Emergency Evacuation of the Neonatal Intensive Care Unit (NICU) During Disasters: A Systematic Literature Review

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Received: 16 Nov. 2020; Accepted: 08 May 2021

Abstract- The evacuation of hospitals has special complications and sensitivities in terms of the presence of patients. Since infants are the youngest and most vulnerable patients in the hospital, the readiness of the neonatal intensive care unit (NICU) to respond appropriately and evacuate at the time of disasters is very important. This article examines the emergency evacuation of neonatal intensive care units during disasters. The present systematic review was done based on the PRISMA guidelines for systematic review studies. Accordingly, all English-language articles published in this field were extracted by the end of January 2020, through searching Web of Science, PubMed, Scopus, and Science Direct, as well as Google Scholar Web Search. The search and screen of the articles were conducted independently by the research team members, and the content of included articles was analyzed thematically. After the final evaluation, 11 articles were subjected to content analysis, which was divided into seven thematic categories: command, training and maneuver, manpower, communication, equipment, transportation, support. Considering that infants are the most vulnerable preparing the staff of the (NICU) along with providing them with specialized and technical support is suggested. By preparing and implementing response and preparedness plans, it is possible to prevent high complications and mortality among infants admitted to the hospital pre-disasters.

Acta Med Iran 2021;59(7):386-392.

Keywords: Infant; Emergency evacuation; Neonatal intensive care unit (NICU); Disasters

Introduction

In the field of disasters, the health sector explains the four stages of mitigation, preparedness, response, and recovery, with the aim of maintaining and promoting physical, mental, and social health at different levels. One of the most important levels in the hospital level, which plays a key role in providing vital care to the community and reducing injuries and deaths (1,2). Hospital disaster preparedness programs and policies and procedures related to each unit are essential to facilitate an effective response to major events or natural and man-made disasters. All disasters put tremendous stress on the resources and staff of the hospital (3). A safe hospital is not destroyed by a disaster or a crisis, and its patients and staff are the least affected. In critical situations that require hospitalization more than ever, a safe hospital can continue its operations and provide important health services to patients and the community (4).

According to global statistics, the success rate of saving the life and health of infants in some developed countries has reached about 70%. Therefore, proper planning and management for providing services to infants on a national scale can increase the quality of services and bring national services closer to the global standards of neonatal health (4). One of the measures that can be taken in response to an event is an emergency evacuation. Meanwhile, the evacuation of hospitals has special complications and sensitivities in

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terms of the presence of patients; environmental conditions affected by the event put a lot of pressure on the management team to make the necessary decisions. So, it is meaningful to make the necessary preparations to deal with such situations, and for this purpose it is necessary to make the required plans in advance (5). Evacuation should be done when employees and patients in the hospital are at risk of injury in the disaster (6). Newborns in NICU are the youngest and most vulnerable population in the hospital, and many of them face complex medical problems without temperature control, respiratory support, monitoring of the cardiovascular system and special cares during disasters (7,8). Hospitals should consider the needs of infants in emergencies and disasters. The readiness of the NICU to respond appropriately is vital at the time of disasters (7,9-12).

In general, infants are more vulnerable than other patients and are at greater risk in times of crisis. Therefore, this study was conducted to identify important emergency evacuation factors in NICU at the time of disasters. The results of the present study can be useful for hospital preparedness and reducing the vulnerability of infants in the intensive care unit during disasters.

Materials and Methods

Design

This study a systematic literature review conducted based on the PRISMA guideline for systematic review (13). All stages of the research, including search, selection of studies, quality assessment of articles, and data collection were performed by the research team members.

Search strategy

Research team conducted articles search .All English-language articles published until the end of January 2020 were extracted by searching the Web of Science, PubMed, Scopus, Science Direct and Google scholar databases. To find synonym keywords, experts' opinion, medical subject mesh websites, synonym dictionaries, and keywords in pertinent articles were applied. To write syntax, AND/OR operators were used. For example:((((((((((("Neonatal ICU") OR "Neonatal Intensive Care Units") OR "Newborn Intensive Care Units") OR "NICU")) AND (((((Hospital*) OR "Health Facility*") OR "Health center") OR "Health service") OR "Health care service")) AND (((((((emergency) OR evacuation*) OR removal*) OR evacuate*) OR*) OR leave) OR abandon)) AND ((((infant) OR newborn) OR neonat) OR "Infant Premature")) AND ((((infant) OR newborn) OR neonate) OR "Infant Premature"))) AND (((Disaster*) OR "Disaster Planning") OR Emergency*)

Inclusion and exclusion criteria

The inclusion criteria for the study were all published English-language articles and guidelines that examined the conditions of NICU at times of crisis and emergency evacuation. Exclusion criteria consisted of contents that were not about emergency and evacuation of NICU and non-English-language published sources.

Quality assessment

Quality assessment of studies was performed using CASP and STROBE checklists. The STROBE checklist consisted of 22 questions that cover all aspects of the study. Each study scores between 0 and 44. The results of the quality assessment of the studies were categorized as low quality (less than 15.5), medium quality (15.5 to 29.5), and high quality (29.5 to 44). The CASP checklist consisted of 3 sections and a total of 10 questions, and the answers to each question were evaluated as *No*, *Can't Tell*, and *Yes*. They were evaluated, and the articles that received a score of 7 or higher were included in the study (14,15).

Screening and data extraction

The research team members screened articles by reviewing the titles and abstracts based on the inclusion and exclusion criteria. Finally, the full texts of the articles were reviewed, and in case of rejection or disagreement, the third person was judged. Data collection was conducted using a pre-designed checklist that included the author's name, place of study, study time, method, Data collection, and Summary of findings.

Findings

Databases searching led to the extraction of 490 studies. Initially, the studies were processed by the Endnote software, and after the initial assessment, 98 repeated studies were removed. Then, 257 studies were excluded by examining the titles and summaries of the articles due to being unrelated, and 135 full-text studies were eligible. Finally, 11 studies met inclusion criteria and were subjected to final analysis (Figure 1). These studies were conducted between 2008 and 2019 in the United States, Israel, and Japan, in the field of emergency evacuation of NICU at the time of disasters (Table 1).

The results were generally divided into seven

thematic categories and introduced the following essential measures in the NICU:

Command

The need for leadership and having a clear command structure and creativity in management plays an important role in timely evacuation and appropriate response during an emergency evacuation of the neonatal intensive care units.

Training and doing exercise

Training and exercising to empower personnel in the events and disasters, as well as identifying the gaps in the operational training program, should be done properly. Accordingly, personnel have the ability to make decisions and anticipate future issues. Training in triage and having a triage algorithm is very important for saving infants during disasters.

Manpower

It is important to provide manpower to transport the infants and support them, in order to provide proper oxygenation, medication, and nutrition.

Communications

Having a plan to coordinate hospitals and agencies for responding appropriately and create situational awareness and regional convergence, referral coordination, paying attention to cell phones, messengers and alert systems, using reports and documentation have been useful in establishing effective and stable communication.

Equipment

It is very important to buy emergency evacuation vests for infants and provide emergency supplies and backpacks next to their beds.

Transportation

Having a plan for moving infants, determining secondary routes for emergency evacuation of infants, availability of transportation resources, identifying a suitable place for air transport by helicopter, determining the places where evacuation was performed with the use of pre-marked colored strips, having a Transportation Consent Performa for admitting in NICU, transporting the infant's records, are the important points for effective evacuation at the time of disaster.

Support

Attention and support to families, having a plan to track caregivers and parents, technical staff support in all aspects, special attention to methods of tracking infants and families are important during disasters.

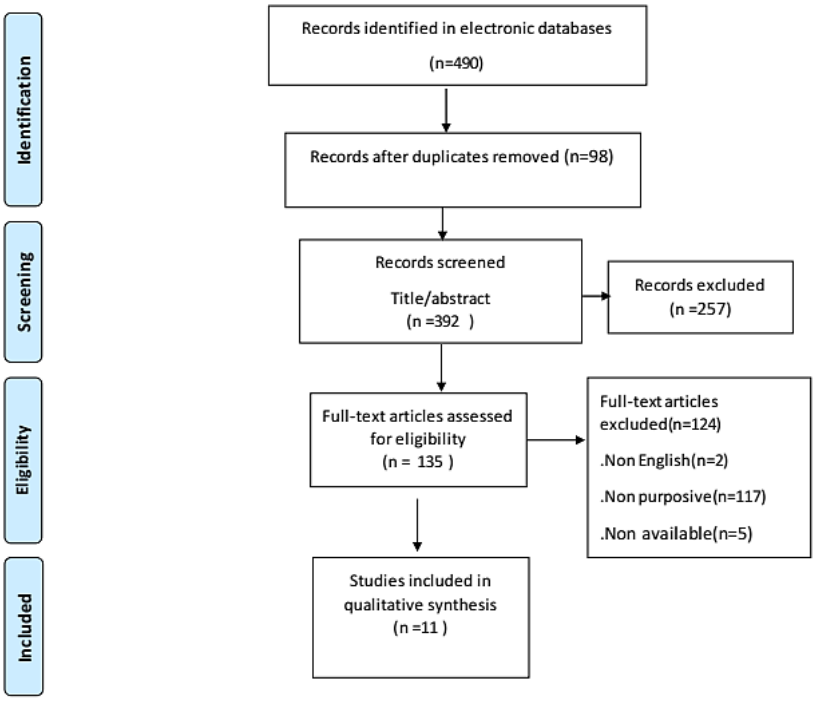

Figure 1. PRISMA flowchart

Table 1. General characteristics of the studied articles for emergency evacuation of the neonatal intensive care unit (NICU) during disasters

Author	Year of study	Place of study Design	Design	Data collection	Summary of findings
Farra.S *et al.*, (16)	2019	United States	Mixed method	Examining differences in learning outcomes among NICU workers who underwent virtual reality simulation and emergency evacuation training versus those who received web-based clinical updates	Training through simulation is important in improving performance and can identify gaps in the operational plan.
Femino M *et al.*, (17)	2013	Israel	Descriptive	Reporting an experience with a full-scale exercise on neonatal intensive care unit evacuation	Essential health care personnel resources included (1) staff to physically transport patients, (2) a central communication/coordinating site, and (3) on-site triage in the holding areas. Flexibility and creativity are essential in disaster management.
Megan M *et al.*, (18)	2019	Washington	Qualitative	Expert nurses were surveyed	Advanced training is needed, especially in decision-making training, emergency communication training, and condition forecasting training to support infants.
Espiritu, M *et al.*, (19)	2014	New York	Descriptive	Neonates were safely evacuated from the medical center's NICU to receiving hospitals within New York City in a span of 4.5 hours	Several important factors of the management of NICU included: a clear command structure, backups, establishing situational awareness, regional coordination, and flexibility as well as special attention to families and to the availability of neonatal transport resources
Schultz, R *et al.*, (3)	2008	New York	Descriptive	Outlining the principles of emergency and disaster planning for neonatal intensive care units	Plans for how sick infants will be moved, clear identification, have an algorithm for triage, locations for helicopter, baby evacuation vests, ascertain secondary evacuation routes, assemble an overall scene management kit (staff roster, patient census, triage tags, communication)
Barfield WD *et al.*, (11)	2017	Atlanta	Descriptive/ Instructions	Report on existing policies in the neonatal intensive care unit	Planning and coordination prepare for possible separation of infants from their parents, program for tracking babies and caregivers, planning for specialized equipment for difficult terrain, planning for communication with transport teams and receiving hospitals.
Phillips P *et al.*, (20)	2012	California	Descriptive	A multidisciplinary approach to ensure integration with hospital-wide emergency planning efforts.	Having an agreement with important centers, safe transport, and safe place, having documentation and consent forms for transport, more than one staff member for evacuate infants, requiring oxygen support, portable suction. IV infusions are stopped temporarily. Double wrapped with hats to provide warmth or chemical warming mattresses. Emergency bedside backpacks, staff training, and exercising response protocols. Using colored tape for doors of the evacuated rooms
Fuzak, JK *et al.*, (21)	2010	Colorado	Descriptive	Moving documents and electronic health records (EHRs) for patients moved were reviewed/ Key administrators were interviewed	Pediatric transfers can be managed rapidly and safely with parallel transfers/ Prior agreements with children's teams are essential
Orlando S *et al.*, (22)	2008	New Orleans	Descriptive	addresses nursing care issues and lessons learned from the events that unfolded in the New Orleans area neonatal units during and after Hurricane Katrina, and guidance in support of disaster education for neonatal nurses.	A clear plan for communication with parents of hospitalized infants is essential/ Backup communication apps / Planning and education are of utmost importance/ The ability to maintain communication and facilitate transportation of neonates out of a disaster area is essential.
Carbine D *et al.*, (23)	2014	California	Descriptive Instructions	Neonatal Preparedness Toolkit	Attention to the types of emergency, horizontal discharge/ attention to the evacuation priority, NICU evacuation plan, roles, and responsibilities, emergency bedside supplies, mobile disaster containers, support equipment, documentation, emergency medication, administration, transport
Iwata, O *et al.*, (24)	2017	Japan	Descriptive	Information regarding the patients' clinical background and evacuation process was obtained from the data archive of the disaster-communication secretary of the Japan Society for Neonatal Health and Development	Successfully evacuated within eighth. There was difficulty in arranging helicopter transportation. Lack of cooperation with the Coordination Office. The coordination system was adult-based. A better system needs to be developed urgently for vulnerable newborn infants.

Discussion

The present study showed that due to the fact that infants are the most vulnerable and youngest patients in the hospital, there is a need for preparedness and response plans covering in all aspects of NICU evacuation during disasters. Command, training, support in all dimensions, awareness, operational zoning, regional coordination, and strong inter-disciplinary management of crisis, are of great importance in NICU evacuation.

Based on the results, the need to prepare staff for neonatal intensive care and specialized and technical support along with providing a safe environment for infants are clear and essential priorities (8,23,25). One of the important points of the present study has been the issue of time and speed in operations. According to the findings of studies, the time it takes to determine which hospital admits the infant (1), transportation (2), communication problems and maintaining situational awareness (3), and transferring medical records and tracking the infant and generally finding hospital beds (4) have been the most time consuming steps, respectively (19,26,27). Ivata (2011) found that a mismatch between operational units and agencies would prolong the evacuation time in the neonatal intensive care unit (28). This study showed that a clear command structure, support attraction and generally support in all areas are very important. As research has shown, hospital staffs have various degrees of coping mechanisms in difficult situations; all of them need physical and emotional support. Managers should note that preparation for the worst-case scenario is a necessity. Service providers in neonatal intensive care should determine the necessary capacity to provide primary care and public health in collaboration with the hospital, physicians, network and region; and maintain it during the crisis. They should also note that newborns are prone to stress and can easily face hypothermia (7,11,29-32). Given that crises are unpredictable, infant intensive care teams need to be seriously involved in hospitals' plans, so that they can respond quickly to a changing situation and meet the unique needs of infants.

Studies have also reported that in the emergency evacuation of neonatal intensive care units, in addition to meeting the needs of infants, families may have unique needs. Family-centered care and identification of parental stress and the establishment of telephone lines to connect infants with parents and family members are increasingly emphasized as an important and necessary element of neonatal intensive care (19,33,34). It is important for infant care providers to consider the medical and psychological needs of mothers as well. The health care providers can be encouraged to be aware of possible ad disasters scenarios and to prepare and implement emergency plans in order to prevent high-risk complications and mortality among the infants.

In general, one of the strengths of the present study was extracting a summary of the issues that need to be addressed in the field of the evacuation of neonatal intensive care units. All of the issues are potential needs in managing events as well as the effectiveness of the existing plans in neonatal intensive care units (NICU). Among the limitations of the present study was the exclusion of articles published in non-English language and using just studies in which full texts were published.

Readiness is a continuous process that changes based on experiences and pieces of evidence, and it is very important for disaster management. It is recommended that service providers in the neonatal intensive care unit recognize the limiting steps of activities and plan to reduce them. Also, in this regard, they should acquire the necessary readiness, through preparing and implementing emergency plans, in order to prevent high complications and mortality among the youngest and most vulnerable patients admitted to the hospital. It is recommended that qualitative research be carried out in the field of emergency evacuation of neonatal intensive care units to obtain and apply the experiences of the experts. Also, designing and performing various simulated exercises for neonatal intensive care units can be suggested.

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