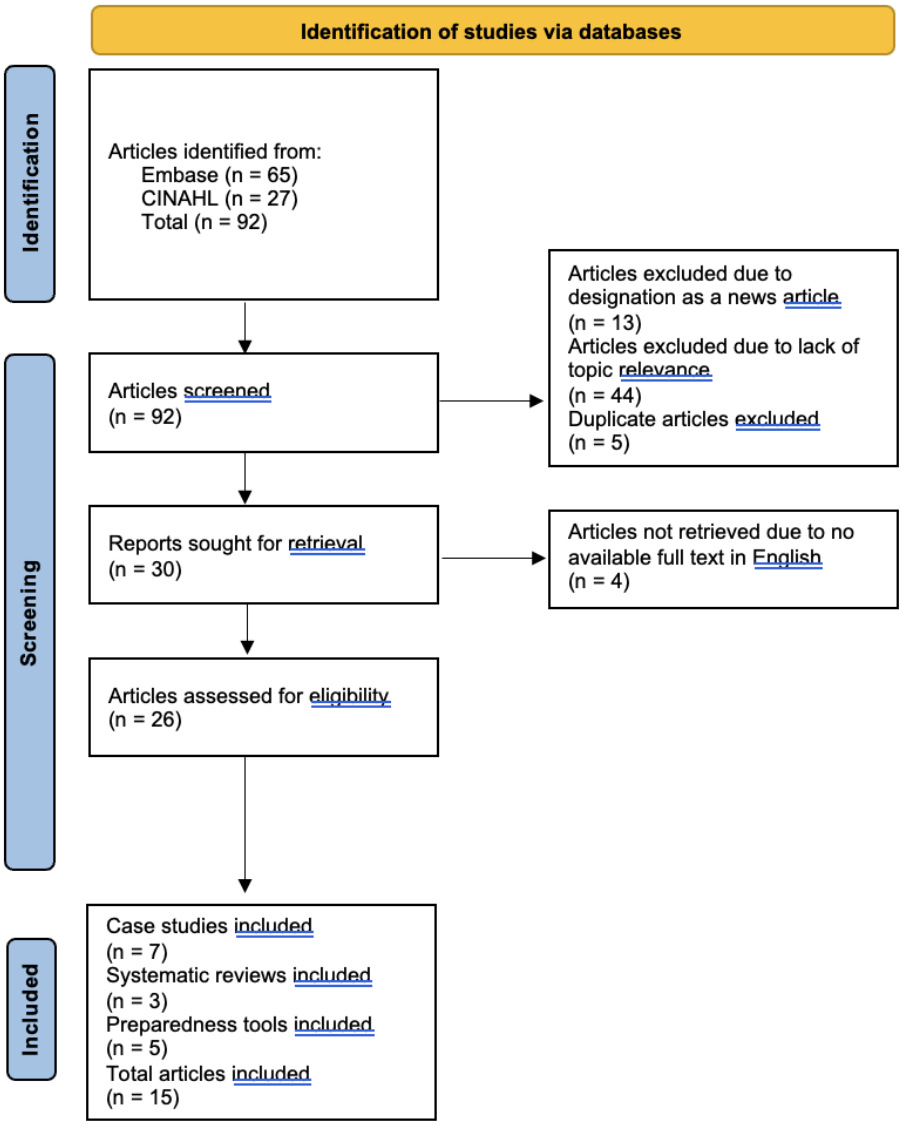
Inclusion criteria for articles consisted of a focus on a hospital evacuation rather than evacuation of a long-term care facility or home-based evacuations, a description of the natural

or man-made disaster that prompted the evacuation, and an analysis of the impact of the disaster and evacuation on the hospital, its patients, and/or the community. No limits were placed on the date of the article's publishment, although all articles were written since the year 2000; the oldest article selected for inclusion was published in 2013. In addition, no restrictions were placed on the type of emergency that necessitated the evacuation of the hospital.

Exclusion criteria included news articles that lacked in-depth analysis of the impacts of disaster and subsequent evacuation on the hospital's functions, the hospital's patients, and/or the surrounding community. In addition, articles were excluded if they described only one search criteria (a hospital evacuation *or* a disaster) rather than both search criteria.

Applying these inclusion and exclusion criteria reduced the 65 potential articles from Embase to 19 and the 27 potential articles from CINAHL to 11, for a total of 30 potential articles. Four of these articles were unable to be reviewed as there was no available full text in English; the remaining 26 articles were then reviewed in-depth to assess their topics, methods of research, conclusions drawn and implications for future disaster response. After this in-depth review, 15 articles were selected for final inclusion in this literature review; of these articles, 7 are case studies of individual hospital evacuations, 3 are systematic literature reviews of hospital evacuations, and 5 are original research surrounding preparedness tools that can be used to improve hospital evacuation in the future. Figure 1 is a PRISMA flow chart that provides a visual depiction of this article selection process.

*Figure 1*




*Flowchart Template from:* Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

*Results*

After article selection was complete, review began with the three systematic literature reviews. Two literature reviews focused on evacuation of pediatric and neonatal units in hospitals while one additional review focused on decision-making strategies by hospital leaders.

Mousavipour et al. (2021) located and reviewed 11 case studies of neonatal intensive care evacuations that resulted from disasters that occurred in the United States, Israel, and Japan. Based on this review, the authors pinpoint seven key factors that are essential for a successful hospital evacuation in this patient population: the presence of a clear command structure, conducting simulation exercises to increase staff knowledge prior to a disaster, sufficient staffing levels at the time of evacuation, a plan to maintain communication between hospital staff and community partners, specialty neonatal equipment for the evacuation itself, a plan for transporting infants to a safe destination, and support staff to assist in communicating with parents/caregivers of the infants. The most common mistakes that were reported in the case studies were a lack of specialized equipment to move neonatal patients (including backpacks with oxygen, suction supplies, and intravenous medications) as well as limited availability of staff to provide updates to the neonates' parents regarding their current medical status and physical location (Mousavipour et al., 2021).

Ghazanfari et al. (2022) also performed a systematic review of available literature regarding hospital evacuations of neonatal patients; like Mousavipour et al. (2021), this study also located 11 articles for review, but only three articles overlapped and were included in both systematic reviews. Ghazanfari's results largely echoed those described above; the authors emphasized that communication is the most frequently reported problem during a hospital evacuation. Gaps were discovered in communication between hospital staff and families of patients, between hospital leaders and government officials, and between hospital leaders and emergency medical services staff. The authors recommend the creation of a dedicated phone line at the hospital so that families can obtain real-time information about the medical

condition and physical location of their child. In addition to challenges in maintaining consistent communication, the authors found that numerous hospitals reported that staff were not sufficiently trained in evacuation procedures; nearly all hospitals included in this literature review stated that staff would benefit from more frequent simulation exercises to practice the hospital's evacuation procedures. Finally, insufficient portable equipment for the evacuation of critically ill patients (ventilators, suction devices, oxygen, and batteries) was identified as a significant problem during several hospital evacuations (Ghazanfari et al., 2022).

Due to the similar nature of these two systematic reviews, Figure 2 provides a visual depiction of the similarities and differences between the reviews.

*Figure 2*

| | **Ghazanfari et al., 2022** | **Mousavipour et al., 2021** |
|---|---|---|
| **Total articles reviewed** | 11 | 11 |
| **Similar conclusions** | • Importance of communication between departments within the hospital, between different hospitals, and between hospital staff and families<br>• Concern for inadequate staff training; staff members did not feel they had adequate knowledge of evacuation plans prior to the disaster<br>• Lack of specialty equipment and transportation for neonatal patients during the evacuation | |
| **Different conclusions** | • The authors recommend the creation of a dedicated phone line for family members to obtain information about their loved ones | • The authors emphasize the need for a clear command structure within the hospital to facilitate efficient decision-making<br>• The authors recommend that hospital leaders call in all available staff in an effort to maximize |

| | | |
|---|---|---|
| | | staffing levels during an evacuation |

A third systematic review was then found in the literature: Yaghoubi et al. (2017) conducted a systematic review and focused specifically on hospital decision-making in the face of disaster and evacuation. The authors identified 34 relevant articles for inclusion in the review; these articles included perspectives from hospital staff in the United States, Turkey, Sweden, and Australia. After reviewing the articles selected for inclusion, the authors noted that the major factors that guide hospital authorities on whether, when and how to evacuate can be placed into four categories: the hospital's infrastructure, the threat (or disaster) itself, internal factors, and external factors. Hospital authorities emphasized that while the decision to evacuate a hospital always involves a degree of uncertainty, communication from local authorities about the nature and specifics of the threat/disaster itself is the single most important tool that must be used in the decision-making process. Hospital leaders expressed that the decision to evacuate the hospital is, as often as possible, based on evacuation orders issued for surrounding areas by local authorities. Hospital leaders also discussed that while having a clear leader is necessary during an emergency situation, it is essential that the designated leader seek and consider input from as many sources as possible, including local authorities, community partners, and hospital staff (Yaghoubi et al., 2017).

In addition to the systematic literature reviews described above, seven individual case studies were examined; these case studies describe and analyze the evacuations of hospitals around the world in response to natural and man-made disasters. The first case study is that of a hospital in Japan that was forced to evacuate after the 2011 tsunami and subsequent nuclear

plant disaster in Fukushima. The decision to evacuate was made by hospital leadership after they received an evacuation order from the local prefecture's police department; 136 patients were admitted and 150 staff members were working in the hospital at the time the evacuation order was received. To begin the evacuation, all patients who were able to walk were either discharged home (if clinically appropriate) or transported via bus to a hospital outside of the evacuation zone. Patients with more serious illness were evacuated in the second wave, which consisted of transport via government truck from the hospital to a helipad that had been set up in a town close to the hospital. Seven government helicopters were utilized to transport patients from the makeshift helipad to other hospitals outside of the evacuation zone; as nightfall approached, however, seven patients and nine staff members had to remain at the helipad overnight as the helicopters ran out of fuel and visibility was poor. The remaining patients and staff members were evacuated from the helipad to surrounding hospitals the next day (Sawano et al., 2020).

Strengths and limitations of this hospital evacuation were discussed by the authors; a major strength of hospital administration is that they swiftly made the decision to reduce the hospital census by discharging all patients who were ambulatory and clinically appropriate for discharge. In addition, leadership demonstrated appropriate triage skills by separating inpatients into two distinct waves of evacuation: clinically stable patients who could be evacuated via bus and clinically complex patients who required continuous monitoring and evacuation via helicopter (Sawano et al., 2020).

The major opportunity for improvement in the wake of the Fukushima disaster and hospital evacuation was communication with both other hospitals in the area and the local and

federal governments. Hospital leadership described difficulty obtaining beds in hospitals outside of the evacuation zone; thus, it was difficult to coordinate a safe and efficient transfer for patients who required ongoing medical care. While transfer agreements between hospitals had been in place prior to the disaster, hospital authorities noted that "patient acceptance agreements with neighboring hospitals in the same area may not be effective in the case of a nuclear disaster" (Sawano et al., 2020, p. 126). Hospital administration estimates that the delays in obtaining bed placement for patients is what led to the seven patients and nine staff members spending the night at the helipad rather than at a hospital with bed availability. In addition, communication between the hospital and both local and federal governments was incomplete; hospital leaders and staff members did not receive detailed information about the disaster at the nuclear power plant and thus could not accurately estimate the immediate risks to their safety or the safety of their patients (Sawano et al., 2020).

A second case study also focused on the aftermath of the 2011 tsunami and nuclear disaster in eastern Japan: Yoshida et al. (2023) examined the impact of the disaster and subsequent hospital evacuation on a hospitalized patient with significant comorbidities. This patient was an 86-year-old male who was dependent on health care staff for all activities of daily living; during his hospitalization in March 2011, he was receiving all nutrition intravenously and had been treated multiple times with antibiotics for aspiration pneumonia. The patient was admitted to a hospital that was forced to evacuate on March 12, 2011 in response to the earthquake and nuclear disaster; he subsequently died before he could be evacuated from the hospital. While the official cause of the patient's death is listed as lung cancer, the authors note that aspiration pneumonia was a contributing factor to this death. This study examines the

impact that disruption of health care can have on individual patients when a hospital is forced to evacuate: “factors that contributed to the decline in the level of health care delivery included manpower shortage associated with hospital evacuation, the changes and disruptions that occurred during the acute phase of the disaster. . .and the difficulty of evacuating seriously ill patients” (Yoshida et al., 2023, p. 3). The authors suggest that hospitals develop detailed plans to obtain additional health care staff before a hospital evacuation begins, so as to prevent disruptions in normal health care operations (Yoshida et al., 2023).

In contrast to the evacuations undertaken as a result of a nuclear disaster in Japan, two case studies were found that examine hospital evacuations after floods in India and Germany. The first of these studies describes the evacuation of a 250-bed hospital in Chennai, India in response to extreme flooding. When it became clear that flooding would inundate the hospital, the first step taken was to create a disaster management task force composed of medical and nursing leaders in the hospital. The task force “identified four focus areas: patient safety, power supply and backup, oxygen, water and medical supplies, and maintaining a communication line with. . . authorities outside the hospital” (Kaliamoorthy et al., 2016, p. 51). As standards of care inside the hospital deteriorated due to a lack of power and backup generators, nursing staff was responsible for triaging patients according to acuity; the highest-acuity patients were then prioritized for transfer to the surrounding hospitals. No helipad existed on the hospital and all roads were impassable due to floodwaters, so patients, hospital staff and family members were evacuated with the assistance of “local fishermen with their boats. . . the hospital was evacuated completely using 12 boats and the assistance of fire services” (Kaliamoorthy et al., 2016, p. 53).

The robust communication that the hospital task force initiated and maintained with surrounding hospitals, local residents and authorities, and national authorities was critical in the successful evacuation of Global Hospital in Chennai, India. Not only did this clear communication inform local authorities of the equipment that was most needed inside the hospital (portable generators), but it facilitated the placement of critically ill patients in hospital beds away from the floodwaters. Finally, the enrollment of local fishermen and their boats into the evacuation effort demonstrates creative thinking on behalf of hospital authorities, as well as a willingness to capitalize on a useful but unconventional resource: local community members who want to help (Kaliamoorthy et al., 2016).

Thousands of miles away in eastern Germany, a similar flood impacted the Dresden Heart Centre and prompted an evacuation. Hospitals leadership approached the evacuation by triaging patients who were appropriate for discharge home; the hospital was able to discharge nearly 30% of its patients in this manner. The remaining patients were evacuated to hospitals outside of the flood zone with available beds via helicopter, ambulance, or taxi (Nitschke et al., 2006).

While no deaths or adverse outcomes were reported among patients or hospital staff during and immediately after the evacuation, leaders at the Dresden Heart Centre were interested in understanding the psychological impact that the evacuation had on patients and families. Researchers developed a questionnaire that asked patients and family members about their experiences during the evacuation with regard to communication from hospital staff, their sense of safety, and their perceived understanding of evacuation procedures. Researchers also screened patients for symptoms of PTSD, depression, and anxiety in the aftermath of the

evacuation; no statistically significant increase was seen in diagnoses of anxiety, depression, or PTSD. While a large majority of patients and family members reported feeling safe during the evacuation process, less than half of patients and families reported clear and consistent communication from hospital staff and local authorities about the status of the floods and the evacuation. The researchers found that "news and decisions broadcasted by TV and radio were often contradictory, so patients within the hospital felt uncertain about what was going on outside in the disaster area" (Nitschke et al., 2006, p. 121). The researchers point to communication between hospital staff, patients/families, and local authorities as the main opportunity for improvement in future hospital evacuations (Nitschke et al., 2006).

In contrast to the flood events described above, wildfires are major threats that hospitals in the western United States face. Case studies were found describing hospital evacuations in the face of wildfires in California, Oregon, and Colorado; qualitative interviews were performed with hospital leaders and surveys were sent to front-line hospital staff in all of these locations.

Similar to other hospitals faced with the reality of an evacuation, the hospitals included in these case studies began their evacuation efforts by relying on nursing staff to triage patient needs according to acuity; all patients who were considered safe for discharge were discharged home with family members immediately. Critically ill patients were slated for transfer to nearby hospitals, but numerous hospital officials reported difficulty obtaining beds for patients in outside hospitals due to a lack of pre-existing transfer agreements. Several hospital leaders emphasized that their relationships were stronger with local emergency medical service

providers, so the coordination of transport was often smooth once a bed was obtained for a patient at an outside hospital (Hick, 2022; Ma et al., 2021).

In addition to difficulties surrounding bed placement at outside hospitals, another challenge was ensuring a smooth transition of the patient's medical record between hospitals; while nearly all hospitals in the US utilize electronic medical records, the type of software used can vary greatly between hospitals and can lead to gaps in communication regarding a patient's medical history, current condition, and plan of care. Hospital staff members attempted to address this shortfall by calling report to staff members at the accepting hospital and sending patients with paper copies of their medication records, health history, and current plan of care whenever possible (Hick, 2022; Ma et al., 2021).

Opportunities for improvement identified in these surveys and interviews consist of the need for transfer agreements with outside hospitals *before* disaster strikes, the continuation and reinforcement of strong working relationships with emergency medical service providers in the community, sending transferring patients with paper copies of pertinent medical records, and more frequent simulations for staff members to practice and develop comfort with evacuation procedures (Hick, 2022; Ma et al., 2021).

In addition to natural disasters impacting normal hospital operations, man-made disasters can lead to difficult conditions and evacuations, as well. This was evident at Western Galilee Hospital in Israel when, in 2006, the hospital was the target of a missile attack. Remarkably, staff was able to safely transfer all hospitalized patients to an underground bunker beneath the hospital in under an hour; no patients or staff members were injured when the missile eventually struck the above-ground portion of the hospital. Hospital leadership credits

the success of this evacuation to the clear incident command structure present in the hospital as well as frequent simulations in which all hospital staff were required to participate; staff members in Western Galilee Hospital reported a strong understanding of and comfort level with emergency evacuation procedures (Lino et al., 2015).

Although this hospital was able to evacuate all patients and staff members safely and quickly, clinicians did report a sharp increase in the number of patients meeting criteria for a diagnosis of acute stress disorder (ASD) after the evacuation and subsequent missile attack. This finding highlights the importance of paying careful attention to the mental health of patients, family members, and hospital staff after an evacuation event (Lino et al., 2015).

Figure 3 provides a summary and visual depiction of the seven case studies described above.

*Figure 3*

| **Authors** | **Country** | **Type of Disaster** | **Outcome** | **Conclusions** |
|---|---|---|---|---|
| Sawano et al. (2021) | Japan | Breach of nuclear plant | Deaths of four hospitalized patients | Importance of patient triage during the evacuation process; difficulty obtaining beds for patients at outside hospitals; importance of hospital transfer agreements prior to a disaster |
| Yoshida et al. (2023) | Japan | Breach of nuclear plant | Death of one hospitalized patient | Staffing shortages during crisis/evacuation |

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| | | | | lead to deterioration in standards of care; importance of developing a plan for obtaining on-call staff during an evacuation |
| Kaliamoorthy et al. (2016) | India | Flood | Safe evacuation of hospital, no deaths or adverse outcomes reported | Robust communication between the hospital, local government, and local community members helped to facilitate the safe transport of patients away from the flooded hospital by boat |
| Nitschke et al. (2006) | Germany | Flood | Safe evacuation of hospital, no deaths reported; adverse psychological symptoms reported | Patients and families were confused by conflicting information received from hospital staff compared to local authorities; importance of consistent communication between hospital, authorities, and patients/families |
| Hick (2022) | United States | Wildfire | Safe evacuation of hospital, no deaths or adverse | Importance of utilizing nursing staff to triage patients; |

| | | | | |
|---|---|---|---|---|
| | | | outcomes reported | facilitating discharge for all stable patients; importance of establishing hospital transfer agreements before disaster / evacuation |
| Ma et al. (2021) | United States | Wildfire | Safe evacuation of hospitals, no deaths or adverse outcomes reported | Difficulty transferring medical records between hospitals that use different software; difficulty obtaining beds at outside hospitals; importance of establishing hospital transfer agreements before disaster / evacuation |
| Lino et al. (2015) | Israel | War; Missile Strike | Safe evacuation of hospital, no deaths reported; adverse psychological symptoms reported | Importance of clear incident command structure within a hospital; importance of evacuation exercises before an event; assess for adverse psychological outcomes after an evacuation event |

After reviewing all selected literature reviews and individual case studies, five articles were analyzed that propose tools for use in future hospital evacuations. These tools address many of the major concerns that hospitals have reported in the aftermath of the evacuations described above.

Researchers in Iran attempted to address the uncertainty that many hospital leaders face when deciding whether to evacuate a hospital or shelter-in-place. While these decisions are often made in collaboration with local or national authorities, hospital leaders must often decide whether to evacuate the entire hospital or only specific parts of the hospital. The researchers developed a 64-item questionnaire that assesses the threat that the hospital is facing, the hospital's ability to continue providing care for patients, and the feasibility of evacuation for patients and staff members. The questionnaire was developed with the input of hospital leaders and emergency managers in both hospital and community settings, and all items were tested for reliability and validity. All questions are weighted according to their importance to the decision to evacuate or shelter-in-place and are assigned an "impact score"; the impact score in each category can then guide hospital leaders toward the decision to either evacuate or shelter-in-place. When utilized in conjunction with guidance from local authorities, this questionnaire can provide decision-making support to hospital leaders while reducing their stress and promoting decisive action (Yaghoubi et al., 2023).

Another strategy that numerous hospitals reported utilizing during an evacuation was the triage of all admitted patients and the prompt discharge of all medically stable patients. Keret et al. (2016) have attempted to improve and increase this evacuation strategy by developing standard criteria for discharge. The authors focused their research efforts on 19

hospitals across Israel, asking emergency managers, medical leadership, and nursing leadership to identify all patients who would be appropriate for discharge in the event that a hospital evacuation was necessary. The authors then analyzed the clinical needs of all patients slated for discharge and discovered that patients could be placed into one of four categories: “patients slated for discharge on same day, candidate for discharge within 24-48 h [and] no further treatment needed, patients whose treatment can be interrupted for a brief period, [and] postpartum mother 24 h after vaginal delivery without complications” (Keret et al., 2016, p. 682).

These triage groups were then incorporated into the hospitals’ formal evacuation policies; when the hospitals were again asked one year later to assess all inpatients who would be appropriate for discharge in the event of an evacuation, the authors found that the structure of the formalized triage groups helped to increase the number of inpatients slated for discharge from 34.2% in the initial survey to 42.9% after the intervention. These results suggest that providing hospital staff with formal criteria for discharge in the event of an evacuation can increase the number of patients identified for discharge and thus reduce the number of patients who will require medical transport and a hospital bed at a neighboring hospital (Keret et al., 2016).

In order to accurately estimate the amount and type of health care resources that will be needed to safely evacuate those inpatients who *cannot* be discharged, researchers in the United States leveraged the triage skills of charge nurses in all inpatient hospital units to assess the resources that would be necessary to safely evacuate their patients. Charge nurses were asked to evaluate patients’ “continuous medical needs, mobility, and comprehension. . . [as well as]

the number of staff members required to assist in evacuating each nonambulatory patient" (Petinaux & Yadav, 2013, p. 121). The authors found that this data allowed hospital leadership and emergency managers to accurately estimate the amount and type of staff, specialty equipment, and transportation that would be necessary to evacuate the entire hospital in the face of an emergency. The data also allows hospital leaders to allocate staff and equipment to the inpatient units that most need these resources, redistributing them from lower-acuity units in the hospital (Petinaux & Yadav, 2013).

In addition to guidance surrounding triage, discharge criteria, and resource allocation for inpatients, hospital leaders identified the need for exercises to allow hospital staff to practice evacuation scenarios. Medical and nursing leaders in the neonatal intensive care unit (NICU) of a hospital in Washington, D.C. began research in this area by assessing the knowledge and comfort levels of all NICU staff members in relation to evacuation procedures via surveys. Utilizing information from these surveys to develop the simulations, NICU leadership decided to conduct exercises twice per month until all NICU staff had the opportunity to participate in an exercise at least once. The researchers discovered that the frequency of evacuation simulations drastically increase staff members' knowledge of and comfort level with evacuation policies/procedures: "staff knowledge increased significantly by a mean of 62% after post-simulated evacuations across disciplines. Result findings. . . indicated that staff members strongly agreed that they knew their role and evacuation plans and would be able to safely evacuate" (Zell et al., 2019, p. 258). The simulations also helped to identify key pieces of equipment that were initially missing from the emergency backpacks that NICU nurses were to carry with them; in addition, triage criteria for neonates requiring the most care were modified

as a result of feedback from nurses and respiratory therapists during the simulations. While the concept of a simulation to prepare hospital staff for an evacuation event is not novel, this research helps to solidify the benefits of frequent simulations and can be presented to hospital leaders to justify the cost associated with evacuation simulations (Zell et al., 2019).

Finally, a crucial gap identified in prior hospital evacuations is the difficulty in transferring medical records to receiving hospitals alongside patients. A critical component of patient care is continuity in medication administration; to address this gap, researchers in Switzerland collaborated with physicians, pharmacists, and nurses at six hospitals to identify potential medication-associated risks to patients during a hospital transfer or evacuation. Medication-related issues were classified as occurring during transfer from the old hospital, during transport itself, or upon arrival to the new hospital. The most common issues identified were vital medications not promptly available during transport or at the receiving hospital, medication administration not tracked during evacuation or transport due to the chaotic nature of an emergency, and duplicate medication administration due to inconsistent or unclear documentation. Mitigation measures were then developed in response to these risks; the most effective intervention was found to be a transfer/discharge checklist that was individualized to each patient with input from the patient's physician, pharmacist, and nurse. This checklist helps to ensure that all medication orders are reviewed by a physician prior to evacuation/transfer, checked for safety and accuracy by a pharmacist, and all administrations are recorded in real time by the nurse administering the medication. The checklist is then sent alongside the patient to the receiving hospital, so that transport personnel and staff at the new hospital have immediate access to the patient's medication orders and records (Schumacher et al., 2021).

Figure 4 provides a summary and visual depiction of the five articles reviewed that offered tools for improved hospital evacuations in the future.

*Figure 4*

| **Authors** | **Country of Origin** | **Preparedness Tool Described** | **Conclusions** |
|---|---|---|---|
| Yaghoubi et al. (2023) | Iran | Decision-making scale | A 64-item questionnaire developed by the authors helped to reduce stress and increase confidence for hospital leaders faced with the decision to evacuate or shelter-in-place during a disaster |
| Keret et al. (2016) | Israel | Standardized discharge criteria | Establishing standardized criteria for discharge led to an increase in the number of stable patients discharged home before a hospital evacuation |
| Petinaux et al. (2013) | United States | Resource-planning survey | Utilizing the triage skills of unit charge nurses allowed hospital leaders to distribute staff members and equipment more efficiently to areas of the hospital where the resources are most needed |

| | | | |
|---|---|---|---|
| Zell et al. (2019) | United States | Simulation | Simulation of a NICU evacuation allowed hospital leaders to pinpoint areas for improvement in the evacuation plan and led to increased staff knowledge and confidence in the evacuation plan |
| Schumacher et al. (2021) | Switzerland | Risk analysis of medication events | A team of physicians, pharmacists, and nurses identified transport and arrival at the receiving hospital as the highest-risk times for medication errors; a transfer checklist was created to improve documentation and reduce errors in medication administration |

*Implications*

A review of existing literature surrounding hospital evacuations around the world demonstrates that while each hospital faces unique challenges depending on a wide variety of factors, several themes are common to nearly all evacuation scenarios. One research question that was asked at the start of this review was “How can the evacuation process of a hospital be improved?” Based on the literature surveyed, a hospital’s evacuation process can be improved

by focusing on clear and frequent communication within and outside of the hospital, implementing frequent evacuation exercises before a disaster strikes so that staff are aware of evacuation plans, and utilizing available preparedness tools to help guide hospital managers toward a decision of evacuation versus shelter-in-place.

The most frequently reported problem during hospital evacuations is communication: communication within the hospital, to patients and families, between hospitals, and between hospitals and local governments. This review clearly indicates that there can be no substitute for early and frequent communication from hospital leaders regarding the operational status of the hospital, the personnel and equipment needed, and the condition of the patients that need to be evacuated. Several case studies addressed in this literature review emphasized the importance of proactively establishing transfer agreements between hospitals *before* a disaster strikes, so that leaders know which hospitals will be likely to accept their patients in need of transfers. Finally, robust communication is necessary between hospitals and emergency medical services providers in the community; this is a crucial partnership that will need to be fostered in order to ensure safe and appropriate transport for all patients who require evacuation.

An additional common theme that emerged through this review is the importance of frequent evacuation exercises for hospital staff. An evacuation plan can only be tested for its strengths and weaknesses by putting it into practice; through these drills, shortcomings of the plan will be discovered and hospital staff will feel more prepared to execute the plan if a real disaster strikes. While evacuation exercises require a hospital to expend significant resources, the literature clearly supports the idea that frequent drills hold a crucial place in a prepared hospital.

Although a hospital evacuation in response to a disaster is often chaotic, this review also demonstrates that there *can* be a clear structure to both the decision to evacuate or shelter-in-place as well as the process of evacuation itself. By utilizing the questionnaire developed by Yaghoubi et al. (2023), hospital leaders can assess the extent of damage to the hospital, the functionality of the hospital, and the acuity of patients to obtain an impact score. This impact score will help leaders to determine the consequences of evacuation vs shelter-in-place; this score can then be considered alongside recommendations from local authorities, allowing hospital leaders to make a thorough and educated decision about whether to evacuate.

*Recommendations*

If the decision to evacuate is made by hospital leaders, a basic framework that emerged from this literature review can be utilized to guide the evacuation process. This framework consists of four overarching stages of evacuation, and it can help to answer this literature review's second research question: "How does a hospital evacuate when a disaster necessitates it?"

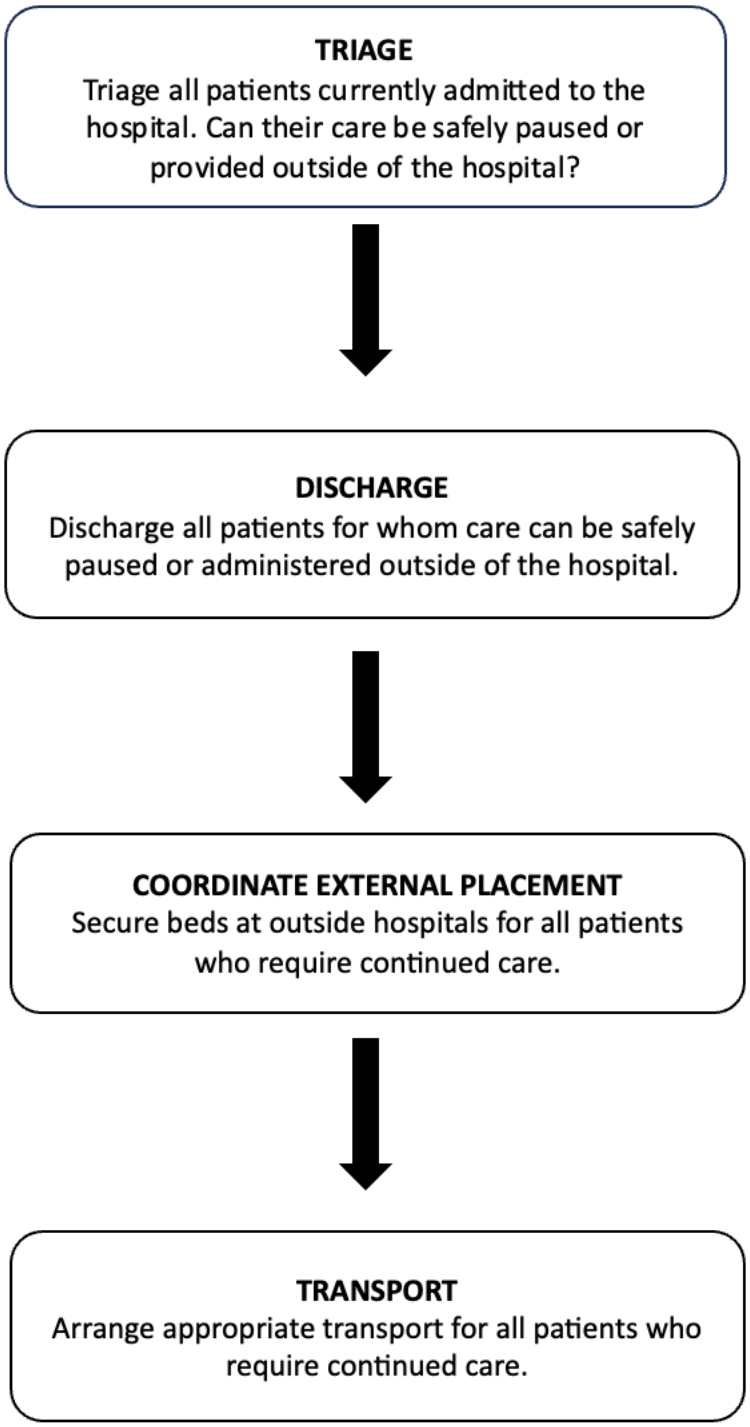
The first step in this framework is to **triage** all patients currently admitted to the hospital. As Petinaux & Yadav (2013) demonstrated, hospital leaders can rely on the expertise of unit charge nurses in conjunction with physicians to assess the needs of their patients and recommend discharge or transfer to an outside hospital. The formal discharge criteria developed by Keret et al. (2016) can be used by these clinicians to quickly assess how many patients can be discharged and how many patients require hospital transfer. This assessment allows hospitals to undertake the logical second step of the framework: **discharge** all patients for whom care can be safely paused or provided outside of the hospital setting.

Once hospital leaders understand which patients require continued care and must be transferred to outside hospitals, they can work with neighboring hospitals to complete step three: **coordinate external placement** at outside hospitals for all patients whose care cannot be paused or safely administered outside of a hospital. This step of the framework will require hospitals to be proactive in building partnerships with outside hospitals, many of whom would be considered "competitors" during normal operations. This step emphasizes the importance of developing the health care coalitions recommended by the United States' Administration for Strategic Preparedness and Response (ASPR, 2023).

Finally, once appropriate beds have been secured for patients at receiving hospitals, hospital leaders can address step four: arranging appropriate **transport** (via ambulance, helicopter, bus, private vehicle, etc.) for all patients who require transfer to an outside hospital. Completion of this step will also require robust communication and coalition-building activities on the part of hospital leaders; a hospital will need strong working relationships with local emergency medical services providers in order to secure transport for all patients.

Figure 5 provides a visual depiction of this four-step framework.

*Figure 5*


TRIAGE
Triage all patients currently admitted to the hospital. Can their care be safely paused or provided outside of the hospital?
DISCHARGE
Discharge all patients for whom care can be safely paused or administered outside of the hospital.
COORDINATE EXTERNAL PLACEMENT
Secure beds at outside hospitals for all patients who require continued care.
TRANSPORT
Arrange appropriate transport for all patients who require continued care.

*Strengths and Limitations*

A strength of this literature review is that it examines a diverse array of hospitals around the world and their response to various disasters. This review incorporates perspectives from hospitals and health care leaders in the United States, Iran, Israel, India, Germany, Switzerland, and Japan in response to wildfires, floods, tsunamis, nuclear disasters, and wars. As hospitals and health care systems can vary greatly depending on local culture, economy, and infrastructure, the inclusion of these diverse perspectives strengthens this review's conclusions and increases the likelihood that they will be generalizable to a wide variety of health systems and disaster responses.

A major limitation of this review is that it is not exhaustive; additional case studies exist in the literature that document the response of hospitals to various disasters, and additional preparedness tools exist that may help in a hospital's efforts to stay prepared for all types of disasters. The fact that additional information exists in the literature highlights the need for continued research into best practices for hospital evacuations.

*Gaps*

While this review identifies a basic framework that all hospitals can utilize to provide structure to an often-chaotic evacuation process, the reality is that many hospitals across the world do not possess the financial resources, personnel resources, or expertise to implement the practices described above into their operations. Recruiting, training, and retaining preparedness staff, conducting frequent emergency exercises, and forging partnerships with other hospitals and community providers all come with substantial costs. Additional research is needed to ensure that best practices for hospital response and evacuation can be implemented

in a cost-effective and equitable manner, so that safe and efficient hospital evacuations are not reserved solely for resource-rich health systems, hospitals, or societies.

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