Review Article

Emergency Evacuation Related Challenges in Specialized Hospitals for Children and Neonates: A Narrative Review

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ABSTRACT

Background: In recent years, the number of emergencies in hospitals has increased. Hospitals are one of the main assets for successful disaster management. One of the significant challenges in a disaster is the evacuation of training wards. There are anatomical and physiological differences between adults and children that make children more vulnerable to accidents and disasters. Rapid transfer of sick children on a large scale has always been challenging in this respect.

Objectives: This study pursued the goal to determine the challenges of emergency evacuation in specialized hospitals for children and neonates.

Methods: Searching online databases, such as Google Scholar, PubMed, Scopus, and Web of Science was done from December 1 to December 20, 2021. The keywords used for the search were based on Medical Subject Headings (MESH) and were combined with other keywords, including evacuation, disaster, pediatric, and patient transfer. All English language studies consistent with the study goal (emergency evacuation challenges in specialized hospitals for children and neonatal) were included in this study.

Results: Out of 2,145 studies, the full text of 11 studies was finally reviewed. The measures taken during natural disasters are divided into three levels: local, state, and national. Emergency evacuation challenges are also divided into five categories: communication, training, transportation, equipment and energy, and management.

Conclusions: This study provided essential perspectives for developing appropriate intervention strategies for the managers and policymakers of health care systems to better prepare in case of natural disasters breaking out in children and neonatal wards.

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1. Context

In recent years, hospital emergencies have constantly increased [1]. Disasters occur in various forms, including natural disasters, such as floods, hurricanes, and earthquakes. On the other hand, new events, such as overcrowding, fires, and terrorist operations have been reported worldwide. The incidence of disasters and concerns about their devastating effects has globally increased [2]. Based on the World Health Organization (WHO), an average of 11,000 deaths from natural disasters are reported annually [3].

Examples of such accidents include the September 11 terrorist attacks in the United States in 2001 [4] and the massive death toll in Mecca in 2015 [5]. With the increase in the damage caused by natural disasters, emergency management as a new field of research has attracted the attention of researchers; therefore, emergency evacuation should be specially focused on as a significant factor in reducing the casualties [6]. Emergency evacuation is a process that emphasizes the rapid evacuation of people from high-risk areas to safe areas. Although the impact of a sudden accident may be small at first, it is likely to cause more casualties if the situation worsens. Therefore, evacuating people from the affected area after an emergency is essential [7].

One of the main assets for successful disaster management is hospitals. Proper hospital response to accidents and disasters increases patient safety and community resilience [8]. Emergency evacuation in hospitals has not been sufficiently considered; as various studies have revealed that many health centers, including hospitals, have been forced to evacuate due to fires, climate change incidents, terrorist threats, and other natural disasters or crises [1, 9-11]. Emergency evacuation is a systematic and complex problem encompassing the behavior and organization of the staff [7].

Undoubtedly, an emergency evacuation can be an interdisciplinary scientific problem that has challenged the medical and hospital systems in its safe use. Today, based on the previous evidence, hospital settings, even in developed countries, are not sufficiently prepared for successful emergency evacuation [1, 12]. Emergency evacuation of a hospital is completely different from the evacuation of other buildings. Relocating hospital-bound patients, many of whom may be in critical condition, is very dangerous, which is one of the reasons for the complexity and difficulty of the evacuation process in hospitals.

Relocating patients to alternative care facilities safely and without interruption in receiving ongoing medical care is critical [13]. On the other hand, it is evident that with the increase of the damage caused by various natural disasters to human society, emergency management as a new field of research has attracted the researchers' attention who consider emergency evacuation a significant issue in emergency management [11].

One of the challenges hospitals face in disasters is the evacuation of children and neonatal wards. The transportation of sick children and neonates is intensive and requires efficient training and adequate equipment [14]. There are anatomical and physiological differences between adults and children that make children more vulnerable to accidents and disasters [15, 16]. Rapid large-scale evacuation of children is challenging, and the children and neonates involved in a mass casualty are exposed to septic shock and hypothermia. They have a limited ability to care for themselves during a crisis [17].

Objective

The particular needs of evacuating neonatal intensive care units (NICUs) and children's wards are not fully understood by the authorities of hospitals or the government. In this article, despite the scattering of published articles in the field of emergency evacuation of children, we tried to review a series of published studies. Therefore, this study examined the challenges of emergency evacuation in specialized hospitals for children and neonates.

2. Methods

In this narrative review, searching online databases, such as Google Scholar, PubMed, Scopus, and Web of Science was conducted from December 1 to December 20, 2021. The keywords used for the search were based on Medical Subject Headings (MESH) and were combined with other keywords, including evacuation, disaster, pediatric, and patient transfer. All English language studies on the emergency evacuation challenges in specialized hospitals for children and neonates were included in the present research. Articles should be in English, easy to access, and published from December 1 to December 20, 2021. A summary of a conference or dissertation, part of a book, and studies published in a language other than English were not included. First, 2,145 articles were gathered related to hospitals' emergency evacuation. About 24 articles examining the emergency evacuation of children's wards during disasters were selected, of which 11 articles were chosen ac-

cording to the inclusion criteria (Figure 1). A systematic review was done by two researchers individually. The due disputes were resolved through consulting with a third researcher. The final articles are listed in Table 1.

3. Results

These results were extracted from 11 articles related to emergency evacuation of pediatric and neonatal wards from December 1 to December 20, 2021 [14, 18-27], of which nine articles were on hurricanes [14, 18-21, 24-27], one on earthquakes [23], and one on fires [22]. Of the nine hurricane articles, seven papers had studied Hurricane Katrina [18, 20, 21, 24-27], one was related to Hurricane Sandy [14], one paper was on Tropical Hurricane [19], one paper was on the Kumamoto earthquake in Japan [23], and one article was on the Toronto Children's Hospital fire [22].

In addition, eight of the included articles had been conducted in the United States [14, 18, 20, 21, 24-27], one in Japan [23], and one in Canada [22]. Also, ten studies were the lessons learned [14, 18-20, 22-27], and one was retrospective [21]. A total of three countries reported emergency evacuation of pediatric and neonatal wards during that period. None of the studies reported children and neonates' mortality during evacuation. Table 1 summarizes the articles related to emergency evacuation of pediatric wards. The results were classified into two main groups:

Measures taken for emergency evacuation of children's hospitals

Measures taken at the local level

Eight studies examined the measures taken in the event of disasters at the local level [14, 18-21, 23, 25, 27]. These measures included the following categories: 1. safety, 2. transportation, 3. communication and information, and 4) equipment and energy.

All the articles considered evacuating the city, transferring patients to safe places and alternative hospitals, and paying attention to traffic control. Also, informing the staff by creating an alert website communicating with the children's parents and the staff's families, and establishing satellite telephone lines were among the measures taken to develop communication and information at the local level. Children needed equipment transfer, such as ventilators and medicines, vaccines and food, and their storage before the accident was announced.

Measures taken at the state level

Eight studies analyzed the state-level measures [14, 18-21, 23, 25, 27], including coordination between different states to provide alternative beds for children, transfer the patients, provide a database of available facilities and patient history, assign one of the treatment centers to children, and to make changes in the rules.

Measures taken at the national level

Eight studies reviewed the measures taken at the national level [14, 18-21, 23, 25, 27], including urgent actions, such as activating the National Crisis Management Center, sending a private transport network to the accident site, sending equipment and facilities of transportation, such as ambulances and helicopters, sending a specialized child care team to the accident site and long-term measures, such as providing the concepts of crisis preparedness, planning, evacuation priorities, and putting pressure on the managers for crisis preparedness programs.

Challenges faced by hospitals during emergency evacuations

Communication challenges

Seven studies addressed disaster-related communication problems [14, 18, 20-23, 25], encompassing lack of effective communication between hospitals, inappropriate contact with the families of sick children and issues related to informed consent, lack of a suitable place for the communication department employees who are worried about their families due to lack of communication and access to medical records due to lack of Internet. In a study on the earthquake in Japan, Internet and telephone lines did not damage due to the elimination of communication problems in the previous earthquake in 2017 [23].

Training challenges

Five studies reported training problems, such as inadequate staff training on how to triage, employing the equipment, insufficient training in symptom identification, awareness and appropriate treatment of patients and their companions, overlooking individual differences, emotional aspects of pediatric trauma, and decision-making skills [19, 21, 22, 24, 27].

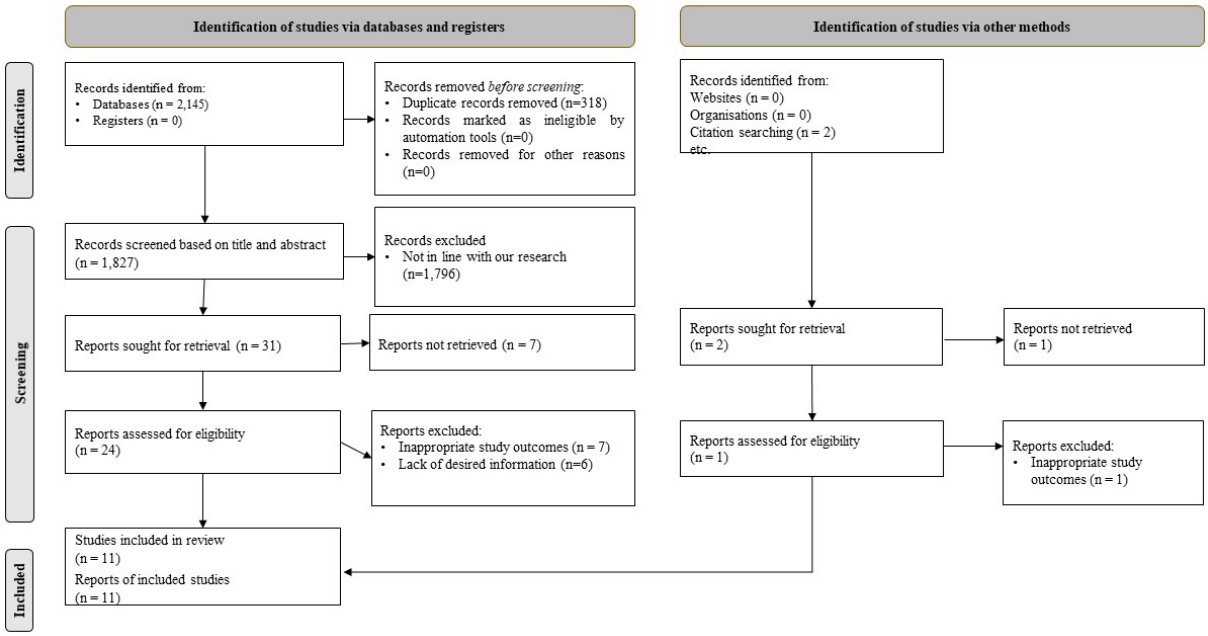

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Figure 1. The flow diagram of the study selection process

Transportation challenges

Four studies examined transportation problems [14, 18, 20, 21], such as excessive traffic, inappropriate roads for transporting patients, lack of suitable landing sites for air transport, restrictions on the movement of several patients simultaneously, lack of attention to geographical distance in emergency evacuation in the crisis program, and inadequate transportation facilities with children; for example, incompatibility of neonatal incubators with the existing transportation system.

Equipment and energy challenges

Seven studies pointed out the shortcomings of equipment and energy, such as energy storage and the need to place generators on higher floors, inadequate storage of energy and equipment, lack of refueling facilities at the used helicopters and battery charging facilities at the accident site, lack of proper access to devices, such as dialysis and ventilator, cardiopulmonary resuscitation (CPR) device, adult-centered equipment, and lack of alternative beds [18-21, 24-26].

Management challenges

Four studies surveyed management problems, such as not paying attention to the children's medical needs in crisis preparation programs, insufficient attention to the processes related to the emergency team, not using the crisis program of other states in the accident site, improperly paying attention to the children's needs in macro-planning, not sufficiently paying attention to finding a safe alternative place for patients, inappropriate communication of the emergency team with government agencies, and not coordinating properly in transferring patients to the destination hospital [18, 19, 26, 27].

4. Discussion

This review study was conducted to determine the challenges of emergency evacuation in specialized hospitals for children and neonates. We examined the measures taken in this respect and the challenges faced by the hospitals. The measures were divided into three levels: local, state, and national. Emergency evacuation challenges were categorized into five categories: communication, training, transportation, equipment, and energy and management.

The first condition for an effective response to accidents and disasters in the hospital is preparedness [28, 29]. Preparedness means identifying the organization's challenges and considering them operationally in planning [30]. Emergency evacuation is an important risk management tool, and there are resource constraints and budgetary considerations in emergency evacuation plans [2].

One of the significant problems is the failure of the communication system (in-hospital, hospitals with other hospitals, and between hospitals and other or-

Table 1. A summary of articles on emergency evacuation of pediatric wards during disasters

Authors	Year	Country	Accident Type	Article Type	Challenges	Measures Taken at Local Level	Measures Taken at State Level	Measures Taken at National Level
Hogan [22]	2002	Canada	Fire	Lesson learned	Having problems in emergency communication due to the lack of familiarity of employees with how to work with wireless devices. Incompatibility of the transfer system with incubators. Concerns of families and assigning an individual to answer.	*****	****	*****
Baldwin [18]	2006	USA	Hurricane Katrina	Lesson learned	Dispersal of children due to lack of proper equipment. No attention to the geographical distance in an emergency evacuation. Improper coordination between the care team and government agencies. Supply shortage. Improper coordination between inter-state authorities. Transportation problems and non-compliance with children	City evacuation order	Interstate communication and sending emergency teams from other states to the accident site	Activation of the National Crisis Management Center Sending a private transport network to the accident site
Distefano [20]	2006	USA	Hurricane Katrina	Lesson learned	Improper roads for transportation. Improper access of personnel to equipment. Improper triage.	Pay attention to food storage. Creating satellite phone. Preparation of warning website. Preparation of electrical energy.	Measures between state hospitals.	Sending the children and neonates care team to the accident site.
McAndrews [25]	2006	USA	Hurricane Katrina	Lesson learned	Lack of communication and mutual support between planning agencies. Lack of sufficient resources to deal with the accident.	Use of portable lights and generators to assist helicopters. Using small boats to carry flood victims.	Coordination between agencies for planning.	Creating appropriate infrastructure in children's hospitals. Coordinating with insurance companies to compensate for damages.
Perrin [26]	2006	USA	Hurricane Katrina	Lesson learned	Improper management of families of sick children. Personnel concerned for their families. Improper location of generators. Lack of alternative water source. Communication problems. Unavailability of medical records due to an Internet outage.	*******	*******	******
Thomas [27]	2006	USA	Hurricane Katrina	Lesson learned	Lack of attention to the medical needs of children in preparation programs. Lack of attention to the processes related to the emergency team. Insufficient attention to the emotional aspects of childhood trauma. No use of the crisis plans of other areas at the accident site. Lack of access to replacement staff during the storm.	Transfer of medicines, food, and vaccines to alternative places. Transfer of children connected to the ventilator to safe hospitals.	Allocating a medical center to children. Providing care to children by the children's team	Adding emergency teams from other states to the accident site. Pushing administrators for training programs

Authors	Year	Country	Accident Type	Article Type	Challenges	Measures Taken at Local Level	Measures Taken at State Level	Measures Taken at National Level
Jonsdottir [24]	2008	USA	Hurricane Katrina	Lesson learned	Improper storage of electrical energy. Ineffective telephone communication. Inadequate staff training on decision-making. Improper triage.	******	******	******
Fuzak [21]	2010	USA	After Hurricane Katrina	Retrospective	Inadequate staff training on triage and use of equipment and identification of patients' symptoms. Improper storage of equipment. Improper access to dialysis machines and ventilators. Heavy traffic jam.	Traffic control by the police.	Agreement of children's regional teams.	Providing crisis preparedness concepts. Planning and priorities of evacuation.
Espiritu [14]	2014	USA	Hurricane Sandy	Lesson learned	Finding an alternative bed Coordination of transfer to the destination hospital Transportation problems Communication problems Awareness	Paying attention to patient safety and equipment Communications Informing the staff Continuity of care communication with parents	Coordination between hospitals	Sending equipment and ambulances
Iwata [23]	2017	Japan	Earthquake	Lesson learned	No use of emergency and resuscitation systems for children. Ineffective communication with the crisis management team. Adult-centered emergency team. No communication problem due to fixing it in the previous earthquake in 2011. Improper triage of children.	Transferring patients to a safe place.	Coordination for alternative hospitals.	Maintain telephone communication systems.
Calgaro [19]	2020	Italy	Tropical Storm	Lesson learned	Lack of oxygen resources. The emergency evacuation of patients without triage. Loss of incubators and infant warmers. Power outages and disconnection inside and outside the hospital. Destroying archive files Poor local and international coordination.	System with several connectors and pipes to provide more oxygen. Training staff about triage.	Accurate local and international cooperation. Use of polyethylene bags and kangaroo mother care.	Creating an electronic archive of files.

ganizations) [31]. Specific attention should be paid to communication requirements in the emergency evacuation program. The supported radio phones should also be considered. The list of emergency telephone numbers of employees should be updated to compensate for the shortage of human resources during accidents and disasters [32].

Cooperation between the hospital staff is a significant factor in improving awareness and performance in emergency evacuation methods. Therefore, due to the prevalence of this problem in the relevant studies, it is suggested that meetings be held to coordinate the hospital staff to make the necessary preparations in order to deal with possible natural disasters [33].

Another significant challenge in the studies was the lack of adequate staff training to deal with possible accidents. Emergency evacuation training may help increase the effectiveness of the evacuation method.

However, another relevant study in China [34] showed that only half of the staff participated in the emergency evacuation exercises, and only half of them had ever practiced using an emergency evacuation device, which may be due to the absence of some employees in the due training programs. Therefore, some hospital staff does not receive any training on emergency evacuation. This result indicates the need to develop appropriate intervention strategies to improve hospital staff's knowledge and performance facing potential disasters.

All hospital staff should be trained about the significant factors in assisted evacuation procedures and proper emergency management. Specific attention should be paid to the pediatric and neonatal wards due to their high sensitivity and vulnerability. Providing the necessary training and employing experienced and trained human resources to deal with possible disasters can minimize the potential casualties in these areas [35-38].

The results of this review study presented new horizons for managers and policymakers of health systems in order to safely deal with natural disasters. However, there were limitations in the studies. Most studies had been done in developed countries. Therefore, limited information is available in low- and middle-income countries. It is suggested that more studies be conducted in less developed countries to design appropriate interventions and strategies.

Limitations

The present study's limitations are as follows: first, only English language studies were included in the study, second, although an attempt was made to include all studies consistent with the purpose of the present study in this review, some studies may not have been included.

5. Conclusions

Overall, this study examined the measures taken in this regard and the challenges the patients face in the pediatric and neonatal wards. The measurements were divided into three levels: local, state, and national, and challenges in various types of communication, training, transportation, equipment, and energy and management. The derived results provide some fundamental insights for the managers and policymakers of health care systems, which include the development of appropriate intervention strategies for higher preparedness in the event of natural disasters in pediatric and neonatal wards.

Ethical Considerations

Compliance with ethical guidelines

There were no ethical considerations to be considered in this research.

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Authors' contributions

All authors equally contributed to designing, running, and writing all parts of the research.

Conflicts of interest

The authors declared no conflict of interest.

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