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Development of performance evaluation indicators for pre-hospital emergency centers

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ABSTRACT

Introduction: Prehospital emergency health care plays an important role in saving lives. Proper performances of different parts of this system result in the rapid and timely deployment of an ambulance in patient's place and prevention of death and disability. Thus, this research was conducted to compile performance evaluation indicators for pre-hospital emergency centers in 2017.

Methods: This study is a qualitative-quantitative research conducted in 2017. In order to compile the indexes for evaluating the performance of pre-hospital emergency centers, the study was done in two phases. In phase one of the study, primary items and their fields were identified according to the recent literature. In the second phase, Delphi technic in three rounds was used to finalize the items and the fields. In the first round of Delphi technic, the identified items and fields were given to experts in forms of checklist. The items and fields with average of >4 and standard deviation of <1 were confirmed, items with average of <2 and standard deviation of <1 were removed, and other items were randomly passed into round two. In the second round, all the items with average of >4 and standard deviation of <1 were confirmed, items with an average of <3 and standard deviation of <1 were removed, and other items were randomly passed into round three. In round three, only items with average of >4 and standard deviation of <1 were confirmed, and other items were removed.

Results: The results of the study showed that 9 items in field of facilities and physical space, 10 items in field of communication, 10 items in field of ambulance, 8 items in field of human resources, 9 items in field of regulations and protocols, 3 items in field of storing equipment in the center, and 3 items in field of training were identified.

Conclusion: Considering the identification of seven effective factors in improving the quantitative and qualitative level of pre-hospital emergency services, it is highly important for authorized managers and decision-makers to improve all necessary factors.

Keywords: performance evaluation, emergency center, pre-hospital, medical emergency

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INTRODUCTION

Every organization needs a system to raise awareness of its services and activities quality, especially if it is a dynamic and complex organization. Moreover, lack of evaluation and control in a system may harm the organization itself.[1] Evaluating the performance of an organization is a tool, not only for the organization to know the efficiency of the staff but also for the staff to aware about their own positions. If this tool is well designed and applied, it can be helpful in improving, training, encouraging and punishing, and fair payment. Thus, this study reviewed the role and importance of pre-hospital emergency centers.[2] Pre-hospital emergency system includes an important part of presenting health service[3,4] in critical conditions outside the hospital and focuses on prevention of acute death and elimination of threatening conditions with rapid diagnosis and prompt treatment.[5] Medical emergency system, which is the most important factor in eliminating death, is the front line of healthcare centers[6] since this system should provide health services according to global standard protocols when dealing with patients. There are some reports showing 12% of the world's disease burden is due to accidents. Regardless of their reasons and concepts, accidents have tremendous effects on the health systems that provide required care and logistics for the victims.[7]

The pattern of diseases have changed in recent years. As an example, the reports of Ministry of Health show that death caused by cardiovascular diseases includes all death in the recent decade. Therefore, risk management and emergency surgery increasingly became interesting subject for further researches in Iran.[8]

Pre-hospital medical emergency services are defined as services bridging the health needs of people outside the hospital. The needs include taking care of life-threatening events, transmitting patients and injured people to health care centers, and being ready to do missions in events with the risk of injury. The more proper, more correct, and faster are these services, the lower will be the number of death and the higher will be people's trust to our health system.

Appropriate performance of different parts of the emergency system results in rapid and well-timed ambulance deployment to the patient's place to prevent death and disability. The success of the system depends on various factors, such as the competence of the staff, trained personnel, facilities, concordance, and communication system.[9] Bahrami et al. in their research on evaluating pre-hospital emergency services in Yazd in 2009 found that only 14.3% of emergency centers have enough personnel and none of the ambulances have all 52 types of the equipment.[9] In order to improve the services, every country should evaluate its emergency medical service (EMS) and start improving its quality which can be reasonably achieved. Considering the importance of pre-hospital emergency centers in saving people's lives, this study was conducted in order to inform authorized managers in Yazd Province on level of standards of pre-hospital emergency services, determine the weak and strong points of each unit, as well as provide proper context to plan promotion of quantitative and qualitative level of these services.

MATERIALS AND METHODS

This quantitative-qualitative study was conducted in 2017 in two phases in order to compile the indexes for evaluating the performance of pre-hospital emergency centers.

Phase One: Literature Review

A checklist was designed by interviewing 30 experienced experts and reviewing researches about this topic, including modified standards of pre-hospital emergency included standards of ambulance and emergency centers equipment (Extracted from Iran National Standards and industrial researches, no. 4373), performance reports of pre-hospital emergency centers, inspection programs approved in emergency centers and drafts of pre-hospital emergency standards in Ministry of Health (No. 25921/401/d).Phase Two: Delphi Technic

In this phase, 20 experts including managers, directors, and staff of pre-hospital emergency centers in the province were selected as the target group of the study. Delphi process was conducted in three rounds.

Round one: The designed checklists for evaluating the performance of pre-hospital emergency centers in the province were given to the experts. The experts individually studied the mentioned items and fields and expressed their opinions in five-option Likert scale { (5 – highly proper) to (1 – completely improper)}. In the first round of Delphi, the identified items and fields with an average score of >4 and standard deviation of <1 were confirmed, items with average score of <2 and standard deviation of <1 were removed, and other items were passed into the second round.

Round two: In this round, checklists were prepared individually and given scores for each item in the previous round, and the average score were given to the experts. In the second round, all items with average score of >4 and standard deviation of <1 were confirmed, and items with average score of <3 and standard deviation of <1 were removed.

Round three: Only items with average score of >4 and standard deviation of <1 were confirmed and other items were removed.

This study was approved by ethics code IR.SSU.SPH.REC.1394.9 in Yazd Shahid Sadoughi University of Medical Sciences.

RESULTS

The results of the study showed that 9 items in field of facilities and physical space, 10 items in field of communication, 10 items in field of ambulance, 8 items in field of human resources, 9 items in field of regulations and protocols, 3 items in field of storing equipment in the center, and 3 items in field of training were identified.

According to table 1, 8 main fields were identified. These fields included building (with 6 items), hoteling (with 3 items), communicating system (with 6 items), ambulance (with 7 items), human resources (with 11 items), regulations and protocols (with 8 items), storing equipment in the center (with 3 items), and training in the center (with 5 items).

The findings in table 2 show that building field and its four items with average score of >4 and standard deviation of <1 were confirmed and other items were passed to the second round. Hoteling field and one of its items with average score of >4 and standard deviation of <1 were confirmed and two other items were passed to the second round. Three items of communication field were confirmed and other items were passed to the second round. In ambulance field, five items were confirmed, one was removed, and one item was passed to the second round. In human resources field, three items were confirmed, two items were passed to the second round, and others were removed. In storing equipment field, two items were confirmed and one item was removed. Finally, in training field, three items were confirmed, one item was removed and two other items were passed to the second round.

Findings of Table 3 indicates that 9 items in the field of building and physical facilities, 5 items in

Table 1 **Fields and items for evaluating performances of pre-hospital emergency centers in literature review phase**

Main Fields	Items
Building	Connecting path to the main road for ambulance[11] Appropriate parking space[12] Possessing the ground of Emergency Center [11] Building area [11] Type of structure [11] Age of the building [11]
Hoteling	Appearance (facade: brick or stone, panel, color of the doors and windows) [13] Separating offices and resting rooms [13] Welfare facilities [11]
Communication System	Telephone Handheld wireless Fixed wireless Computer and its accessories Fax Internet (Shams Network), radio and batteries for emergency cases [11]
Ambulance	Type of ambulance (Type A – Type B) Medical equipment Medicine equipment Technical equipment GPS [11] Safety of the ambulance [14] Periodical visits to maintain the ambulance
Human Resources	Present staff Establishment of district authority in the center Operator Crew Shift supervisor (Acceptance terms) On-time personnel Complete preparation of personnel to do missions Clean and tidy uniforms Timely tracking of sectorial shortages by center supervisor Concordance with the doctor present in the center according to the regulations [14] Observing ethical and Islamic standards and administrative regulations
Regulations and Protocols	Presence of the operational area map on the wall Daily checking of the equipment by personnel Controlling expiration date of the medicine according the time table Observing and installing free-services instructions inside the ambulance[16] Complete filling up the mission form Ambulance and equipment checklist Written explanations of the duties The latest edition of the attendance and mission book
Storing Equipment in the Center	Administrative equipment Medical and medicine equipment A storage of shelves for medicines
Training in the Center	Training books and pamphlets Holding briefing Training equipment such as mannequins etc. Improving operational performance of emergency technicians Enhancing the knowledge and insights of emergency technicians [17]

the field of communication, 5 items in the field of ambulance, 5 items in the field of human resources, 5 items in the field of regulations and protocols, 1 item in the field of storing equipment and 1 item in the field of training were confirmed with the average score of >4 and standard deviation of <1.

As seen in table 4, two items in the field of communication with the average score of >4 and standard deviation <1 were confirmed.

Table2 Status of the fields and items for evaluating performance in first round of Delphi technic

	Average score	SD	Status	
Building	4.1	0.36	Confirmed	Proposed items
Connecting path to the main road for ambulance	4.7	0.48	Confirmed	Parking lot for personnel's autos Exercising space Emergency exit Distance between the center and a hospital Identifying accident-prone centers Greenery of the center Distance between the center and a village or town Installing flash light outside or at the door of the center Type and facilities of the center
Appropriate parking space	4.3	0.65	Confirmed	
Possessing the ground of Emergency Center	3.7	1.3	Second round	
Building area	3.9	0.75	Second round	
Type of structure	4.05	0.99	Confirmed	
Age of the building	4.4	0.68	Confirmed	
	Average score	**SD**	**Status**	
Hoteling	4.2	0.65	Confirmed	Center cleanliness Lightening of the center CCTV Refreshment for personnel Fencing the center Security of the center
Appearance (facade: brick or stone, panel, color of the doors and windows)	3.5	1	Second round	
Separating offices and resting rooms	3.7	0.92	Second round	
Welfare facilities	4.2	0.69	Confirmed	
	Average score	**SD**	**Status**	
Communication	4.7	0.47	Confirmed	VOIP telephone Strapping wireless Safety of the wireless Cellphone GIS in order to record the address
Telephone	4.5	0.6	Confirmed	
Handheld wireless	4.05	0.82	Confirmed	
Fixed wireless	4.8	0.52	Confirmed	
Computer and its accessories	3.8	0.81	Second round	
Fax	2.5	0.88	Second round	
Internet (Shams Network)	3.9	0.91	Second round	
	Average score	**SD**	**Status**	
Ambulance	4.7	0.44	Confirmed	Light releasing equipment Age of the ambulance Installing related protocols in the ambulance (coding, stickers, and advertisements on ambulance) Motor lance Ambulance cleanliness Technical ambulance safety Type of ambulance for urban and mountain situations
Type of ambulance (Type A – Type B)	4.3	0.73	Confirmed	
Medical equipment	4.6	0.75	Confirmed	
Medicine equipment	4.6	0.82	Confirmed	
Technical equipment	4.6	0.67	Confirmed	
GPS	4.05	0.75	Confirmed	
Safety of the ambulance	1.9	0.9	Removed	
Periodical visits to maintain the ambulance	2.5	0.68	Second round	

Table2 ***Continued***

	Average score	SD	Status	
Human Resources	4.8	0.36	Confirmed	Number of personnel Work experience Type of employment Native employment conditions
Present staff	4.6	0.68	Confirmed	
Establishment of district authority in the center	3.3	0.33	Second round	
Operator	3.05	0.68	Second round	
Crew	3.3	0.73	Second round	
Shift supervisor (acceptance terms)	4.3	0.73	Confirmed	
On-time personnel	1.2	0.62	Removed	
Complete preparation of personnel to do missions	1	0.65	Removed	
Clean and tidy uniforms	4.1	0.81	Confirmed	
Timely tracking of sectoral shortages by center supervisor	1.5	0.56	Removed	
Concordance with the doctor present in the center according to the regulations	1.9	0.92	Removed	
Observing ethical and Islamic standards and administrative regulations	0.95	0.64	Removed	
	Average score	**SD**	**Status**	
Regulations and protocols	4.3	0.65	Confirmed	Archive system for mission forms The latest version of code changes Guidelines for crisis and incidents Off-line protocol (in the case of notification) Air Emergency Aid Instruction on Airborne Emergency Road Updated and accessible protocols Schedule for presence of personnel in the center
Presence of the operational area map on the wall	4.1	0.55	Confirmed	
Daily checking of the equipment by personnel	1.6	0.62	Removed	
Controlling expiration date of the medicine according the time table	1.8	0.82	Removed	
Observing and installing free-services instructions inside the ambulance	2.4	0.42	Second round	
Complete filling up the mission form	3.3	0.68	Second round	
Ambulance and equipment checklist	4.2	0.76	Confirmed	
Written explanations of the duties	4.2	0.82	Confirmed	
The latest edition of the attendance and mission book	4.3	0.65	Confirmed	
	Average score	**SD**	**Status**	
Storing equipment	4.4	0.5	Confirmed	Capital equipment- rescue equipment
Administrative equipment	4.5	0.6	Confirmed	
Medical and medicine equipment	4.2	0.82	Confirmed	
A storage of shelves for medicines	1.9	0.85	Removed	

Table2 ***Continued***

	Average score	SD	Status	
Training in the centers	4.4	0.5	Confirmed	Accessing training – scientific websites
Training books and pamphlets	4.5	0.73	Confirmed	
Holding briefing	4.3	0.83	Confirmed	
Training equipment such as mannequins etc.	1.6	0.64	Removed	
Improving operational performance of emergency technicians	3.6	1.08	Second round	
Enhancing the knowledge and insights of emergency technicians	2.8	0.74	Second round	

Table 3 Fields and items for evaluating the performance in the second round of Delphi technic

Field of Building and physical facilities	Average score	SD	Status
Possessing the ground of Emergency Center	4.1	0.81	confirmed
Building area	4.1	0.67	confirmed
Parking lot for personnel's autos	2.3	0.58	Removed
Exercising space	1.2	0.41	Removed
Emergency exit	1.1	0.36	Removed
Distance between the center and a hospital	1.3	0.47	Removed
Identifying accident- prone centers	1.7	0.47	Removed
Greenery of the center	1.6	0.67	Removed
Distance between the center and a village or town	2	0.79	Removed
Installing flash light outside or at the door of the center	4	0.64	Confirmed
Type and facilities of the center	4.2	0.69	Confirmed
Appearance (facade: brick or stone, panel, color of the doors and windows)	4.1	0.71	Confirmed
Separating offices and resting rooms	4.3	0.58	Confirmed
Center cleanliness	4.2	0.82	Confirmed
Lightening of the center	4.3	0.73	Confirmed
Refreshment for personnel	2.05	0.39	Removed
Security of the center (CCTV, Fencing the center)	4.2	0.92	Confirmed
Proposed items		-	
Communication field	**Average score**	**SD**	**Status**
Computer and accessories	4.2	0.53	Confirmed
Fax	4	0.32	Confirmed
Internet (Shams Network)	4.2	0.61	Confirmed
VOIP telephone	4.5	0.6	Confirmed
Strapping wireless	2.3	0.74	Removed
Safety of the wireless	2	0.45	Removed
Cellphone	4.3	0.81	Confirmed
GIS in order to record the address	2.5	0.88	Removed
Proposed items	**Radio with batteries for emergency situations- satellite phone**		

Table 3 *Continued*

Ambulance	Average score	SD	Status
Periodical visits to maintain the ambulance	1.9	0.82	Removed
Light releasing equipment	4	0.45	Confirmed
Age of the ambulance	4.6	0.5	Confirmed
Installing related protocols in the ambulance (coding, stickers, and advertisements on ambulance)	4.2	0.68	Confirmed
Motorlance	2.5	0.68	Removed
Ambulance cleaning	4.6	0.48	Confirmed
Technical ambulance safety	4.1	0.44	Confirmed
Type of ambulance for urban and mountain situations	2	0.36	Removed
Proposed Items		-	
Human Resources	**Average score**	**SD**	**Status**
Establishment of district authority in the center	2.3	0.68	Removed
Operator	4.05	0.51	Confirmed
Crew	4	0.56	Confirmed
Work experience	4.1	0.64	Confirmed
Type of employment	4	0.72	Confirmed
Native personnel conditions	4.05	0.99	Confirmed
Proposed Items			
Regulations and protocols	**Average score**	**SD**	**Status**
Observing and installing free-services instructions inside the ambulance	1.9	0.82	Removed
Complete filling up the mission form	2.05	0.51	Removed
Archive system for mission forms	4.2	0.76	Confirmed
The latest version of code changes book	4.2	0.65	Confirmed
Guidelines for crisis and incidents	4.05	0.94	Confirmed
Off-line protocol (in the case of notification)	4.05	0.82	Confirmed
Air emergency aid instruction on airborne emergency road	4.1	0.91	Confirmed
Updated and accessible protocols	2.4	0.48	Removed
Schedule for presence of personnel in the center	2.3	0.73	Removed
Proposed items		-	
Storing equipment	**Average score**	**SD**	**Status**
Capital equipment	2	0.85	Removed
Rescue equipment	4.5	0.6	Confirmed
Proposed items			
Training in the centers	**Average score**	**SD**	**Status**
Accessing training websites	4.1	0.64	Confirmed
Proposed items			

Table 4 **Fields and items for evaluating the performance in the third round of Delphi technic**

Communication field	Average score	SD	Status
Radio with batteries for emergency situations	4.2	0.68	Confirmed
Satellite phone	4.5	0.6	Confirmed

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Table 5 **Fields and items for evaluating the performance of pre- hospital emergency centers in Yazd Province**

	Field	Items
1	Building and physical facilities	Possessing the ground of Emergency center Building area Type of the structure Ambulance parking Appearance (facade: brick or stone, panel, color of the doors and windows) Security of the center (CCTV, fencing the center, neighboring offices and buildings) Welfare facilities Type of the center and building facilities
2	Communication system	Telephone Handheld wireless Fixed wireless Computer and accessories Fax Internet (Shams Network) Radio with batteries for emergency cases VOIP telephone Cellphone Satellite phone
3	Ambulance	Type of ambulance (Type A – Type B) Medical equipment Medicine equipment Technical equipment GPS Light releasing equipment Age of the ambulance Installing related protocols in the ambulance (coding, stickers, and advertisements on ambulance) Ambulance cleanliness Technical ambulance safety
4	Human resources	Present personnel Operator Crew Shift supervisor (acceptance terms) Work experience Type of employment Native employment conditions Observing personnel dressing
5	Regulations and protocols	Ambulance and equipment Checklist equipment Written explanations of the duties The latest edition of the attendance and mission book Archive system for mission forms The latest version of code changes book Guidelines for crisis and incidents Presence of the operational area map on the wall Off-line protocol (in the case of notification) Air emergency aid instruction on airborne emergency road
6	Storing equipment in the centers	Administrative equipment Medical and medicine equipment Rescue equipment
7	Training in the centers	Training books and pamphlets Holding briefing Accessing scientific-training websites

Findings in Table 5 shows that total 9 items in the field of building and physical facilities, 10 items in field of communication, 10 items in the field of ambulance, 8 items in the field of human resources, 9 items in the field of regulations and protocols, 3 items in the field of storing equipment, and 3 items in the field of training were confirmed.

DISCUSSION

According to the literature review and experts' opinion, seven factors were selected as effective factors in pre-hospital emergency centers in Yazd Province. In this study, the field of human resources was identified as an index for evaluating pre-hospital emergency centers. In a study by Pakhere et al. on ranking the effective factors on the readiness of pre-hospital emergency centers in the view of operational personnel in Mazandaran, human resources were identified as effective factor.[18] Another study in Tehran showed that 100% of kermanshah emergency centers lack personnel and solutions for providing sufficient human resources, operator, and crew for each center as well as solving multi-shift problem were proposed.[19] The mentioned studies are compatible with this study.

Another factor to increase the efficiency of emergency centers is sufficient equipment of the centers in Yazd Province. Iri et al., in their study on defining the concept and challenges if service providing in pre-hospital emergency centers, considered lack of sufficient equipment and facilities as a critical challenge of the emergency centers in providing services.[20] Findings of a study by Bahrahi et al. on evaluating the performance of pre-hospital emergency centers in Yazd Province indicated that none of the present emergency centers owned standardized equipment. The findings of the above-mentioned studies are consistent with this study.

Another important index in evaluating the emergency centers is the field of regulations and protocols. Adnet study which was conducted in France in 2004 indicated that training-related regulation could be a critical step to integrate health care services.[21] In the study by Iri et al., approved regulations was similarly effective in patients' satisfaction. Another effective index on the performance of the emergency centers is the equipment and improvement of the ambulances. The results of a study done in Suskatchewan State in the USA showed that financial issues for providing required equipment for ambulances were considered as a priority in pre-hospital emergency centers there.[22] Vaitkaitis reviewed the most important critical problems in emergency services in Lithuania. The findings of his study indicated that age of present ambulances and loss of integrating standard for medical education were effective factors resulting in a weak performance of emergency centers in Lithuania.[23] A challenge for providing prevention medical services in Iri's study (2015) in Mazandaran was inappropriate cooling and heating systems in ambulances, age of ambulances, lack of integrity in the fleet of ambulances, inappropriate arrangement of equipment in ambulances, time-consuming repairing of ambulances, lack of facilities, low quality of equipment, lack of cutting and dispensing devices, and lack of equipment for transferring patients from the upper floors of buildings. The results of the mentioned studies are compatible with the results of this study.

In designing pre-hospital system, appropriate communicative devices should be provided for all EMS service- givers as well as all EMS personnel. This study identified the field of communication as an effective index. Bahadori prioritized the effective factors on the readiness of pre-hospital emergency centers and introduced communication as the most effective factor.[24] Mann considered applying IT tools such as telemedicine and GIS as an effective factor in managing health care, and accessing and controlling effective communication.[25] Askari et al. studied designing a model for evaluating the responsiveness of the health system to accessing primary services and equipment.[26] The results of these studied were compatible with results of this study.

The field of building and physical facilities was another effective factor in the performance of pre-hospital emergency centers. The results of a study by Moti et al. on prevalence of stressors in male technicians of the emergency centers proved that the most important stressors in male technician were physical stressors, the most important of which were lack of enough time for resting, lack and loss of appropriate facilities, lack of a suitable place for resting, unsatisfactory of welfare facilities, and noise pollution in resting places. This study is compatible with the mentioned study.

Training is another important factor in the performance of pre-hospital emergency centers ,as mentioned in the researches of Bahadori and Haghani. Bahadori recognized training and regulations as effective indexes.[23] Haghani concluded that unawareness and weak performance of the emergency center's personnel can be solved by constant trainings.[27]

CONCLUSION

Regarding the identification of the seven effective factors in the improvement of quantitative and qualitative level of pre-hospital emergency centers in Yazd province, improving evaluation system, establishing an approved organizational chart, leveling pre-hospital emergency centers' staff, upgrading equipment, continuing training, and improvement

of communication systems considered necessary. Finally, it is suggested to review personnel's ideas as owners of pre-hospital emergency processes understanding their challenges inside and outside the organization. A comprehensive view can be codified and presented as guidelines to the decision-makers.

RESEARCH LIMITATIONS

The remoteness of some emergency centers from the provincial capital and the timing of the information gathering process were subject to research constraints.

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