

*Original/Research Paper***Effect of early warning system on the preparedness of hospitals in emergencies and disasters: A quasi-experimental study****Hamid Reza Khankeh^a  | Mehdi Rahgozar^b  | Hedayat Jafari^c  | Vahid Delshad^a  | Fahimeh Ghasemi Charati^{d*} **

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<https://doi.org/10.32598/JNRC.P.23.39>

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Abstract

The present study aims to determine the effect of the early warning system (EWS) on the preparedness of hospitals in emergencies and disasters. This study was a quasi-experimental study conducted with two groups. One month, and then three months after determining hospital preparedness (HP) through the world health organization standard checklist, a seminar and two-session workshop as intervention, and installing a flowchart for activating the EWS in important hospital sections, HP was reevaluated and analyzed by longitudinal descriptive statistics. A total of 30 nurses were included in the present research. The findings suggested the preparedness score of intervention hospitals before the intervention, one month, and three months after that the biggest change occurred in the communication sector with a 10-point increase; the smallest change occurred in the continuity of essential services and post-disaster recovery; the overall score of HP changed from being poor before the intervention to medium after three months ($P < 0.05$). In the control hospital, human resources had the biggest change with a 4-point increase; command and control, communications, continuity of essential services, and post-disaster recovery had the smallest change with a 1-point increase; the overall HP was poor and remained poor despite the increase in scores ($P < 0.05$). In sum, the outcomes of this study imply that the intervention hospital has a moderate level of disaster preparedness. The findings of this study highlight the importance of instituting an EWS in all hospitals across the country to enhance readiness for calamities. Hence, implementing EWS in similar conditions in other hospitals in the country can improve the preparedness of these hospitals in emergencies and disasters to a great extent.

Keywords: Hospital Preparedness, Early Warning System, Accidents, Disasters.

1 | Introduction

Disasters, as common occurrences worldwide, can profoundly affect communities, families, and individuals [1]. As per the center for research on the epidemiology of disaster, the year 2020 witnessed 389 natural disasters, resulting in 15,080 fatalities, over 98 million people affected, and economic losses amounting to 171.3 billion dollars across the globe. Asia experienced 41% of disasters, and 64% of the total population was affected. All of the top 5 countries in the world for natural disasters are located in

Asia [2]. Due to its location, Iran is highly vulnerable to disasters, and over 90% of its population is at risk of experiencing different types of disasters. This is particularly challenging for a developing country like Iran. Today, the international slogan of "preparedness for the unexpected event", is at the top of disaster management programs, both nationally and internationally, especially in accident-prone countries [3]. Global disasters typically challenge hospitals, and it is confirmed that healthcare providers must be prepared to provide, maintain and expand essential services in

times of crisis [4]. Health services are the main factor for human survival in natural disasters, but healthcare systems typically face many challenges at the national, local, and international levels in response to global disasters [3]. The recent COVID-19 outbreak has shown how epidemics/pandemics can challenge countries' healthcare systems. Proper equipment and human resources management are critical to providing adequate medical care to all patients admitted to the hospital [5].

Reducing response time is crucial in minimizing the long-lasting effects of injuries during disasters [6]. The purpose of preparedness is to know what to do in an accident and what tools and equipment are needed [7]. Therefore, getting ready and planning before disasters is essential in the health system [8].

The most crucial point in an emergency is the timely notification of the incident so that the relevant authorities can be present as soon as possible and make the necessary arrangements. According to a study in Indonesia, the decision-making process for disaster management requires several essential attributes. These include coordination, response and recovery planning, communication and information management, logistics and evacuation, human resources, finance, patient care, support services, decontamination, and security [9]. One of the critical components in disaster management is the early warning system (EWS), which the world health organization (WHO) considers to be the first component of the response plan [10]. And if a hospital lacks it, it will not be able to respond appropriately [3]. Therefore, given that hospitals play a key role in treating, caring for, and reducing the severity of injuries, they should be encouraged to remain prepared in the occurrence of an emergency; thus, with the correct assessment of possible incidents, we can take steps to prepare hospitals to deal with disasters so that they can have the best performance in critical times [3]. Based on the cases mentioned, and considering that this system is one of the factors of hospital accreditation in the country, the purpose of this study is to investigate the effect of EWS on the preparedness of hospitals in emergencies and disasters.

2 | Methods

2.1 | Study design

The present study is a quasi-experimental investigation that was carried out to explore the influence of the EWS on the readiness of Imam Khomeini Hospital in Sari, Iran, and Razi Hospital in Qaem Shahr, Iran, during emergencies and disasters.

2.2 | Ethics consideration

The present study was derived from a master's thesis of nursing approved ethics committee of the Research and Technology deputy of the University of Social Welfare and Rehabilitation Sciences (IR.USWR.REC.1395.61). The present study was conducted according to ethical guidelines. At the end of the research, the research results were provided to both hospitals to be used in the control hospital.

2.3 | Participants

Imam Khomeini Hospital in Sari was the intervention group, and Razi Hospital in Qaem Shahr was the control group to prevent educational mixing. The intervention hospital is a general center with advanced services, an academic, and a research center for people and students of Mazandaran province. The disaster risk management committee (DRMC) members and senior hospital officials played a crucial role in developing and implementing the system. They attended meetings to collaborate on the study. Sampling for the analysis was done through a census.

2.4 | Inclusion and exclusion criteria

This study included nurses who held a bachelor of Science in Nursing and were members of the DRMC. However, those who chose not to participate were excluded from the study.

2.5 | Intervention

Data were gathered by WHO hospital emergency response checklist. The WHO regional office in Europe has created a checklist designed to assess hospital preparedness (HP) in order to assist hospital emergency personnel and managers in delivering an appropriate response to the most likely scenarios during disasters. It includes nine dimensions: A) command and control, B) communication, C) safety and security, D) triage, E) surge capacity, F) continuity of essential services, G) human resources, H) logistics and supply management and I) post-disaster recovery, and a total of 91 items scored according to a Likert response scale and a 3-point frequency scale, (1=pending, 2=ongoing, and 3=completed). Based on the total score, the level of overall preparedness of the hospital is categorized (93-152), medium (153-212), and strong (213-273) [11]. The checklist was translated, and its reliability and validity were examined by Karimiyan et al. [12]. Data was collected for this project with the cooperation of DRMC members through observation and document review after obtaining permission from officials at Mazandaran University of Medical Sciences and introducing the project to hospitals.

The intervention hospital held a one-day seminar titled "The Importance of EWS in Emergencies and Disasters" as the first

step. Senior officers, such as vice presidents, crisis committee secretaries, matrons, supervisors, chiefs, and nurses, attended a seminar discussing the importance of EWS and its role in increasing public awareness of using the system during accidents and disasters. Then, a two-day workshop entitled "The need to use and activate the EWS, and how to implement it to prepare for response to emergencies and disasters" was held in that center. The workshop outlines were compiled from the national program for preparedness of hospitals in disasters and incidents (NPPHDI) by Khankeh *et al.* [3]. During the workshop, the DRMC members collaborated to create a primary activation flowchart and determine the best way to communicate news within the hospital. They followed the guidelines outlined in the HP book and ensured their plan was compatible with the hospital's management structure. To put this system into action, the DRMC members of the hospital participated actively in a series of meetings that spanned two months. Then a flowchart was sent to several professors in this field to complete and revise, and their expert opinions were used according to the NPPHDI, and the list of hazards threatening the hospital was prepared with the participation of hazard monitoring organizations. Also, a checklist of cases that could be reported by the hospital and the pre-hospital emergency department to the university emergency operation center (EOC) was compiled based on the NPPHDI and the hospital conditions; next, the supervisors, heads of departments and units were taught the final flowchart. The hospital director circulated the flowchart for activating EWS, as well as the announcement and notification lists, to all teams and wards of the hospital. These were also installed in key parts of the hospital. Also, in this study, a checklist for receiving and confirming the news by the researcher and under the supervision of professors in this field was made and provided to the members of DRMC. During this period, no intervention was implemented in the control hospital. Longitudinal descriptive statistics and linear comparison analyzed the collected data, and the scores obtained in all aspects of HP in both hospitals before, one month later, and three months later were completed again by the researcher in collaboration with the members of DRMC.

2.6 | Statistical analysis

The data were examined using SPSS software (version 16.0, SPSS Inc., Chicago, IL, USA). The means (standard deviation [SD]) and frequencies (percentages) were provided for continuous and categorical variables. The Kolmogorov-Smirnov test evaluated the normality of the data. Data were analyzed using the Wilcoxon test. $P < 0.05$ was considered in all statistical tests.

3 | Results

3.1 | Participants

A total of 30 nurses were included in the present research. Among the participants, 70% had a bachelor's degree, and the majority had a background in management and had attended crisis training classes. But more than 90% had no history of helping disaster victims. At the control hospital, 68% of risk management committee members had a bachelor's degree and most had a history of managing and attending crisis training classes, but 88% had no history of helping victims.

3.2 | Effect of EWS on the preparedness of hospitals in emergencies and disasters

The findings suggested the preparedness score of intervention hospitals before the intervention, one month, and three months after that the biggest change occurred in the communication sector with a 10-point increase; the smallest change occurred in the continuity of essential services and post-disaster recovery; the overall score of HP changed from being poor before the intervention to medium after three months ($P < 0.05$) (Table 1). In the control hospital, human resources had the biggest change with a 4-point increase; command and control, communications, continuity of essential services, and post-disaster recovery had the smallest change with a 1-point increase; the overall HP was poor and remained poor despite the increase in scores ($P < 0.05$) (Table 2).

4 | Discussion

Since hospitals play a key role in treating, caring for, and reducing the severity of injuries, they should be encouraged to be prepared in an emergency. Therefore, with the correct assessment of possible disasters, we can prepare hospitals to deal with accidents so that they can perform best in critical times [3]. The results indicated that both hospitals had a low level of preparedness before the intervention, which was in line with a study that showed hospitals were unprepared for pandemics like COVID-19. Hospital spaces should be restructured to increase medical and critical care capacity. It is also recommended to provide healthcare workers with advanced training [5]. Also, a qualitative study reported that the level of preparedness of Indonesian hospital staff in the face of disaster was insufficient [13], But it did not agree with the study of Karimiyan *et al.* [12] and Alsalem *et al.* [14] who assessed the HP as being strong.

HP in this study was evaluated in both hospitals. Preparedness in components of command and control in the intervention hospital was increased, which shows the correct understanding of the officials and members of DRMC about the importance of

equipping the command center to implement the requirements of the EWS and installing flowchart activation in different parts of the hospital. This dimension was consistent with the study of Amiri *et al.* [15] and Delshad *et al.* [16] and their colleagues, who assessed the preparedness of hospitals in contingency

management at a good level. A study in the USA showed that continuous efforts are needed nationwide to improve the management capabilities of hospitals in disasters [4]. This component was weak at the control hospital.

Table 1. The score of the dimensions of preparedness of intervention Hospital, before, 1 month, and 3 months after the intervention and the maximum score.

Dimensions of preparedness	Before the intervention	1 month after the intervention	3 months after the intervention	Maximum score
Command and control	10	15	15	18
Communication	13	16	23	27
Safety and Security	18	21	27	33
triage	18	23	23	33
Surge capacity	25	26	30	39
Continuity of essential services	12	14	14	24
Human resources	23	28	30	45
Logistics and support management	17	23	23	33
Post-disaster recovery	13	15	15	27
Total score	149	181	201	273

Values are given as a mean for continuous variables.

Table 2. The score of the dimensions of preparedness of Razi Hospital, before, 1 month, and 3 months after, and the maximum score.

Dimensions of preparedness	Before the intervention	1 month after the intervention	3 months after the intervention	Maximum score
Command and control	8	9	9	18
Communication	11	12	12	27
Safety and Security	16	18	19	33
triage	16	17	18	33
Surge capacity	19	20	22	39
Continuity of essential services	12	12	13	24
Human resources	21	23	25	45
Logistics and support management	16	17	19	33
Post-disaster recovery	10	10	11	27
Total score	129	138	148	273

Values are given as a mean for continuous variables.

Given that the implementation of the requirements of this dimension does not require a lot of infrastructure or financial costs, it is suggested to use this to prepare other hospitals. In the communication dimension, due to the importance of the role of communication in the EWS and after the implementation of the requirements of this dimension, we saw at the end of the study that although the least change in the control hospital was in the dimension of communication, the most change in this hospital is related to this dimension. This was consistent with a study that assessed the preparedness of Motahari Hospital after implementing the EWS in this dimension [16]. In a study by Liu *et al.* [17], key findings indicated communication challenges. Because the general public has high expectations of hospitals for sympathy and rescue of the injured in the face of disaster, with extensive care and support, hospitals should be aware of the principles of hospital communication management to communicate effectively inside, outside and with other organizations.

In this study, with the identification of the hospital safety team and the necessary rules for the presence of people in the hospital during emergencies and disasters, the hospital's preparedness in terms of safety and security was upgraded to a strong level after the intervention, and This rise in preparedness levels could be due to the focus on recognizing weaknesses in the training workshops for the deployment of the EWS application. A study in Belgium found that there are serious gaps in HP for biological, nuclear, and terrorism disasters, and lack of funding is a major obstacle to adequate preparedness [18]. Also, in cases such as determining places with high vulnerability, it was not in line with the study of Karimiyan *et al.* [12] and Amiri *et al.* [15]. According to the results of this study, hospitals should use methods in cooperation with other organs to integrate their programs to carry out hospital security operations regarding the triage domain; even though the level of preparedness was moderate, the difference was noteworthy compared to the control hospital, aligning with the findings

of Faraji et al.'s research [19]. This proportion can be attributed to the intervention in both studies, not just education. A different study demonstrated a noteworthy correlation between expertise and awareness of disaster preparedness and decision-making in triage [20]. In the dimension of surge capacity, there was a significant increase. The results of a study in Italy on increasing hospital capacity in incidents showed that members of DRMC should recognize the importance of being aware of critical resources to increase capacity in disasters [21]. In the component of surge capacity, even though the control hospital has only one score increased, the level of HP has increased from poor to medium, one of the reasons which can be related to the short range of scale scores, that increased by only one score. One of the suggested ways to upgrade other hospitals in this dimension is to identify alternative treatment locations around the hospital; one of the challenges faced by the health system has always been a shortage of human resources, especially in disasters. In this study, the human resources dimension with a medium score was consistent with the studies of Delshad [10] and Karimiyan [12]. In this dimension, the preparedness score of the control hospital remained poor despite the increase, but this increase was the only scale component in the control hospital that had the most change. One of the reasons for the growth of preparedness in this dimension is that the role of human resources in managing hospital services in disasters has always been very prominent, and the approach of the Ministry of Health is to attract more staff in hospitals in recent years. In the logistics and support management, the preparedness was medium, which means progress in effective communication and coordination with the EOC, guidance headquarters, disaster monitoring organizations and pre-hospital emergency that are the necessities of implementing EWS. But at control hospital, we saw a slight difference after 3 months. The results of this part of the intervention were in accordance with studies that show the preparedness of the hospital at a medium level [16, 22]. Lack of financial resources in hospitals is a reason leading to lack of growth in preparedness in continuity of essential services, and lack of proper processing to the fourth level of prevention, i.e., recovery and rehabilitation in our country, is a reason for not improving in post-disaster recovery. Typically, disasters and medical emergencies are not an exception, either. While post-disaster recovery requires more time and more studies with longer time, in this dimension, the control hospital had the least amount of change.

4.1 | Limitations

The most important limitation of the present study was the lack of statistical analysis, which can affect the generalizability of this study.

4.2 | Implications for clinical practice

Increase in the level of HP with the implementation of the EWS, indicates the need to develop and implement this system to increase the level of HP in disasters. Expressing the need to identify vulnerabilities and emphasizing to ward officials to identify hazards as one of their tasks in the workshop of using EWS led to improving the hospital's preparedness in this regard. Finally, the implementation of EWS significantly increased the preparedness of intervention hospitals to deal with emergencies and disasters. While in the control hospital, despite the increase in score, the preparedness of the hospital remained at a poor level. This indicates that the implementation of EWS, which is one of the elements of accreditation in our country, can increase the preparedness of hospitals to deal with emergencies and disasters.

4.3 | Recommendations for future research

It is suggested that researchers design well-designed interventions in future studies to confirm our findings regarding the effect of EWS on the preparedness of hospitals in emergencies and disasters.

5 | Conclusions

In sum, the results of the present study have shown that EWS is vital for all hospitals and should be created by each hospital's condition for a quick and appropriate response in case of emergencies and disasters; because of the increase in emergencies and disasters, and WHO's emphasis on the need for HP in disasters.

Acknowledgements

Not applicable.

Authors' contributions

Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work: HRK, MR, HJ, VD, FGC; Drafting the work or revising it critically for important intellectual content: HRK, MR, HJ, VD, FGC; Final approval of the version to be published: HRK, MR, HJ, VD, FGC; Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved: HRK, MR, HJ, VD, FGC.

Funding

Self-funded.

Ethics approval and consent to participate

The present study was derived from a master's thesis of nursing approved ethics committee of the Research and Technology deputy of the University of Social Welfare and Rehabilitation Sciences (IR.USWR.REC.1395.61). The present study was conducted according to ethical guidelines. At the end of the research, the research results were provided to both hospitals to be used in the control hospital.

Competing interests

We do not have potential conflicts of interest with respect to the research, authorship, and publication of this article.

Availability of data and materials

The datasets used during the current study are available from the corresponding author on request.

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How to cite this article: Khankeh HR, Rahgozar M, Jafari H, Delshad V, Ghasemi Charati F. Effect of early warning system on the preparedness of hospitals in emergencies and disasters: A quasi-experimental study. *J Nurs Rep Clin Pract.* 2023;1(3):126-132. <https://doi.org/10.32598/JNRCP.23.39>.