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Original Article

Assessing hospital disaster preparedness: A scoping review of available tools

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Abstract

One of the problems faced after a disaster is health service for victims and hospitals play a critical role in handling disaster victims. Therefore, hospitals must enhance their preparedness and establish a disaster-safe environment to effectively fulfill their role as a provider of health services during a crisis. The aim of this scoping review was to identify hospital disaster preparedness tools used around the globe and to identify the critical aspects that need to be included in hospital disaster preparedness. This study used the five stages of Arksey and O'Malley's scoping review framework to determine what disaster preparedness tools can be used in a hospital setting. The electronic literature searches of English articles published between 2018 and 2023 were conducted using PubMed, Elsevier, ProQuest, ISI Web Science, and Google Scholar databases. The searched keywords were combined into several search terms such as sub-discipline, subtitle, year, language, and content type. The keywords of sub-title searching were “preparedness”, “hospital” and “disaster”. After applying some inclusion criteria, ten articles out of 1,221 identified records were included in the final analysis. The World Health Organization (WHO) Hospital Safety Index, WHO Hospital Emergency Checklist or their modified versions, and modified Public Health Emergency Preparedness were tools used in assessing hospital disaster preparedness. These tools evaluate some aspects such as structural safety, non-structural safety, and functional capacity. The studies indicated that each tool used to measure hospital disaster preparedness has strengths and weaknesses in each assessed aspect. Although some tools have been recommended to assess hospital disaster preparedness, assessing each tool validity and reliability are critical and needs to be conducted.

Keywords: Safe hospital, instrument, assessment, good health, well-being

Introduction

Disaster is a situation that cannot be avoided and causes health, social, and economic problems for the community and government [1]. Indonesia is one of the countries at risk of disaster because of its location on the Pacific “ring of fire” [2] and it also has a climate influenced by location and geographical characteristics stretching between the Pacific and the Indian Ocean [3]. Indonesia has a local climate system that causes dramatic differences in rainfall patterns [4] and has high seismic activity with earthquakes, volcanic eruptions, and tsunamis [5].

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The tsunami was one of the biggest disasters ever in Aceh, Indonesia, in 2004 and resulted in severe damages [6], in particular to healthcare facilities such as hospitals [7]. This condition demands that hospitals mitigate disaster in preventing more significant damage if it occurs in the future [8]. Disasters have increased in recent decades due to the increasing vulnerability of populations and therefore health system services should prepared their preparedness to face the disasters [9]. Since hospitals play a crucial role in handling disaster victims [10], they must enhance their preparedness and establish a disaster-safe environment to effectively fulfill their role as a provider of health services during a crisis [11].

There are some important variables needed to be assessed in hospital disaster preparedness such as structural safety, non-structural safety (electrical system, communication system, water supply system, waste disposal system, heating ventilation and air conditioning system, medical gases system, fire detection and suppression system, emergency exit system, furniture and equipment systems, and architectural components of the building), and functional capacity (planning, supply source, developing an organizational structure and business continuity) [7]. Therefore, identifying tools that can be used by the hospitals in assessing disaster preparedness is important. The aim of this scoping review was to identify the hospital disaster preparedness tools that have been investigated, recorded, and used globally. This study also defined the parameters and indicators used to evaluate hospitals' structural safety, non-structural safety, and functional capacity in the disaster preparedness framework. This study could provide recommendations for tools to evaluate the hospital's preparedness to deal with disasters and offer suggestions or improvements to the existing tools.

Methods

Study setting

This scoping review was guided by the Arksey & O'Malley methodological framework (2005) [12]. There are five stages to review the studies which include: identifying the questions of the studies, identifying some relevant studies, the study selection, charting the data, and then collating, summarizing, and reporting the results. This scoping review mapped and reviewed the literature on hospital disaster preparedness topics from empirical evidence. The main strength of the scoping study is providing rigorous and transparent methods for scoping or mapping the area of research and describing the area of study interest based on the proposed research question. Furthermore, it could identify gaps based on evidence-based and summarize and disseminate research findings that can be useful and effective for policymakers, practitioners, and consumers [13].

Search strategy and study selection

The database searches were conducted in May 2023 on five electronic databases: PubMed, Elsevier, ProQuest, ISI Web Science, and Google Scholar. The keywords used were combined into some search terms such as sub-discipline, subtitle, language, and content type to screen the relevant studies. All studies assessing disaster in hospital using clear tool(s) were considered eligible. The keywords of sub-title searching were: "preparedness", "hospital" and "disaster". The searches were restricted to: (a) studies published from 2018 to 2023 to identify the updated studies; (b) writing in English; and (c) primary study.

Data extraction and synthesis

We used the standardized form based on Arksey and O'Malley's Framework during data extraction processes [12]. The information of the author(s), year publication, study location, tools, aims of the study, and important results were collected. Then, the data with qualitative descriptive were analyzed by sifting, charting, coding, and sorting material according to the aims of the study. The results of charting data were summarized into three aspects (structural safety, non-structural safety, and functional capacity).

Results

Study selection results

The searches yielded 1,221 records of which 873 were excluded due to not being specific to hospital, duplicate studies, and unrelated topics. A total of 35 articles were included for full-text assessment. From the assessment, an additional 25 articles were excluded because did not fulfill the inclusion criteria. Finally, ten articles were analyzed by utilizing a scoping review. The flow of the processes of selecting the articles is provided in **Figure 1**. Out of ten studies included in the present scoping review, they were from Turkey [14], Iran [15], Lebanon [16], Indonesia [17], India [18], Ethiopia [19], Saudi Arabia [20], Pakistan [7], Philippines [21], and Saudi Arabia [20], which implemented the tools of disaster preparedness in the hospital. The characteristics of the data included studies are presented in **Table 1**.

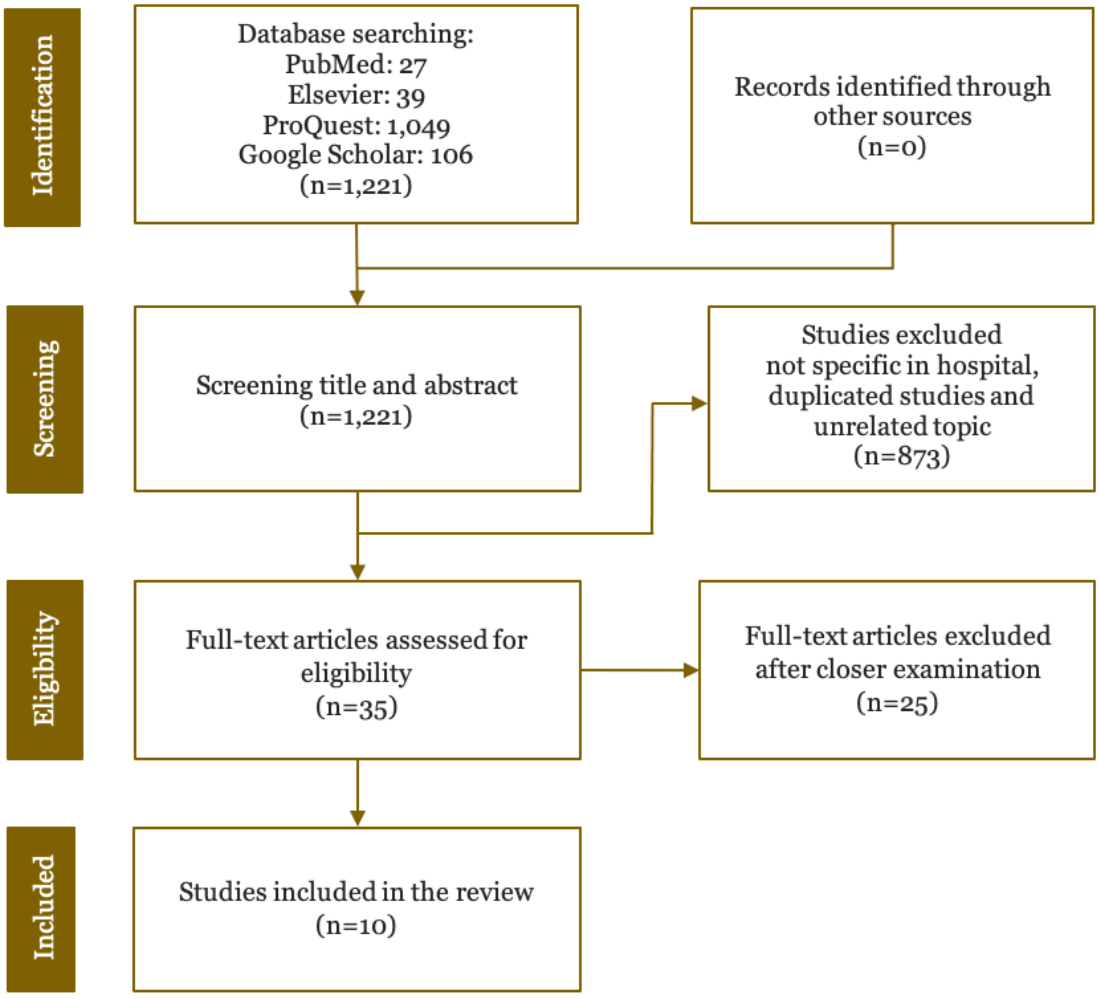

Figure 1. PRISMA flowchart of the process selecting the articles.

Hospital disaster preparedness tools

Most of the studies used modified tools by experts to assess the hospital's disaster preparedness. Five studies used the World Health Organization (WHO) Hospital Safety Index (HSI) as a reference to assess hospital disaster preparedness [7,17-20]. Although studies used the HSI tool, it was modified and therefore the results are still in line with the aim of the studies [7,17-20]. Two studies used the modified hospital preparedness tool by the expert with 34 sub-criteria and 110 sub-criteria [14,15]. Three studies used the WHO Hospital Emergency Checklist [16,21,22], and one study used modified Public Health Emergency Preparedness [18] to measure public hospital preparedness and resilience to health emergencies. The characteristics of the data included studies are presented in **Table 1**.

Table 1. Study characteristics and main findings on critical aspects included in hospital disaster preparedness tools

Authors/year of publication	Study location	Tool	Aim of the study	Important results		
				Structural safety	Non-structural safety	Functional capacity
Serdar *et al.*, 2021 [14]	Turkey	Modified hospital preparedness tool by the expert with 34 sub-criteria	To evaluate the disaster preparedness of hospitals	• Hospital buildings	• Equipment, communication • Transportation • Flexibility	• Personal
Miraki *et al.*, 2022 [15]	Iran	Modified hospital preparedness tool in terrorist attacks by the expert with 110 sub-criteria	To generate an item pool for the preparedness evaluation of Emergency Medical Services (EMS) in terrorist attacks.	• Safety and security	• Education and exercise • Surge capacity • Command, control, and coordination • Information and communication management • Policy and planning	• Response operation management
Al-Hajj *et al.*, 2020	Lebanon	World Health Organization (WHO) Hospital Emergency Checklist with 110 sub-criteria	To perform a comprehensive assessment of the country's level of hospital disaster and emergency preparedness		• Management (e.g., resources, logistics, staff, facility, lab, blood bank, safety, and security) • The existing plan, mechanism of activation, drills, and trained personnel	• Incident command system (ICS) (e.g., number of coordinators and roles, replacements, meeting area with a communication system) • Communication (e.g., internal communication system and external communication with government and non-governmental agencies)
Lestari *et al.*, 2022 [23]	Indonesia	WHO Hospital Safety Index (HSI with 151 sub-criteria	To examine the level of the hospital safety index in nine hospitals in four provinces based on the guidelines from the WHO	• Building integrity • Infrastructure protection, access, and physical security • Telecommunication • Water supply system • Fire protection • Waste management system • Fuel storage • Medical gas • Heating • Ventilation and air conditioning	• Architectural safety • Equipment and supplies (office and storeroom furnishings and equipment, medical and laboratory equipment supplies used for diagnosis and treatment) • Prior events affecting hospital safety	• Coordination of emergency and disaster management activities, • Hospital emergency and disaster response and recovery planning, • Communication and information management • Human resources • Logistic and finance • Patient care and support services • Evacuation, decontamination and security
Sharma and Sharma, 2020 [18]	India	Modified Public Health Emergency Preparedness by the expert, not	To measure of public hospital preparedness and resilience at times of health emergencies		• Triage readiness of health facilities • Health workers • Facility/room • Drugs, vaccine	• Capacity community • Structural resilience

Authors/year of publication	Study location	Tool	Aim of the study	Important results		
				Structural safety	Non-structural safety	Functional capacity
		available number of sub-criteria			• Training • Potential life risks of health workers	
Ayenew *et al.*, 2022 [19]	Ethiopia	Modified WHO HSI with 40 sub-criteria	To determine the level of hospital and disaster preparedness at public hospitals		• Human resources • Logistics and finance • Patient care and support service • Evacuation, decontamination and security	• Coordination and disaster management activities • Emergency and disaster response and recovery • Communication and information management
Alsalem and Alghanim, 2021 [20]	Saudi Arabia	Modified WHO HSI with 48 sub-criteria	To assess the level of Saudi hospital disaster preparedness	• Building integrity • Architectural safety • Infrastructure protection, access, and physical security • Telecommunication • Water supply system • Fire protection, • Waste management system • Fuel storage • Medical gas • Heating • Ventilation and air conditioning	• Equipment and supplies (office and storeroom furnishings and equipment, medical and laboratory equipment and supplies used for diagnosis and treatment) • Prior events affecting hospital safety	• Coordination of emergency and disaster management activities, • Hospital emergency and disaster response and recovery planning, • Communication and information management, • Human resources • Logistics and finance • Patient care and support services • Evacuation, decontamination and security
Khan *et al.*, 2021 [22]	Saudi Arabia	WHO Hospital Emergency Checklist with 92 sub-criteria	To evaluate the Ministry of Health (MoH) hospitals preparedness for potential disasters and crisis events		• Continuity of essential services • Communication • Triage • Safety and security	• Command and control • Post disaster recovery • Logistics and supply management • Surge capacity and human resources
Ul-Haq *et al.*, 2019 [7]	Pakistan	Modified WHO HSI with 51 sub-criteria	To identify hospital preparedness for disaster and mass causality management		• Networking • Materials • Safety • Planning	• Staff readiness
Clores *et al.*, 2022 [21]	Philippines	Modified WHO HSI, not available number of sub-criteria	To evaluate the hospital's preparedness for disaster		• Physical and material capacities • Access route • Facilities/equipment • Standby power supply • Emergency and non-emergency vehicles, and medicines • The hospital's water supply and communication facility	• The capacity of the hospital's personnel

Critical variables needed in hospital disaster preparedness

The findings of ten studies related to the three aspects (variables) assessed by the tools used are presented in **Table 1**. The three variables are structural safety, non-structural safety and functional capacity. Not all articles included every aspect of disaster preparedness in hospitals. The following presents a detailed analysis by classifying the sub-criteria to be assessed in each article based on aspects of structural, non-structural and functional capacity.

Structural safety

The data of the included studies reveal that it is important to have hospital buildings designed with high safety standards, including earthquake resistance, fire-resistant building materials, and protection against disaster damage [14,15].

In terms of architectural safety, there is a need for planning that takes into account building safety standards, including protection of infrastructure, accessibility and physical security. Architectural safety includes electrical systems, telecommunications, water supply systems, fire protection, waste management systems, fuel storage, medical gases, heating, ventilation and air conditioning (**Table 1**) [17,20]. The physical and material capacity of the hospital should be prepared for some aspects such as hospital buildings, access routes, facilities/equipment, backup power supply, emergency and non-emergency vehicles, and medicines (**Table 1**) [21]. In addition, water supply and hospital communication facilities must also be a significant concern in maintaining smooth operations during a disaster [17].

Non-structural safety

Hospitals can improve disaster preparedness and protect patients, staff and facilities by paying attention to non-structural safety, one of which is effective management. This management includes managing resources, logistics, staff, facilities, laboratories, blood banks, security, and safety. Studies emphasize the need to develop a comprehensive plan, good coordination between various stakeholders, and increase the capacity to deal with disaster [14,21].

Effective planning and policies also have a significant role, including developing a comprehensive disaster plan, clear activation procedures, regular personnel training, and implementing simulations and drills. Hospital preparedness needs to pay attention to the management of necessary equipment and supplies, such as office furniture and equipment and medical and laboratory equipment used for diagnosis and treatment. In addition, service continuity readiness is essential in maintaining the smooth running of hospital services during a disaster, including effective communication, efficient triage, and patient and medical personnel safety and security (**Table 1**) [14,21].

Another critical aspect of hospital disaster preparedness is a good communication network. Communication quickly and effectively between medical staff, patients and external parties such as governments and aid agencies are critical in emergencies. Hospitals also need to ensure flexibility in planning and organization and increase education and training to improve disaster response capabilities (**Table 1**) [14,21].

Previous disasters can provide valuable lessons in improving hospital protection and recovery and identifying weaknesses that need improvement. Therefore, information from past events is essential in planning and updating disaster policies [21]. The integrity of hospital buildings is also a critical factor in disaster preparedness. Policies and practices that encourage regular maintenance and periodic inspection of building structures are essential to ensure their strength and reliability. Structural weaknesses can threaten the safety of patients, medical staff and the facility. To develop a holistic plan and ensure adequate resources are available in an emergency, the hospital must coordinate well with the government and other related institutions. The development of this plan includes defining roles and responsibilities, resource allocation, and effective communication to support quick and appropriate coordinating actions [14,21].

Functional capacity

A study showed that functional capacity, especially in the preparedness of hospital human resources, is the most important criterion for disaster preparedness [14]. The availability of human resources is needed during a disaster [19]. This aspect is a strength for hospitals so that the hospitals are ready to respond to disasters during emergencies and increase mitigation efforts

that have an impact on the humanitarian crisis in Lebanon [15]. For this reason, hospitals need to increase staff knowledge and skills through training activities to ensure that they are ready to deal with disasters in the future [22]. A study showed that proper training and education on disasters were significant and important to increase healthcare workers' knowledge [17]. The knowledge of the staff about disaster management could provide positive implications for hospitals, in particular in increasing the staff's ability to receive good information when the disaster happens, and providing staff with the right options in action [24]. Therefore, hospitals are recommended to provide the staff with healthcare professional trainings in disaster by maneuvers, and drills and create the actual disaster events between the preparedness and response stages [24].

Discussion

The hospital is a health service facility that has a crucial role in ensuring the health and safety of the victims and community members during a disaster [21]. One of the efforts to determine which hospitals are safe from disasters can be made by conducting a disaster preparedness assessment. A hospital will be safe if it has a good disaster preparedness assessment from structural safety, non-structural safety, and functional capacity [25]. The Pan American Health Organization (PAHO) and WHO recommend these aspects of the assessment as a guide for hospitals to assess disaster preparedness. Hospital preparedness is one of the disaster management and should be determined based on standardized procedures [26]. Hospitals should ensure the validity and reliability of some checklists or tools to recognize the gaps and strengths [27]. In this present study, we identified some tools that previous studies used to evaluate hospital disaster preparedness based on three aspects (structural safety, non-structural safety and functional capacity).

Structural safety is one aspect of the hospital that will be evaluated for the facility's safety, which involves assessing the type of structure, materials, and previous exposure to natural and other disasters [28]. The aim is to identify whether the structure meets the standards for providing services to the population even in the case of a significant disaster or whether it could compromise structural integrity and functional capacity in the event of a disaster [28].

Non-structural safety is an aspect that will evaluate and verify the stability of non-structural elements and whether the equipment can function during and after a disaster [29]. This aspect includes an electrical system, communication system, water supply system, waste disposal system, heating, ventilation and air conditioning system, medical gases system, fire detection and suppression system, emergency exit system, furniture and equipment systems, and architectural components of the building [30].

The third aspect is the functional capacity, which evaluates the preparedness of hospital human resources in responding to disaster situations [31]. This aspect can be seen in terms of the Hospital Disaster Management Plan team, disaster command center, operational plans for internal and external disasters, medical preparation plans for various types of disasters, operational planning, preventive maintenance and restoration of essential services, availability of medicines, materials, instruments, emergency equipment, developing an organizational structure and business continuity [32].

There are some tools used to measure hospital preparedness to deal with disaster and each tool has strengths and weaknesses in each aspect that is being assessed. Most of the previous studies used the tools developed and combined because the tools are not relevant enough to be applied to all types of disasters in each country, such as nuclear disasters, terrorists, emergencies, natural hazard-caused disasters and pandemics.

There are some limitations of this present study that need to be discussed. Our study assessed the studies from the past five years to determine the methods used by the hospitals to gauge their preparedness for emergencies. The range of tools gathered may be more diverse if the duration of the literature search is extended. The data collected from the previous studies were qualitative and therefore not possible to analyze the data further sung meta-analysis.

Conclusion

This is a comprehensive summary of hospital disaster preparedness tools assessing structural safety, non-structural safety, and functional capacity. The results underline the significance of enforcing vigorous actions to assure the safety and resilience of hospitals during emergencies. This study contributes to the theory of hospital disaster preparedness by broadening the understanding of existing preparedness tools and factors to consider in planning an effective disaster response. The findings from this study can enrich the theoretical framework of disaster preparedness. This can be used to develop more comprehensive theories and models in the hospital context. The significant practice implications of this study benefit hospitals in developing and increasing their disaster preparedness. Healthcare practitioners can use information about existing preparedness tools and identified areas of improvement to design and implement more effective preparedness strategies. This can help hospitals improve their response, protect infrastructure and assets, keep services flowing, and ensure patient and staff safety during a disaster. The results of this study also contribute to policy-making related to hospital disaster preparedness. Research recommendations can guide policymakers in formulating policies that support increasing hospital preparedness. These implications include developing comprehensive regulations, increasing training and human resources, better technology integration, and strengthening coordination between related agencies. The information and findings can be used as a reference for researchers, practitioners and policymakers to improve hospital preparedness for disasters. By strengthening our understanding of existing preparedness tools and identifying areas of improvement needed, we can enhance hospital security, safety and preparedness for future disaster challenges.

Ethics approval

Not required.

Competing interests

The authors declare that there is no conflict of interest.

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Underlying data

All data underlying the results are available as part of the article and no additional source data are required.

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