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Effect of Tabletop Exercise on the Preparedness Improvement of Military Hospitals in Mass Casualty Incidents

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ABSTRACT

Aims Hospitals are the first centers affected by accidents and disasters. Formulating a preparedness plan that takes into account the training of all employees, regular exercises, and the forecasting of required resources is essential for effective disaster management response. The present study was conducted to investigate the effectiveness of disaster management training based on the tabletop exercises approach on the ability of members of the hospital incident command system to manage mass casualties in one of the selected military hospitals in Tehran.

Materials & Methods This semi-experimental research employed a pre-test and post-test design. The statistical population consisted of the members of the hospital incident command system, of whom 20 individuals were selected based on the entry criteria. A researcher-made questionnaire was used to measure the hospital's readiness regarding the incident command system, excess capacity, and early warning system.

Findings The average total score of preparedness before the intervention was 6.47±0.87. The average total scores of the members' ability and attitude in dealing with disasters before the intervention were 3.19±0.72 and 3.28±0.41, respectively. The average scores of overall readiness and competence among nurses immediately after the intervention and one month later showed significant improvement compared to the scores before the intervention. After completing the course in the simulated environment during the workshop, 100% of the students achieved scores at a good level. Additionally, in the area of acquiring pre-hospital skills, 100% of the students scored at the proficient level. Furthermore, after the training workshop concluded, 100% of the students rated themselves as completely proficient.

Conclusion The tabletop exercises have a significant effect on enhancing the capabilities of the members of the incident command system and the hospital in managing disasters.

Keywords Mass Casualty; Exercise; Disasters; Education; Hospitals

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Introduction

In recent decades, major accidents and disasters have been increasing globally, including in Iran. The occurrence of these incidents affects more people every day, disrupts the provision of health services, and slows down the development process [1, 2]. In accidents with mass casualties, not only are a large number of individuals in the affected community injured, but such incidents also lead to physical, mental, and social disabilities [3, 4]. Mass casualty incidents are those, in which hospital emergency service resources, including staff and equipment, cannot adequately respond due to the number and severity of injuries [5]. Given the high demand for health services during accidents and disasters, having a plan for preparedness and response is essential for effective hospital risk management [6, 7]. Developing a preparedness plan that includes training for all employees and regular exercises, along with forecasting the necessary resources, is crucial for incident management response [8]. Capacity building in hospitals, as the primary providers of health services during incidents with a high number of injuries, is a priority for the health system [9].

Health sector employees are the first group to respond to accidents and disasters involving mass casualties; therefore, their level of preparedness and appropriate response is a critical factor in determining the rates of death and potential injuries during such events [10, 11]. Exercises provide practical learning opportunities and serve as an effective method for assessing and improving personnel performance in simulated conditions based on various scenarios. Exercises empower personnel by enhancing their ability to analyze information and make decisions [12, 13]. These exercises are conducted for different purposes, including training personnel, increasing individual capabilities and skills, and identifying weaknesses and needs. Exercises can be categorized in various ways; one common method divides them into two types, including discussion-based and performance-based [14]. Performance-based training involves a form of training that combines practical work. This type of exercise is designed to evaluate plans, policies, memorandums, and procedures, clarify roles and responsibilities, and identify resource deficiencies in an operational environment. Performance-based training includes three types of exercises, including functional training and full-scale training [14, 15]. Unfortunately, recent studies have indicated that healthcare workers are not adequately prepared to respond to accidents. Various studies have been conducted to investigate the effects of discussion-based exercises, including roundtable exercises, in mass casualty incidents. Abbasi Dolatabadi *et al.* identified a lack of knowledge and preparation as factors contributing to emotional stress during the execution of duties in crisis and disaster situations. They believe that preparedness to respond to disasters enhances healthcare workers' self-confidence and reduces the extent of damage and vulnerability when facing unforeseen events [16]. Khankeh *et al.* highlighted the trained workforce as one of the facilitating factors in providing health services [17, 18]. Kang *et al.* reported that training healthcare workers has long been recognized as a crucial component of disaster preparedness [19]. Experiences also indicate that health workers are not only inadequately prepared to respond to incidents, but inconsistencies and parallel or conflicting actions have exacerbated the situation, revealing a gap in crisis management methods. A scientific review of past experiences shows that the primary weakness of crisis management in hospitals is intra-organizational inconsistency and lack of coordination among primary responders, depending on the type and severity of incidents during disasters. One significant challenge is the unfamiliarity of healthcare workers with team functions in the context of crisis management. Unfortunately, most functions occur in isolated "islands," leading to inefficiencies and an excess of responsible parties and incident commanders. Previous experiences have demonstrated that conducting training and various exercises focused on coordination and team performance, particularly among the members of the incident command system in hospitals, has resulted in better outcomes in crisis management [17, 19].

Achieving coordination and coherence among the various members of the incident command system involved in incidents requires a solid foundation, one of the key elements of which is team training, exercises, and coordination. Unfortunately, the prevailing approach to training for groups involved in accidents tends to focus on single-professional methods, which not only fail to prepare them for effective team performance but also foster an individualistic mindset. In a consolidated review study, Jose & Dufrene investigated the most effective methods or educational approaches to enhance the ability of healthcare workers to respond to a crisis. Their findings, based on a review of more than 190 primary studies, indicated that the most effective educational approach in this context is the implementation of roundtable exercises and simulations. To provide an effective, coordinated, and organized response to the impacts of various types of disasters and emergencies, the existence of emergency operation plans (EOPs) is essential [20]. However, it is important to note that this program should not only exist theoretically but should also be validated in written form through the execution of different types of exercises. Exercises are activities conducted with the purpose of training and enhancing capabilities.

Since the selected military hospital is located in a strategic area of Tehran, and preparedness to

respond to accidents and disasters is particularly important in this region, the present study aimed to investigate the effectiveness of training on accident and disaster management based on a practical approach. The study focused on the ability of members of the hospital incident command system (HICS) to manage mass casualties in a selected military hospital in Tehran.

Materials and Methods

Study design and sample

The current semi-experimental research involved a single group, including 20 directorate, senior and middle managers, doctors, nurses, and health and emergency managers, assessed before and after a tabletop exercise scenario focused on incidents with mass casualties in Tehran in 2023. The statistical population consisted of the members of the HICS who (Table 1).

Table 1. The statistical population of the research

No.	Job title	Level of education	Work experience (year)
1	Hospital manager	Master of hospital management	23
2	Health manager/Support manager	Bachelor of environmental health	26
3	Health expert	Bachelor of professional health	21
4	Nursing manager	Master of nursing	25
5	Emergency manager	Nursing expert	12
6	Nursing supervisor	Nursing expert	24
7	Nursing supervisor	Nursing expert	23
8	Nursing supervisor	Nursing expert	26
9	Nursing supervisor	Nursing expert	26
10	Nursing supervisor	Nursing expert	13
11	Infection control supervisor	Nursing expert	18
12	Educational supervisor	Master of nursing	24
13	Engineering manager	Master of civil engineering	19
14	General practitioner	A professional doctor	20
15	General practitioner	A professional doctor	22
16	Director of treatment assistance services	Bachelor of physiotherapy	28
17	Laboratory manager	Bachelor of laboratory science	25
18	Director of public relations	Bachelor of public relations	5
19	HSE manager	Management expert	29
20	Responsible for physical protection	HSE associate	13

Study instrument

Data collection was conducted using a researcher-developed questionnaire, which underwent content and face validity assessments by ten experts. The questionnaire was designed to measure components of the hospital's readiness regarding the HICS, overcapacity, and early warning system (Table 2).

Table 2. Demographic information of experts and specialists in the content validity of the questionnaire

NO	Job title	Level of education	Work experience (year)
1	University faculty member and crisis manager	PhD in nursing	33
2	University faculty member	PhD in disaster health	29
3	Hospital accreditation consultant	PhD in disaster health	20
4	Emergency doctor	Doctorate in emergency medicine	31
5	Medical equipment manager	PhD in medical engineering	25
6	Crisis manager	Senior HSE expert	28
7	General physician (responsible for passive defense and crisis management)	PhD	35
8	Health expert	Health expert	22
9	Emergency manager	Senior expert in emergency nursing	15
10	Crisis manager	Senior expert in crisis management	15

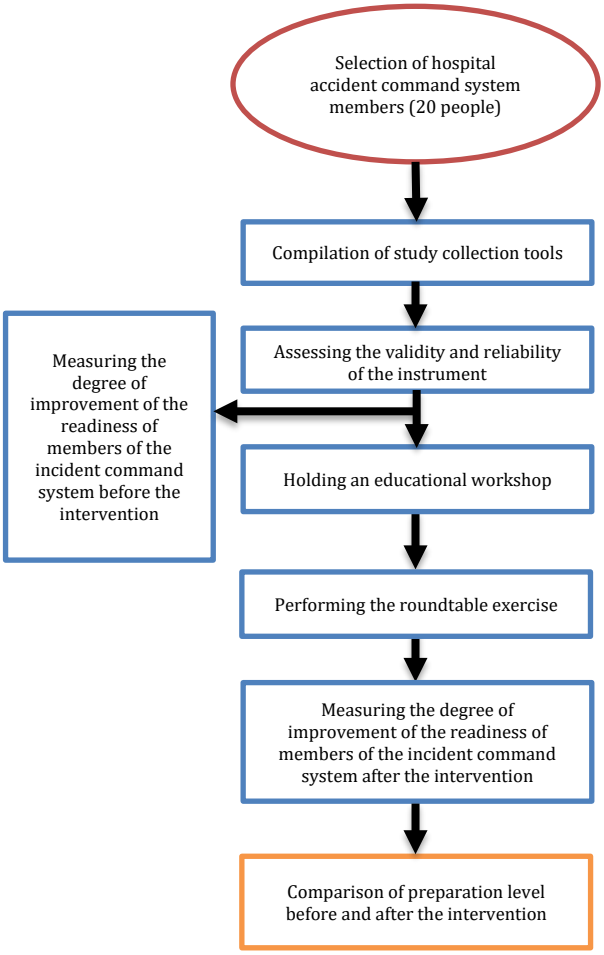

Figure 1. Flowchart of research execution method

Data collection

After confirming the news of the accident and announcing the crisis code, the members of the HICS were summoned to the hospital's command center by the commander. During the roundtable exercise, each process owner participating in the research was

asked to describe their tasks. At the end of the roundtable exercise, the strengths and weaknesses, as well as the effectiveness of the training provided, were discussed through interaction, mutual thinking, and reflection. The members of the HICS participated in a training workshop that included presentations on the theoretical foundations of crisis management and the HICS, along with descriptions of duties and the roles of the members defined in the HICS. To implement the roundtable exercise, the emergency operations center (EOC) of the University of Medical Sciences was informed of the incident by announcing the arrival of the injured at the news center, according to the prepared scenario. The intervention consisted of two two-day (4-hour) training workshops on accident and disaster risk management, which included presentations on the fundamentals of the HICS and a practical component involving the scenario-based roundtable exercise with the participation of the process owners.

Statistical analysis

Data were collected before and after the intervention using a standard questionnaire to assess readiness, both prior to and following the roundtable exercise (Figure 1). SPSS version 21 software was used for data analysis and data were expressed using descriptive statistics.

Findings

This study involved 20 members of the HICS and assessed the components of the early warning system, the incident command system, overcapacity, and operational plans were examined in two dimensions, including preparation and response, both before and after the roundtable exercise.

Table 3. Preparation scores before the roundtable exercise

Parameter	Activity	Under review (0)	In progress (1)	Terminated (2)
Preparation	1- Has the early warning system been designed and compiled?	-	1	-
	2- Is there a hospital incident command system?	-	1	-
	3- Is there a plan to activate the hospital's incident command system?	-	1	-
	4- Is there a hospital control room (HCC) activation program?	-	1	-
	5- Has the system activation plan been developed based on the severity of the incident?	-	1	-
	6- Has the hospital response program to mass casualty incidents been activated?	-	1	-
	7- Has the hospital's response plan to mass casualty incidents been compiled?	-	1	-
	8- Has a plan been developed regarding the employment of specialized human resources in the hospital?	-	1	-
	9- Is there a plan for calling volunteers?	-	1	-
	10- Is there a plan regarding the physical space (patient triage)?	-	-	2
	11- Are there plans for the physical space (temporary cold storage)?	-	1	-
	12- Has a plan been developed regarding drugs and (medical) equipment?	-	1	-
	13- Is there a plan for support (vehicles)?	-	-	-
	14- Has a plan been developed regarding the processes (contracting with other centers)?	-	-	-
	15- Has a plan been developed regarding the processes (emergency evacuation)?	-	1	-
	16- Regarding the processes (immediate response 0-2 hours), have plans been developed?	-	-	-
	17- Regarding the processes (immediate response 2-12 hours) have plans been developed?	-	1	-
	18- Regarding the processes (immediate response of more than 12 hours), has a plan been developed?	-	-	2
Response	1- Was the early warning system activated?	0	-	-
	2- Has the hospital's incident command system been activated?	-	1	-
	3- Was the hospital's incident command system operational?	-	1	-
	4- Has the Hospital Command Center been activated?	-	1	-
	5- Was the system activation plan implemented based on the severity of the incident?	-	1	-
	6- Has the hospital response plan to incidents with mass casualties been operational?	-	1	-
	7- Has the hospital response plan to mass casualty incidents been implemented?	-	1	-
	8- Has the program to employ specialist human resources of the hospital been implemented?	-	1	-
	9- Has the operational plan for calling volunteers been implemented?	0	-	-
	10- Has the operational plan of the physical space (patient triage) been implemented?	-	1	-
	11- Has the operational plan of the physical space (temporary cold storage) been implemented?	-	1	-
	12- Was the drug and equipment (medical) operational plan implemented?	-	1	-
	13- Has the operational support plan (vehicles) been implemented?	0	-	-
	14- Were the organizations that agreed with the hospital activated during the crisis?	0	-	-
	15- Has a plan been developed regarding the processes (emergency evacuation)?	-	1	-
	16- Regarding the processes (immediate response 0-2 hours), have plans been developed?	-	1	-
	17- Regarding the processes (immediate response 12-2 hours) have plans been developed?	-	1	-
	18- Regarding the processes (immediate response of more than 12 hours), has a plan been developed?	0	-	-

Table 4. Preparation scores after the roundtable exercise

Parameter	Activity	Under review (0)	In progress (1)	Terminated (2)
Preparation	1- Has the early warning system been designed and compiled?	-	-	2
	2- Is there a hospital incident command system?	-	-	2
	3- Is there a plan to activate the hospital's incident command system?	-	-	2
	4- Is there a hospital control room (HCC) activation program?	-	-	2
	5- Has the system activation plan been developed based on the severity of the incident?	-	1	-
	6- Has the hospital response program to mass casualty incidents been activated?	-	1	-
	7- Has the hospital's response plan to mass casualty incidents been compiled?	-	-	2
	8- Has a plan been developed regarding the employment of specialized human resources in the hospital?	-	1	-
	9- Is there a plan for calling volunteers?	-	1	-
	10- Is there a plan regarding the physical space (patient triage)?	-	-	2
	11- Are there plans for the physical space (temporary cold storage)?	-	-	2
	12- Has a plan been developed regarding drugs and (medical) equipment?	-	1	-
	13- Is there a plan for support (vehicles)?	-	1	-
	14- Has a plan been developed regarding the processes (contracting with other centers)?	-	1	-
	15- Has a plan been developed regarding the processes (emergency evacuation)?	-	-	2
	16- Regarding the processes (immediate response 0-2 hours), have plans been developed?	-	1	-
	17- Regarding the processes (immediate response 2-12 hours) have plans been developed?	-	-	2
	18- Regarding the processes (immediate response of more than 12 hours), has a plan been developed?	-	-	2
Response	1- Was the early warning system activated?	-	1	-
	2- Has the hospital's incident command system been activated?	-	-	2
	3- Was the hospital's incident command system operational?	-	1	-
	4- Has the Hospital Command Center been activated?	-	-	2
	5- Was the system activation plan implemented based on the severity of the incident?	-	1	-
	6- Has the hospital response plan to incidents with mass casualties been operational?	-	1	-
	7- Has the hospital response plan to mass casualty incidents been implemented?	-	-	2
	8- Has the program to employ specialist human resources of the hospital been implemented?	-	1	-
	9- Has the operational plan for calling volunteers been implemented?	-	1	-
	10- Has the operational plan of the physical space (patient triage) been implemented?	-	-	2
	11- Has the operational plan of the physical space (temporary cold storage) been implemented?	-	-	2
	12- Was the drug and equipment (medical) operational plan implemented?	-	1	-
	13- Has the operational support plan (vehicles) been implemented?	-	-	2
	14- Were the organizations that agreed with the hospital activated during the crisis?	-	1	-
	15- Has a plan been developed regarding the processes (emergency evacuation)?	-	1	-
	16- Regarding the processes (immediate response 0-2 hours), have plans been developed?	-	-	2
	17- Regarding the processes (immediate response 12-2 hours) have plans been developed?	-	-	2
	18- Regarding the processes (immediate response of more than 12 hours), has a plan been developed?	-	1	-

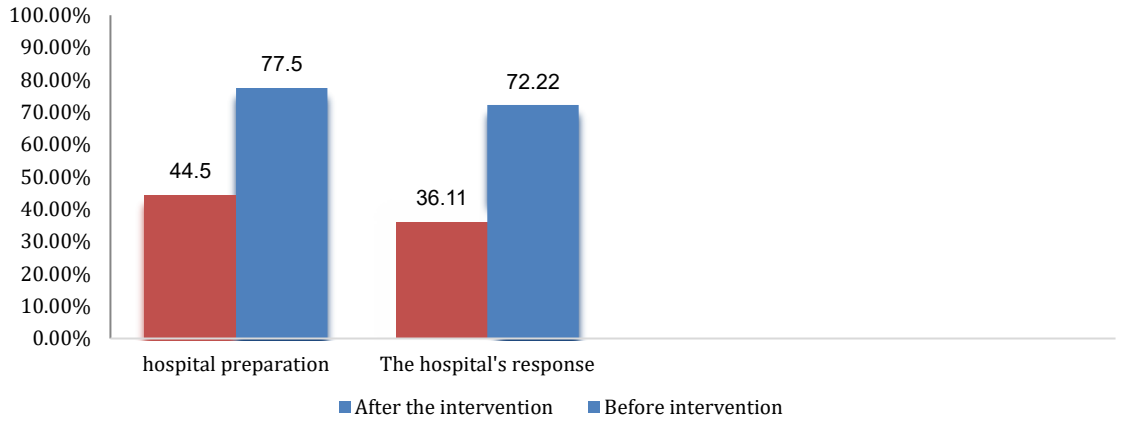

Figure 2. Comparison of the hospital's readiness and response percentages before and after the intervention

Despite the impact of desk training on the readiness of members of the HICS to manage incidents with mass casualties, the average percentage of readiness and response before the intervention was 44.5% and 36.11%, respectively. After the intervention involving desk training, the percentage of readiness increased to 77.5%, while the hospital's response score rose to 72.22%, which increased by 33% for readiness and 36.11% for response (Tables 3 and 4). In total, the hospital improved by 33% in the readiness index and 36.11% in the response index, indicating that the roundtable exercise was effective in enhancing the hospital's preparedness in the face of accidents and disasters (Figure 2).

Discussion

This study was designed to determine the effect of educational interventions and tabletop exercises on the preparedness of healthcare workers at a selected military hospital in Tehran to handle incidents involving mass casualties. Approximately half of the healthcare workers (48%) had faced crises and disasters, and 65.3% of nurses reported that they had received training in disaster response. However, most of them (92%) felt that they needed additional training, which may indicate that the training provided was either ineffective and insufficient or not delivered at the appropriate time.

In the study by Pek *et al.*, evaluation outcomes across full-scale exercises are different, leading to challenges in consolidating the effectiveness of simulations into a single measure [21]. It is recommended that best evidence-based practices for simulation be adhered to in full-scale exercises so that training can translate into better outcomes for casualties during actual disasters or mass-casualty incidents. Additionally, the reporting of simulation use in full-scale exercises should be standardized using a framework, and the evaluation process should be rigorous to determine and compare effectiveness across full-scale exercises [21, 22].

In the study by Al-Romaihi *et al.*, the evaluation outcomes indicated that the overall mean knowledge score regarding communicable disease (CD) threats among study participants is 75.0%, with the majority of participants having a favorable attitude toward CD preparedness during mass gatherings (MG) events. Participants achieved high scores in workshops on triaging, first aid, and infection control. Additionally, study participants had positive perceptions of the current preparedness of their respective hospitals to respond to CD outbreaks during MG events [23, 24].

Teng-Calleja *et al.* showed that the overall scores in the areas of knowledge, attitude, and performance increased significantly after the intervention compared to before [25, 26]. Xia *et al.* reported that students receiving the program display greater increases in knowledge and skills related to disaster preparedness than those in the control group. One month after the intervention, the experimental group still demonstrated significantly higher levels of disaster knowledge and skills than the control group. There were no statistically significant differences over time in attitude measures. This program enhanced students' abilities, and the findings can serve as a basis for further developing public health education for all nurses. Chinese leaders of public health institutions and nursing administrators can create guidelines for public health nursing (PHN) competencies and prepare the public health nursing workforce to be effective in disaster preparedness, response, and recovery [27].

Nejadshafiee *et al.* indicated that the majority of experts (76%) assess the necessity of training and developing the required capabilities in nurses for handling accidents and disasters and caring for the injured as "very high," while 23.53% rate it as "high" [28]. In the study by Mulyasari *et al.*, the evaluation outcomes regarding the level of healthcare in dealing with disasters are reported to be average [29]. Fung *et al.* found that nurses in Hong Kong are not adequately prepared for disasters but are aware of the need for such preparation. Therefore, disaster management training should be included in the basic education of nurses [30, 31].

Training programs for disaster response will enhance hospital personnel's awareness of existing disaster management plans, increase employee participation in planning and problem-solving related to these programs, and improve employees' skills in performing their assigned tasks [24]. Consequently, training and practice are effective methods for preparing personnel to respond to disasters and to face unexpected events [25, 26].

Skryabina *et al.* indicated that the main advantage of participating in the exercise and learning how to respond to an incident is that, considering the rarity of major incidents with mass casualties, simulation exercises are the only option for testing major incident programs. These exercises help keep response protocols up-to-date by enhancing skills and knowledge to improve response coordination through adherence to practiced incident plans, thereby increasing people's confidence when responding [32].

Moss & Gaarder suggest that training is likely to boost employees' self-confidence and make them feel more prepared. Practice should be tailored to the needs and potential challenges of each healthcare system [33].

Ugelvik *et al.* found significant gaps between prehospital rescue and emergency services in Norway regarding preparedness efforts. This highlights the need for national standards, minimum requirements, follow-up procedures for organizations, and future re-evaluations. The implementation of mandatory interdisciplinary training among fire/rescue, police, and emergency ambulance services appears to have been beneficial.

Regular reviews of the standards can serve as a useful tool for evaluating and tracking mass casualty preparedness at the national, regional, and local levels [34].

Schulz *et al.* investigated the perceptions of first medical responders regarding mass casualty scenario training. Support for realistic scenarios, inter-agency collaboration, improved incident management skills, and thorough post-training evaluations are identified as important factors. Additionally, utilizing the potential of virtual reality technologies as a valuable tool for training significantly enhances the training experience [35].

Cocco & Thomas-Boaz, in their research, demonstrated that the lessons learned from preparedness assessments are closely related to those from actual incidents, highlighting the importance of these assessments. They play a crucial role, and exercises of any kind can effectively identify and improve opportunities while increasing preparedness. Mitigating interoperability issues during an emergency requires investment in training, planning, and preparedness, as well as routine mass casualty incident training and exercises that involve all affected departments and services throughout the hospital environment. Additionally, incorporating the principles of capacity management into hospital emergency plans is essential for maintaining the continuity of health center operations during a crisis [36].

Veenema *et al.* demonstrated that among different disciplines, nurses report the lowest level of knowledge and confidence. This indicates serious deficiencies in healthcare providers' knowledge, skills, and self-perceived abilities to participate in a large-scale mass casualty event [37].

Ashkenazi *et al.* found that conducting exercises helps identify deficiencies in the hospital's disaster plan, particularly in triage, emergency department management, and the appropriate use of resources such as radiology, operating rooms, and secondary patient transport. Having prior knowledge about disease diagnosis, identifying problems, and understanding the statistics of deficiencies, as well as specifying resources, enables accurate identification in clinical decision-making and effective resource management [38].

According to the results of the present study, accident and disaster managers must conduct training courses continuously in this field and implement limited operational exercises to improve the readiness of members of the incident command system and hospital staff, enabling them to respond effectively to accidents with mass casualties.

Limitations of the study included limitations in time and resources for implementing round table exercises, difficulty in coordinating and ensuring the participation of all key personnel due to military duties, and restrictions on access to sensitive and confidential information.

Conclusion

The tabletop exercises have a significant effect on enhancing the capabilities of the members of the incident command system and the hospital in managing disasters.

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