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Integrated Review

Conceptual Model of Hospital Preparedness in Response to Crises: An Integrated Review Study

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Abstract

Introduction: The term "Disaster" refers to an unexpected and undesirable event. Healthcare facilities face a range of challenges, varying in both nature and severity. To effectively manage such critical situations, healthcare centers need to have well-defined guidelines and protocols in place.This integrative review aims to create a comprehensive conceptual framework that outlines hospital preparedness during Disasters.

Methods: This study employed an integrative review design, following Whittemore's five-stage framework: problem identification, literature search, data evaluation, data analysis, and data presentation. The search terms included "disaster preparedness," "crisis," "emergency response," and "hospital preparedness." Databases searched were PubMed, Scopus, Web of Science, and others, covering literature from January 1993 to August 2021. Studies in English or Persian, including quantitative, qualitative, and mixed methods, were included. Methodological quality was assessed using specific tools for each study type, and all included studies were rated as high quality.

Results: The study involved a thematic analysis of 25 articles, including 21 quantitative studies, two qualitative studies, and two mixed-method studies. From this analysis, the central theme of Hospital Preparedness in Response to Disaster emerged. The key concepts related to this theme were systematically examined and categorized into four principal groups: Command and Control, Management of Support and Procurement, Communications, and Ethical and Legal Considerations. These groups represent the essential components necessary for effective crisis management within healthcare institutions.

Conclusion: Hospitals must be prepared for Disasters. The results of our study suggest a comprehensive model that focuses on Command and Control, Support and Procurement Management, Communications, and Ethical and Legal aspects. Further research is necessary to identify practical solutions for various crisis scenarios and enhance hospital preparedness.

Keywords: Hospital Planning, Disaster, Disaster Planning, Models.

Introduction

Throughout history, we have witnessed incidents and Disasters that have become intertwined with human life, leading to significant human and financial consequences. In the modern world, global Disasters are more prevalent than ever, significantly affecting individuals' lives and overall well-being. This disruption can hinder a nation's ability to meet its essential needs, putting its stability at risk. Additionally, disasters often result in substantial financial costs for both individuals

and governments due to property damage and loss[1]. Experimental investigations have revealed a notable increase in the incidence of diverse global catastrophes over the past few decades. Concurrently, the ensuing societal damages have tripled, underscoring the imperative for implementing measures aimed at mitigating the detrimental impacts stemming from these occurrences[2].

Iran's geographical and geopolitical location makes it particularly susceptible to Disasters, with numerous incidents occurring each year. International reports indicate that Iran ranks among the top 10 nations in the world that are most vulnerable to such situations. On average, the country faces 253 such incidents annually[3].

The range of global Disasters is vast and diverse, encompassing natural disasters such as earthquakes, floods, and hurricanes, as well as artificial catastrophes like industrial accidents and terrorist attacks. The severity of these Disasters, whether small or large-scale, depends on the type of situation and the number of people at risk. One crucial characteristic of Disasters, particularly those that stem from natural causes, is their unpredictability, emphasizing the importance of being prepared and proactive in the face of potential events[4]. Effective preparation is paramount in mitigating or avoiding the negative impact of Disasters. When a crisis strikes, local authorities must quickly respond to manage damages and prioritize saving human lives. During this crucial time, healthcare systems and hospitals are indispensable. Within the first 24-48 hours of a crisis, medical attention is needed for 85% to 90% of survivors. As such, hospitals must create crisis management strategies to guarantee an efficient response[5].

The lack of preparedness and meticulous planning can lead to irreparable damage to a nation's healthcare infrastructure[6]. Numerous factors play a vital role in determining a hospital's preparedness to handle Disasters effectively. These factors encompass financial resources, equipment and facilities, staff training and awareness, as well as crisis management strategies. A well-crafted management plan that can be readily executed during hospital Disasters enables the optimal utilization of human resources, equipment, and space, ultimately aiding in minimizing loss of life and minimizing damage caused by Disasters in the critical initial 24-hour period[7] . As part of a research endeavor in Zanjan province, an evaluation was undertaken to assess the crisis management structure, planning, training protocols, and intra-organizational and inter-organizational coordination of rehabilitation centers. Regrettably, the findings revealed that these centers were inadequately equipped to handle unexpected events and disasters. The study emphasized the importance of adhering to mandatory laws and promoting a deeper understanding of crisis management plans among managerial staff[8]. In Italy, a study found that hospitals were not adequately prepared by World Health Organization standards[9]. In a separate study conducted in Tanzania, an investigation and assessment of 25 hospitals revealed that preparedness levels in all aspects varied between 20% and 60%[10].

A broad range of studies from various countries emphasize the importance of hospital preparedness during disasters. However, there remains a lack of comprehensive guidelines and fundamental concepts specifically tailored to address the diverse challenges faced by healthcare centers globally. This knowledge gap underscores the need for focused investigation to develop a model and a well-suited preparedness plan that can minimize casualties and physical consequences in the aftermath of a crisis by optimizing the use of equipment, facilities, training, and human resource preparedness. Given the inevitable occurrence of disasters worldwide, it is essential to have a clear understanding of hospital preparedness during such events. To address this critical gap, we conducted an integrative review aimed at developing a comprehensive conceptual framework that outlines the key parameters of hospital preparedness in response to disasters.

Methods

Study design

An integrative review was used as the design for this study. Whittemore described five stages to enhance rigor in integrative reviews based on Cooper's framework as applied to systematic review and meta-analysis methods. Therefore, Whittemore mentioned five essential stages for integrative reviews: problem identification, literature search, data evaluation, data analysis, and data presentation[1].

Inclusion and exclusion criteria

The inclusion and exclusion criteria for this review were determined based on the research questions that guided the study. Studies were included if they were peer-reviewed, had full-text availability in English or Persian, and were published between January 1993 and August

2021. Various study designs, including quantitative, qualitative, and mixed methods, as well as theses and dissertations, were also considered. Conversely, studies were excluded if they were non-peer-reviewed (such as editorials, commentaries, or letters), lacked full-text availability, were published in languages other than English or Persian, or were published outside the specified date range.

Search strategy

The search strategy for this integrative review was completed in August 2021. The databases used for searching included Cochrane Database of Systematic Reviews, PubMed, Scopus, and Web of Science. The primary search terms used across all databases were "disasters," "Disasters," "emergencies," and "preparedness." Additional keywords incorporated into the search included "disasters," "Disasters," "natural disaster," "Biological warfare," "emergency," "Model," "Theory," "Strategy," "Pattern," "Approach," "Emergency preparedness," "hospital preparedness," "hospital readiness," "healthcare," and "health care." The search covered literature published from January 1993 to August 2021. Table 1 presents the search terms and databases, as well as the results of the searches employed in this study. EndNote was used as the reference management system for this integrative review.

In the first phase of our study, we compiled a comprehensive list of articles evaluating hospitals' readiness for emergencies. Two experienced researchers then thoroughly and independently evaluated each article. In cases where both reviewers agreed to reject an article, the reason for dismissal was carefully documented. If there was any disagreement, a third reviewer was called in for a definitive assessment.

Initially, we identified 2,622 articles on hospital preparedness during crises and emergencies. However, 2,594 articles were excluded due to duplication across databases and lack of relevance to the core focus of our study. After reviewing the abstracts, three articles were disqualified due to the absence of essential information, misalignment with the study's target criteria, and failure to adhere to a standardized definition for hospital preparedness indicators. Ultimately, 25 articles that met our stringent criteria remained. These articles were meticulously analyzed for data extraction.

Table 1: A summary of search strategies in search databases

	The strategies in search databases	
PubMed	(Disaster*[Title] OR Crisis*[Title] OR "natural disaster"[Title] OR "Biological warfare"[Title] OR emergency*[Title]) AND (Model*[Title] OR Theory*[Title] OR Strategy [Title] OR Pattern*[Title] OR Approach*[Title]) AND (hospital* "Emergency preparedness"[Title] OR "hospital preparedness"[Title] OR "hospital readiness"[Title] OR healthcare [Title] OR health care [Title])	
Web of Science	#1	(((((((TI=(hospital)) OR TI=("Emergency preparedness")) OR TI=("hospital preparedness")) OR TI=("hospital readiness")) OR TI=("hospital preparedness")) OR TI=("hospital readiness")) OR TI=(healthcare)) OR TI=("health care ")
	#2	((((TI=(Model)) OR TI=(Theory)) OR TI=(Strategy)) OR TI=(Pattern)) OR TI=(Approach)
	#3	((((TI=(Disaster)) OR TI=(Crisis)) OR TI=("natural disaster")) OR TI=("Biological warfare")) OR TI=(emergency)
Scopus	Disaster OR Crisis OR "natural disaster" OR Biological warfare OR emergency and Model OR Theory OR Strategy OR Pattern OR Approach and "Emergency preparedness" OR hospital preparedness" or "hospital readiness" OR "hospital preparedness" OR hospital readiness" OR healthcare OR "health care "	

Quality evaluation

The primary researcher assessed each included study for methodological quality using two different quality rating tools for quantitative and qualitative studies. For the mixed methods study, a quantitative tool was used to evaluate the quantitative part, and a qualitative tool to assess the qualitative part. For quantitative studies, "Quality Assessment Too" was adapted from other published reviews[2]. This tool assesses four primary criteria: research design, sample, measurement/instrument, and statistical analysis. Thirteen criteria were assessed, with a total maximum score of 14. Thus, studies can be categorized as low (0–4), moderate (5–9) or high (10–14). For qualitative studies, the Critical Appraisal Skills Program tool was used, which consists of 10 questions related to rigor, credibility, and relevance[3]. The highest score is 9 in this tool.

All studies were rated as high quality; therefore, none were excluded. The results for the design section included all 21 quantitative studies, and two quantitative parts of the mixed methods study were prospective. Table 2 presents a summary of the quality assessment for 21 quantitative studies and the two quantitative parts of the mixed-methods study. The results of the qualitative study appraisal showed that of the two qualitative studies reviewed, two qualitative studies and two qualitative parts of the mixed-methods study were rated as 8 out of a maximum score of 9. In contrast, the other qualitative study was rated as 9. All of them had a clear statement of aims; used appropriate study designs, methodologies, recruitment strategies, and data collection; considered ethical issues; had sufficient data analysis; and presented a clear statement of findings. However, only one qualitative study described the relationship between the researcher and participants in terms of any involvement with the participants before recruitment. Tables 3 and 4 present a summary of the quality assessment for two qualitative studies and the two qualitative parts of two mixed-method studies.

Table 2: Summary of quality assessment for the 23 quantitative studies— (includes 21 quantitative only studies, one quantitative part of a mixed method)

Criteria		yes	no
Design	Prospective studies Used	23	0
	probability sampling	20	3
Sample	Appropriate/justified sample size	10	13
	Sample drawn from more than one site	23	0
	Anonymity protected	23	0
	Response rate >60%	12	11
Statistical analyses	Correlations analyzed when multiple effects studied	23	0
	Management of outliers addressed	23	0
Scores: Yes (= 1) No (= 0)			
Note: Low (0–4); medium (5–9); High (10–14). High (n = 6).			

Table 3: Summary of the quality assessment for the four qualitative studies— (includes two qualitative-only studies and two qualitative parts of the mixed method study

Scores:	**Yes (= 1) No (= 0)**	
Clear statement of research aims	4	0
Appropriate methodology	4	0
Appropriate research design	4	0
Appropriate recruitment strategy	4	0
appropriate data collection	4	0
The relationship between the researcher and participants described	3	1
Ethical issues considered	4	0
Sufficient data analysis	4	0
Clear statement of findings	4	0
Total score: 9	**3 studies = 8**	**1 study = 9**

Data extraction

A detailed summary list follows a comprehensive collection of articles related to hospital preparedness. To ensure accuracy, two researchers independently evaluate each article, and a third reviewer intervenes in cases of disagreement. A refined group of 25 articles that meet strict criteria undergoes thorough data analysis.

Data analysis

A thematic approach was used to analyze the data carefully. This approach was designed based on the expected outcomes and findings outlined in the initial investigation. To ensure accuracy and consistency, the data extraction process was carried out with meticulous attention to detail. The focus was on key aspects, including authorship, main themes, and significant findings in the studies. The collected data were then systematically arranged and categorized based on these dimensions. This well-organized categorization served as a guide for the overall analysis and synthesis of the results. Consequently, codes, subgroups, and principal themes were generated systematically.

Ethical considerations

The study adheres to ethical standards and received approval from the Ethics Committee of Baqiyatallah University of Medical Sciences (code ir.bmsu.rec.1402.011).

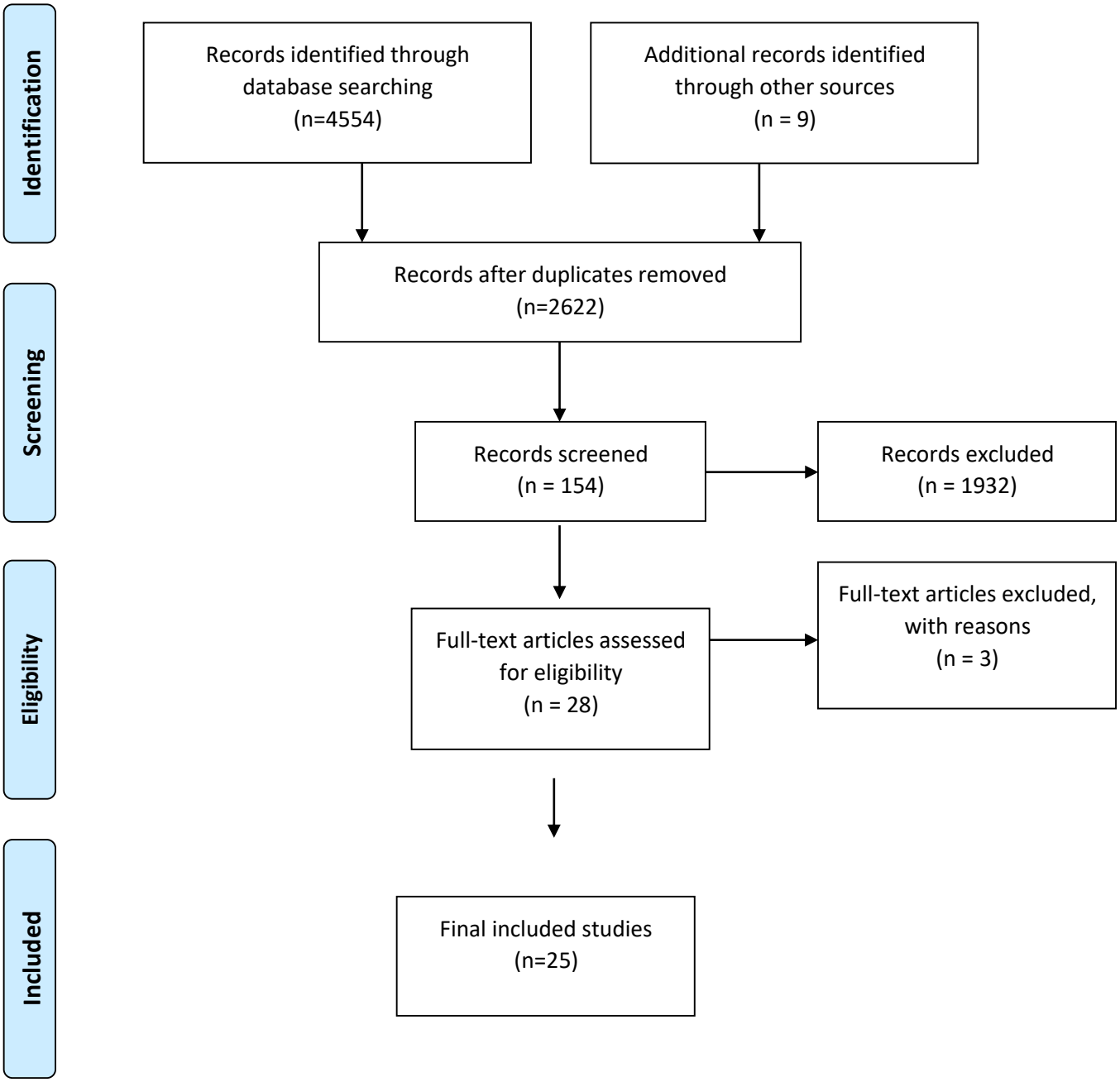

Figure 1: A PRISMA flow diagram was used to illustrate the study selection process.

Results

This research includes a total of twenty-five articles. Out of these, twenty-one have employed quantitative methodology, while two are qualitative studies, and two are mixed-method studies. After a thorough review of the text and using a thematic method, the concepts related to hospitals' preparedness against Disasters were extracted from the articles. The sample size in these studies varied significantly, ranging from 30 to 750 people. Moreover, the time duration of the studies showed considerable variation, ranging from a few months to a maximum of eight years. The research encompasses healthcare facilities, clinics, and a systematic exploration of healthcare frameworks, including individuals (Table 4).

Table 4: An Overview of Reviewed Articles

row	Author	Year	Title	Study Type	countery	Crisis Type
1	Robert M. Kaplan[4]	1993	Applying a public health policy model in the crisis of American healthcare	quantitative	United States	Healthcare Crisis
2	Laura C[5]	2005	Using problem-based learning as a strategy for interdisciplinary emergency preparedness	quantitative	United States	Preparedness for Natural and Unnatural Disasters
3	Blanca Terri BB. T. Berro[6]	2005	A primary healthcare strategy in crisis conditions	qualitative	Colombia	Natural Disasters
4	K. Davies[7]	2006	Support for healthcare professionals in disasters: a practical and virtual approach	quantitative	Europe	Crisis Conditions
5	Oscar Ramirez[8]	2006	An all-hazards approach to preparedness in a healthcare setting	quantitative	United States	Hazards
6	D. K. Henderson[9]	2009	Emergency preparedness collaboration in hospitals in Batsada: an inter-organizational model	quantitative	United States	Emergency Preparedness
7	James G. Hodge Jr[10]	2011	Facilitating hospital emergency preparedness: introducing a memorandum of understanding model	quantitative	United States	Medical Emergencies
8	Dennis Darrin Pruitt[11]	2018	Setting goals for emergency preparedness across a healthcare system region: the approach adopted by the Department of Health and Mental Hygiene of New York City	quantitative	United States	Healthcare System Readiness
9	Bruria Adini[12]	2012	Evidence-based approach to an all-hazards readiness	quantitative	Israel	Emergency Readiness
10	Patrick Melmer[13]	2019	Mass casualty shootings and emergency preparedness: a multifaceted approach for an unpredictable event	Mixed Methods	Global	Mass Casualty Shootings
11	Ibrahim Salmani[14]	2019	Conceptual model of managing health care volunteers in disasters: a mixed method study	Mixed Methods	Iran	Natural Disasters
12	Stav Shapira[15]	2019	Healthcare workers' willingness to respond following a disaster: a novel statistical approach toward data analysis	quantitative	Israel	Earthquake
13	N Binello[16]	2020	Building a Covid-19 unit in a state of emergency: a cross-generational working model. Healthcare delivery lessons from the pandemic	quantitative	Italy	COVID-19 Pandemic
14	Joerg Steier[17]	2020	The load and capacity model of healthcare delivery: considerations for the crisis management of the COVID-19 pandemic	quantitative	United Kingdom	COVID-19 Pandemic

15	Arman Bahari[18]	2020	A Simulation Optimization Approach for Resource Allocation in an Emergency Department Healthcare Unit	quantitative	Iran	Natural Disasters
16	Robert S. Crupi[19]	2003	Meeting the Challenge of Bioterrorism: Lessons Learned from West Nile Virus and Anthrax	quantitative	United States	Bioterrorism Attacks
17	Lauren M. Sauer[20]	2009	Major Influences on Hospital Emergency Management and Disaster Preparedness	quantitative	United States	All Disasters
18	Shinji Nakahara[21]	2021	Bottom-Up Approach to Establish Coordination Mechanisms for Disaster Preparedness Among Largely Private Health-Care Providers in Central Tokyo	quantitative	Japan	Earthquake
19	Kyan C. Safavi[22]	2021	The power of modeling in emergency preparedness for COVID-19: A moonshot moment for hospitals	quantitative	United States	COVID-19 Pandemic
20	N Binello[16]	2020	Building a Covid-19 unit in a state of emergency: a cross-generational working model. Healthcare delivery lessons from the pandemic	quantitative	Italy	COVID-19 Pandemic
21	Joerg Steier[17]	2020	The load and capacity model of healthcare delivery: considerations for the crisis management of the COVID-19 pandemic	quantitative	United Kingdom	COVID-19 Pandemic
22	R. Bazregar[23]	2013	The evaluation of the application of coordination-based disaster response model in Rajaye hospital disaster preparedness	quantitative	Iran	Earthquake
23	HR. Khankeh[24]	2007	Health Care Services at Time of Natural Disasters: A Qualitative Study	qualitative	Iran	Earthquake
24	F. Paul[25]	2009	Crisis Management in Bioterrorism Attack: Medical Approach	quantitative	European	Bioterrorism Attacks
25	Wayne Higgins[26]	2004	Assessing hospital preparedness using an instrument based on the Mass Casualty Disaster Plan Checklist: Results of a statewide survey	quantitative	United States	All Disasters

After analyzing 25 articles and extracting codes related to hospital preparedness for Disasters, a classification emerged with four general groups and eleven subgroups.

Table 5: Extracted Concepts from Studies

Main Theme	group	subgroup	Codes
Concepts of coping with disaster in health care centers	Command and Control	Organizational Structure and Systems	Decision-making Hierarchy, Efficient Processes
		Management and Leadership	Transformational Leadership Style, Employee Participation in Decision-Making
		Preparedness planning and assessment	Comprehensive Emergency Plan, Training and preparation
	Management of Support and Procurement	Infrastructure and Facilities	Adequate Space, Proper Ventilation
		Medical Equipment and Treatment	Emergency Equipment, Adequate Drug Stockpiling
		Human Resources	Educational Programs, Material, and Spiritual Motivators
	communications	Information and Communication Systems	Internal Communication Network, Hazard Alert System
		Hospital and Non-Hospital Networks and Alliances	Utilizing Shared Resources, Knowledge Sharing
		Collaboration with External Organizations	Coordination with Local Organizations, Collaboration with the Ministry of Health
	Ethical and Legal Considerations	Ethical Issues in Medicine	Respecting patient privacy, fair allocation of resources
		Legal Issues and Laws and Regulations	Emergency laws, legal responsibilities

Conceptual Framework Illustrating Hospital Preparedness for Disasters

Based on the conceptual model developed to identify the factors that affect hospitals' ability to withstand Disasters and emergencies, several critical elements have been identified as significant determinants of hospital preparedness and resilience. These include Management of Support and Procurement, Command and Control, communications, and ethical and legal considerations. Figure 2 illustrates the Concepts of coping with crises in healthcare centers.

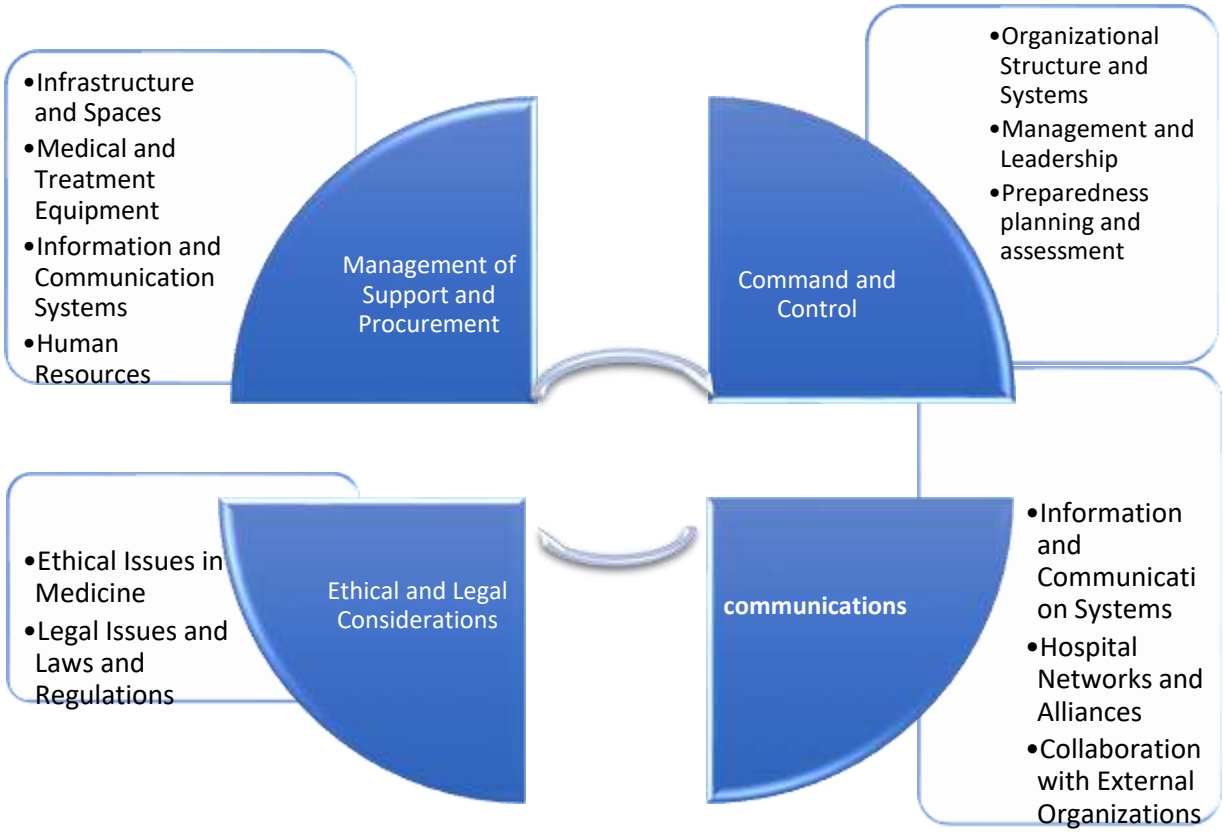

Figure 2: Conceptual Framework Illustrating Hospital Preparedness for Disasters

Each of these factors possesses the capacity to directly augment hospital readiness or indirectly influence other variables, thereby playing a pivotal role in fortifying and enhancing hospitals' resilience during crisis scenarios.

Command and Control

The subsets of Command and Control encompass a wide range of organizational structures, management and leadership practices, preparedness planning, and evaluation procedures.

Organizational Structure and Systems: "The presence of a command and execution system based on hierarchy indicates the hospital's readiness during Disasters. " The existence of a hierarchical command and execution system is indicative of the hospital's readiness during Disasters[27].

"The findings of this project furnish unequivocal evidence of a comprehensive organizational and educational program, exemplifying requisite efficiency during Disasters to address the needs of those involved"[7], [23].

Management and Leadership: "In the response phase, according to expert opinions, it is optimal to conduct a rapid assessment of the affected area using a transformational leadership style before any deployment. The well-defined process of mobilizing and deploying volunteers, along with the essential division of tasks among health volunteers and the specification of their duties, should also be articulated. Coordination, communication, command, control, and the assessment of volunteers (daily and at the mission's conclusion), along with the provision of feedback, formed another integral aspect of the plan proposed by the interviewees" [11], [14].

"None of the collaborating entities had personnel specifically designated for exclusive involvement in this initiative. The pivotal element for success in this endeavor was the careful selection of committed and determined individuals capable of contributing to decision-making, with a proven track record of success. Empowering them to carry out the assigned tasks and, ultimately, holding them accountable for various work products were crucial components" [9], [28].

Preparedness planning and assessment: "Numerous recommendations exist for improving the performance of healthcare providers and hospitals during mass casualties. An effective measure includes engaging in exercises, simulations, and exposure to real-life situations" [7], [8], [13].

Management of Support and Procurement:

The Management of Support and Procurement group encompasses subgroups, namely Infrastructure and Spaces, Medical and Treatment Equipment, and Human Resources.

Infrastructure and Facilities: "Hospitals that are closer to the site of an incident may experience an uneven influx of injured patients. Although unexpected events in healthcare systems are infrequent, emergency departments (EDs) and trauma centers worldwide develop protocols to remain prepared for such eventualities. They increase the capacity of treatment areas, beds, and equipment" [13], [16], [26].

"The emergency department should have its own ventilation system that is separate from the general ventilation system of the hospital. Additionally, it is recommended that a negative-pressure room be included in this department for patients who may be exposed to contaminated chemical gases. The air in these rooms should be exchanged multiple times per minute and directed outside to minimize the risk of contamination " [9], [25], [27].

Medical and Treatment Equipment: "Essential equipment for managing various hazards, including ventilation devices, personal protective equipment, vaccinations, and antiviral drugs, should be procured to ensure an effective emergency response. Similarly, vital infrastructures such as decontamination areas or helipads should be installed" [12], [17].

"All hospitals should maintain reserves of essential drugs and medical equipment necessary for CBRN incidents. Regular reviews of these reserves should be conducted, and if the expiration date of drugs is reached, they should be replaced" [4], [12], [22].

Human Resources: "Numerous recommendations exist for improving the performance of healthcare providers and hospitals during mass casualties. A valuable measure among them is the utilization of exercises and simulations. The merits of these activities include the identification of weaknesses, the formulation and execution of solutions, and the augmentation of confidence in plans, along with the assimilation of lessons learned" [8], [13], [15].

"Given the prevailing indifference of most hospital staff towards disaster preparedness, a domain not intricately connected to their daily responsibilities, their initial endorsement for exercises was subdued. Stimulating their involvement in exercises can be realized by leveraging external motivators" [12], [21].

communications

The communications group has subgroups, including Information, Communication Systems, Hospital Networks, Coalitions, and Collaboration with External Organizations.

Hospital and Non-Hospital Networks and Alliances: "During the phase 1 focus groups, representatives discussed the difficulties associated with organizing and carrying out exercises that involve frontline healthcare providers. They also emphasized the importance of learning from these exercises, particularly in terms of gaining insight into how incident management operations can work together more effectively with urban agencies to improve collaboration during emergencies and pre-hospital emergencies." [11],[13],[23].

Collaboration with External Organizations: "The New York City Department of Health and Mental Hygiene, aiming to evaluate the preparedness status of the health system, convened focus groups with representatives from hospitals and collaborative healthcare organizations for Disasters. Coordination between hospitals and responder organizations during Disasters, encompassing firefighting, police, emergency management, and emergency medical services, is deemed crucial" [5],[19].

Information and Communication Systems: "Hospitals have articulated the requirement for up-to-date data and information during emergency conditions to enable more effective and higher-quality communication"[11].

"The future progress in crisis and pandemic response systems relies on the connectivity of primary systems" [20].

Ethical and Legal Considerations

The Ethics and Law group comprises subgroups addressing medical ethics issues and legal aspects, encompassing laws and regulations.

Ethical Issues in Medicine: "The integration of medical records with authorized access, along with the observance of medical ethics during Disasters, such as sharing patients' medical information and medication history, has contributed to enhanced professional communication within the healthcare system during Disasters " [14],[29].

"Emergency plans that factored in the storage of antibiotics and essential supplies reported that only 25% maintained a dedicated storage of antibiotics for treating

staff in the event of a bioterrorism incident. This plan entailed the distribution of drugs to less privileged counties and regions that lacked drug warehouses" [26].

Legal Issues and Laws and Regulations: "In normal situations, prevailing laws and policies provide appropriate guidance for the legality of decisions and various actions in allocating scarce resources. However, in declared emergencies, disasters, or public health Disasters, the legal framework undergoes a shift. The declaration of emergency status activates a set of special powers crafted to facilitate response efforts through both the public and private sectors" [10].

Discussion

This research aims to analyze the existing scientific literature on the conceptual framework of hospital preparedness. This involves a thorough review of the literature and an investigation of the concepts and factors that impact hospital preparedness for disasters. In the following sections, the developed model concepts will be explained and interpreted, and the designed model will be compared with existing models related to hospital preparedness.

A crucial theme that underpins the conceptual framework of hospital preparedness is the ability of healthcare centers to respond effectively to crises. This concept involves the ability of healthcare centers to absorb, adapt, and recover from the adverse effects of disasters. Coping with crises extends beyond immediate response measures and includes long-term strategies that healthcare centers must adopt to mitigate the impact of disasters. These strategies encompass building resilience within the organization, fostering adaptability in crisis management practices, and ensuring the continuity of care during and after disasters. Additionally, the psychological well-being of healthcare personnel is vital, as it significantly influences the effectiveness of the crisis response. Ensuring that staff members have access to mental health support and stress management resources is crucial for maintaining their capacity to function effectively during prolonged crises. Norouz Zadeh conducted a study underscoring the significance of integrating simulation-based training into hospital preparedness frameworks. The findings suggest that simulation-based training significantly improves healthcare professionals' capacity to manage complex and unpredictable disaster situations, thereby fostering a more resilient healthcare system [30].

Al Thobaity provides additional support for this perspective by highlighting the importance of mental preparedness for healthcare workers in disaster scenarios. Their research suggests that hospitals should incorporate psychological training and resilience exercises into disaster preparedness programs to ensure the mental well-being and effectiveness of healthcare personnel during crises [31].

Our investigation has revealed that effective command and control during disasters is a complex process influenced by various factors. The organizational structure is a critical component that can either facilitate or hinder response efforts. Similarly, management and leadership styles are essential determinants of how organizations respond to disasters. Strategic planning is another vital factor in the effectiveness of command and control during disasters. Organizations with well-developed contingency plans are better equipped to manage unexpected events than those without such plans.

Additionally, the availability of resources is crucial in ensuring an effective crisis response. Organizations with adequate resources can quickly mobilize and deploy personnel and equipment to affected areas. Our findings align with the research conducted by Zaboli and colleagues, which highlights that organizations facing issues in management and communication, structural complexities, insufficient resources, and suboptimal deployment of human resources, compounded by financial constraints, will encounter significant challenges during disasters. Therefore, organizations must invest in developing robust systems that support effective command and control during crises. A dynamic organizational framework, coupled with effective management styles and sufficient resources, is essential for strengthening hospitals' preparedness against crises [32]. The findings of Azrami further emphasize that hospitals, as critical infrastructure for disaster response, play a vital role during crises and are expected to maintain their performance during and immediately after disasters. This study explored strategies to enhance disaster risk management in hospitals and, through thematic analysis, identified and categorized organizational and managerial strategies, preventive and risk reduction strategies, preparedness strategies, response strategies, and recovery strategies. Implementing these strategies can significantly improve

hospital preparedness in the face of disasters [33]. O'Neill expands on this by emphasizing the importance of adaptive leadership in disaster situations. Their research suggests that adaptive leadership promotes a culture of flexibility and rapid decision-making, both of which are crucial for effectively responding to the dynamic nature of disasters [34].

Moreover, this comprehensive conceptual framework also comprises several crucial aspects essential for the effective management of both natural and human-made disasters. The framework covers various areas, including infrastructure, spatial considerations, medical equipment, treatment, and human resources. A crucial aspect, as emphasized by studies such as the investigation by De Jong et al., is the availability of sufficient equipment. Their study focused on hospital preparedness for Ebola outbreaks and determined that adequate equipment and reliable information systems are critical for improving the quality of healthcare services during emergencies. Our research findings corroborate these conclusions [35]. The availability of adequate medical equipment is particularly significant, as it plays a crucial role in effectively managing both natural and human-made disasters. Medical equipment, such as ventilators, pharmaceutical supplies, and oxygen therapy devices, is crucial for diagnosing and treating various health conditions during a crisis. Moreover, sufficient equipment can reduce the burden on healthcare personnel, enabling them to provide better care to patients. For instance, the use of telemedicine and remote monitoring devices can help healthcare providers deliver care to patients in remote or underserved areas.

Furthermore, a systematic qualitative review by Azrami identified several barriers to hospital disaster risk management (HDRM), including technical-physical, organizational-managerial, financial, and human barriers. This study, which analyzed 762 articles and documents, emphasizes that addressing these barriers is crucial for improving HDRM. The insights gained from this study can be invaluable in developing strategies and interventions to overcome these obstacles, thereby enhancing hospital preparedness and response during both natural and human-made disasters [36].

Cheng emphasizes the significance of integrating new technologies, such as artificial intelligence, into medical equipment management to improve hospital preparedness. The study highlights that AI-driven tools can optimize resource allocation, equipment maintenance, and supply chain logistics during disasters, resulting in more efficient care delivery [37].

Conclusion

In summation, the issue of hospital preparedness for disasters emerges as both critical and imperative. The prevailing models and frameworks for governing, managing, and preparing hospitals for disasters have, to date, experienced only partial success. The concepts and models posited in this study encapsulate diverse elements, ranging from organizational structure, human resources, and equipment and facilities, to inter-organizational collaborations, and ethical and legal considerations. These variables exert considerable influence over the efficacy of hospital preparedness and responsiveness during disasters. It is imperative to develop and implement a comprehensive model for assessing and enhancing hospital preparedness in this context.

For future studies, it is recommended to focus on identifying key factors and solutions that can further enhance hospital preparedness across various crisis scenarios. Additionally, research could explore the development of standardized assessment tools and investigate the role of emerging technologies in improving preparedness and response efforts.

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Conflict of Interest Disclosures

The authors do not express any conflict of interest in this study.

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Authors' Contributions

All authors read and approved the final manuscript. All authors take responsibility for the integrity of the data and the accuracy of the data analysis.

Ethical Statement

This study was approved by the Ethics Committee of Baqiyatallah University of Medical Sciences, Tehran, Iran (Ethical Code: IR.BMSU.REC.1402.011). The authors affirm that all ethical principles were observed throughout the research process, and no human or animal subjects were directly involved. The study was conducted in accordance with the ethical standards of institutional and national research committees and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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