# Audit of preparedness of selected military hospital in the face of biological threats: action research study

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# Abstract

Introduction In today's societies, the threats caused by chemical, biological, radiological and nuclear accidents, whether accidental or intentional, have become a great concern. Acquiring knowledge about how to respond to the management of these incidents and the complications caused by them in order to preserve societies and ensure stability is essential. Due to the fact that hospitals play an important role in dealing with the victims of biological threats, this study was conducted with the aim of auditing the preparedness of selected military Hospital in facing biological threats in 2023-2024.

Methods This applied research was conducted with the participatory action research method in all departments of selected military Hospital during one year from July 2023 to July 2024. The level of biological preparedness of the hospital was investigated using the hospital's preparedness tool in biological events with 147 items in 8 main dimensions and 20 sub-dimensions, and the weak areas of the hospital (9 areas) were identified. Then, in the hospital audit cycle, using the FOCUS-PDCA model, a program to improve work processes and improve the biological preparedness of different departments of the hospital in the face of accidents and disasters was implemented. The level of biological preparedness of the hospital before and after the implementation of the change was compared and analyzed using SPSS. version 22 software.

Results The preparedness in the studied hospital in facing biological threats before the change was 196 out of 294 and the hospital's biological preparedness percentage was 66.66%, which was in the average range, and after the change, the preparedness score reached 228 and the hospital's preparedness percentage was 77.55%, which was in the range Well classified. In 9 fields where the level of biological preparedness was moderate and weak, the highest preparedness was created in the field of employees and volunteers with 86.36% and the lowest preparedness was related to the field of corpse management with 50%.

**Conclusion** Considering the impact of training in improving the hospital's preparedness program in the face of biological threats, it is suggested that other medical centers include audits in their work plan.

Keywords Audit, Hospital, Biological threats, Action research

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## Introduction

In today's societies, the threats caused by chemical, biological, radiological and nuclear accidents, whether accidental or intentional, have become a great concern [1]. According to the definition of the world health organization, Biological agents are organisms or toxins that can kill or disable people, livestock, and crops. A biological attack is the intentional release of microbes or other biological substances that can make people sick. Biological agents are very dangerous with lethal doses [2]. Advances in biotechnology and biochemistry have the potential to make biological weapons more powerful than conventional chemical weapons. The ease of production and availability of various biological agents and technical knowledge has led to the spread of biological weapons and the increase in the desire of nations as well as terrorists to have them [3]. A biological attack may manifest immediately or appear delayed [4]. In most cases, local health care workers will report an unusual disease pattern or there will be a surge of sick people seeking emergency medical care. People are alerted through an emergency radio or television broadcast, a phone call, or a home visit. The purpose of bioterrorism, According to the definition of the world health organization, is to scare people and civilian authorities, as well as to fulfill the political, religious and ideological demands expected by terrorists [5]. Such attacks cause panic and fear among people, chaos in many areas of life, economic losses and loss of trust in government officials. The potentially massive number of victims reveals inefficiencies in emergency services and the health care system [2, 6, 7]. The spread of many diseases caused by biological accidents in the past decades, such as acute respiratory syndrome [8], influenza [9, 10], Ebola [11, 12], emerging and re-emerging infectious diseases [13, 14], bioterrorism events [15, 16], in addition to the threat of high mortality, they can paralyze healthcare systems and cause significant social and economic disruption in society [17]. Also, the coronavirus disease was first discovered in Wuhan, China, in December 2019 [18, 19] and On January 30, 2020, 2020 was declared by the World Health Organization as an international public health emergency [20, 21]. The response to diseases caused by biological events is still one of the most important health issues in developing countries that must be addressed. Iran is also located in the eastern Mediterranean region with neighbors that still do not have a dynamic, active and coherent health system, and due to the emergence of biological events in Iran such as the outbreak of influenza, Crimean Congo fever and the corona virus pandemic in 2019–2020, there is a need to prepare hospitals. It is felt to deal with these incidents at the local and national levels [22]. Therefore, a quick and appropriate response to biological accidents can play an important role in reducing the harmful effects of these accidents on physical health and reduce their psychological effects to a great extent [23]. Max Smith et al.'s (2022) research entitled CBRNE3 Medical Challenges in Harsh Environments shows that strong planning and training is the key to managing CBRNE3 incidents in a harsh environment [24]. Also, social distancing and quarantine measures in pandemics like Corona show that telemedicine is the safest and most suitable solution for patients and doctors [25, 26]. Hospitals should have an acceptable level of knowledge, awareness, attitude and preparation in facing bioterrorism. However, according to reports, the level of awareness of specialists has not been evaluated favorably [27, 28]. Evaluating disaster preparedness in order to strengthen national health systems will increase the resilience of health institutions [29]. Various tools have been presented to evaluate the preparedness of hospitals in accidents and disasters, which are usually in the form of checklists with an all-risk approach, and most of them cannot evaluate the performance indicators of preparedness and response in biological events [20]. To evaluate hospital preparedness against disasters, the national health system needs new tools compatible with the principles of scientific tool design to enable more accurate prediction of hospital preparedness during disasters before they occur [30]. Among the most important tools that perform a comprehensive and comprehensive assessment is the preparedness audit, which extracts weaknesses as an action research and tries to fix them [31]. Audit is a systematic, independent and documented quality improvement process to find evidence and evaluate them with a series of specific and standard criteria and apply changes when necessary [32]. Every audit has a cycle that includes (1) Examining the current situation (2) Setting and compiling standards (3) Comparing the results with the standards (4) Making changes and changing the performance based on the results (or providing a solution) (5) Re-auditing to ensure performance improvement [33]. In case of crisis management audit, weaknesses, opportunities, threats, and risks can be determined, increasing managers' awareness of crisis management, preventing repetitive tasks, and guaranteeing the successful implementation of crisis management programs [34]. Among the effective and widely used tools in the field of health that have been used in recent years at the national and even international level to improve organizational processes, comprehensive quality management and its important tool is FOCUS-PDCA [35]. FOCUS-PDCA is a scientific, coherent and practical method to improve processes and has a complete and relevant management toolbox to solve organizational challenges with the help of process owners [36]. Considering that in the past studies, due to the lack of specific tools to measure the biological preparedness of hospitals, the existing tools have practically measured the vulnerability

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of hospitals, and in almost no study in the field of health, the audit of hospital preparedness in facing biological threats has not been reported, Also since military hospitals are at the forefront of responding to all kinds of crises, and in the meantime, this hospital is one of the most important military hospitals and can practically show a clear picture of its potential and actual capabilities as a representative of the hospital. therefore, the present study was designed and implemented with the aim of auditing the preparedness of selected military hospitals in the face of biological threats.

## Methods

This applied research was conducted with the participatory action research method in all departments of the selected military hospital during one year from July 2023 to July 2024.

The fourth stage of the audit, in which the change in the form of biological preparedness program training was considered as a change, in this research, using the Aminizadeh tool with 147 items with the aim of "evaluating the hospital's preparedness in biological events" with three themes (capacity, ability and competency). and 8 main dimensions and 20 sub-dimensions that include

 Table 1
 The scope of scores of the fields of the guestionnaire

Range of score	Number of field questions	Fields of the questionnaire
0-14	7	Planning
0-10	5	Organize
0–6	3	Legal requirements
0–28	14	Structure
0–16	8	Medicines, equipment and medical supplies
0-22	11	Staff and volunteers
0-12	6	Education and training
0-10	5	Practice and maneuver
0-16	8	Risk notification and communication
0–8	4	Communication and coordination
0-10	5	Environmental safety and health
0-12	6	Security
0–38	19	Infection prevention and control
0-12	6	Laboratory diagnostic capacity
0–18	9	Early warning and syndromic care system
0-12	6	Biological triage
0-18	9	Diagnosis and treatment
		management
0–8	4	Management of corpses
0-14	7	Continuity of performance
0-10	5	Essential support services

The range of scores of the "Preparedness of Hospitals in Biological Events" questionnaire, which includes 20 fields. Therefore, the score of each subscale can be calculated from the sum of the scores of the items of that subscale and the total score from the sum of the scores of the subscales

the development of management structures (planning, organization, legal requirements), increasing capacity (structure, drug management, medical equipment and supplies and staff and volunteers), training and exercise (training and exercise and maneuver) information and communication management (danger communication and information, communication and coordination), care and laboratory system (laboratory diagnosis capacity and early warning and syndromic care system), safety and security (environmental safety and health, security and infection prevention and control), patient management (biological triage, diagnosis and treatment management and corpse management) and resilience of the hospital (continuity of operation and essential support services) are considered (Table 1), as well as for statistical analysis of data using SPSS version 22 software and descriptive statistics was used.

By converting the score obtained from the questionnaire into a percentage and comparing it with the maximum and minimum scores of the questionnaire, the level of preparedness of hospitals in biological events was calculated and interpreted.

The following linear conversion formula was used to convert the scores of the dimensions (area/subscale) and the entire questionnaire to a score of 0 to 100.

	$The \ raw \ score \ obtained -$
Como in nonconto no	Minimum raw score possible
Score in percentage=	$\frac{100}{Maximum raw score possible-} \times 100$
	Minimum raw score possible

If all the items are given a weight of one, the scoring will be from 0 to 100 as follows; The scores of the dimension items (area/subscale) are added together and then according to the linear transformation formula, a percentage score is calculated as follows for the dimensions (area/subscale) and the entire questionnaire. Low scores indicate the high level of hospital preparedness in It will be biological events. The whole questionnaire has a range of scores from zero to 294. Therefore, the score of each subscale can be calculated from the total scores of the items in that subscale, and the total score can be calculated from the total scores of the subscales. By converting the score obtained from the questionnaire into a percentage and comparing it with the maximum and minimum scores of the questionnaire, the level of preparedness of each hospital in accidents and disasters is calculated and interpreted, and in order to calculate the score, an Excel tool will be designed, which will obtain the score based on the above formula. reports coming from the tool. (Table 2)

Table 2 The level of he	ospital preparedness in bi	iological events
The score obtained by the hospital	Hospital preparedness percentage	The level of biological pre- paredness of the hospital
0–98	33%-0%	Weak
196–99	66%-34%	Average
197–294	99%-67%	Good

The level of preparedness of the hospital in biological events is based on the obtained score and percentage, which is classified into three levels: weak, medium and good

#### The validity and reliability of the instrument

The instrument is the result of Aminizadeh et al.'s doctoral thesis, after checking and confirming the face and content validity of the initial instrument, the average content validity index for the entire instrument containing 147 items was calculated as 0.92. In order to ensure construct validity, the tool was sent to hospitals all over the country and 400 hospitals from all over the country completed this tool and the construct validity of this tool has been confirmed. Reliability between evaluators in the fields of the questionnaire (inter-rater reliability), intra-cluster correlation (ICC) agreement between evaluators was 0.92 with a confidence interval between 0.88 and 0.96, as well as the equivalence or internal reliability of evaluators by one observation. with an interval of 2 weeks in 10 hospitals (interrater reliability); The intracluster correlation test (ICC) of 0.94 with a confidence interval between 0.89 and 0.97 indicated the appropriate reliability of the tool.

# Determining the hospital's preparedness standards in the face of biological threats

In order to design and validate, first, a number of experts in the field of accidents and disasters with experience in biological events were interviewed, and based on the results, "preparedness standards for hospitals in the face of biological threats" were extracted. In order to validate the educational content, the face validity method was used. For this purpose, the content was provided to 20 experts in crisis management in the field of health and their opinions about the content were obtained using the Delphi method. The results of the three Delphi rounds showed the validation of the "Program of Standard Guidelines for the Preparedness of Hospitals in the Face of Biological Threats".

- In the first step of the Delphi technique, a guide was selected from the members of the research team to carry out the work.
- In the second step, experts in the field of health were identified in accidents and disasters. (The number of 20 people consisting of infectious disease specialists, internal specialists, hospital managers and the risk

and accidents and disasters committee who had experience during the Covid-19 period)

- In the third step, the problem was raised for the experts on the subject of "Program of standard guidelines for the preparation of hospitals in the face of biological threats". General questions were asked in the form of a survey, and the outlines of the contents were described, and the main views of experts regarding the standard guidelines for the preparedness of hospitals in the face of biological threats were extracted and secondary and marginal opinions were discarded. (first round of Delphi)
- In the fourth step, according to the answers to the questions of the first round, more explanation was given about the subject so that the experts could explain the issues clearly. The results were collected, unimportant criteria were separated and common answers were extracted. (To remove unimportant criteria in the 5-option Likert scale, if the average of an index was below 3, that index was removed.) (2nd round of Delphi).
- In the fifth step, the experts were asked the third round of questions. In fact, this round was the basic decision-making stage regarding "the program of standard guidelines for the preparation of hospitals in the face of biological threats". At this stage, the research team focused more on the points of understanding and the indicators were screened again. (third round of Delphi)
- In the sixth and final step, the final guidelines, including the compiled titles and content, were seen by the experts and were approved and finally agreed upon. (Table 3)

#### The procedure

- In the first step, the declaration of need and approval for the implementation of the mentioned project was obtained from the selected military hospital. After receiving the letter of introduction from the university research and presenting it to the head of the hospital and making the necessary coordination with the hospital's accident and disaster risk management secretariat, it was done.
- According to the "hospital preparedness" audit cycle, the following steps were taken to implement the plan(Fig. 1):
- In accordance with the first step of the audit, which is "examination of the existing situation", the level of preparedness of the selected military hospital in facing biological threats was determined by the tool of Dr. Aminizadeh (2021) and the preparedness score

The first round of the Delphi technique	The second round of the Delphi technique	The third round of the Delphi technique	The final stage of the Delphi technique
Content titles suggested by experts	Content titles suggested by experts	Content titles suggested by experts	Final titles ap- proved by experts
planning	planning organize	planning organize Legal requirements	Development of management structures
Structure	Structure Medicines and equipment	Structure Medicines and equipment Staff and volunteers	Increase capacity
Educational planning	Educational planning Approved budget	Education and training Practice and maneuver	Training and practice
Notification Communication	Notification Risk communication coordination	Risk notification and communication Communication and coordination	Information and communication management
Environmental health safety	safety-supply	Environmental safety and sanitation security Infection control	Safety and security
Early warning system	Laboratory and diagnostic capacity	Laboratory diagnostic capacity Early warning and syndromic care system	Care system and laboratory
Biological triage	Biological triage Management of corpses	Biological triage Diagnosis and treatment management Management of corpses	Patient management
Continuity of performance	Continuity of performance Support services Performance of special sections	Continuity of performance Essential support services	Hospital resilience

 Table 3
 Summary of the topics agreed upon by experts

Summary of topics agreed upon by experts in the field of health in accidents and disasters with the experience of biological events

"The program of standard instructions for the preparation of hospitals in the face of biological threats" in three rounds of the Delphi technique where the final instructions, including the compiled titles and content, were approved and finally agreed upon

1-Make the necessary coordination with the relevant parts

2-Assessment the current situation

3- Set and develop standards

4-Compare results with standards

5-Perform the intervention

6-R<u>e-audit</u>

Fig. 1 Audit implementation steps

of each area was extracted according to its desired score in the tool. (The first step of the audit)

• In the implementation method of the first step to investigate the current situation of the selected military hospital, the researcher first collected the primary information with the permission of the senior officials of the hospital and with the help of the directors of the hospital's risk committee. In this regard, the documents of the risk committee regarding each of the areas of the hospital's preparedness tools in the face of biological threats were seen and reviewed. The final grade of the first step of the audit was extracted and recorded based on the grades obtained in this step.

In accordance with the second step of the audit, which is "determining the standards" and the third step of the audit, which is "comparing the existing situation with the standard", considering that the instrument of Aminizadeh (2021) as a result of his doctoral dissertation, was made according to the scientific steps and standard of instrument making. And its psychometrics has been confirmed, and therefore the score of each question in the tool is the standard of functional preparedness for that question.

- In the phase of determining the standards, the program of standard guidelines for the hospital's preparedness in the face of biological threats for the owners of the process (managers, treatment personnel and administrative staff) was compiled according to the Delphi method, and in the phase of comparing the current situation with the standard, which includes the second and third steps of the audit cycle The score of each area was compared with the standard score of that area in the tool. (The second and third step of the audit cycle)
- In accordance with the fourth step of the audit, which is "making a change", the program has taught standard instructions for hospital preparedness in the face of biological threats for process owners (managers, treatment personnel and administrative staff) with the method of discussion in focus groups (FOCUS-PDCA). and appropriate solutions were presented. (the fourth step of the audit).
- According to the fifth step of the audit, which is "re-audit", the preparedness score of the selected military hospital in the face of biological threats was extracted after the change and the comparison of pre- and post-preparedness was done according to the standard score of each field in the tool. (The fifth step of the audit).
- The information obtained from the hospital evaluation was analyzed and reported using SPSS software.

#### Method of change

According to the points and standards related to each area, separately in the areas that were at the medium and weak level (9 areas with a score of less than 67%), Necessary training regarding the program "Standard guidelines for the preparation of hospitals in the face of biological threats" was held in the form of holding a conference, briefing classes and exercises and maneuvers on 31/10/2023 and 29/11/2023. According to the leveling of personnel in the areas of managers, treatment staff and other personnel (including procurement, security and facilities, etc.) in three two-hour sessions in the conference hall of the hospital, standard instructions were taught in accordance with the established standards. In addition, 9 quality improvement teams were formed for each area and continuous quality improvement meetings were held. Necessary trainings were conducted for the managers and personnel of each area focusing on the weaknesses in that area (deviation from the standard).

Also, 9 virtual groups were formed in Telegram according to the level of participants to answer their questions and doubts. The reports were followed up through cyber space. Again, during four weeks, the researcher, together with the hospital's risk committee team, visited all parts of the hospital in person and reminded them again of the contents according to their expertise. Then, with the cooperation of the personnel and officials of each part, according to their expertise in the desired areas, changes are made based on the discussion in the focused group (FOCUS-PDCA), focusing on suggestions, solutions and measures that 1- take less time 2- reduce costs Less 3- They had more executive ability, to correct the existing weaknesses according to the standard instructions of hospital preparation according to the audit cycle (making changes and providing solutions) were counted and implemented. The re-evaluation of the hospital's functional preparedness was done two months after the completion of the training by the researcher with the help of the managers of the hospital's risk committee, and finally the results before and after the change were compared and reported according to the fifth step of the audit. (Research steps algorithm) Fig. 2.

#### Findings

The purpose of analysis in any scientific research is to obtain results and provide scientific proposals. Therefore, in this research, the results were examined according to the obtained information. In line with this, descriptive statistical methods were used to describe the data, the response percentage of the sample population to each of the questions in the questionnaire from the preparedness percentage table. The relative mean of preparedness in the studied hospital in facing biological threats before the change of score was (196) from (294) and the percentage of biological preparedness of the hospital was (66.66) percent, which was in the average range, and after the change of the preparedness score was (228). And the biological preparedness percentage of the hospital reached (77.55) percent, which was classified as good. Also, in 9 fields where the level of biological preparedness was moderate and weak, the highest preparedness was created in the field of employees and volunteers with 86.36% and the lowest preparedness was related to the field of corpse management with 50% (Chart 1). The information was summarized in the form of 9 columns below (Table 4). Then the results obtained before and after the change were compared and the level of biological preparedness of the selected hospital was reported (Tables 5 and 6).







Chart 1 General comparison of each area, before and after the change. A general comparison of the biological readiness of the hospital in 9 areas before and after the change, where the lowest percentage is related to corpse management and the highest percentage is related to staff and volunteers

Row	Fields of the questionnaire	Maximum instrument score	The score obtained before the change	The score obtained after the change	Hospital pre- paredness per- centage before the change	The level of biologi- cal preparedness of the hospital before the change	Hospital preparedness percentage after change	The level of biolog- ical preparedness of the hospital after the change
1	Planning	14	8	12	57.14%	Average	85.71%	Good
2	Staff and volunteers	22	13	19	59.09%	Average	86.36%	Good
3	Education and training	12	7	10	58.3%	Average	83.3%	Good
4	Practice and maneuver	10	2	7	20%	Weak	70%	Good
5	Biological triage	12	6	8	50%	Average	66.66%	Good
6	Diagnosis and treatment management	18	10	13	55.55%	Average	72.22%	Good
7	Management of corpses	8	1	4	12.5%	Weak	50%	Average
8	Continuity of performance	14	8	10	57.14%	Average	71.42%	Good
9	Essential sup-	10	5	7	50%	Average	70%	Good

#### Table 4 Evaluation before and after the change

The preparedness of the selected hospital in facing biological threats before and after the change, which was used to describe the data, descriptive statistical methods, the percentage of response of the sample population to each of the questionnaire questions from the preparedness percentage table

 Table 5
 Preparation before and after the change

Result	Before the	After
Variable	change	the
		change
The score obtained by the hospital	196	228
Hospital preparedness percentage	66.66%	77.55%
The level of biological preparedness of the	Average	Good
hospital		

Overall comparison of the biological readiness of the hospital before and after the change, the level of biological readiness of the hospital was improved from average to good

# Discussion

Hospitals, as the first reception centers for the injured when disasters occur, must have the necessary preparation to deal with accidents and disasters. The unpreparedness of hospitals in dealing with disasters is one of the important factors that has a direct impact on the vulnerability of a country [37]. The preparation of a longchain hospital includes multiple and connected links. Therefore, it is very important to ensure the use of a suitable tool to evaluate the necessary preparation in an acceptable response in the face of disasters in order to properly measure all these interconnected components [38, 39]. The present study has used an audit in the preparedness of a hospital in the face of biological threats, as a single example. Considering that no study has been found in the field of "hospital preparedness audit in the face of biological threats", this study was compared with studies in the field of hospital preparedness against biological disasters. The discussion about the areas that had average and poor scores (9 areas with a score of less than 67%) is given in the order mentioned and is reported according to the audit cycle.

In the case of planning, which is one of the important elements in the hospital's preparedness to effectively respond to biological threats, the percentage of preparedness achieved in the current situation review phase of the audit cycle (before the change) was 57.14%, which in the re-audit phase (after the change and solution presentation) reached 85.71%. The preparedness of the hospital in this area improved from average to good after the change. The results of the present study are consistent with the results of the study of Abbaspour et al. (2023) that planning to hold drills and develop protocols for accidents and biological threats, in addition to reducing the psychological burden and stress resulting from the disease in the society and hospital staff, can provide an appropriate response and bring fast response [40]. Also, with the results of the study by Mesgarpour et al. (2020), which identified the response of Iran's health system to deal with the Covid-19 pandemic in seven main areas of health, treatment, education, logistics, crisis management, research management and communication and information management, and 46 sub-areas. And they recorded it, it is consistent. In his study, he came to the conclusion that in the field of crisis management, the issue of contact tracing and disease transmission chain control is still neglected. There are also no comprehensive guidelines for reducing or stopping social contacts and limiting population mobility in urban areas. Therefore, they suggested that comprehensive guidelines be

Area	Cases of deviation from the standard	Changes based on the FOCUS-PDCA model According to the standard preparation guidelines
Planning	<ul> <li>Failure to conduct a risk assessment to identify biological hazards, vulnerabilities and internal and external capacities</li> <li>Failure to design and develop a preparedness plan (operational response plan, training plan, and training plan) in biological events</li> <li>Annual monitoring and review of processes and protocols in biological events based on the results of exercises, experiences and lessons learned irregularly.</li> </ul>	<ul> <li>Conducting a risk assessment to identify biological hazards, vulnerabilities and internal and external capacities (HVA)</li> <li>Designing and preparing the preparedness plan (early warning system, operational response plan, training plan and exercise plan) in biological events</li> <li>Designing and compiling the plan for the continuity of vital services and recovery (rehabilitation and reconstruction) in biological events</li> <li>Annual monitoring and review of processes and protocols in biological events based on the results of exercise, experiences and lessons learned regularly</li> </ul>
Staff and volunteers	<ul> <li>Failure to prepare an updated list of employees and volunteers</li> <li>Failure to establish a work policy for non-clinical employees in order to reduce the spread of contamination (working hours, reduction of personnel)</li> </ul>	<ul> <li>Preparation of updated list of employees and volunteers and their contact numbers for recall</li> <li>Employing and training additional staff (nurses of the retirement center) according to the anticipated needs in the face of biological events</li> <li>Reduction of non-clinical staff in biological event response guidelines</li> </ul>
Education and training	<ul> <li>Failure to formulate annual educational programs according to the type of biological event</li> <li>Failure to hold specialized training courses for employees in the face of biological events</li> </ul>	<ul> <li>Holding a conference and a training class on the use of personal protective equipment in biological events, all employees have been trained</li> <li>Conducting a comprehensive exam for the nursing group using the Ascii method (one of the test stations was the topic of infection control and personal protective equipment in biological events)</li> <li>Periodic supervision of the infection control supervisor to make the trainings effective</li> <li>Conducting a CBRNE virtual training course and discussing the specialized topics of biological events</li> </ul>
Practice and maneuver	<ul> <li>Failure to implement all kinds of exercises (discussion-oriented, operation-oriented) in biological events based on possible scenarios at least annually (within the organization) based on national guidelines.</li> <li>Failure to evaluate the effectiveness of exercises</li> </ul>	<ul> <li>The program was compiled and taught</li> <li>It was evaluated in various exercises (table and operational)</li> <li>Designing, compiling and implementing all kinds of exercises as joint and inter-organizational exercises with organizations responding to biological incidents</li> <li>Evaluating the effectiveness of exercises, identifying weaknesses and strengths, and revising existing programs if necessary</li> </ul>
Biological triage	<ul> <li>Failure to design a protocol and follow up the suspect through telephone triage</li> </ul>	$\cdot$ Designing the protocol and follow-up process of the suspicious person after identification through telephone triage in the face of biological events
Diagnosis and treatment management	<ul> <li>Failure to designate an equipped waiting and examination room for suspected or sick people</li> <li>Lack of referral and follow-up of suspected or infected outpa- tients to designated comprehensive health centers for biological events</li> </ul>	<ul> <li>Considering a separate space for triage and admission of patients during biological crisis</li> <li>Taking into account the necessary preventive measures in times of biological crisis with the cooperation of the involved organizations such as health centers, universities of medical sciences, etc. in the guidelines compiled to respond to biological events</li> </ul>
Management of corpses	<ul> <li>Failure to isolate infected bodies in biological incidents.</li> <li>Absence of separate capacity to accept corpses</li> </ul>	<ul> <li>Triage and separation of infected bodies in biological incidents according to the type of biological incident (in terms of decontamination method and burial conditions)</li> <li>Increasing the capacity to receive dead bodies by creating a temporary mortuary and contracting with other centers and ensuring the provision of special shrouds and covers</li> </ul>

Table 6 (continued)

Area	Cases of deviation from the standard	Changes based on the FOCUS-PDCA model
		According to the standard preparation guidelines
Continuity of performance	<ul> <li>Lack of performance analysis and review of actions taken in</li> </ul>	ullet Performance analysis and review of actions taken in response to biological events in order to make
	response to biological events	the hospital more resilient and respond better in subsequent events
Essential support services	Failure to foresee alternative sources for establishing vital arteries	<ul> <li>Prediction of alternative sources of fuel required for the operation of buildings, generators and essen-</li> </ul>
	of the hospital	tial transportation services
		<ul> <li>Forecasting alternative sources for establishing vital arteries of the hospital (water, electricity and</li> </ul>
		communication infrastructures, etc.)
		<ul> <li>Also conducting water outage maneuvers (developing the water storage source) and electricity (to</li> </ul>
		ensure that the emergency electricity is not overloaded)

ndicators of deviation from the standard and changes in accordance with the guidelince of the standard of preparation in 9 areas based on the FOCUS-PDCA model, which are detailed in each of the 9 areas that received average of poor grades, the above changes were applied

developed to monitor the performance of the crisis management of the Corona pandemic in the country [41].

The shortage of manpower with insufficient expertise can make crisis preparation difficult even with the necessary facilities and equipment. Since human resources play an important role in running hospitals and preventing wastage of resources, studies show that the shortage of human resources is more noticeable in critical situations, so the need for planning to provide human resources and the necessary forecast for critical cases should be considered. It is one of the priorities. In the field of employees and volunteers, the percentage of preparedness obtained by the selected military hospital in facing biological threats in the stage of reviewing the current situation of the audit cycle (before the change) was 59.09%, and in the re-audit stage (after the change and presenting a solution) it was 86.36%. arrived. The preparedness of the hospital in this area improved from average to good after the change. The results of the present study with the results of the study of Abbaspour et al. (2023), which states that one of the most important dimensions that should be considered in biological practice is the dimension of the organization of practice and human capital, which refers to determining the role and responsibility of people, providing and paying attention to the force Human needs and the organization of biological practice guidance [40], there is a congruence.

Developing a scenario, teaching and training hospital personnel in different ways is one of the dimensions of this tool. Based on the findings of the research, empowering the hospital forces to deal with and respond appropriately to biological threats with appropriate educational content and effective educational methods is one of the important aspects of preparation in this field [42]. In the field of education and training, the percentage of preparedness of the selected military hospital in facing biological threats in the stage of reviewing the current situation of the audit cycle (before the change) was 58.3%, and in the re-audit stage (after the change and providing a solution) it was 83.3%. arrived. The preparedness of the hospital in this area improved from average to good after the change. The results of the present study are in line with the results of the study conducted by Amiri et al. entitled Auditing the operational preparedness of selected military hospitals in the face of accidents and disasters in 2019. This study shows that personnel training in the studied areas as well as audits can increase the level of personnel preparation and identify the weaknesses and strengths of hospitals [31]. Max Smith et al.'s (2022) research titled CBRNE3 Medical Challenges in Harsh Environments indicates that strong planning and training is the key to managing CBRNE3 incidents in a harsh environment [24], which is consistent with the present study. Also, the results of SANDSTRÖM et al.'s (2014) study entitled "Training of public health workers in dealing with emergencies of chemical, biological, radiological and nuclear (CBRN) incidents" is a desktop practice card concept with the present study. They designed a general exercise tool, which includes a set of adaptable scenarios with guidelines and support questions that deal with preparedness, acute response, and mitigation efforts. The training tool was tested in three different environments with positive results and was evaluated as a cost-effective tool for training and testing public health response to CBRN incidents [1].

Based on the findings of the present study, one of the most important areas that should be considered in the preparation of the hospital in the face of biological threats is the training and maneuver area. In the area of training and maneuvers, the percentage of preparedness obtained by the selected military hospital in facing biological threats in the stage of reviewing the current situation of the audit cycle (before the change) was 20%, and in the re-audit stage (after the change and presenting a solution) it was 70%. Arrived. The hospital's preparedness in this area improved from poor to good after the change. The results of the present study are in line with the results of CASALINO et al.'s (2020) study on preparedness for Covid-19 among French emergency departments. This study showed that the preparedness of selected French emergency departments is low in all its dimensions, which indicates vulnerability. Preparedness and response face certain and continuous risk that are closely related to each other. Organization, management and interoperability are the main determining factors. The strength of the present study is the assessment of preparedness and response to a current risk, not to a theoretical or previous risk [43]. Also, in the study of Ahmad Al-Ahmari et al., a descriptive and cross-sectional study was conducted in 2020 entitled "Chemical, Biological, Radiological and Nuclear Preparedness of Riyadh Public Hospitals", it indicates that hospital staff should be trained to manage CBRNE emergencies. and perform local exercises to improve their preparation [44], which is in line with the present study.

The quick and correct triage of the injured in the hospital is very important. The presence of equipment, manpower, physical space of the triage area, as well as the triage nurse and doctor are among the important points. In this area, the percentage of biological preparedness obtained by the selected military hospital in the current situation review phase of the audit cycle (before the change) was 50%, which reached 66.66% in the reaudit phase (after the change and providing a solution). The preparedness of the hospital in this area improved from average to good after the change. The results of the present study are consistent with the results of the study conducted by Khoncheh et al. (2023) with the aim of managing the challenges of biological triage in the Covid-19 pandemic. This study shows that the complete separation of the triage area until the hospitalization of the Covid-19 patients, the use of resistant structures, the development of support beds in the emergency room, and the preparation of biological pandemics based on a coherent algorithm are of particular importance [45].

Management of diagnosis and treatment is one of the secondary and important dimensions of the present tool, and the preparedness of the selected military hospital in facing biological threats in this area was considered moderate. If this aspect is not done well and according to the principles, and if the participants do not pay special attention to it, it will cause a severe and even uncontrollable spread of the biological disease. In this area, the percentage of biological preparedness obtained by the selected military hospital in the current situation review phase of the audit cycle (before the change) was 55.5%, which reached 72.2% in the re-audit phase (after the change and providing a solution). The preparedness of the hospital in this area improved from average to good after the change. The results of the present study with the results of the study of Shakoor et al. (2015) in their study as hospital preparedness for the outbreak of measles in the community, challenges and recommendations for low-resource environments found that hospitals in poor environments (lacking AIR measures) should have appropriate and sustainable infection control strategies to prevent Design of measles transmission. Naturally ventilated single rooms or measles wards are sufficient for such isolation measures and are preferable to temporary measures. Mandatory vaccination of employees against measles reduces the risk of transmission and prevents long-term absence from work due to illness. Hospital policy should ensure that adequate preventive measures are taken in outbreak situations [46]. Also, in the study of Heydaranlu et al., which was conducted with the aim of investigating the level of functional preparedness of selected hospitals in Tehran in the face of biological events, the findings of this study show that the officials pay attention to the issue of increasing capacity and creating solutions and drastic and quick measures and using the experiences of military hospitals. In order to improve preparedness, he suggests biological threats [47], which is in line with the present study.

In the field of corpse management of the hospital, there should be a clear plan regarding space, equipment, quick and quiet movement of corpses away from the public eye, requested documents for the clearance of corpses, delivery of the deceased to the legal guardian and legal confirmation of death. Also, by creating a temporary mortuary and increasing the capacity to accept corpses, and making agreements with other centers and providing special shrouds and covers, it should be ensured. In this area, the percentage of biological preparedness obtained by the selected military hospital in the current situation review phase of the audit cycle (before the change) was 12.5%, which reached 50% in the re-audit phase (after the change and providing a solution). The hospital's preparedness in this area was upgraded from poor to moderate after the change. The present study is based on the results of Abbaspour et al.'s study (2023), which states that in the implementation stage of biological practice, transportation activities, evacuation, care and treatment diagnostic measures, triage, waste management and wastewater management, corpse management and decontamination are among the things that It should be done [40], there is congruence.

Analyzing the performance and reviewing the actions taken in response to biological events is essential in order to make the hospital more resilient and respond better in subsequent events. In this area, the percentage of biological preparedness obtained by the selected military hospital in the current situation review phase of the audit cycle (before the change) was 57.14%, which reached 71.42% in the re-audit phase (after the change and providing a solution). The preparedness of the hospital in this area improved from average to good after the change. The results of FOOT et al.'s study (2017) showed that the use of standard scenarios, evaluation guides and reporting templates can help public health authorities in evaluating the capabilities and gaps of the entire system to guide changes [48], which is similar to the results of the present study.

It is essential to predict alternative resources for establishing the vital arteries of the hospital (water, electricity and communication infrastructures, etc.), alternative resources regarding the fuel required for the operation of buildings, generators and transportation services [49]. In this area, the percentage of biological preparedness obtained by the selected military hospital in the current situation review phase of the audit cycle (before the change) was 50%, which reached 70% in the re-audit phase (after the change and providing a solution). The preparedness of the hospital in this area improved from average to good after the change. The results of the present study with the results of the study by GLANTZ et al. (2020) which aims to investigate the possibility of establishing a flexible response system to increase capacity in emergency situations by examining the main components of capacity increase (force, work, structure, system) in the facilities of interest in the region Western Sweden was done is consistent. The mentioned study showed that the concept of increasing flexible capacity is a practical approach for emergency management [50].

# **Conclusions and suggestions**

The findings of the present study, which is titled the audit of the preparedness of the selected military hospital in facing biological threats, shows that the training of personnel in the studied areas as well as the audit can increase the level of personnel preparedness and identify the weaknesses and strengths of the hospitals and according to these results and according to the situation of our country in terms of the occurrence of biological threats and due to the great importance of the preparedness of hospitals in facing biological threats and in order to create the necessary guarantee for the managers to address this issue, and that obtaining a degree of accreditation Hospitals and medical training centers of the country are subject to obtaining the appropriate level of preparation of the hospitals. The preparedness of the studied hospital in facing biological threats was in the medium range before the change and was classified in the good range after the change. In 9 areas where the level of biological preparedness was medium to low, the highest preparedness was created in the field of employees with 86.36% and the lowest preparedness was related to the area of corpse management with 50%. As a result, it is very important to pay attention to the point that ensuring the effective response of the hospital to the effects of biological hazards requires good preparation of the hospital in all the measured areas in a homogeneous way, Therefore, it is necessary to recommend that the authorities pay more attention to the areas that have obtained a lower score, and since it is necessary to ensure the effective response of hospitals to all possible risks, it is necessary to maintain their preparedness throughout the years of service provision, so it is suggested. Assessment of the hospital's preparedness should be done at least annually.

#### Supplementary Information

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Supplementary Material 1

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#### Author contributions

"AB and E H and A E and A M: Idea and study design.""E H and A B, A M: data collection. ""E H, A B: data analysis. ""EH, AS, AM: study supervision.""EH, AB, AM: manuscript writing."" AM, EH: critical revisions for important intellectual content. "All authors read and approved the final manuscript.

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#### Data availability

No datasets were generated or analysed during the current study.

#### Declarations

#### Ethics approval and consent to participate

The present article is taken from the approved research project 401000503 at Baqiyatullah University of Medical Sciences with ethics IR.BMSU. REC.1402.012. This study was conducted in 2023,2024 this article does not contain any studies with animals performed by any of the authors. Informed consent was obtained from all participants participating in the study. The confidentiality and anonymity of the participants were determined by coding the questionnaires. Study participants were informed of their freedom to withdraw from the study at any time without giving a reason.

#### **Consent for publication**

Not applicable.

#### **Competing interests**

The authors declare no competing interests.

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