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INVESTIGATION OF FIRE SAFETY MANAGEMENT STATUS FOR PRIORITIZING MEASURES AND PROMOTION OF FIRE SAFETY IN THE BUILDING OF IRANIAN HOSPITALS

Hamed AKBARI¹, Amir ADIBZADEH¹, Hesam AKBARI¹, Abdolvahed BAZMARA^{1*},
Mohammad Hassan NASERI²

¹Health Research Center, Lifestyle Institute, Baqiyatallah University of Medical Sciences, Tehran, Iran.

²Atherosclerosis Research Center, Baqiyatallah University of Medical Sciences, Tehran, Iran.

***Corresponding Author:**

Email: vahed.bazmara@yahoo.com

ABSTRACT

Introduction: Fire is one of the most dangerous phenomena that causing serious financial damages and casualties. Hospital fires are a major problem due to the presence of disabled and sensitive patients, lack of public awareness, access to fire extinguisher equipment, access to escape routes, and so on. Evaluation of fire safety management is essential to identify measures to prevent fire and promotion of fire safety. Objective: The objective of this study is to evaluate the status of fire safety management in order to prioritize measures and promotion of fire safety in the building of selected hospitals in Tehran and Tabriz. Methods: This cross-sectional descriptive-analytical study was conducted in 10 selected hospital buildings of Tehran and Tabriz. Research tools included interviews with health and safety representatives and a questionnaire presented by L.T. Wong in the form of fire safety evaluation (FSE) checklist and based on localization conditions translated. The questionnaire consists of 4 categories: First: building specifications and features (5 items), Second: fire service installation and implementation (10 items); Third: fire safety management (19 items) and Fourth: fire safety maintenance and repair (9 items). By using checklists and formulas of mean item scores, the score of achieving fire safety level for each category and building score obtained as well as overall fire safety level of hospital buildings. Results: The status of fire safety management in selected hospitals of Tehran and Tabriz by using FSE checklist shows that building score, which indicates the level of overall fire safety of hospital building is about 55.87%. conclusion: Given the fire safety level status, which is below 60% and interviews with hospital health and safety representatives, it was determined that in most of the studied hospital buildings, there is no ramps or slope routes for patients as well as automatic fire extinguishing systems or sprinklers and smoke stop doors, and there is no regular and periodic inspection and maintenance of fire extinguishing equipment.

Keywords: Fire safety, Safety evaluation, Hospital, Risk.

INTRODUCTION

In general, hospitals are regarded by the public as a very safe place because it allows them to provide a safe environment for their patients, although the number of fire disasters in hospitals around the world indicates otherwise, which these disasters cause danger and fire incidents that patients must be faced. (Farra et al., 2019) Increasing the number of victims and the

demand for more hospital beds makes the structure and architecture of hospitals inadequate, and the demand for development and expansion of hospital building increases, and changes have to be added to the hospital building to meet human and medical needs. These changes in the structure of the hospital also may have adverse effects on patients. (Best, 1981) Fire occurrence in residential buildings, commercial complexes, small and large industries each year causes a variety of environmental, financial, and casualties damages to diverse communities. Half of all deaths from the fire are reported to occur in building. (Oteng-Ababio and Sarpong, 2015) Causes of high fire casualties in buildings are generally associated with improper use of buildings, substandard installations of buildings, lack of proper maintenance and repair for installation and implementation of fire services, damages to smoke stop doors and having obstacles in escape routes and emergency exit routes. Hospital fires can occur for many reasons, such as short-circuit currents, heat due to electrical overload, kitchen oil or gas in the kitchen, stored flammable liquids, intentional fires or smoking in the bedroom. (Chowdhury, 2014) Today, fire safety management is one of the biggest challenges facing designers and users of medical sections. Lack of awareness, inactivity, and high dependence on stationary equipment reveal the importance of patient safety in fire incidents. (Tubiana et al., 2016) According to data released by the US National Fire Protection Association in 2005, an average of more than 8,000 hospital fires occurs annually around the world, which due to the lack of appropriate performance in this regard, the results can be catastrophic. (Olsson and Engineer, 1999) According to information obtained from occurrence of fire in hospitals, the main factors in fire are the cases such as fire in garbage can, clothes and curtains in the nursing room, fires and sparks caused by fluorescent lamps in stores, fire caused by stoves or heating instruments, smoking in personnel restrooms, fires in the kitchen, intentional fires in places such as waste accumulation and defects in electrical systems. (Beranek, 2005) In most modern hospitals, there are three types of care, including outpatient, general and special care for patients. Outpatients can be safe in the event of a fire occurrence unless the smoke and heat are severe. Patients in the general care unit may be moved by trolley or wheelchair but with little difficulty. For this group of people, there is a possibility to move in horizontal and vertical directions in emergency cases, although it would not be possible to move these people freely without assistance. Patients in ICUs are mostly patients who depend on specific care equipment. It is not impossible to move even at short distances and discharge these people without endangering their lives. (Gildea and Etengoff, 2005) Given this, a hospital can be assimilated to seaborne. As a result, it is advisable for the hospital to keep the fire away from the patients until the patients get out of the fire. Therefore, hospital planners and beneficiaries should employ methods that prevent the fire from occurring in the first phase and in the case of occurrence detect and control the fire in the first phases and minimize its consequences. Due to the type of activity at the health centers, all fire protection measures must be taken to ensure the life safety of individuals. One of the first principles in fire safety design in medical practices is that safety should not be entirely dependent on one type of limited performance. (Min et al., 2019) The fire safety evaluation (FSE) checklist for life safety is a practical tool and a valid technique for engineers. Parameters for overall fire safety evaluation level have been identified in various fire risk evaluation models and can be used to determine the fire safety level of hospitals.



LT Wong and colleagues 2007, in the study of "Fire safety evaluation system in old Hong Kong buildings" concluded that only less than 5% of the total 122 buildings inspected met the standards required to implement the safety requirements and about 95% were not satisfied with the level of fire safety. (Chowdhury, 2014)

Woon Chin et al. 2019, in the study of "Problems in implementing of fire safety management at the Malaysian public hospital" concluded that in manager of the hospital, influential people, with full authority in hospital and contractors of maintenance and repair for proper implementation of a fire safety management system in hospital buildings should have full cooperation. (Wei-Wen et al., 2011)

Ying-Yueh Chen et al. 2011, in the study of "Selecting fire safety management to promote the fire safety level of existing buildings", concluded that this study is a safety evaluation method based on human behavior risk. Therefore, it cannot be applied to all types of buildings, and they conclude that fire safety management measures can be effective for improve safety in existing buildings. (Chen et al., 2012)

Fray et al. 1997, in the study of " Warning system for giving verbal instruction during fire and method of operating the warning system " concluded that by increasing door widths up to 2 meters larger, can prevent the narrowing at the time of hospital discharge and can accelerate the measures of personnel and sensitive patients discharge. (Fray, 1997)

In general, it is important to consider fire safety management issue for the following reasons. Most hospitals are controlled by public systems, and it is believed that society, through the government, is responsible for taking care of individuals for any reason. Therefore, fire safety management in hospitals is morally and legally is a very sensitive case, so if patients or staffs are damaged due to external factors such as fire, this will have a direct impact on the quality of the overall management of the health care system. (De-Ching et al., 2011) At the occurrence of fire in hospitals due to lack of awareness, inactivity and inability of individuals, the life of people threatened. On the other hand, the hospital is one of the places where interruption and disrupt in its activities has vital importance. In addition, due to the high cost of purchasing the equipment, as well as the difficulty in their replacement, the financial risk of hospital fire is very high and of particular importance. Another important reason is that it is extremely difficult to prioritize the rescue of enabling and disable people that gather in hospital in one place and the costs and damages that paying to patients after the incident are far greater than the costs are allocated to improve the hospital's fire safety status. 30,000 thousand people are hospitalized in Iran annually because of severe burns, of which 3,000 lost their lives. In addition to this number, annually more than 200,000 people who suffer from burning are not hospitalized in hospitals and treatment centers. The cost of treatment per patient is only 20 million tomans in the acute phase of burn, and generally the cost of treatment varies from 5 to 200 million tomans for these patients. Annually 600 billion tomans are spent on the treatment of patients in the acute phase of burning alone, and these patients in long term need 3,000 billion tomans to continue their treatment. If there is poor cooperation in fire safety improvement measures, fire safety problems in the building can get worse. Therefore, a timed plan should be implemented to accurately improve fire safety. (Min et al., 2019) Therefore, evaluation of fire safety management in hospitals is essential, especially in developing countries where fire safety management is not considered much, as there are few studies



conducted on fire safety management in Iran. Therefore, the evaluation of fire safety management can be a better option in determining the level of fire safety.

OBJECTIVE

The objective of the present study is to investigate the status of fire safety management in order to prioritize measures and promotion of fire safety in selected hospital buildings of Tehran and Tabriz.

METHODS

This cross-sectional descriptive-analytical study was conducted in 2019 in selected hospital buildings of Tehran and Tabriz. The research tool and data collection method included a questionnaire in the form of a checklist based on the method of fire safety evaluation and interviews with health and safety representatives. This tool was designed and implemented by L.T.Wong et al. in 2007 that the questionnaire translated based on localization conditions and used as the "Fire safety evaluation (FSE) checklist"(appendix). The questionnaire (appendix) in the form of 33 items and 4 categories is as follows: First category: building specifications and features with 5 items, Second category: fire service installation and implementation with 10 items; Third category: fire safety management with 19 items and Fourth category: fire safety maintenance and repair with 9 items. (Molina et al., 2018) Each is a sign of adaptation and confirmation and each is considered as a sign of lack of compliance and confirmation and the mean score for each item was determined by the number of and for all hospitals obtaining by the use of the following formula:

$$I_i = \frac{N_r}{N_r + N_f} \times 100$$

In which I_i is the mean score for each item, N_r is the number of true and N_f is the number of false . The score of P_j indicates achieving fire safety level in that category and is equal to:

$$P_j = \frac{\sum_{i=1}^{N_i} I_i}{N_i} \times W_j$$

In this formula, N_i is the total value of the items under the same category and W_j is the weight factor for the same category. For the weight factor according to the conducted study in 1999, categories 1 and 2 are of equal importance and equality scores of 1/1 were considered for them and categories 3 and 4 were compared with each other. According to the results of the EB-FSRS et al. study in 2002 and LO et al. in 1999, (Chow et al., 1999) the weight factor for this study was 0/375 for categories 1 and 2, score of 0/162 for category 3, and score of 0/088 attained for category 4. Building score B (in percentage) shows the overall fire safety level of a hospital building, which attained by using the formula is given below and N_j is the total number of categories:

$$(\%) B = \sum_{j=1}^{N_j} P_j$$

According to Formula B, the fire safety status of the hospitals under study is obtained by using the following table:

Table 1: Status of fire safety level based on the score of building in hospitals

Raw	Score of building (B)	Status of fire safety level
1	80% or more	The level of building fire safety is acceptable
2	Between 60% to 80%	The level of fire safety is not satisfying and immediately requires measures to improve the fire safety
3	Below 60%	The level of fire safety is dangerous and improving measures are essential and enforceable

Literature Review of Fire safety assessment of hospitals

Risk assessment subject is an important role to guarantee that any healthcare centers have proper systems and that they identify probable disasters and apply actions to ensure that records are confident. Health Information Technology Coordinator (USA) (2015) states that the risk assessment manner detects possible security weaknesses and defects and there is a need to occasionally perform such assessments as there might be altering environments and novel challenges. (Leidenberger et al., 2015) The significance of risk assessment is emphasized by the Medical Insurance Exchange of California (2008) which states that nothing is more distressing to a harmless defense against the contentions of medical malpractice than an imprecise and illegible. We should be exist attention to the potential consequences of fires, hence we may not be sufficiently exposing fires with lower consequences but because of their frequency, the risk is much higher. It has been noted that very severe fire happens in hospitals can occur if have no fire cautions. (Fargnoli et al., 2019) Therefore, can be recognized ignition sources and ignitable material, evaluate how quickly a fire would grow and how quickly indefensible situations would develop. Existing hospitals facilities can be evaluated for the objective of recognizing and eliminating fire dangers, and performing the lowest requirements of present international regulation. (Ardalan et al., 2014) The legislative necessities are obligatory provisions. These requirements determine minimums to protect the health and safety of the society and generally display a concession between ideal safety and economic practicability. The recent findings indicated that the walkthrough control would comfort the improvement of a plan of correct helpful activities in the short, intermediate, and long term to develop the current situation of fire safety in the hospitals facility under review. This would certainly diminish the chance of a fire occurring, or if the worst does happen, keep losses to a lowest. (Lehna et al., 2015)



RESULT

The present study conducted to investigate the fire safety management in 10 selected building hospitals of Tehran and Tabriz. By considering the FSE checklist (attachment) and researcher inspection of hospitals the following results were obtained:

Table 2 shows that for category 1, the highest and lowest mean scores are for the second and fifth items, with mean scores of 100% and 20%, respectively, and the score for achieving fire safety level given to the constant weight factor is 24%.

Table 2: Mean score for each item and score of achieving fire safety level for category 1

score of achieving fire safety level for category 1	Mean score for each item for totals of hospitals (%)	items	Category
$P_1 = \frac{\sum_{i=1}^{N_i} I_i}{N_i} \times W_1 \Rightarrow$ $P_1 = \frac{320}{5} \times 0.375 = 24\%$	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{8}{8+2} \times 100 = 80\%$	I ₁	(Building specifications) C ₁
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{10}{10+0} \times 100 = 100\%$	I ₂	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{6}{6+4} \times 100 = 60\%$	I ₃	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{6}{6+4} \times 100 = 60\%$	I ₄	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{2}{2+8} \times 100 = 20\%$	I ₅	

Table 3 shows for category 2 the highest mean score for the fifth, sixth, and ninth items with a mean score of 80% and the lowest mean score for the second and eighth items with a mean score of 0 percent, and the score for achieving fire safety level given to the constant weight factor is 18/37%.

Table 3: Mean score for each item and score of achieving fire safety level for category 2

score of achieving fire safety level for category 2	Mean score for each item for totals of hospitals (%)	items	Category
$P_2 = \frac{\sum_{i=1}^{N_i} I_i}{N_i} \times W_2 \Rightarrow$ $P_2 = \frac{490}{10} \times 0.375 = 18.37\%$	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{7}{7+3} \times 100 = 70\%$	I ₁	C ₂ (Installation and) implementation of fire service C ₂
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{0}{0+10} \times 100 = 0\%$	I ₂	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{6}{6+4} \times 100 = 60\%$	I ₃	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{4}{4+6} \times 100 = 40\%$	I ₄	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{8}{8+2} \times 100 = 80\%$	I ₅	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{8}{8+2} \times 100 = 80\%$	I ₆	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{1}{1+9} \times 100 = 10\%$	I ₇	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{0}{0+10} \times 100 = 0\%$	I ₈	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{8}{8+2} \times 100 = 80\%$	I ₉	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{7}{7+3} \times 100 = 70\%$	I ₁₀	

Table 4 shows for category 3 the highest mean score for the fourth and seventh items with a mean score of 100% and the lowest mean score for the ninth and tenth items with the mean

score is 0 percent, and the score for achieving fire safety level given to the constant weight factor is 9/12%.

Table 4: Mean score for each item and score of achieving fire safety level for category 3

score of achieving fire safety level for category 3	Mean score for each item for totals of hospitals (%)	items	Category
$P_3 = \frac{\sum_{i=1}^{N_i} I_i}{N_i} \times W_2 \Rightarrow$ $P_3 = \frac{1070}{19} \times 0.162 = 9.12\%$	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{6}{6+4} \times 100 = 60\%$	I ₁	(Fire safety management) C ₃
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{7}{7+3} \times 100 = 70\%$	I ₂	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{5}{5+5} \times 100 = 50\%$	I ₃	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{10}{10+0} \times 100 = 100\%$	I ₄	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{4}{4+6} \times 100 = 40\%$	I ₅	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{4}{4+6} \times 100 = 40\%$	I ₆	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{10}{10+0} \times 100 = 100\%$	I ₇	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{4}{4+6} \times 100 = 40\%$	I ₈	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{0}{0+10} \times 100 = 0\%$	I ₉	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{0}{0+10} \times 100 = 0\%$	I ₁₀	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{8}{8+2} \times 100 = 80\%$	I ₁₁	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{5}{5+5} \times 100 = 50\%$	I ₁₂	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{7}{7+3} \times 100 = 70\%$	I ₁₃	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{5}{5+5} \times 100 = 50\%$	I ₁₄	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{9}{9+1} \times 100 = 90\%$	I ₁₅	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{9}{9+1} \times 100 = 90\%$	I ₁₆	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{2}{2+8} \times 100 = 20\%$	I ₁₇	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{5}{5+5} \times 100 = 50\%$	I ₁₈	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{7}{7+3} \times 100 = 70\%$	I ₁₉	



Table 5 shows that for category 4, the highest mean score for the seventh item with a mean score of 100% and the lowest mean score for the first item with the mean score is 20% and the score for achieving fire safety level given to the constant weight factor is 4/40%.

Table 5: Mean score for each item and score of achieving fire safety level for category 4

score of achieving fire safety level for category 4	Mean score for each item for totals of hospitals (%)	item	Category
$P_4 = \frac{\sum_{i=1}^{N_i} I_i}{N_i} \times W_4 \Rightarrow$ $P_4 = \frac{450}{9} \times 0.088 = 4.40\%$	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{2}{2+8} \times 100 = 20\%$	I ₁	(Fire safety maintenance and repair) C ₄
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{4}{4+6} \times 100 = 40\%$	I ₂	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{4}{4+6} \times 100 = 40\%$	I ₃	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{4}{4+6} \times 100 = 40\%$	I ₄	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{3}{3+7} \times 100 = 30\%$	I ₅	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{3}{3+7} \times 100 = 30\%$	I ₆	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{10}{10+0} \times 100 = 100\%$	I ₇	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{7}{7+3} \times 100 = 70\%$	I ₈	
	$I = \frac{Nr}{Nr+Nf} \times 100 \Rightarrow I = \frac{8}{8+2} \times 100 = 80\%$	I ₉	

According to Tables 2 to 5, the score of the hospital building, which actually shows the overall safety level of the hospital, is equal to total achieving scores to fire safety level of all four categories as follows:

$$(\%) B = \sum_{j=1}^{N_j} P_j \Rightarrow B = P_1 + P_2 + P_3 + P_4 \Rightarrow B = 24 + 18.37 + 9.12 + 4.40 = 55.87$$

$$B = 55.87\%$$

DISCUSSION

The present study was carried out in selected hospitals of Tehran and Tabriz to investigate fire safety management status. In addition to the FSE checklist, completed by the researcher while visiting hospitals, interviews with hospital representatives in the department of health and safety were also conducted due to the urgency and importance of the issue and achieving near-realistic results. Based on the interviews and Tables 1 to 4 and using the mean score for items (I), the results showed that the main problems that are commonly existed in all hospitals, includes following cases: in most of the hospitals route acceptance capacity based on individual numbers per escaping route was less than or equal to 2000. There were no automatic fire extinguisher systems or sprinklers and smoke stop doors. In most of the hospitals, fire hydrant and active smoke control system didn't work well. There was a barrier in stairway routes and in front of exit signs in most of the hospitals for access and escape through emergency exit route as well as the access route to fire services inlet. Installation and implementation fire services, Portable fire extinguishers, fire alarm point, Fire hydrants and hose reels were not regularly inspected, maintained, and properly recorded. The present study supports the results of the study of fire safety status in Shiraz Medical Sciences Hospitals, which show that none of the hospitals have fire detection systems, but 5/83% of hospitals had sufficient fire

extinguishers and 61% had fire boxes. (Hatam et al., 2012) Also, the fire safety status at Gilan University of Medical Sciences showed that there was no fire detection system and the fire extinguisher was the only available fire extinguishing equipment. (Pourreza and Akbari, 2006) In Tanzanian hospitals, the results also showed that there is no specific guideline for discharging patients in hazardous conditions for hospitals. (Manyele et al., 2008) The present study of the mean score of zero for items indicates that no hospital building can meet the standards required to implement safety requirements. The building score indicates that the hospital buildings are at a dangerous fire safety level and that preventive measures are taken quickly. One of the main reasons for the low score may be that insufficient funding is provided annually for hospital fire promotion and another reason is that there is insufficient registration, archiving, inspection and monitoring of existing fire equipment.

It has been noted that is not paying adequate consideration to fire safety in hospitals and the universal standard of fire manage systems are those which may be alarm people in the start of fire. (Wolf et al., 2010) In further, fire alert in Indian hospitals provided suggestions for a change in system performance that is similar with the US fire protection association (FPA), which is probable to prevent fire in hospitals in the various countries of the world, that attained by Kanchan et al in 2013. The role of hospital administrators in operating facilities of the current study has concluded. (Chowdhury, 2014) The concept of fire risk management has discussed in the present study and the role of fire inspections as a risk reduction strategy to assurance the subordination of presence fire safety regulation in international hospitals. The findings of current research carried out on the level of fire safety awareness of the hospital staff in Iran in 2019 exhibited that most of the works did not have sufficient information about fire safety, there were not any fire systems in the hospitals under study, and the staff was not skilled on fire monitoring. The accordance between the results of the current study and the present one shows that the fire safety status has not improved in the hospitals of Iran during the previous 2 years.



CONCLUSION

The results showed that the overall fire safety level for this study was 55/87%, indicating that the building score is below 60% and that the building is at a dangerous fire safety level. Preventive and control measures are required and enforceable. Therefore, hospital owners or hospital managers need to consult with relevant specialists to coordinate and implement these measures. Among the major problems identified by the FSE checklist and interview method was: lack of ramp or slope routes for patients in case of emergencies. In most of the hospitals route acceptance capacity based on individual numbers per escaping route was less than or equal to 2000. There were no automatic fire extinguisher systems or sprinklers and smoke stop doors. In most of the hospitals, fire hydrant and active smoke control system didn't work well. There was a barrier in stairway routes and in front of exit signs in most of the hospitals for access and escape through emergency exit route as well as the access route to fire services inlet. Installation and implementation fire services, Portable fire extinguishers, fire alarm point, hose reel and fire valves were not regularly inspected, maintained, and properly recorded. Therefore, to taking preventive measures and enhancement of fire safety level it is first recommended to allocate a budget called fire management or crisis budget. Second, crisis

management procedure (with the aim of forming an Emergency Response Team and communicating team members' duties, training in crisis management, preparing maps of fire extinguisher, hydrants, hose reels, sensitive and hazardous areas, etc.... acquaintance with exit and escape routes, maneuvers, determining master point assembly, shelters, emergency evacuation and stops measures, etc.) should be written and implemented. Third, automatic fire extinguisher systems and smoke stop doors should be installed in hospitals. Fourth, the review must be considered in the field of change management for sensitive locations including exit routes, exit door capacity, ramps for sensitive groups, etc. all of the cases related to fire safety including fire extinguishing and fire alarm equipment such as capsules, hose reels and hydrants, detectors, etc., regular fire service installation and etc., must properly inspected and maintained, and all of the implied changes on them must be recorded. It is also recommended that the fire maneuvers be performed, and their performance evaluated in terms of the positive and negative points in the maneuver periodically. One of the limitations of this study was the poor cooperation of hospital managers and relevant authorities. For future studies, it is suggested that some changes and corrections implies on existing parameters in checklist and the topic of fire safety management be expanded and that more hospitals be studied.

FOOTNOTE

Authors' Contribution: Abdolvahed Bazmara, Hamed Akbari and Amir Adibzadeh: designing and conducting the study and writing of the manuscript; Nafisseh EsHagh Hosseini and Hesam Akbari: analysis of data and writing of the manuscript; Abdolvahed Bazmara: designing and conducting the study; Mohammad Hassan Naseri: analysis of data

Conflict of interests: The authors declare that they have no conflict of interests.

Ethical Approval: This study and were approved by Baqiyatallah University of Medical Sciences (Reference No. 91012906).

APPENDIX:

Fire safety evaluation checklist

Categories	items	answer	
		Yes	No
Building specifications	Fire load density is less than class 1 among the risk (average danger).		
	Hospital building is a single application		
	The height of the hospital building is 50 meters or more		
	The number of exit doors of escape routes is proportional to the exit capacity		
	Route reception capacity is based on the number of people on the escape route less than or equal to 2000		
Installation of fire services	Portable fire extinguishers are in good condition		
	Sprinkler systems have a good status		
	Fire detection systems have a good status.		

	The fire hydrant system is in good condition		
	The fire alarm system is in good shape		
	Hose reel systems are well positioned		
	Active smoke control systems are in a good position		
	Smoke doors are in good condition		
	Signs of exit are good		
	Emergency lighting is in good shape		
Fire safety management	Doors open on the roof easily and without using the key from inside the building.		
	Doors at the entrance to the hospital building are easily accessible without using the key inside of the building.		
	Doors that open to escape routes do not result in obstruction		
	Stairway walls are not opened for any type of facility		
	There are no obstacles on the way to escape such as the corridor and lobbies		
	There are no obstacles on the stairs		
	The brightness of the escape routes is in good condition		
	There are no obstacles in front of the exit signs		
	Smoke stop doors are in good condition and there are no obstacles on the paths leading to it		
	Smoke doors are always closed properly.		
	There is no obstacle in the way of accessing emergency vehicles for rescue operations (deployment area of relief vehicles).		
	There are no obstructions and unauthorized building materials on the roof of the hospital building		
	There are no obstacles in the way of Portable fire extinguishers		
	There is no obstacle to accessing the fire alarm points.		
	There is no obstacle in access to the hose reel		
	There is no obstacle to accessing the fire hydrant		
	There is no obstacle to accessing the fire services inlet.		
The letters shown on the hose reel position are legible			
Training notes for hose reel operations are legible.			
Maintenance and repair of fire safety	The installation and maintenance of fire services are regularly inspected, maintained and properly recorded and recorded.		
	Portable fire extinguisher are regularly inspected, stored and properly recorded and recorded.		



The fire alarm points are regularly inspected, maintained and properly recorded and recorded		
The hose reel are regularly inspected, stored and properly recorded and recorded.		
Fire hydrants are regularly inspected, stored and properly recorded.		
All communication points of cables and wires are in good condition		
Emergency power wiring is in good condition		
Electrical wires and electrical installation are not damaged		
Electrical installation and Electric wires are ordered regularly.		

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