

ORIGINAL ARTICLE

Safety issues faced by paramedics in ambulances in Saudi Arabia

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ABSTRACT

Background: According to the National Highway Traffic Safety Administration, the risk of accident-related fatalities in the rear of an ambulance is more than five times greater than it is in the front seat. The main objective of this research was to assess ambulance design safety and identify limitations that endanger emergency medical service (EMS) providers in Saudi Arabia during their day-to-day work, especially in the rear cabin.

Methods: An observational cross-sectional study was conducted via online surveys filled by EMS providers and a checklist filled out by supervisors, section heads, and chiefs, in Saudi Arabia, from March 2020 to April 2020. Additionally, a retrospective review was also conducted on reports by various US and international safety organizations.

Results: A total 861 participants (832 surveys and 29 checklists) were enrolled. EMS providers expressed significant challenges in terms of ensuring their own safety as well as that of the patients due to the current ambulance design, where 79% (22/29) of checklist participants and 87% (718/861) of survey participants indicated dissatisfaction with the current ambulance designs.

Conclusion: Practically, the design of the current ambulances is often unsafe for providing emergency medical treatment, and therefore the rear cabin is a dangerous environment for both the patient and the EMS provider.

Keywords: Ground ambulance, rear cab, emergency medical services, injuries, safety system, cabin design.

Introduction

Emergency medical service (EMS) is one of the most important aspects of providing pre-hospital healthcare in the community. Today, it is a greater responsibility than ever to develop an efficient system and raise the level of safety for EMS providers and patients. This can be achieved by updating the standards of medical care provided and reducing the incidence of problems that cause inefficiency or increase fatalities. Hence, there is a need to assess the ambulance design used in Saudi Arabia. EMS providers are the cornerstones of this system and addressing the problems they face daily is the first step in helping them provide better emergency service in a safe environment and in decreasing the number of potentially fatal incidents. The main objective of this research was to assess the ambulance design safety and identify limitations that endanger EMS providers in their day-to-day work, especially in the rear cabin, in Saudi Arabia.

Subjects and Methods

The study was conducted in the Kingdom of Saudi Arabia from 7 March 2020 to 7 April 2020. This study is divided into three parts: a retrospective review, an observational cross-sectional survey, and a checklist.

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The study was conducted via online survey, which was distributed to EMS providers in Saudi Arabia. The survey contained 22 quantitative questions designed to collect demographic data and data related to safety knowledge and awareness of EMS providers. The goal was to measure satisfaction with the current ambulance design and to identify opportunities for improvement. The inclusion criteria included EMS providers who were 18 years or older in Saudi Arabia. Links to the survey were sent every 4 days, at different times of the day, to encourage the greatest possible level of participation.

A direct electronic link was used, which could be opened from any device and place. The link was sent to all identified groups of EMS providers on multiple platforms, including WhatsApp and Telegram, and by text message. The link reached nearly 5,000 people working in the EMS field, accompanied by a simple explanation and an assurance of confidentiality for the participant. The other part of the study was the creation of a checklist for the ambulance design, based on criteria found in the collected reports.

The inclusion criteria stipulated that the participants must be a department supervisor, chief, manager, or section head; had previously worked in the field with ambulances; had a degree of no less than a diploma; and had at least 1 year of managerial experience.

The aim of the checklist was to explore the opinions of the most experienced individuals in the field. To expand the research base to include the different sectors and regions, it was made sure to distribute the list to 40 people who

met the above-mentioned criteria via electronic link, and received responses from 29 of them.

The data included responses to a checklist (from supervisors, head sections, managers, and chiefs), demographic information, and opinion surveys (from EMS providers). Each participant's responses to the 22 closed-ended questions were recorded, and the data were compiled on an Excel Spreadsheet. Checklist data were recorded and compiled separately. A combined data set was then created to conduct a comparative analysis. For the statistical tests, the data were uploaded into Statistical Package for the Social Sciences software version 22.0 (IBM Corp., Armonk, NY), which was used to conduct analysis and developed descriptive tables and relevant graphs. Categorical variables were presented as percentage and frequency. Chi-square test for independence of proportion was carried out, where $p < 0.05$ was considered as statistically significant. The goal was to extract the information needed to identify areas of ambulance design that needed improvement and to measure satisfaction with the current design.

Results

The total number of participants who completed the checklist was 29, and those who completed the survey were 832.

The demographics of the participants shown in Tables 1 and 2 are those who completed the checklist and the survey, respectively. Of the participants who completed the checklist, 87% ($n = 25$) were male, compared to 66% (n

Table 1. Demographic analysis of the checklist participants.

Gender	Count (n) & percent (%)		Degree	Count (n) & percent (%)	
Female	4	(13%)	Diploma	2	(7%)
Male	25	(87%)	Bachelor's	8	(28)
Total	29	(100%)	Master's	14	(48%)
			PhD	5	(17%)
Experience in EMS	Count (n) & percent (%)		Total	29	(100%)
1-2 years	4	(13%)			
2-4 Years	5	(17%)	Region of workplace	Count (n) & percent (%)	
4-8 years	6	(23%)	Central	7	(24%)
Over 8 years	14	(47%)	Eastern	4	(14%)
Total	29	(100%)	Northern	6	(21%)
			Southern	8	(28%)
Subordinates	Count (n) & percent (%)		Western	4	(14%)
10 or fewer	6	(21%)	Total	29	(100%)
Between 10 and 20	3	(10%)			
20 to 30	6	(21%)	Worked in an ambulance	Count (n) & percent (%)	
30 to 40	5	(17%)	YES	23	(79%)
Over 40	9	(31%)	NO	6	(21%)
Total	29	(100%)	Total	29	(100%)
Position	Count (n) & percent (%)				
Chief	7	(24%)			
Head of section	8	(28%)			
Manager	1	(3%)			
Supervisor	13	(45%)			
Total	29	(100%)			

= 553) of those who took the survey. Female participants made up 13% ($n = 4$) of checklist participants, compared to 34% ($n = 279$) of survey takers.

Of the female checklist participants, one (25%) was a chief and three (75%) were supervisors. Six (24%) male participants were chiefs, eight (32%) were heads of sections, one (4%) was a manager, and 10 (40%) were supervisors. In terms of the educational degrees held by checklist participants, one (25%) of the female participants and seven (28%) of the male participants had a bachelor's degree, three (75%) of the female participants and 11 (44%) of the male participants held a master's degree, five (20%) of the male participants held a PhD, and two (8%) of the male participants held a diploma. The checklist also asked participants if they had ever worked in an ambulance before, and 79% said yes and 21% said no.

Questions from the survey and checklist are listed in Table 3 to compare the results from both types of participants. Note that the two comparison samples differ in many aspects. However, their daily interactions and experiences in the field are closely related in terms of what challenges they face.

Three results demonstrated highly significant p -values ($p \leq 0.01$). These were patient compartment free of all sharp projections ($p = 0.0008$); two fire extinguishers in the ambulance ($p = 0.0067$); and ability to load another

patient without any risk ($p = 0.0001$, two blank responses). Responses to the other nine questions showed no significant differences ($p > 0.05$). Tables 4 and 5 present the rest of the questions from the survey and the checklist.

Discussion

Research conducted over the past two decades has indicated that the passengers in the patient compartment of an ambulance have a significant morbidity and mortality rate. A study conducted in USA showed about 12.7 per 100,000 EMS workers each year, which is above the national rate in the USA of 5 per 100,000 workers. In addition, the study had estimated an injury rate in the USA of about 19.6 per 100 full-time workers in EMS, which was also higher than the national average of 7.0 per 100 full-time workers [1].

Ambulance personnel reported that they needed to be unrestrained to perform approximately 40% of any procedure during transport. Another report showed that only 37% of EMS providers could reach all equipment while seated, while 51% of them could reach some of the controls and pieces of equipment [2]. EMS personnel most often need to be in a standing position and unrestrained when taking care of the patient in the patient compartment, due to poor patient compartment design. In the present study, 90% ($n = 26$) of the checklist participants reported the absence of a sliding chair in ambulances in their workplaces.

According to the National Highway Traffic Safety Administration, 84% of EMS providers in the patient compartment were not restrained [3]. Another study showed that, when they were not taking care of the patient, 36% of EMS providers used restraint systems most of the time, but only 3% wore a restraint when treating the patient. In this situation, a sudden stop or crash can lead to serious or fatal injury for the EMS providers [1]. Not using restraints may increase the number of work-related injuries in EMS providers' experience, especially in the back cabin of the ambulance. In the present study, 87% (n

Table 2. Demographic analysis of the survey participants.

Gender	Count (n) & percent (%)	
Female	279	(34%)
Male	553	(66%)
Total	832	(100%)
Job description	Count (n) & percent (%)	
Emergency medical technician (EMT)	238	(29%)
Paramedic	592	(71%)
Total	830 #2-BR	(100%)

#2-BR = The number represents the participants who did not answer the question; BR = blank response.

Table 3. Comparison of similar questions from the survey and the checklist.

Question	Survey participants (832)				Checklist participants (29)				p Value
	YES		NO		YES		NO		
	(n) & (%)				(n) & (%)				
Perform effective Cardiopulmonary Resuscitation while restrained?	49	6%	783	94%	3	10%	26	90%	0.4119
Live camera in patient compartment #2-BR	147	18%	683	82%	4	14%	25	86%	0.8042
Approach defibrillator/monitor from seated position and while restrained #4-BR	251	30%	577	70%	8	28%	21	72%	0.8395
Clear communication between the driver and EMS provider in the patient compartment #1-BR	227	27%	604	73%	7	24%	22	67%	0.8335
Patient compartment is fire-resistant #3-BR	77	9%	752	91%	5	17%	24	83%	0.1862
Patient compartment free of all sharp projections	501	60%	331	40%	8	28%	21	72%	0.0008
Airbags in patient compartment #3-BR	64	8%	765	92%	1	3%	28	79%	0.7180
Driver compartment provides clear side, rear, front view #3-BR	216	26%	613	74%	9	31%	20	69%	0.5252
Two fire extinguishers in the ambulance	583	70%	249	30%	13	45%	16	55%	0.0067
Ability to load another patient without any risks #2-BR	508	61%	322	39%	5	17%	24	83%	0.0001
Cot system to reduce movement of the patient during incidents/accidents #1-BR ²	234	28%	597	72%	8	28%	21	72%	1.0000
Easy accessibility to all equipment while seated and restrained #2-BR	110	13%	720	87%	3	10%	26	90%	1.0000

#2-BR = The number represents the participants who did not answer the question; BR = blank response.

Table 4. Survey questions and answers.

Question	YES		NO	
	(n) & (%)			
Seat allows EMS provider to reach all of patient's body while restrained #2-BR	52	6%	778	94%
Cot supports safe loading and unloading	135	16%	697	84%
Emergency door release in rear cabin	168	20%	664	80%
Equipment labeled for easy access #4-BR	143	17%	685	83%
Drawers fail to keep equipment and tools from falling #1-BR	633	76%	198	24%

#2-BR = The number represents the participants who did not answer the question; BR = blank response.

Table 5. Checklist questions and answers.

Question	YES		NO	
	(n) & (%)			
Four-point seat belt in the bench seat	2	78%	27	93%
Four-point seat belt for cabin seat	2	7%	27	93%
Seat belt for pediatric patients	3	10%	26	90%
Power load cot system	3	10%	26	90%
Cot system remains in place in +20% g-forces	7	24%	28	76%
Equipment is stored within 12 inches of the patient	9	31%	20	69%
All control devices accessible while seated and restrained	9	31%	20	69%
Emergency release for door and drawers	8	28%	21	72%
Automatic doors and drawers	1	3%	28	97%
Patient compartment considered noise cancelling	1	3%	28	97%
System records accidents	1	3%	28	97%
Cockpit provides easy access for the left-hand driver	8	27%	21	73%

= 720) of EMS providers in the survey indicated that they could not access all equipment while they were seated and restrained. A very similar number of the checklist participants, 90% ($n = 26$), reported the same result. Also, 94% ($n = 778$) of participants in the survey said they cannot reach all parts of the patient while they were seated and restrained.

Another study found that the current ambulance designs prevented EMS providers from providing perfect care to patients while seated and restrained, increasing the rate of fatal injuries of personnel to around 83%. This study also reported that severe injuries could result from unsecured equipment, such as the life pack, which can lead to traumatic brain injury [4].

A major problem with current ambulance designs, especially older ones, is lack of adequate restraint systems. A report published in 2011 showed that lap and shoulder belts were provided in only 32% of ambulances. In addition, four- and five-point restraint systems existed in only 16% of ambulances [2]. As shown in Figure 1, the majority of the participants in the present research survey, 70% ($n = 578$), said that their ambulances only had two-point seat belt systems. Another 23% ($n = 188$) said they had three-point systems, while only 6% ($n = 54$) said they had four-point systems (1%, $n = 10$, answered, "I do not know"). Consistent with the survey results, 7% ($n = 2$), of the checklist participants reported the

existence of four-point seat belt systems in ambulances at their workplaces.

Only 51% of the participants in one study said they could reach life packs from a seated position with no restraint [2]. In the present study, 70% ($n = 577$) of the survey participants reported that they could not reach the defibrillator/monitor while they were seated and restrained.

Previous studies showed that the floor height and design of the patient compartment must allow one EMS provider to load and unload the cot system without any injury, and the center of gravity should be low to eliminate any hazards [5]. In the present study, 84% ($n = 697$) of the participants in the survey replied that the cot system in their workplace did not allow one EMS provider to load and unload the stretcher without any injury over the long term.

According to the Civil Aviation Authority of Singapore Ground Vehicle Standard v.1.0, the interior design of the patient compartment must be waterproof and fire-resistant. The interior of the body must be free of all sharp projections, and fire extinguishers should be present in both the cockpit and in the patient cabin [6]. Participants were asked in both present survey and checklist about these points; 70% ($n = 583$) of the survey participants reported the presence of two fire extinguishers in their ambulance, while 45% ($n = 13$) of checklist participants

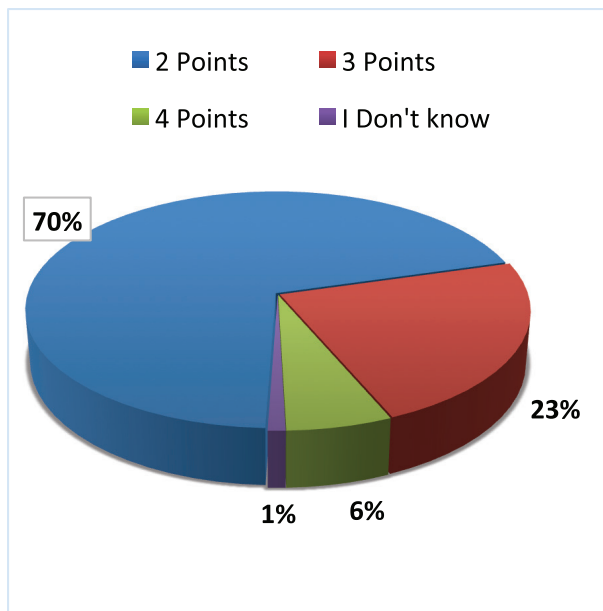


Figure 1. Answers to the survey question about seat belt systems (What kind of EMS provider's seat belt is in the back cabin of your ambulance?).

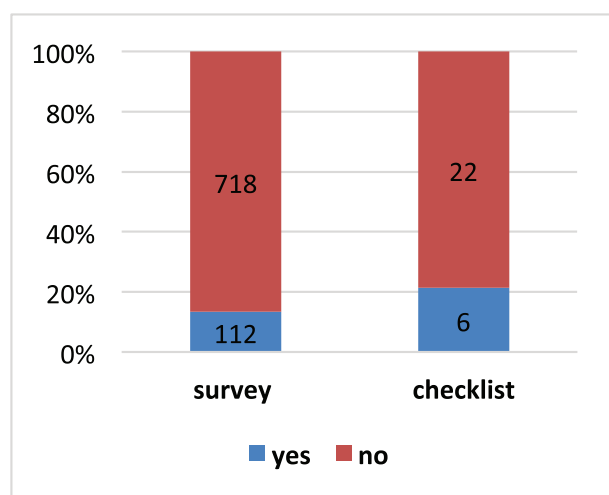


Figure 2. Answers to the survey and checklist questions about satisfaction with overall ambulance quality. (Are you satisfied with the quality of the ambulance in your agency?).

did. When asked about dangerous objects and sharp projections, 40% ($n = 331$) of the participants in the survey reported their presence, while 72% ($n = 21$) of checklist participants did. The vast majority of participants in the survey, 91% ($n = 752$), reported that the patient compartment was not fire-resistant, while 83% ($n = 24$) of checklist participants reported the same result.

According to Society of Automotive Engineers J3102 standards, the undercarriage of the patient compartment must be rigid to hold the cot system during crashes [7]. In the present study, 76% ($n = 28$) of checklist participants reported that their cot systems would not remain in place during an accident in which g-forces increased by 20%.

Research has also revealed communication problems in ambulances were common; 54% of EMS providers said they used mainly verbal means to communicate, while only 9% used radio communications [2]. In the present study, 73% ($n = 604$) of the participants in the survey replied that communication between the ambulance driver and a paramedic in the patient compartment was unclear. A similar percentage of checklist participants, 76% ($n = 22$), agreed.

Participants were asked about the quality of the ambulances used at their workplaces. Answers are shown in Figure 2.

The research touched on many aspects of ambulance safety and presented opinions of people working in various roles in EMS, such as EMTs, paramedics, department supervisors, and department heads. This diversity of opinions strengthens the results, especially in a vast area such as the Kingdom of Saudi Arabia. The latest and most important safety standards applied in the USA were used to measure and identify defects. The research had certain expected limitations, such as a lack of access to the ambulance standards of agencies that did not want to provide them.

Conclusion

This study suggests that the ambulance design in Saudi Arabia is associated with significant safety issues for both EMS providers and patients; the tools used in the research make this very clear. In the absence of ambulance design standards, it is recommended to introduce a new ambulance design based on the latest standards from the USA. Accordingly, it is suggested to improve ambulance safety by implementing the following features and measures; install a sliding chair allowing the EMS provider to move easily through the rear cab while restrained; equip EMS provider's chair with a five-point belt; use five-point belts in the cot system; provide a hydraulic stretcher to reduce musculoskeletal injuries to EMS providers in all types of ambulances; apply labels in the same places in all ambulances so that EMS providers can work equally effectively in any setting; provide noise canceling from the outside environment for more clear communication; use automatic doors and drawers for easy access; doors and drawers should have emergency releases; live and recording cameras should be present in the patient compartment; and air bags should be present in the patient compartment.

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List of Abbreviations

EMS	Emergency medical service
EMT	Emergency Medical Technician
USA	United States of America

Conflict of interest

The authors declare that they have no conflicts of interest.

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None.

Consent for participation

Written consent was obtained from all participants.

Ethical approval

The institutional review board of Imam Abdulrahman Bin Faisal, Dammam, Saudi Arabia (study number IRB UGS-2020-03-065), granted ethical approval.

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