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A qualitative study on barriers and strategies to hospital preparedness against chemical, biological, radiological, and nuclear incidents

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Abstract:

BACKGROUND: The effects of chemical, biological, radiological, and nuclear (CBRN) incidents on human society can be irreparable. Preparing the health system for these incidents is essential. This study aims to identify obstacles to hospital preparedness against CBRN incidents and provide solutions.

MATERIALS AND METHODS: This qualitative study was conducted using semi-structured interview method in 2022. The research community included experts in the fields of CBRN, and 17 persons were included in the study through purposive sampling. The interviews were collected by interview guide and recorded face-to-face and online and were analyzed using thematic content analysis method in MS Word 2016.

RESULTS: The interviews' analysis was classified into two main categories and 34 sub-categories. Some of the most important obstacles to the hospital preparedness against CBRN incidents were the lack of proper crisis management, the lack of specialist staff, the stress of employees, the lack of turnover and sufficient rest for employees, legal gaps, and so on. The main strategies were determining the type and extent of the risk factor, strong crisis management, the lack of parallelism, continuous monitoring, having a protocol and road map, appropriate training programs, having skilled personnel, rapid response of personnel, positive attitude of the staff, and the favorable condition of the building.

CONCLUSION: The appointment of an expert in the field of CBRN and having a specialized unit, the existence of specialized and trained staff along with access to the required facilities, clear instructions, and intra-departmental and inter-departmental cooperation affect the readiness of hospitals against CBRN incidents.

Keywords:

Bioterrorism, disasters, hospitals, qualitative research, risk management

Introduction

In the 21st century, the rate of natural disasters has been increasing, which has caused a lot of fatalities and economic costs. Meanwhile, in developing countries, deaths caused by natural disasters are 3 to 4 times higher than those in developed countries and the number of injured is 40 times higher. In other words, more than 90% of deaths in developing countries and less developed countries are caused by incidents and disasters.[1-4] The important natural and man-made incidents are chemical, biological, nuclear, and radiological incidents.[5-8]

Chemical weapons are compounds that cause human and other living organisms to

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experience all kinds of injuries and lesions (pulmonary, blood, skin, etc.) permanently or temporarily in the organ system and finally death as a result of direct contact with these substances. On the other hand, huge amounts of dangerous chemicals are produced, transported, stored, and used for industrial and domestic purposes every day. However, the main revolution and the great leap and in fact the gateway to the use of chemical weapons were World War I and then World War II initiated by Nazi Germany. Chemical warfare was first started when the Germans threw tear gas shells at the French in October 1214. Regarding chemical incidents, the worst industrial disaster in the world was the explosion of a chemical plant in Bhopal, India, in 1984, which killed 2500 people and injured 200,000 ones.[9] In the 8-year Iran–Iraq war, more than 50,000 military and civilian populations were affected directly and indirectly by chemical attacks.[10] Chemical agents can be classified into four groups: 1. suffocating agents, 2. blister agents, 3. blood agents, and 4-nerve agents.[11-14]

Biological agents refer to any pathogenic living organism or pathogenic secretions of a living agent. Biological agents enter the human body through different routes such as skin, oral, and inhalation, none of which are as dangerous as inhalation and blood. Regarding biological incidents, it can also be said that a microbial incident can be described as the intentional or accidental release, overt or hidden, of a microbial agent, such as the possibility of a pandemic flu or the threat of terrorist groups using microbial weapons against the civilian population.[9] In the past few decades, various emerging and re-emerging diseases have spread in different geographical areas, including avian flu, severe acute respiratory syndrome (SARS), corona, Crimean-Congo hemorrhagic fever, Ebola, and so on. These factors are mainly divided into six categories: bacteria (anthrax, plague, tularemia, cholera, etc.), viruses (smallpox, encephalitis, SARS, swine flu, etc.), fungi (dermatitis, amanitida muscaria, and food spoilage fungi), poisonous plants, toxins secreted by microbes and viruses, and poisonous plants (botulinum, aflatoxin, ricin) and disease carriers.[15-17]

Regarding radiology and radiation, it can be said that with the rapid development of technology in today's world, the use of ionizing radiation and radioactive materials has also expanded significantly.[18] In general, rays have found a specific place in human lives so that their planned use in research, industrial, and medical applications lays the foundation for significant progress in these fields. However, the investigation of incidents such as Chernobyl, Fukushima, and similar cases has shown that these incidents, while being preventable, can cause irreparable harms to the human society because of the lack of strict control of the use of ionizing radiation and the lack of attention to the necessary safety considerations in this field which are varied in terms of intensity and scope. Another danger that is always feared is the possibility of a terrorist attack on power plants, including the explosion and leakage of radioactive materials and radiation incidents in the health care centers.[19]

On the other hand, hospitals are known as the front line of the treatment and one of the most important places for providing health care services. During the occurrence of incidents and disasters, the role of hospitals and health care centers is very sensitive and they are among the first units that their fast, optimal, and timely health care services can reduce deaths and increase the number of survivors.[20-23] Hospitals are the cornerstones of health systems, which serve as safe environments for staff and patients during incidents and disasters. The role and importance of hospitals in critical incidents are very important to save the lives of clients, and their preparation is the main factor of success in crisis and disaster control. When a disaster and an accident occur, working conditions in hospitals change completely and create significant demands on the health care system and cause an imbalance between supply and demand. Having a regular and resistant structure along with improving the ability of hospitals to manage unusual situations is one of the most important priorities for reducing the complications of natural disasters.[24]

Evaluating hospitals for incidents and disasters is a way to determine the strengths and weaknesses of crisis management and to solve them and increase the effectiveness of crisis management with necessary interventions. In this regard, the preparation of the managers of the centers providing health care services and having the necessary information about disaster management will make them do the necessary planning in order to act wisely during disasters and fulfill their role as they should.[25] The lack of planning and organization to deal with incidents, the lack of preparedness of hospitals, and the lack of training staff to control the crisis can cause irreparable damage to the health care system of the country and the people. The hospitals of each region will be the first centers that people refer to receive medical services in case of any big or small disasters and incidents for the society and people.[26] The evidence shows that the health field in general and all health care centers in particular need to prepare themselves to deal with incidents and disasters because relying on resources and facilities outside the affected area and expecting to receive health services from other areas will result in more deaths and human suffering.[6,24,27-30] Given that chemical, biological, radiological, and nuclear (CBRN) incidents are alarming events for governments, health care providers, and the public and given that hospitals

are often the front line for dealing with incidents, it is necessary to have the preparations needed to deal with these incidents. In this regard, there is no comprehensive qualitative research that provided the obstacles of preparing hospitals against CBRN. Therefore, the purpose of the present study is to determine the obstacles to the preparedness of hospitals against CBRN incidents and to provide solutions in this field.

Materials and Methods

Study design and setting

This applied study was conducted in 2022 using a qualitative method and a semi-structured interview with experts.

Study population and sample

The research community included experts in the fields of chemistry, biology, nuclear science, and radiology, with sufficient knowledge and experience about the research subject. They were included in the study through purposive sampling. First, the most knowledgeable experts in the field of study were identified and selected, and in the next steps, other experts were identified according to their opinions. In consensus studies, there are no strong and clear rules on the selection process and the number of experts. The number of participants is usually less than 50 and mostly 15 to 20. Several researchers stated that 30 is sufficient to reach data saturation and duplicate responses.[31,32] The inclusion criteria were managers and policymakers in the field of study at the hospitals, universities of medical sciences, the Ministry of Health, the country's passive defense organization, and specialists and professors in the field of health in disasters. Unwillingness to participate in the study was an exclusion criterion to the research. Thus, in order to achieve the maximum diversity of the statistical sample of the research (in terms of education, management experience, expertise, operational experience), 17 experienced experts in the studied filed were interviewed [Table 1].

Data collection tools

The data were collected through a semi-structured interview guide designed by the research team. The interview questions included the following: "What problems do the hospitals face in terms of readiness against chemical, biological, nuclear and radiological incidents?" What are the issues, shortages, factors, and problems that need to be solved for hospital preparedness?" "What factors are needed to increase the level of preparedness against CBRN incidents?" The interviews were conducted both in person and online. First, informed consent to participate in the study was sent to the experts via e-mail, and the exact time of the interview was determined. For the face-to-face interview, the researcher visited the experts' offices and getting their permission, a tape recorder was used to record the statements of the interviewees. For the online interview, the Skype environment and its recording capability were used to conduct the interviews. During the interview, note-taking method was used to record the important points of each interview.

Data analyzed

After recording, each interview was transcribed and MS Word 2016 software was used for data analysis. In order to analyze the data, Lundman and Graneheirn's content analysis method was used. This method includes five

Table 1: Demographic information of the interviewees

Number	Degree	Field of Study	Occupation
1	Ph.D.	health in disasters	faculty member
2	Ph.D.	health in disasters	faculty member
3	Ph.D.	Physician	Deputy of the country's passive biological defense
4	Ph.D.	Chemistry	Deputy of the passive biological defense base
5	Ph.D.	epidemiology	faculty member
6	Ph.D.	infectious disease specialist	faculty member
7	Ph.D.	emergency medicine/physician	Head of the accident and emergency center of Yazd province
8	Ph.D.	physician	Secretary of defense at ministry of health
9	Ph.D.	medical physics	faculty member
10	Ph.D.	infectious specialist/physician	Senior expert on infectious and emerging diseases of the Ministry of Health/Member of the Ministry of Health group to fight against corona virus
11	Ph.D.	Healthcare services management	faculty member
12		medical emergency	Expert in passive defense, Urmia University of Medical Sciences
13	Ph.D.	laboratory science	Head of the general laboratories of Urmia University of Medical Sciences
14	M.S	radiologist	The head of the general radiation unit of Urmia University of Medical Sciences
15	M.S	nurse	Metron (Center of biological and chemical incidents)/educational supervisor experience
16	M.S	nurse	Supervisor of emergency (biological and chemical accident center)/experience of educational supervisor
17	Ph.D.	Virology	faculty member

steps: 1, writing the entire interview immediately after conducting it; 2, reading the entire interview text to get a general understanding of its content; 3, determining meaning units and primary codes; 4, classifying similar primary codes into more comprehensive classes; 5, determining the content hidden in the data. Therefore, in this study, immediately after each interview, the text was handwritten and typed word for word, and then the written texts were read several times and the primary codes were extracted. Later, the primary codes that were related to each other were merged to categorize them based on their similarities, and finally, the concepts hidden in the data were extracted.[33] Also, in order to ensure the reliability and validity of the data in the qualitative phase, the criteria of validity, effectiveness, and reliability were used according to the opinion of Linclon and Gouba.[34] Therefore, semantic units were extracted from the interviews and classified into main and sub-categories. In this way, the researcher had a long relationship with the participants which helped them to trust him. After identifying the primary codes, the opinions of the participants were used to ensure the correctness of the codes and their interpretations, and if the codes were inconsistent with the opinions of the interviewees, the necessary corrections were made, and the method of control by two faculty members and experts in the field of qualitative research was used to agree on the selected codes and their classification.

Ethical consideration

This article is extracted from a doctoral thesis entitled "Evaluation of hospital preparedness against chemical, biological, radiological and nuclear incidents to provide a model", which was approved by the Ethics Code IR.KMU.REC.1399.489 from the Ethical Committee at Kerman University of Medical Sciences in 23 November 2020.

Results

The analysis of interviews with experts resulted in the extraction of 98 primary codes that were classified into two main categories and 34 sub-categories [Table 2].

Discussion

This study was carried out to determine the obstacles to the hospital preparedness against CBRN incidents and provide strategies to remove the obstacles. The results showed that there are different obstacles for preparedness of hospitals against CBRN events, including the lack of proper crisis management; the lack of expert staff and the burnout of them; the stress of employees because of their family being in danger; the lack of work flow and sufficient rest for employees; legal gaps; the lack of access to appropriate information sources; the lack of job descriptions; the lack of explanation of the importance of the issue; the lack of a framework, guidelines, or certain standards; non-operational laws; the lack of attention to the possibility of CBRN occurrence and its types; the lack of cooperation between vice presidents and managers; the lack of interpersonal cooperation; and so on. Among these obstacles, providing the skilled human resource has the main role for preparing hospitals against disasters.[35,36]

In this regard, Moradi Majd *et al*.'s[37] study has shown that most countries have started planning hospital preparedness against chemical incidents and threatening activities, although these plans are not satisfactory. In many countries, the preparedness program has been designed while it has not been implemented, and the readiness of hospitals is often not satisfactory. Issues such as databases, hospital preparation team members, communication, and so on are still a challenge. Therefore, the lack of understanding the risk of chemical incidents and the cost of equipping hospitals are among the main factors of ignoring the adequate preparation of hospitals against these incidents. Seyedin *et al*.'s[38] study showed that the preparedness plan for chemical incidents should be based on hospital capacities, level of hospital preparedness, current knowledge, personal protective equipment, and sufficient decontamination. They considered the suitable platform for creating hospital preparedness and reducing the adverse consequences of chemical incidents to avoid the insecurity of chemical incidents and raise the risk perception of managers, officials, and people. Triage in biological incidents has a different mechanism than other triage methods. In the study of Aminizadeh *et al*.,[39] most interviewees pointed out that most hospitals do not have a proper infrastructure for the triage of infectious patients and the screening of patients is not performed correctly.

The necessary solutions were to deal with the possible obstacles to the hospital preparedness against CBRN incidents, such as determining the type and extent of the risk factor, strong crisis management, deleting parallelism, continuous monitoring, having protocols and roadmaps, appropriate training programs, having skilled personnel with psychological preparation, the fast reaction of personnel, the positive attitude of the employees, the favorable condition of the building, the presence of an emergency equipped with separate spaces, the presence of special triage for each incident, the presence of isolation and quarantine departments, and so on. In this regard, education is as a key factor in preparing for crises, including CBRN incidents.[40] Based on the evidence, it is recommended that technical trainings and exercises related to CBRN incidents be repeated periodically and preferably every 6 to 9 months in order to maintain competence, effectiveness,

Table 2: The obstacles of hospital preparedness against CBRN incidents and strategies

Categories	Sub-categories	Evidence (quotation)
Obstacles	- Mismanagement - Lack of educational and executive supervision - Lack of skilled and trained personnel - Burnout and stress of personnel about their families - Lack of breaks for employees - Legal gaps - Lack of access to required information and equipment - Failure to explain the importance of the issue - Absence of a certain framework, guidelines, or standards for passive defense - Not considering the possibility and diversity in CBRN incidents - Lack of inter-personal, departmental, and organizational cooperation - Lack of financial and educational priorities for CBRN - Inadequate infrastructure and physical space	"The lack of financial credit to buy CBRN pegs is not part of the financial priorities approved by the university." Interviewee 12 "Also, in such chemical, biological and nuclear incidents, there is a sense of danger and concern for the health of the personnel and their families, which must also be worked on psychologically. Increasing the psychological readiness of the personnel will be effective in improving the readiness of hospitals." Interviewee 6 "The lack of financial credit to buy CBRN pegs is not part of the financial priorities approved by the university." Interviewee 12
Strategies	- Determining the type and extent of risks - Capable management - Deleting work parallelism - Continuous monitoring - Documentation, protocols, and road map - Appropriate educational programs - Providing skilled personnel with psychological preparation - Positive attitude of employees - Having an emergency equipped with separate spaces - Existence of specialized triage for each incident - Existence of isolation and quarantine departments - Hot rooms and negative pressure rooms - Access to decontamination and cleaning areas - Access to equipped laboratories (ventilator, etc.), transfer (stretcher, etc.), and hospitalization (ICU, etc.) of the patient - Appropriate and sufficient rehabilitation facilities - Proper waste storage - Proper sewage - Quick and safe burial facilities - Existence of proper communication - Existence of sensors and warning system - Providing medicine, antidotes, and vaccines	"The biggest capital of any country is human resources, and we should not put human resources at risk with mismanagement and unnecessary savings. I hope, God willing, all these problems will be resolved." Interviewee 16 "In education, one should pay attention not only to the doctors and nurses, but also to all hospital staff, patient carriers, and services, because the slightest ignorance will spread the infection throughout the hospital." Interviewee 5 "Hospitals should have an electronic structure and an integrated system of information and data with other organizations involved in crises." Interviewee 10

and appropriateness. These trainings and exercises help the correct, effective, and safe use of protective equipment.[37,41,42]

Another study has also emphasized that during biohazards, hospitals should strengthen their diagnostic laboratory capabilities, such as blood culture bottles and blood culture tools for continuous monitoring and rapid detection and identification of biological agents. It is also necessary to allocate additional space to the diagnostic laboratories and improve the air flow in the rooms during the occurrence of biological agents, trained technicians in bioterrorism, and guidelines and procedures in this regard.[43] The findings of Stinson's study indicated that the key components of a hospital emergency preparedness plan to respond to a radiological or nuclear disaster are (a) a qualified hospital emergency manager, (b) conducting education and exercises, (c) developing emergency operations plans, (d) creating joint relationships (external and internal), and (e) the managers supporting the hospital's emergency preparedness plan.[44] It was seen that the level of hospital's preparedness was related to the number of courses and training programs completed by the participants, and medical personnel with post-graduate education were the most prepared, followed by medical graduates and nursing personnel.[45]

In the pandemics of the last few years that affected a lot of people around the world, the strategies adopted and the results obtained required knowledge of the risk perception of the people of the same regions. For example, officials and people in different countries have different behaviors in controlling infectious diseases including SARS, influenza pandemic, swine flu epidemic, and coronavirus disease 2019 (COVID-19).[46,47] In addition, there should be a specialized team for hospital planning in disasters, including personnel responsible

for emergency planning, emergency services, senior medical and nursing staff of the emergency department, doctors of the urgent care association, specialist units, public health, occupational health, environmental organization, water organization, and so on.[24] A good plan for chemical incidents includes all key factors such as assessment of existing conditions and status, recognition of hazardous substances, availability of essential resources and drugs, zoning, use of personal protective clothing, triage stations, and medical services and special treatments to improve the results.[37,48] In biological incidents, part of the preparedness planning of hospitals is related to infection control, and additional spaces such as negative pressure rooms suitable for air infection and respiratory systems of existing isolation rooms should be considered.[43] In general, hospital crisis management is a dynamic process that requires continuous planning and organization, and efforts and should not be ignored.[49] Another study showed that a comprehensive performance assessment system needs to measure all dimensions of hospital performance.[50] In their review, Mohammadi *et al*.[51] pointed to employee training, planning to deal with incidents, PPE, risk perception, decontamination of centers and departments, detection of CBRN contamination, availability of drugs and antidotes, and the presence of experts and health care staff related to the hospital preparedness against CBRN incidents.

Limitations of the study

One of the limitations of the current study was the occurrence of the COVID-19 pandemic and the difficulty of interviewing experts who were encouraged to participate in the study as much as possible or were asked to introduce other available people.

Conclusion

The results of this study showed that various obstacles affect the preparedness of hospitals to deal with CBRN, and it is necessary that health managers and policy makers develop strategies to reduce the complications caused by these incidents. Therefore, providing the necessary economic, human, and managerial infrastructure along with providing training to employees is essential in order to prepare for such incidents. Therefore, it is suggested that hospitals appoint an experienced official as CBRN coordinator and establish disaster management units. All hospitals should prepare plans for regular implementation of actions in cooperation with local emergency response units.

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Conflicts of interest

There are no conflicts of interest.

References

1. Rahmanian F, Abbasi B, Bolvardi E, Maleki F, Habibzadeh SR, Foroughian M, *et al*. The level of disaster preparedness of Iranian hospitals: A systematic review. Iran J Emerg Med 2021;8:e13.
2. Khademipour G, Nakhaee N, Anari SMS, Sadeghi M, Ebrahimnejad H, Sheikhbardsiri H. Crowd simulations and determining the critical density point of emergency situations. Disaster Med Public Health Prep 2017;11:674-80.
3. Nejadshafiee M, Nekoei-Moghadam M, Bahaadinbeigy K, Khankeh H, Sheikhbardsiri H. Providing telenursing care for victims: A simulated study for introducing of possibility nursing interventions in disasters. BMC Med Inform Decis Mak 2022;22:54.
4. Rezaei F, Maracy MR, Sheikhbardsiri H. Hospitals preparedness using WHO guideline: A systematic review and meta-analysis. Hong Kong J Emerg Med 2018;25:211-22.
5. Ahmadi B, Foroushani AR, Tanha N, Abad AM, Asadi H. Study of functional vulnerability status of Tehran hospitals in dealing with natural disasters. Electron Physician 2016;8:3198-204.
6. Aminizadeh M, Saberinia A, Salahi S, Sarhadi M, Afshar PJ, Sheikhbardsiri. Quality of working life and organizational commitment of Iranian pre-hospital paramedic employees during the 2019 novel coronavirus outbreak. Int J Healthcare Manag 2022;15:36-44.
7. Sheikhbardsiri H, Khademipour G, Davarani ER, Tavan A, Amiri H, Sahebi A. Response capability of hospitals to an incident caused by mass gatherings in southeast Iran. Injury 2022;53:1722-6.
8. Sheikhbardsiri H, Yarmohammadian MH, Khankeh H, Khademipour G, Moradian MJ, Rastegarfar B, *et al*. An operational exercise for disaster assessment and emergency preparedness in south of Iran. J Public Health Manag Pract 2020;26:451-6.
9. Yarmohammadian MH, Nasr-Isfahani M, Anbari E. Assessment of preparedness and response of teaching hospitals of Isfahan, Iran, to chemical, biological, radiological, and nuclear incidents. Health Inf Manag 2016;12:777-84.
10. Malkari B, Karimian N. Psychological-social consequences chemical bombardment of the Sardasht victims (a qualitative study). Iran J War Public Health 2013;5:7-13.
11. Young RA, Bast CB. Blister agents, in Handbook of Toxicology of Chemical Warfare Agents. Elsevier; 2020. p. 149-69.
12. Nair A, Yadav P, Behl A, Sharma RK, Kulshrestha S, Butola BS, *et al*. Toxic blister agents: Chemistry, mode of their action and effective treatment strategies. Chem Biol Interact 2021;350:109654.
13. Bhuvaneswari R, Nagarajan V, Chandiramouli R. Exploring adsorption mechanism of hydrogen cyanide and cyanogen chloride molecules on arsenene nanoribbon from first-principles. J Mol Graph Model 2019;89:13-21.
14. Chai PR, Boyer EW, Al-Nahhas H, Erickson TB. Toxic chemical weapons of assassination and warfare: Nerve agents VX and sarin. Toxicol Commun 2017;1:21-3.
15. Jebelli B, Varahram M, Razlighi MS, Palizdar M, Ghazanchaei E. Management strategies to control the COVID-19 crisis in Masih Daneshvari Hospital, Tehran, Iran. J Mil Med 2020;22:616-22.
16. Mayor A. Chemical and Biological Warfare in Antiquity, in Toxicology in Antiquity. Elsevier; 2019. p. 243-55.
17. Powell T. Biological warfare in Korea: A review of the literature. Social Democr 2019;33:67-107.

18. Kollek D. Canadian emergency department preparedness for a nuclear, biological or chemical event. Can J Emerg Med 2003;5:18-26.
19. Moradi E. Comparison of Two Methods for Nuclear Emergency Care Training to Lecture and Multi-Media Software Packages to Levels of Learning of Nurses Sadoughi Hospital in Esfahan [MSC]. Tehran: Baghiyatallah University; 2011.
20. Kardanmoghadam V, Moasheri BN, Khazaee M, Moghaddam HK. Assessment of hospital disaster preparedness in the city of Birjand, Iran, in 2011. J Manag Med Inf School 2014;2:10-9.
21. Beyramijam M, Khankeh H, Shahabi-Rabori M, Aminizadeh M, Sheikhbardsiri H. Hospital disaster preparedness in Iranian province: A cross-sectional study using a standard tool. Am J Disaster Med 2021;16:233-9.
22. Molavi-Taleghani Y, Ebrahimpour H, Sheikhbardsiri H. A proactive risk assessment through healthcare failure mode and effect analysis in pediatric surgery department. J Compr Ped 2020;11:e56008.
23. Sheikhbardsiri H, Nekoei-Moghadam M, Yarmohammadian MH, Khankeh H, Aminizadeh M, Ebadi A. Developing and psychometric testing of the evaluation tool for disaster exercises design stage: A mixed method study. PLoS One 2022;17:e0260581.
24. Mehri S, Soola AH, Mohammadi M-A, Hamidkholag G, Dadkhah B. Exploring managers' experiences of hospital disaster preparedness: A qualitative study. J Qual Res Health Sci 2022;11:156-63.
25. Aminizadeh M, Farrokhi M, Ebadi A, Masoumi G, Kolivand P, Khankeh H. Hospital preparedness challenges in biological disasters: A qualitative study. Disaster Med Public Health Prep 2022;16:956-60.
26. Mohammadi S, Aminisaman J, Karimpour H, Kavinnezhad R, Ezzati E. Assessing of preparedness for disasters and crisis in centers of trauma and accidents of Kermanshah university of medical sciences in 2016. J Clin Nurs Midwifery 2017;6:69-80.
27. Sahebi A, Yousefi A, Abdi K, Jamshidbeigi Y, Moayedi S, Torres M, *et al.* The prevalence of post-traumatic stress disorder among health care workers during the COVID-19 pandemic: An umbrella review and meta-analysis. Front Psychiatry 2021;12:764738.
28. Sheikhbardsiri H, Afshar PJ, Baniasadi H, Farokhzadian J. Workplace violence against prehospital paramedic personnel (city and road) and factors related to this type of violence in Iran. J Interpers Violence 2022;37:NP11683-98.
29. Sheikhbardsiri H, Doustmohammadi MM, Mousavi SH, Khankeh H. Qualitative study of health system preparedness for successful implementation of disaster exercises in the Iranian context. Disaster Med Public Health Prep 2022;16:500-9.
30. Heidaranlu E, Tavan A, Aminizadeh M. Investigating the level of functional preparedness of selected Tehran hospitals in the face of biological events: A focus on COVID-19. Int J Disaster Resil Built Environ 2022;13:150-62.
31. Rahimi H. Design performance evaluation model of governmental hospitals using an integrating of balanced scorecard and interpretive structural Modelling (BSC- ISM), 2014-2015, in School of management and Medical Information. 2015, Shiraz university of medical sciences, School of management and Medical Information: Shiraz. p. 134.
32. Rahimi H, Haghdoost A, Noorihekmat S. A qualitative study of challenges affecting the primary care system performance: Learning from Iran's experience. Health Sci Rep 2022;5:e658.
33. Graneheim UH, Lundman B. Qualitative content analysis in nursing research: Concepts, procedures and measures to achieve trustworthiness. Nurse Educ Today 2004;24:105-12.
34. Guba EG, Lincoln YS. Fourth Generation Evaluation.Sage; 1989.
35. Keshvari M, Shirdel A, Mirghaedi MT, Yusefi AR. Challenges in the optimal management of human resources in hospitals: A qualitative study. J Qual Res Health Sci 2020;7:349-60.
36. Nobakht S, Shirdel A, Molavi-Taleghani Y, Doustmohammadi MM, Sheikhbardsiri H. Human resources for health: A narrative review of adequacy and distribution of clinical and nonclinical human resources in hospitals of Iran. Int J Health Plann Manag 2018;33:560-72.
37. Moradi Majd P, Seyedin H, Bagheri H, Tavakoli N. Hospital preparedness plans for chemical incidents and threats: A systematic review. Disaster Med Public Health Prep 2020;14:477-85.
38. Seyedin H, Moradimajd P, Bagheri H, Dolatabadi A, Nasiri A. Providing a chemical events and threat's preparedness model for hospitals in the country: A qualitative study. J Mil Med 2021;23:220-7.
39. Aminizadeh M, Farrokhi M, Ebadi A, Masoumi G, Kolivand P, Khankeh H. Hospital preparedness challenges in biological disasters: A qualitative study. Disaster Med Public Health Prep 2020:1-5.
40. Djalali A, Della Corte F, Segond F, Metzger MH, Gabilly L, Grieger F, *et al.* TIER competency-based training course for the first receivers of CBRN casualties: A European perspective. Eur J Emerg Med 2017;24:371-6.
41. Aminizadeh M, Farrokhi M, Ebadi A, Masoumi GR, Beyrami-Jam M, Khankeh HR. COSMIN checklist for systematic reviews of the hospital preparedness instruments in biological events. J Nurs Meas 2021;29:441-61.
42. Aminizadeh M, Farrokhi M, Ebadi A, Masoumi GR, Kolivand P, Khankeh HR. Hospital management preparedness tools in biological events: A scoping review. J Educ Health Promot 2019;8:234.
43. Dowlati M, Seyedin H, Moslehi S. Hospital preparedness measures for biological hazards: A systematic review and meta-synthesis. Disaster Med Public Health Prep 2021;15:790-803.
44. Stinson NL, Preparedness of Metropolitan-Area Hospitals for Responding to a Radiological or Nuclear Emergency, in School of Public Service and Education. Capella University; 2021.
45. Azeem AR, Sharif MW, Akhtar A, Sohail CS, Dar AA, Khan M, *et al.* Perception of preparedness of health care professionals in case of a nuclear, chemical, biological attack/emergency in a tertiary care hospital. Cureus 2019;11:e4657.
46. Yeung NCY, Lau JTF, Choi KC, Griffiths S. Population responses during the pandemic phase of the influenza A (H1N1) pdm09 epidemic, Hong Kong, China. Emerg Inf Dis 2017;23:813-5.
47. Farnoosh G, Alishiri G, Zijoud SRH, Dorostkar R, Farahani AJ. Understanding the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease (COVID-19) based on available evidence-a narrative review. J Mil Med 2020;22:1-11.
48. Olivieri C, Ingrassia PL, Della Corte F, Carenzo L, Sapori JM, Gabilly L, *et al.* Hospital preparedness and response in CBRN emergencies: TIER assessment tool. Eur J Emerg Med 2017;24:366-70.
49. Bhatia G, Sandhu N. Preparedness of health facilities in Chandigarh for biological disasters. Disasters 2018;12:25-45.
50. Malekzadeh R, Abedi G, Mahmoodi G. Identification of effective components in hospital performance assessment: A qualitative study. J Qual Res Health Sci 2021;10:100-7.
51. Mohammadi SB, Amirheidari B, Danesh T, Moghadam MN, Yazdi-Feyzabadi V, Hassani E, *et al.* Identification and analysis of parameters and global experiences of hospital preparedness against chemical, biological, radiological and nuclear disasters: A scoping review. J Clin Res Paramed Sci 2022;11:1-14.