

Original Research

Cite this article: Khorram-Manesh A, Phattharapornjaroen P, Mortelmans LJ, Goniewicz K, Verheul M, Sørensen JL, Pereira I, Ricklin ME, Faccincani R, Dark PM, Carlström E, Marzaleh MA, Peyravi MR, Al Sultan M, Santamaria E, Comandante JD, Burkle F (2022) Current perspectives and concerns facing hospital evacuation: the results of a pilot study and literature review. *Disaster Med Public Health Prep* 16: 650–658 doi: <https://doi.org/10.1017/dmp.2020.391>.

First published online: 3 February 2021

Keywords:

emergency services; hospital evacuation; disaster planning guidelines; surge capacity; triage

Corresponding authors:

Amir Khorram-Manesh,
Email: amir.khorram-manesh@surgery.gu.se.

© Society for Disaster Medicine and Public Health, Inc. 2021. This is an Open Access article, distributed under the terms of the Creative Commons Attribution licence (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted re-use, distribution, and reproduction in any medium, provided the original work is properly cited.

Current Perspectives and Concerns Facing Hospital Evacuation: The Results of a Pilot Study and Literature Review

Amir Khorram-Manesh MD, PhD^{1,2} , Phatthranit Phattharapornjaroen MD³, Luc J Mortelmans MD⁴, Krzysztof Goniewicz PhD⁵ , Marlous Verheul PhD⁶, Jarle L Sørensen DBA, PhD⁷, Irene Pereira MD^{8,9}, Meret E Ricklin MD¹⁰, Roberto Faccincani MD¹¹ , Paul M Dark MD, PhD¹², Eric Carlström RN, MSc, PhD^{13,14}, Milad Ahmadi Marzaleh PhD¹⁵, Mahmoud Reza Peyravi MD, PhD¹⁵, Mohammed Al Sultan RN¹⁶, Emelia Santamaria MD¹⁷, John David Comandante MD¹⁸ and Frederick Burkle MD, MPH, DTM¹⁹ 

¹Institute of Clinical Sciences, Department of Surgery, Sahlgrenska Academy, Gothenburg University, Gothenburg, Sweden; ²Department of Research and Development, Swedish Armed Forces Center for Defense Medicine, Gothenburg, Sweden; ³Department of Emergency Medicine, Center of Excellence, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand; ⁴Center for Research and Education in Emergency Care, University of Leuven, Leuven, Belgium; ⁵Military University of Aviation, Dęblin, Poland; ⁶University Medical Center Utrecht, Utrecht, the Netherlands; ⁷Emergency and Crisis management, Department of Business, School of Business, University of South-Eastern Norway, Kongsberg, Norway; ⁸Research group on Emergency and Disaster Medicine (ReGEDiM), Vrije University, Brussels, Belgium; ⁹University of the Azores, Ponta Delgada, Azores, Portugal; ¹⁰Department of Emergency Medicine, Inselspital, University Hospital Bern, Bern, Switzerland; ¹¹Emergency Department, IRCCS San Raffaele, Milano, Italy; ¹²Division of Infection, Immunity & Respiratory Medicine, University of Manchester PA, Manchester, UK; ¹³School of Business, Campus Vestfold, University of South-Eastern Norway, Kongsberg, Norway; ¹⁴Health and Crisis Management and Policy, Sahlgrenska Academy, Gothenburg University, Gothenburg, Sweden; ¹⁵Department of Health in Disasters and Emergencies, Health Human Resources Research Center, School of Management and Medical Informatics, Shiraz University of Medical Sciences, Shiraz, Iran; ¹⁶Emergency Department, King Khalid Hospital, Najran, Saudi Arabia; ¹⁷Health Emergencies and Disasters (HEAD) Study Group, National Institute of Health, University of the Philippines-Manila, Philippines; ¹⁸Department of Emergency Medicine, Prehospital Disaster and Ambulatory Care Medicine, Ospital ng Makati, Makati City, the Philippines and ¹⁹Harvard Humanitarian Initiative, T.H. Chan School of Public Health, Harvard University, Cambridge, MA, USA

Abstract

Objective: To analyze the evacuation preparedness of hospitals within the European Union (EU).

Method: This study consisted of 2 steps. In the first step, a systematic review of the subject matter, according to the PRISMA flow diagram, was performed. Using Scopus (Elsevier, Amsterdam, Netherlands), PubMed (National Library of Medicine, Bethesda, MD), and Gothenburg University's search engine, 11 questions were extracted from the review and were sent to representatives from 15 European Union (EU)- and non-EU countries.

Results: The findings indicate that there is neither a full preparedness nor a standard guideline for evacuation within the EU or other non-EU countries in this study. A major shortcoming revealed by this study is the lack of awareness of the untoward consequences of medical decision-making during an evacuation. Some countries did not respond to the questions due to the lack of relevant guidelines, instructions, or time.

Conclusion: Hospitals are exposed to internal and external incidents and require an adequate evacuation plan. Despite many publications, reports, and conclusions on successful and unsuccessful evacuation, there is still no common guide for evacuation, and many hospitals lack the proper preparedness. There is a need for a multinational collaboration, specifically within the EU, to establish such an evacuation planning or guideline to be used mutually within the union and the international community.

Introduction

During Major Incidents and Disasters (MID) and with the increasing myriad of crises such as epidemics, pandemics, war, and conflict, civilian hospitals are expected to be functional, receive, and manage victims with a variety of injuries as well as continue the local and referral population in need of emergency or non-emergency care.¹⁻³ A major aim of a hospital disaster plan is to provide professional and material resources to receive as many victims as possible from the

affected area, and by targeting all 4 elements of the surge capacity, i.e., Staff, Stuff, Structures, and Systems.⁴⁻⁶ As the response chain to MID consists of many units, the interaction between these entities at all levels may proceed more efficiently with a central coordination center.⁷ These coordinated actions between collaborating partners create the foundation for a plan, which should be tested and validated before MID.⁸

In recent years, it has become clear that hospitals may be the targets of both natural and man-made MID.⁹⁻³¹ Vulnerabilities of a medical facility/hospital vary between countries due to the type of event and the geographical conditions. In some countries, e.g., South American countries, more than 50% of healthcare facilities (hospitals and primary care) are in high-risk areas for natural disasters. In comparison, the figure is much lower (8-9%) for other countries such as the United Kingdom. Several potential events such as hurricanes, earthquakes, floods, landslides, tornados, storms, volcanos, cyclones, tsunamis, fires, explosions, CBRN (Chemicals, Biological, Radionuclide threats), cyberterrorism, terrorism, armed attacks and bombings, as well as rapidly changing technological issues within hospital infrastructure can result in a mandatory hospital evacuation.^{3,9-31} Some factors such as increasing population numbers and density, rapid unsustainable urbanization, biodiversity losses, and climate changes may complicate the outcome of these events. Indeed, the latter changes are increasingly accelerating infectious disease outbreaks, epidemics, and pandemics.³² Although each event may have a particular impact on a hospital, it affects either hospitals 'structural' or 'non-structural' components and, consequently, its functionality. According to the Sendai Framework for Disaster Risk Reduction 2015-2030, substantial reduction of disaster damage to critical infrastructure and disruption of basic services should take place globally. Healthcare and educational facilities are particularly encouraged to develop their resilience by 2030. Although a hospital evacuation might be unavoidable, planning for hospital evacuation will make it more resilient during the future events.³³

Compared to a disaster plan, a hospital evacuation plan has a reverse pattern, i.e., instead of creating more space and surging capacity within the hospital, all patients should be evacuated and transported to other areas or medical facilities to receive continuous care. An evacuation does not need to be total and patients might be sheltered in place, evacuated horizontally or vertically, within the same hospital. However, although rare, whenever a decision for total evacuation is made, the situation will be more complicated and the task more complex. An extensive/total evacuation of a hospital is associated with several medical and non-medical difficulties such as insufficient internal and external logistics, lack of routine for tracking patients, diverse ethical issues, as well as unattended injury or deaths to patients and staff alike during evacuation.^{3,34-38}

There is conceptual confusion in available literature about the word 'EVACUATION,' which is used to describe the need to transfer, move, or drain materials, equipment, or people from an existing building. Many languages may have different words for evacuation with a different meaning, e.g., 'EXIT' and 'EVACUATION.' The former correctly indicates the need for time-limited escape from danger (e.g., fire). The term 'EVACUATION' might then mean a need for the exit, transport, and final placement in another facility.¹³ Such a situation may take a longer time and have a higher impact on patients' health and outcome. In this report, we aim to study the result of total evacuation. The aim of this paper is 2 fold:

- 1) To determine the significant difficulties in the management of hospital evacuation through a review of the literature.
- 2) To confirm the current readiness for evacuation among some European and non-European countries.

Methods

Review

This study consists of 2 steps. In the first step, a systematic review of the subject matter, according to the PRISMA flow diagram was performed.³⁹ Using Scopus, PubMed, and Gothenburg University's search engine, the following keywords were used to review the current and related literature about hospital evacuation. The terms 'hospital evacuation' or 'healthcare facilities' and 'evacuation' were searched as MeSH (Medical Subject Heading) terms alone or in combination. Obtained articles were manually searched. Inclusion criteria were articles in English describing evacuations between January 1995 and February 2020. Partial evacuations, healthcare facilities not identifiable as a hospital, and narrative reports were excluded. Figure 1 shows the process of search according to the PRISMA flow diagram.³⁹

Questionnaire

The main author (AK) assembled a group of 3 independent professionals (1 physician, 1 hospital nurse, and 1 prehospital nurse, not included as authors), all academically and clinically active within the hospital and prehospital preparedness and disaster management. AK performed the literature review, and presented the results in 3 different rounds, based on the Nominal Group Technique.⁴⁰ In the first round, a list of obtained documents was presented by AK, and the group agreed on the literature which should be included for further evaluation. In the second round, the abstracts of chosen literature were presented and literature for the in-depth study was chosen. Finally, in the third round, 2 members of the group studied the selected documents and presented their findings to the whole group. These findings were then sorted and inserted in Table 1. Together, the group summarized these findings into 10 statements/questions based on qualitative saturation of thematic areas. A qualitative content analysis of the manifest content was performed manually by 1 of the authors (EC).^{41,42} First the thematic contents were identified and then condensed into core contents. At a point where no new novel information was extracted from the data, the statements were outlined. Question, number 11, was added to provide all participants a possibility to comment/add other items needed. The questions were sent to 20 professionals, representing 15 different countries in the second step. The respondents (physicians, nurses, or PhDs educated and actively involved in MID management), were asked to answer the questionnaire individually or in collaboration with the responsible units in their countries. Respondents participated voluntarily and were recruited either by showing a direct interest in the topic or indirectly by being recommended as researchers registered in ResearchGate, a European social networking site for scientists and researchers, which is the largest European academic network in terms of active users. Scientists and researchers share papers, ask and answer questions, and find research collaborators.⁴³ The questions were;

- 1) Incident Command System is a vital element in the successful management of MID. It is especially essential to see whether various countries have collaboration between hospitals and a

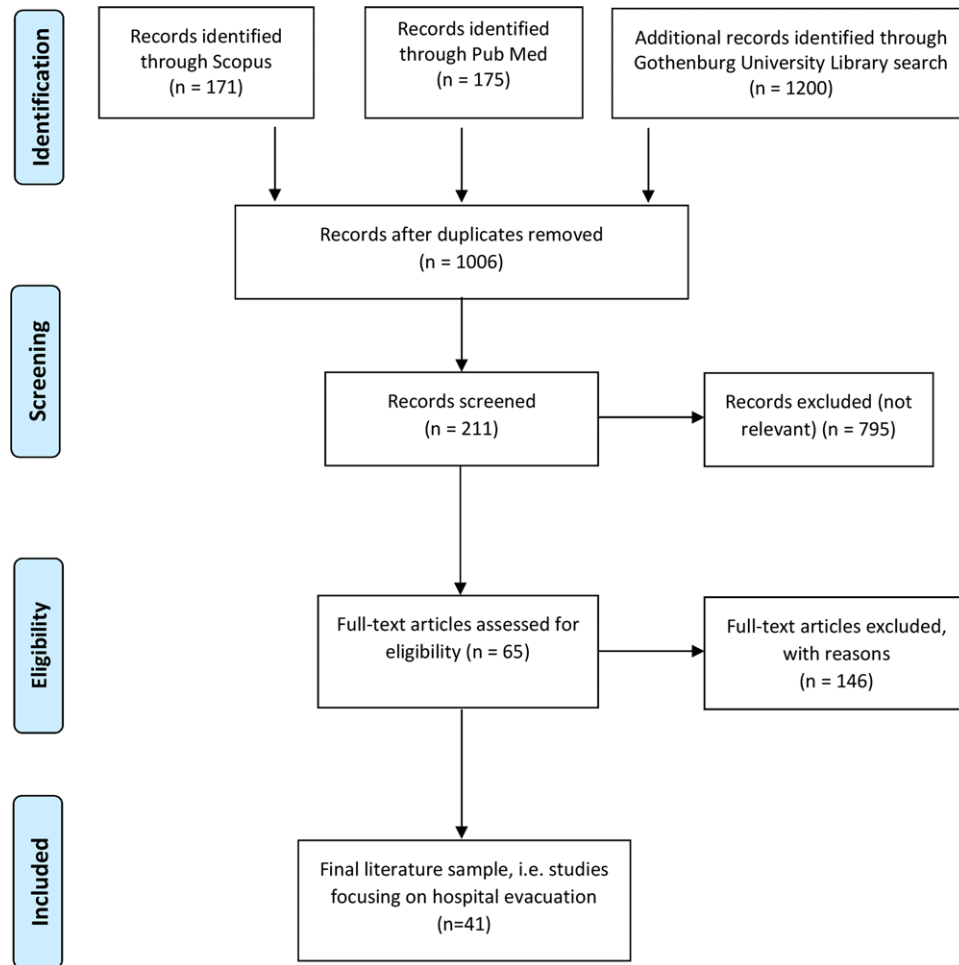


Figure 1. Systematic review of the subject matter, according to the PRISMA flow diagram.

management/coordination center. In this perspective, the role of private hospitals should be explored.

- a) Central command vs. independent hospital
- b) Plans for surge capacity
- c) The role of private hospitals
- 2) Communications, collaboration, coordination with other agencies are attractive measures in all levels of action, including the private sector.
 - a) Different managerial levels
 - b) Private organizations
- 3) Ethical perspectives of hospital evacuation are directly related to the decision-making process and information delivery, information sharing. How transparent are decisions? How aware are staff and the public? Are there any guidelines/protocols?
 - a) Awareness of difficult medical decision-making
 - b) Who makes the final decision (Administrators, Medical Staff, combination, etc.?)
 - c) Staff and public awareness
 - d) Any guidelines?
- 4) Legal perspectives on hospital evacuation may put different agencies in different zones and create difficulties in collaboration between various agencies? How to act? How to respect duties and responsibilities vs. willingness to work?
 - a) Multi-agencies?
 - b) Guidelines?
- 5) An internal logistics plan is a prominent issue to follow regarding internal resource management.
 - a) Staff
 - b) Staff
- 6) An external logistics plan is a prominent issue correlated with resource utilization.
 - a) Central dispatch
 - b) Reserve staff and staff
 - c) Ability to move staff, sending staff
 - d) Known receiving-hospitals/facilities and whether they are electronically compatible and easily transferable within your system.
- 7) The lack of specific plans for vulnerable groups may have a significant impact on the outcome.
- 8) Insufficient or absence of procedures for removing critically sick patients, e.g., ICU patients, is an obstacle.
- 9) Knowledge about reverse triage/triage (The evacuation triage algorithm uses mobility and dependency to determine the evacuation triage priority, categorizing patients into the groups; Very Dependent, Dependent, and Independent. Independent patients evacuating first)^{34,35} is decisive in resource utilization and survival outcome.
- 10) Training and exercise is a parameter always written but never performed.
- 11) Any comments/missing issues or subjects.

Table 1. Findings/notions from historical evacuation incidents and some simulation exercises. The results are grouped based on the notions, type of disaster, and country of publication

Major published studies	Year	Significant findings/Conclusions
<i>Fires, United Kingdom</i> Wise J. ¹² Wapling A, et al. ¹³ Murphy GRF, et al. ¹⁴	2009 2009 2011	Essential with leadership and knowledge of evacuation routes, spaces, etc. Access to the electrical power source. Regular training and exercises. Proximity to hospitals for transfer of patients. New staff. Information delivery and information sharing. Excellent communication (qualitative and quantitative).
<i>Storms, United States</i> Waring S, et al. ¹⁵ Sultz CH, et al. ¹⁶ Sterberg E, et al. ¹⁷ Vilke GM, et al. ¹⁸ Brodie M, et al. ¹⁹ Brunkard J, et al. ²⁰ Bagaria J, et al. ⁹ Powell T, et al. ²¹ Redlener I, et al. ²² Downey EL, et al. ²³	2002 2003 2004 2006 2006 2008 2009 2012 2012 2013	Need for a reliable plan based on risk and vulnerability analyses. Knowledge of routes, spaces, etc. Collaboration with other agencies to optimize resource availability. Plan for vulnerable groups. Role identification within each organization and between agencies. Realistic training/exercises. Evacuation of patients may include the caretaking of relatives. Important to note safety and security issues. Communication through regular briefing and functional communication system. Knowledge of triage in the evacuation. Staff continuity and adequate supplies. Effective leadership and central command. Surge Capacity measures and early decision-making. Use of volunteers. Emergency departments should plan for continuous patient arrival during evacuation. Shelter-in-place results in critical and prolonged periods of shortage.
<i>Flooding, Thailand</i> Tanavud C, et al. ²⁴ Khorram-Manesh A, et al. ²⁵	2004 2014	Disaster plan should be based on risk and vulnerability analyses. Action cards for staff. Training. Reliable internal and external communication. Information sharing and delivering. Electrical Power source. Supplies delivery. Collaboration with other agencies. Follow-up of the psychological trauma. Positive reinforcement with hand-written journals and escorting prehospital teams with drug supplies. The role of private facilities.
<i>Earthquake, Japan</i> Nagata T, et al. ²⁵	2017	ICS. Medical decision-making. Communication, Coordination, and Collaboration. External logistics plan. Disaster Medical Assistance Teams. Revision of disaster plan.
<i>Chemical, flood, etc. Sweden</i> SoS, Ammonia leakage ²⁶ SoS. Fire ²⁷ Näsman U et al. ¹¹ Catovic L, et al. ²⁸	1997 2007 2007 2018	Information delivery and information sharing. Proximity to other hospitals. Reliable communication. Complete backup system. Access to field hospitals. Access to electrical power sources. Collaboration with other agencies, including armed forces. ICS with stable leadership and decision-makers. Internal supporting systems in hospitals for water, heat, and food. Coordination and collaboration between staff. Patients need assistance and the need for training on evacuation routines.
<i>Other countries</i> Rojek A, et al. Australia ²⁹ Mortelmans L, et al., Belgium ³⁰ De Cauwer, et al. Belgium ³¹	2013 2017 2017	Needs for modern facilities with evacuation considered in design and location. Risk and vulnerability analysis. Surge capacity measures. Create a detailed facility evacuation plan, recovery plan, and debriefing plan. Determine alternative facility plans to meet emergency needs. Assess the planning needs of nursing homes. Communicate with and involve external organizations. Clearly define the necessary minimum timeframe for pre-emptive evacuation, and an early decision-making. Have detailed plans for vulnerable groups. Provide regular simulation experience of evacuation. Regular briefings. Functional and reliable communication system. Information delivery and information sharing. ICS. Internal and external logistics. External resource delivery. New staff.

The first 10 questions could be organized as; Command and Control, Ethical and legal perspectives of hospital evacuation, Logistics, Systems-rules-guidelines, Training, and exercises.

Results

Literature Review

Table 1 presents the summary of the findings from the systematic literature review, presented as significant findings or lessons learned, based on studies from 1997–2018.^{3,9–31} The results were grouped after the country of publication and thematically. they covered: 1) The importance of leadership, and the difficulties and lack of awareness in medical decision-making and its medical, ethical and, legal consequences, 2) Unprepared and untrained command and control, 3) The lack of proper communication, and 4) The shortcoming in logistics planning. Table 1 was not presented to the respondents.

Questionnaire

Representatives of 15 countries: Belgium (MD), Croatia (MD), Germany (MD), Iran (MD and PhD), Italy (MD), Netherlands (PhD), Norway (PhD), Philippines (2 MDs), Poland (PhD), Portugal (MD), Saudi Arabia (PhD), Sweden (MD, and PhD), Switzerland (MD), Thailand (MD), and UK (MD) received the

questions. A total of 18 (out of 20 = 90%) professionals from 13 (out of 15 = 87%) countries replied. Although 2 more requests were sent to the representatives of Croatia and Germany, they did not respond due to the lack of time. The answers obtained by all countries included in this study are summarized and presented in Tables 2–7 (ICS, C3, and ethics in Tables 2 and 3; legal and logistics in Tables 4 and 5; vulnerable groups and triage in Tables 6 and 7).

According to the participants, all countries have ICS in which hospitals are independent but in collaboration with a central command. Most of the hospitals have a plan for surge capacity, but not specifically for hospital evacuation. In most countries, private hospitals have their own disaster and evacuation plans (unclear in 4 countries, Table 2). However, the content of the plan was not available. Collaboration, coordination, and communication did exist at all managerial levels, both in hospitals and with other agencies outside the hospital. However, collaboration with private hospitals and their managerial levels was not fully functional (Table 3). There was insufficient information about ethical awareness and difficulties in medical decision-making as public hospitals especially seemed to lack enough knowledge about the imbalance between resources and needs and the necessity for critical decision-making. There were no examples of ethical guidelines for the staff and decision-makers (Table 3). It appeared that the legal perspectives of hospital evacuation followed those needed

Table 2. Presence of Incident Command System (ICS) regarding hospital evacuation in 10 countries. (NSE=Not specifically for Hospital Evacuation, OP=Own Plan)

Country	Do you have ICS system?	Do hospitals follow Central command or act independently?	Do you have plans for surge capacity?	Are private hospitals included in your contingency plans?
Belgium	Yes	Collaborative	NSE	OP
Iran	Yes	Both	NSE	Centrally governed
Italy	Yes	Independent hospitals	NSE	OP
Netherlands	Yes	Collaborative	Yes	OP
Norway	Yes	Independent hospitals	Yes	Unknown
Philippines	Yes	Both	Yes, never tested	OP
Poland	Yes	Independent hospitals	NSE	OP
Portugal	Yes	Independent hospitals	Yes	OP
Saudi Arabia	Yes	Both	Yes	Centrally governed
Sweden	Yes	Collaborative	Yes	Included in the regional plan
Switzerland	Yes	Independent hospitals	Unknown	Unknown
Thailand	Yes	Both due to the size	Mostly	Unknown
UK	Yes	Collaborative	Yes	Yes for small private sector

Table 3. The status of inter-organizational collaboration, coordination, and communication (C3), and ethical perspectives, regarding hospital evacuation in 10 countries. (NSE=Not specifically for Hospital Evacuation)

Country	Do you have all managerial levels?	Do Private hospitals have all managerial levels?	Is there an awareness of difficult medical decision-making?	Is there an Ethical awareness staff/public?	Do you have ethical guidelines?
Belgium	All levels	Some	None	None	None
Iran	Unknown	None	Yes	Unknown	None
Italy	All levels	Some	None	None	None
Netherlands	All levels	Some	Unknown	Unknown	None
Norway	All levels	Some	Yes	Some/Little	None
Philippines	All levels	Operational	None	Yes	None
Poland	All levels	Yes	None	None	None
Portugal	All levels	Some	Unknown	Unknown	NSE
Saudi Arabia	All levels	Yes	Unknown	Yes/None	None
Sweden	All levels	Some	None	Unknown	None
Switzerland	All levels	Some	Unknown	Unknown	None
Thailand	Unknown	Some	Unknown	Unknown	None
UK	All levels	Some	Yes	Yes/unknown	NSE

Table 4. The status of legal perspectives of hospital evacuation in 10 countries (NSE = Not specifically for Hospital Evacuation, RD = Red Cross, CD = Civil Defense)

Country	Defined legal responsibility. Having any guidelines?	Legal Guidelines for Police tasks before, during, after HE	Legal Guidelines for Rescue teams tasks before, during, after HE	Legal Guidelines for Function of other agencies
Belgium	NSE	Yes	Yes	RC, CD
Iran	NSE/None	Most of the regions, not synchronized	Most of the regions, not synchronized	None
Italy	By General director and safety & security dept./ None	Yes	Yes	None
Netherlands	NSE/None	Yes	Yes	RC
Norway	Yes/Yes	Yes	Yes	RC, CD
Philippines	Yes/No	Yes, not synchronized	Yes, not synchronized	Some
Poland	NSE/None	Yes	Yes	RC, Volunteers
Portugal	Yes/Yes	Yes	Yes	Unknown
Saudi Arabia	Unclear	Yes	Yes	Unknown
Sweden	Yes/Yes	Yes	Yes	Unknown
Switzerland	NSE/None	Only fire	Only fire	Unknown
Thailand	NSE/None	Only fire	Only fire	None
UK	Yes/Yes	Yes	Yes	Yes

Table 5. The status of internal and external logistic plans regarding hospital evacuation in 10 countries (NSE = Not specifically for Hospital Evacuation, RC = Red Cross)

Internal plan			External plan						
Country	Staff	Stuff	Central dispatch	Reserve Vehicles	HR management plan	Plan to move devices	Sending medication	Receiving hospitals	
Belgium	Yes, NSE	Yes, NSE	Yes	RC	Yes	Unknown	No	Yes	
Iran	Yes	Yes	Yes	Yes	Yes	Unknown	Unknown	No	
Italy	Yes, NSE	Yes, NSE	Yes	Yes	Yes	No plan	No	No	
Netherlands	Unknown	Unknown	Yes	Unknown	Unknown	Unknown	Probably	Yes	
Norway	Yes	Some	Yes	Yes	Yes	Unknown	Unknown	Yes	
Philippines	Yes	Yes	Both	Unknown	Some	Some	No	No	
Poland	Yes, NSE	Yes, NSE	No	Yes	Yes	Unknown	No	Yes	
Portugal	Yes	Yes	Yes	Unknown	Unknown	Unknown	Unknown	Yes	
Saudi Arabia	Yes	Yes	Yes	Yes	Yes	Unknown	No	No	
Sweden	Yes, NSE	Yes, NSE	Yes	Yes	Unknown	Unknown	No	No	
Switzerland	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	
Thailand	None	None	No	Unknown	Unknown	Some plans	Unknown	No	
UK	Yes, NSE	Yes, NSE	Yes	Yes	Yes	Unknown	Unknown	Unknown	

Note: Central dispatch refers to ambulances being dispatched by a central center. HR management plan refers to extra staff that can be available in the short and long-term. Plan to move devices refer to moving critical equipment such as ventilators.²⁵ Sending medication refers to send 7-10 days of ordinary medication to the receiving hospital and concern cancer patients or those having rare diseases.

for disaster management in general (Table 4). There were some Non-Governmental Organizations (NGOs), such as Red Cross/Crescent, available in all countries. However, the relation between these organizations with the disaster management authorities and their designated role within the nation’s disaster management system was not clear (Table 4).

Most of the participant countries seemed to have internal logistic plans for staff and stuff, external logistic plans, and a central dispatch center. They had reserved vehicles, but not any specific pool of personnel. They had no plans to move staff and equipment. Half of them had predetermined receiving hospitals (Table 5). In critical situations, such as in patients with cancers or very rare diseases, whether patients’ medications were sent with them or not, were unclear or unknown. Most countries did not have any procedures for evacuation of vulnerable groups. Only the United Kingdom seemed to have plans for vulnerable groups. Some other countries had plans for elderly, pregnant women and children. Plans for blind and deaf individuals were missing (Table 6). The principles of reverse triage, i.e., to categorize patients in Very Dependent, Dependent, and Independent, were unknown or not implemented. Some countries with strong religious beliefs referred to their spiritual responsibilities. According to their religion, people have the same value and every individual has the responsibility to act morally and ethically, and treat other individual fairly as written in the holy book. However, they had no official documents, and it was not clear how people with other religious backgrounds might act. All participants, except 1, reported 1 exercise/year. Most of the exercises were fire evacuation, and no specific activity for evacuation was conducted (Table 7).

Discussion

A shortcoming revealed by this study is the lack of awareness of the untoward consequences of medical decision-making during an evacuation, which is very different from those taken in peacetime, and during the management of MID.^{3,5,8-10,34,35} The medical decisions made during an evacuation do not only concern the quality of care, but rather, how the limited quantity of everything affects or guarantees the best outcome. Although today’s healthcare is under constant pressure to prioritize patients due to the economic strain, the ethical discussion about who is to be prioritized and why, is avoided. The consequences of various medical decision-making will be more difficult in MID and much more during an evacuation when 1 decision may indicate no treatment for a specific group of patients for the sake of the rest. Understanding this kind of reasoning can be difficult for staff and the public, and there is a major need to learn more about the determinants of the subject before any MID and hospital evacuation.^{3,10,36}

Another important finding in this study is insufficient or defective planning for vulnerable groups, including very sick patients.⁴⁴ The majority of hospitals have no planning for vulnerable groups or specific groups such as ICU patients or patients under surgery. These patients are all cases that might be left in place during an evacuation. Some countries may rely on triage to select the priority of the patients, and there are specific triage methods for evacuation (Healthcare Evacuation Reverse Triage Priorities),^{34,35} which may ease up the process of selection. However, they usually are not practiced, nor are they widely known. Irrespective of the method for screening, these cases are far too challenging to move in an evacuation process and the decision of leaving them behind may trigger anger and confusion in people who are not aware of

Table 6. The management of vulnerable groups, including critically sick patients, regarding hospital evacuation in 10 countries

Country	Deaf	Blinds	Elderly	Children	Pregnant women	Extreme obesity	Others	Special group
Belgium	No	No	No	No	No	No	No	Yes
Iran	No	No	No	No	No	No	No	Unknown
Italy	No	No	No	No	No	No	No	Planned by sections respectively
Netherlands	No	No	No	No	No	No	No	Unknown
Norway	No	No	No	No	No	No	No	Not formal, decision-based
Philippines	No	No	No	No	No	No	No	Unknown
Poland	No	No	No	No	No	No	No	None
Portugal	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Saudi Arabia	No	No	No	No	No	No	No	No
Sweden	No	No	No	No	No	No	No	None
Switzerland	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Thailand	No	No	No	No	No	No	No	Unknown
UK	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: The Participants answered that there is a general lack of planning to evacuate vulnerable groups, especially critically sick patients (Special groups; critically sick patients, e.g., ICU patients, patients under surgery, patients treated for cancer).

Table 7. The awareness of reversed triage (to identify patients least in need of urgent treatment to free up beds during surge demand), and the status of training and exercises, regarding hospital evacuation in 10 countries

Country	Awareness of reversed triage	Status of training
Belgium	Unknown	Once a year for fire control, not for evacuation
Iran	Unknown	Twice a year
Italy	Known, but unclear how many can practice it	Once a year
Netherlands	Unknown	Small sessions for fire evacuation with no patients
Norway	Not formalized, decision-based	Once a year for fire evacuation. Others: table-top exercises
Philippines	No	Yes, multiple for fire, earthquakes
Poland	Unknown	Once every 2 years
Portugal	Unknown	Once a year
Saudi Arabia	Unknown	Twice a year
Sweden	Unknown	Once a year for fire evacuation
Switzerland	Unknown	Once a year for fire evacuation
Thailand	Known, but only of physicians	Once a year for fire evacuation
UK	Yes	Once a year

the situation, options, and difficulties emergency managers may have.^{3,34,35,45}

Internal and external logistics are always a big issue in MID. Although several reports indicate a need for the development of external logistics, the internal logistics in the event of an evacuation is much more affected.^{3,10,11} Experience has shown that in many cases, staff who have accompanied patients out of hospital may not get back.³ Simultaneously, it can be extremely difficult to receive new personnel to a hospital which is already under evacuation. Our study shows a good capacity for internal logistics in MID, yet such ability is unknown or defective in external logistics. Both actions need to be done smoothly. Internal logistics are more demanding in an evacuation, and more consideration should be given to better planning and training. External logistics, on the other hand, demand good collaboration with other entities, which might not be easy to achieve if these entities have not looked into possible ways of cooperation, research, and information sharing.

The Incident Command System has been mentioned as 1 of the significant factors for the successful management of MID.^{1-3,7,10}

Such a procedure enables the systematic management of an event based on experience and scientific sound guidelines. It also enables collaboration between hospitals and regional entities. In our survey, the majority of included countries had ICS, and the partnership between hospitals and local coordination centers was evident. The contribution and participation of private hospitals/medical facilities in the total preparedness system is a critical issue in many countries and needs to be settled in a way that gives both sides responsibilities but also benefits in their collaboration. The need for such engagement is revealed in the results of our survey in which the roles of private organizations and hospitals are very unclear and not synchronized. A significant way of achieving a good collaboration and rational resource and information sharing is interactive courses and exercises to identify each organization's weaknesses and capabilities and the areas that can be coordinated and synchronized.⁸ The educational initiatives, exercises, and training methods enable all organizations to identify their limitations and capabilities. A significant benefit is to know and understand the legal responsibility of each emergency organization. Although the legal perspectives in MID seem to be well prepared

and can also be used in an evacuation, it is essential to discuss all possible issues that may exist in an evacuation, and which may change the course of management and medical outcomes.⁴⁶ Most of the guidelines concerning evacuation deal with short and less complicated cases of fire. Although many countries have legal guidelines that are associated with fire incidents, these guidelines need to be expanded to encompass long-term evacuation of a hospital with all issues it may have.

These results can conclude the need for exercise and training within the organization and in collaboration with others. Exercise and training are mentioned in the plans but are rarely conducted. Concerning an evacuation, they deal with short and temporary evacuation due to fires. Although such preparedness is proper, it is far from what is needed for a total evacuation of a large hospital and its consequences.^{3,8} An important factor in an evacuation is to clarify who makes the final decision to evacuate^{3,6,10}; is it the hospital administrator, the chief of medical services/nursing, chief of security, or a predetermined combination? Such a plan should consist of a list of people, who can make such a vital decision, if 1 or more of the decision makers are not available or incapacitated by the crisis event.

Limitations

The study is mainly based on English and in some cases, Swedish publications. Consequently, some important information published in other languages may have been missed in the review process. Nevertheless, the search was completed by the questionnaire, which was sent to representatives of 15 countries. Although the number of countries included might be low, the combination of the literature search and survey can give a good picture of the field internationally. However, it must be remembered that each participant has reported according to his/her total knowledge of hospital evacuation plan in their countries, and thus specific routines or plans from some hospitals might be missing. Another limitation might be the absence discussion on the recovery phase of the evacuation. However, since recovery is an important phase of the disaster management, it was not included in the discussion about hospital evacuation, which was our primary aim.

Conclusions

Evacuation of a hospital is more complicated than the management of MID, because the reverse actions necessary for hospital evacuation are associated with more technical and ethical decisions.^{2,3,9,10,34,35,47} Reported experiences show that significant problems and complications lie in the process of total evacuation. Although sheltering on-site may in the long-term result in severe shortages in a hospital, the complete evacuation presents the hospitals and their managers with more difficulties. It increases the need for more collaboration, coordination, and communication within the hospital as well as outside the hospital. The change of paradigm in disaster management necessitates proactivity in the hospital evacuation plan by activating society's resources.^{2,3,7,33,45,48}

The recent discussion on flexible surge capacity targets all elements of surge capacity to find out alternatives for staff, stuff, structure, and systems. In an evacuation situation, it is necessary to plan for all these alternatives.^{45,48}

Future research should investigate how civilians can be empowered to act as immediate responders and assist professional first responders.⁴⁸ It should also evaluate the need for alternative leadership and alternate care facilities within a community, which could either take responsibility for the care of lightly injured victims or for accepting lighter emergency cases from a nearby hospital to unburden emergency departments. These steps need legal and ethical evaluations but together will facilitate a flexible surge capacity that can be used in hospital evacuation as well as in other emergencies, to achieve the final goal, which is to secure the continuity of medical care for the patients.^{45,48}

References

1. Stander M, Wallis LA, Smith WP. Hospital disaster planning in the Western Cape, South Africa. *Prehosp Disaster Med.* 2011;26(4):283-286.
2. World Health Organization (WHO). *Hospital emergency response checklist. An all-hazards tool for hospital administrators and emergency managers*; 2011. http://www.euro.who.int/data/assets/pdf_file/0008/268766/Hospital-emergency-response-checklist-Eng.pdf. Accessed October 9, 2020.
3. Khorram-Manesh A, Anghthong C, Pangma A, et al. Hospital evacuation; Learning from the past. Flooding of Bangkok 2011. *Br J Med Med Res.* 2014;4(1):395-415.
4. Barbisch DF, Koenig KL. Understanding surge capacity: Essential elements. *Acad Emerg Med.* 2006;13(11):1098-1102.
5. Kaji A, Koenig KL, Bey T. Surge capacity for healthcare systems: A conceptual framework. *Acad Emerg Med.* 2006;13(11):1157-1159.
6. Verheul MLMI, Dückers MLA. Defining and operationalizing disaster preparedness in hospitals: A systematic literature review. *Prehosp Disaster Med.* 2020;35(1):61-68.
7. Khorram-Manesh A, Hedelin A, Örténwall P. Regional coordination in medical emergencies and major incidents; plan, execute and teach. *Scand J Trauma Resusc Emerg Med.* 2009;17:32.
8. Khorram-Manesh A, Berlin J, Carlström E. Two validated ways of improving the ability of decision-making in emergencies; Results from a literature review. *Bull Emerg Trauma.* 2016;4(4):186-196.
9. Bagaria J, Heggie C, Abrahams J, Murray V. Evacuation and sheltering of hospitals in emergencies: A review of international experience. *Prehosp Disaster Med.* 2009;24(5):461-467.
10. Nero C, Örténwall P, Khorram-Manesh A. Hospital evacuation; planning, assessment, performance and evaluation. *J Acute Disease.* 2012;1(1):58-64.
11. Näsman U, Zetterberg Randén B, Brändström H. KAMEDO Report No. 88: Floods in the Czech Republic and South East Germany, 2002. *Prehosp Disaster Med.* 2007;22(1):90-92.
12. Wise J. Hospitals must plan for full evacuation, concludes review of fires. *BMJ.* 2009;339:b4268.
13. Wapling A, Heggie C, Murray V, Bagaria J, Philpot C. Review of five London hospitals fires and their management, January 2008- February 2009. National Health Service London; 2009. <http://www.gao.gov/new.items/d06826.pdf>. Accessed October 09, 2020.
14. Murphy GRF, Foot C. ICU fire evacuation preparedness in London: A cross-sectional study. *Brit J Anaesth.* 2011;106(5):695-698.
15. Waring SC, Reynolds KM, D'Souza G, Arafat RR. Rapid assessment of household needs in the Houston area after Tropical Storm Allison. *Disaster Manag Response.* 2002;3-9.
16. Scultz Ch, Koenig KL, Lewis RJ. Implications of hospital evacuation after the Northridge, California earthquake. *N Engl J Med.* 2003;348(14):1349-1355.
17. Sternberg E, Lee GC, Huard D. Counting crises: US hospital evacuations, 1971-1999. *Prehosp Disaster Med.* 2004;19(2):150-157.

18. **Vilke GM, Smith AM, Stepanski BM, Ray LU, Murrin PA, Chan TC.** Impact of the San Diego county firestorm on emergency medical services. *Prehosp Disaster Med.* 2006;21(5):353-358.
19. **Brodie M, Weltzien E, Altman D, Blendon RJ, Benson JM.** Experiences of hurricane Katrina evacuees in Houston shelters: Implications for future planning. *Am J Public Health.* 2006;96(8):1402-1408.
20. **Brunkard J, Namulanda G, Ratard R.** Hurricane Katrina Deaths, Louisiana, 2005. *Disaster Med Public Health Prep.* 2008;2(4):215-223.
21. **Powell T, Hanfling D, Gostin LO.** Emergency preparedness and public health. The lessons of Hurricane Sandy. *JAMA.* 2012;308(24):2569-2570.
22. **Redlener I, Reilly MJ.** Lessons from Sandy—preparing health systems for future disasters. *N Engl J Med.* 2012;367(24):2269-2271.
23. **Downey EL, Andress K, Schultz CH.** Initial management of hospital evacuations caused by Hurricane Rita: A systematic investigation. *Prehosp Disaster Med.* 2013;28(3):257-263.
24. **Tanavud C, Yongchalerchai C, Bennui A, Densreerekul O.** (2004) Assessment of flood risk in Hat Yai Municipality, Southern Thailand, using GIS. *J Nat Disaster Sci.* 2004;26(1):1-14.
25. **Nagata T, Himeno S, Himeno A, et al.** Successful hospital evacuation after the Kumamoto Earthquakes, Japan, 2016. *Disaster Med Public Health Prep.* 2017;11(5):517-521.
26. Swedish National board of Health and Welfare. Ammonia accident in Kävlinge 1997. https://www.socialstyrelsen.se/globalassets/sharepoint-dokument/artikelkatalog/vagledning/2000-0-16_0000016.pdf (pages 10-11). Accessed October 09, 2020.
27. Swedish National board of Health and Welfare. *The fire on Huddinge University Hospital*; 1991. <https://www.socialstyrelsen.se/globalassets/sharepoint-dokument/artikelkatalog/ovrigt/1993-3-19.pdf> (page 35). Accessed October 09, 2020.
28. **Catovic L, Alniemi C, Ronchi E.** A survey on the factors affecting horizontal assisted evacuation in hospitals. 3rd European Symposium on Fire Safety Science 12–14 September 2018, Nancy, France. 2018;1107. (Journal of Physics: Conference Series). <https://doi.org/10.1088/1742-6596/1107/7/072001>. Accessed October 09, 2020.
29. **Rojek A, Little M.** Review article: Evacuating hospitals in Australia: What lessons can we learn from the world literature? *Emerg Med Australia.* 2013;25(6):496-502.
30. **Mortelmans LJM, Lievers J, Sabbe M, et al.** Are Belgian military trained medical officers better prepared for CBRN incidents than civilian emergency physicians? *Int Rev Armed Forces Med Serv.* 2017;90(2):24-27.
31. **De Cauwer H, Somville F, Sabbe M, et al.** Hospitals: Soft target for terrorism? *Prehosp Disaster Med.* 2017;32(1):94-100.
32. **Haines A, Kovats RS, Campbell-Lendrum D, et al.** Climate change and human health: Impacts, vulnerability and public health. *Public Health.* 2006;120(17):585-596.
33. **United Nations Office for Disaster Risk Reduction.** *Sendai Framework for Disaster Risk Reduction 2015-2030.* <https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030>. Accessed October 9, 2020.
34. **Cheshire and Wirral Partnership, NHS foundation Trusts.** CWP Major Evacuation Plan. 2020. <http://www.cwp.nhs.uk/media/5158/ep4-issue-3-evacuation-plan.pdf>. Accessed October 9, 2020.
35. **NHS England Emergency Preparedness, Resilience and Response (EPRR)** planning for the Shelter and Evacuation of people in healthcare settings. 2014. <https://www.england.nhs.uk/wp-content/uploads/2015/01/epr-r-shelter-evacuation-guidance.pdf>. Accessed October 09, 2020.
36. **Zane R, Biddinger P, Hassol A, Rich T, Gerber J, DeAngelis J.** *Hospital evacuation decision guide.* Agency for Healthcare Research and Human Services. 2010; AHRQ Publication No. 10-0009. <https://archive.ahrq.gov/prep/hospvacguide/>. Accessed May 10, 2020.
37. **Bish DR, Tarhini H, Amara R, Zoraster R, Bosson N, Gausche-Hill M.** Modeling to Optimize Hospital Evacuation Planning in EMS Systems. *Prehosp Emerg Care.* 2017;21(4):503-510.
38. **Harvard School of Public Health.** *MDPH Hospital Evacuation Toolkit*; 2014. <http://www.mass.gov/eohhs/docs/dph/emergency-prep/hospital-evacuation-toolkit/planning-guide.pdf>. Accessed October 9, 2020.
39. **Moher D, Liberati A, Tetzlaff J, Altman DG;** PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Med.* 2009;6(7):e1000097.
40. **Harvey N, Holmes CA.** Nominal group technique: An effective method for obtaining group consensus. *Int J Nurs Pract.* 2012;18(2):188-194.
41. **Sandelowski M.** Whatever happened to qualitative description? *Res Nurs Health.* 2000;23(4):334-340.
42. **Graneheim UH, Lundman B.** Qualitative content analysis in nursing research: Concepts, procedures and measures to achieve trustworthiness. *Nurse Educ Today.* 2004;24(2):105-112.
43. **Nicholas D, Clark D, Herman E.** ResearchGate: Reputation uncovered. *Learned Publishing.* 2016;29(3):173-182.
44. **Khorram-Manesh A, Yttermyr J, Sörensson J, Carlstrom E.** The impact of disasters and major incidents on vulnerable groups: Risk and medical assessment of Swedish patients with advanced care at home. *Home Healthcare Manag Pract.* 2017;29(3):183-190.
45. **Khorram-Manesh A.** Flexible surge capacity-public health, public education, and disaster management. *Health Promot Perspect.* 2020;10(3):175-179.
46. **Goniewicz K, Misztal-Okońska P, Pawłowski W, et al.** Evacuation from healthcare facilities in Poland: Legal preparedness and preparation. *Int J Environ Res Public Health.* 2020;17(5):1779.
47. **Khorram-Manesh A, Hedelin A, Ortenwall P.** Hospital-related incidents: Causes and its impact on disaster preparedness and prehospital organizations. *Scand J Trauma Resusc Emerg Med.* 2009;17:26.
48. **Khorram-Manesh A, Plegas P, Högstedt Å, Peyravi M, Carlström E.** Immediate response to major incidents: Defining an immediate responder! *Eur J Trauma Emerg Surg.* 2020;46(6):1309-1320.