Use of Ultrasound for Pre-hospital Care in Saudi Arabia: A National Survey

Lujain Hamza Arafsha, Nizar Ahmed Bakhashwain, Wejdan Essam Rahali, Sultan Alshali, Sohil Khaleel Saddiqi, Lama Sameer Maksood, and Abdullah R. Alharbi

Abstract—**BACKGROUND**

The use of pre-hospital ultrasound (U/S) in Saudi Arabia requires further elucidation.

AIM

We aim to assess the use of pre-hospital ultrasound, as well as its barriers and enablers, among emergency medical services (EMS) providers in Saudi Arabia.

METHOD

This is a cross-sectional observational study, based on a self-administered questionnaire distributed to emergency services personnel in Saudi Arabia between May and August 2022.

RESULT

420 EMS providers responded to this survey. 55.5% (n=233) of them had a positive attitude towards using ultrasound in their practice, although about 81% (n=341) had no ultrasound training. Barriers to the implementation of ultrasound included the need for training, difficulty using ultrasound in an ambulance, case overload, and shortage of personnel, among others.

CONCLUSION

Our findings indicate that emergency care providers have a positive attitude towards the use of ultrasound in the pre-hospital setting. Saudi Arabian EMS should invest in training, raising awareness, and establishing or strengthening existing regulations in this regard.

Index Terms—**Imaging, Emergency care, prehospital, Ultrasonography, Diagnostic Imaging**

I. INTRODUCTION

The use of ultrasound as a diagnostic technique has increased significantly since the 1980s. Although initially restricted to in-hospital settings due to the cost and operability limitations [1], technological advancements have since made these machines smaller, with improved image quality. Hence, portable ultrasound machines have become more feasible and efficient in diagnosing trauma and cardiovascular and abdominal conditions and other pathologies , as evidenced by many studies [2-4]. In addition, the increased feasibility and portability of ultrasound machines have been associated with their increased use outside the hospital, to investigate cardiac, peritoneal, and vascular conditions in military and emergency care [5, 6].

Many investigators have tested the durability and validity of ultrasound machines during emergency care. For instance, an ultrasound machine was used successfully, over the course of one year, to assess 100 patients receiving helicopter ambulance services [6]. Furthermore, even in extreme environmental conditions with high temperatures and frequent battery charging, the ultrasound machine worked continued to work without fault [7]. The enhanced portability of ultrasound machines has also led to a rapid increase in their pre-hospital use during rapid patient transport [1, 5, 8].

Lujain Hamza Arafsha is with Emergency Department, King Abdullah Medical City, Saudi Arabia, e-mail: Lujain.arafsha@hotmail.com (Corresponding author).

Nizar Ahmed Bakhashwain is with King Abdulaziz University - Faculty of Medicine, Saudi Arabia., e-mail: na7med@icloud.com

Wejdan Essam Rahali is with Umm Al-Qura University - College Of Medicine, Saudi Arabia., e-mail: Wejdan.rahali@gmail.com

Sultan Alshali is with King Abdulaziz University Medical School, Saudi Arabia., e-mail: sultankalshali@gmail.com

Sohil Khaleel Saddiqi is with Umm Al-Qura University- College of Applied Medical Sciences, Saudi Arabia., e-mail: Sohailkhaleel6@gmail.com

Lama Sameer Maksood is with Umm Al-Qura University- College of Medicine, Saudi Arabia., e-mail: Maksood.Lama@gmail.com

Abdullah R. Alharbi is with College of Medicine, Umm Al-Qura University, Saudi Arabia., e-mail: Abdullah.rabeh1998@gmail.com

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Training of emergency staff in the use of portable pre-hospital ultrasound machines was not challenging, and a short training period may suffice [9, 10]. Moreover, being a doctor or a paramedic has not proved a significant barrier to receiving ambulant or emergency care staff training in pre-hospital ultrasound. A study found a 100% success rate among paramedical staff in an ultrasound scanning course with an Observed Structured Clinical Encounter (OSCE) [11].

In Saudi Arabia, a positive attitude was found among Red Crescent health staff, including radiological technicians, emergency doctors, paramedics, and managerial staff. The majority of participants supported the use of pre-hospital ultrasound in ambulances to accelerate diagnosis and improve patient outcomes [12]. Furthermore, a qualitative study highlighted the barriers to the use of pre-hospital ultrasound in the Saudi Red Crescent and the National Guard Hospital. The majority of participants identified cost, training, and education as potential barriers to incorporating pre-hospital ultrasound into ambulant or emergency care [13].

As the qualitative research approach aimed to highlight the main barriers, a subsequent quantitative approach was recommended to estimate the magnitude of the problem. Thus, the present study aims to investigate the use of pre-hospital ultrasound and its determinants in a pre-hospital care setting and assess its barriers and enablers among Emergency Medical Services (EMS) providers in Saudi Arabia.

II. METHOD

This is a cross-sectional observational study based on a self-administered questionnaire. An Arabic version was compiled from two different validated resources [13, 14]. The study population was healthcare workers working as EMS providers in Saudi Arabia during the proposed study period of May to August 2022. We excluded students and paramedics working outside Saudi Arabia.

The number of participants required for this study was calculated using the following equation:

$$n = \frac{P(1-P)\,z^2}{d^2}$$

As no previous studies have reported on the prevalence of pre-hospital ultrasound use among EMS providers in Saudi Arabia, we assumed a prevalence of 50%. Thus, at a confidence level of 95% and an estimation error of 0.05, the sample size is calculated as follows:

$$n = \frac{0.50(1-0.50)\,1.96^2}{0.05^2} = 384 \text{ participants}$$

After adding 10% to compensate for item non-response, the final sample size was 422 participants. Data were analysed using the Statistical Package of Social Science SPSS, version 26. The chi-squared test was applied to evaluate the association between the determinants and the outcome variables, and any P-value < 0.05 was deemed an indication of a statistically significant association or difference. Data were collected through multiple techniques including snow bowling method and through social media platforms .

Participants were Consented to be part of the survey. Moreover, Ethical approval was sought from King Abdullah Medical City Research Center; IRB number 22-914.

III. RESULTS

Demographics:

Out of 422 targeted participants, 420 emergency service providers responded to the survey, accounting for a 99.5% response rate. The region where the respondent's practice is shown in Figure 1. Of our sample, 86% were male (n=353), the majority (n=259) were aged below 36 years, and only 8.6% were older than 40 years, as illustrated in Table 1. More than half the respondents were paramedics, while fewer than 1% were paramedic consultant. In addition, about 57% have fewer than five years' work experience, while 10.5% have more than 15 years' experience (Table 1).

Baseline characteristics of the EMS practice and setting:

A. Scoop and run vs stay and play

82.9% of respondents (n=348) reported treating the patient on the scene and then transferring them. Less commonly, 6.9% (n=29) reported treating the patient without the need for transfer. The latter represents 17 EMS specialists, 6 EMS technicians, and one physician; the balance identified themselves as 'other'.

B. Experience with intravenous cannulation

Intravenous catheter insertion was acknowledged as a task of emergency service providers by 71% (n=298) of respondents; of these, only 19.7%(n=58)

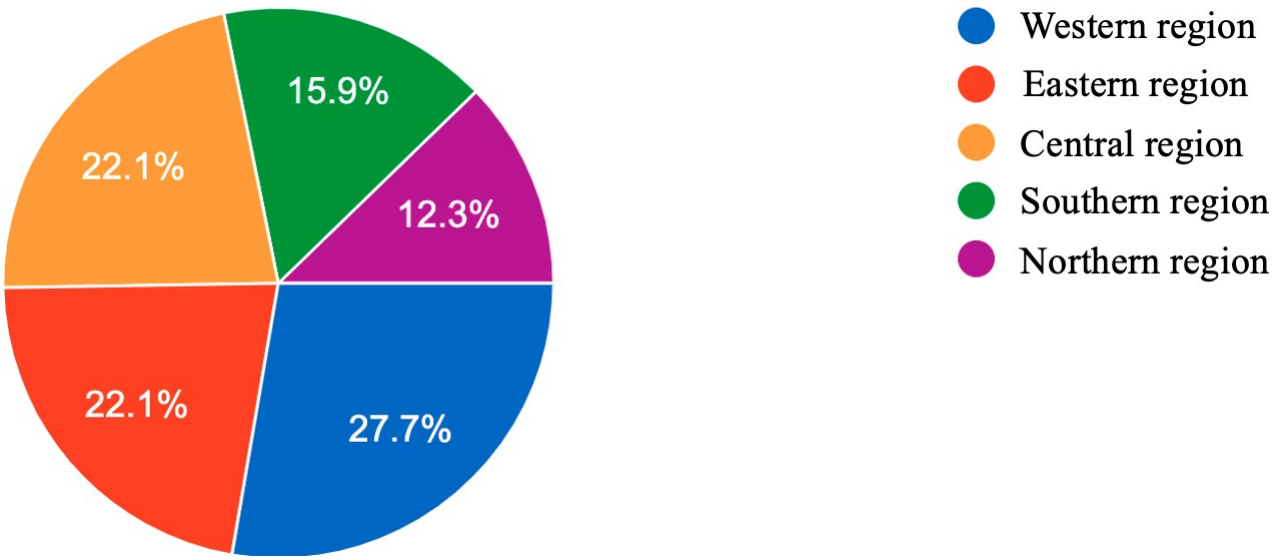

Fig. 1. Respondents' region of practice

Table 1. Demographic characteristics of respondents

Characteristics	Frequency	Percent (%)
Age group		
21-25	109	26.0
26-30	150	35.7
31-35	87	20.7
36-40	38	9.0
> 40	36	8.6
Profession		
Emergency medical technician	99	23.6
Paramedic	228	54.3
Senior paramedic	12	2.9
Paramedic Consultant	3	0.7
Medical assistants	35	8.3
Doctors	25	6.0
Others	18	4.3
Work experience (in years)		
< 5	241	57.4
6-10	82	19.5
11-15	53	12.6
16-20	33	7.9
> 20	11	2.6
Number of times the respondent has transferred patients		
< 5	64	15.2
6-10	41	9.8
11-15	26	6.2
16-20	12	2.9
> 20	277	66.0

reported having training in this task. The failure rate of intravenous catheter insertion varied from < 5 times, as reported by 41.5% (n=66), to > 20 times in 27.7% (n=44) of respondents.

C. Ultrasound experience and training among emergency care providers:

About 81% (n=341) had no abdominal and chest ultrasound training, while 55.7% (n=234) had no experience, as illustrated in Table 2. We also noted that 55.5% (n=233) had a positive attitude towards using ultrasound in their practice.

Factors related to willingness to use pre-hospital ultrasound:

Our investigation revealed that, of all the Saudi regions, respondents in the eastern region were the least willing to use ultrasound in the emergency setting; X^2 (4, 420)=12.3, p = 0.015.

Moreover, Emergency medical technicians and medical assistants were less enthusiastic than Paramedics and physicians; X^2 (6, 420) = 40.1, p = <0.001.

Respondents with experience in the use of ultrasound (irrespective of experience) showed more willingness, X^2 (4, 420) = 8.9, p = 0.030; as did those with ultrasound training, X^2 (1, 420) = 11.0, p = 0.001. Finally, those who identified themselves as responsible for intravenous cannulation were also more willing to use ultrasound; X^2 (1, 420) = 13.0, p = <0.001.

Age and gender, on the other hand, were not significantly associated with willingness to use ultrasound (p=0.699 and 0.888, respectively). We also noted that work experience, having training in intravenous cannulation, and even the number of failed cannulations were not factors that influenced willingness to use ultrasound (p=0.071, 0.061, and 0.357, respectively) (Table 3)

Perceived barriers to the use of pre-hospital ultrasound:

Factors that emerged as barriers to using ultrasound are illustrated in Table 3. When these barriers were analysed with regard to the willingness to use ultrasound in the pre-hospital setting, only the cost of equipment was not significantly associated with the willingness/unwillingness to use pre-hospital ultrasound (p=0.75), as illustrated in Table 4.

IV. DISCUSSION

Our data revealed that more than half of first emergency responders in Saudi Arabia favour the use of ultrasound in pre-hospital care. It is noteworthy that more than half of the responders had training in abdominal and chest ultrasound, which can be attributed to self-learning and interest. This demonstrates a positive attitude towards using such devices irrespective of the training system.

Furthermore, we might infer that those participants who did not have a positive attitude towards pre-hospital ultrasound might lack an understanding of its usefulness. This notion is supported by the findings, in which one third of respondents were 'neutral' in supporting or refuting the role of ultrasound in the pre-hospital setting.

However, an in-depth inquiry into the enabling and hampering factors is required. Our findings noted that the respondent's willingness to use ultrasound was related to their experience in its use, previous training, profession, and their region of practice, rather than gender or age. For example, Emergency medical technicians and medical assistants, especially in the eastern region and those without prior experience or training in the use of ultrasound, were less enthusiastic about using it. Such respondents should be the target population for awareness initiatives.

Most respondents reported having the credentials to insert an intravenous cannula, but only a low percentage of them had received training. Such baseline knowledge should be considered before implementing training for ultrasound-guided cannulation. Furthermore, the lack of significant association between the number of failed cannulation attempts and the willingness to use ultrasound triggers questions surrounding the awareness of ultrasound-guided peripheral intravenous insertion, particularly its proven benefit of reducing the need for central venous catheter insertion [15,16].

Table 2. Ultrasound experience, training and attitude among emergency care providers

Characteristics	Frequency	Percent (%)
Have you had training in emergency abdomen/chest ultrasounds?		
Yes	79	18.8
No	341	81.2
How would you describe your experience in the use of emergency ultrasound?		
No experience	234	55.7
Poor experience	97	23.1
Moderate experience	51	12.1
Good experience	38	9.0
Do you support the use of pre-hospital ultrasound in emergency settings?		
Disagree	44	10.5
Neutral	143	34.0
Agree	233	55.5

Table 3. Association between emergency care factors and willingness to use prehospital ultrasound

Factors	Willingness to use pre-hospital ultrasound		Chi-square	P-value
	Yes	No		
Work experience in years				
< 5	145 (60.2)	96 (39.8)	8.6	0.071
6-10	36 (43.9)	46 (56.1)		
11-15	31 (58.5)	22 (41.5)		
16-20	17 (51.5)	16 (48.5)		
>20	4 (36.4)	7 (63.6)		
How do you assess your experience in using emergency ultrasound?				
No experience	117 (50)	117 (50)	8.9	0.030*
Poor experience	57 (58.8)	40 (41.2)		
Moderate experience	31 (60.8)	20 (39.2)		
Good experience	28 (73.7)	10 (26.3)		
Did you have training in abdomen/chest ultrasound in the emergency situations?				
Yes	57 (72.2)	22 (27.8)	11.0	0.001*
No	176 (51.6)	165 (48.4)		
Is it your task to put intravenous catheter?				

Yes	182 (61.1)	116 (38.9)	13.0	<0.001*
No	51 (41.8)	71 (58.2)		
If yes, did you have training in intravenous catheter?				
Yes	42 (72.4)	16 (27.6)	3.5	0.061
No	140 (59.1)	97 (40.9)		
If yes, how many time did you fail in putting intravenous catheter?				
< 5	44 (66.7)	22 (33.3)	4.4	0.357
6-10	16 (76.2)	5 (23.8)		
11-15	13 (59.1)	9 (40.9)		
16-20	2 (33.3)	4 (66.7)		
>20	27 (61.4)	17 (38.6)		

Table 4. Perceived barriers to pre-hospital ultrasound use in emergency care

Level of agreement	**Frequency (%)**	**Willingness to use pre-hospital ultrasound N (%)**		**Chi-square**	**P-value**
		Yes	**No**		
Cost of equipment is a barrier to pre-hospital ultrasound use					
Disagree or strongly disagree	73 (17.4)	48 (65.8)	25 (34.2)	5.2	0.075
Neutral	149 (35.5)	74 (49.7)	75 (50.3)		
Agree or strongly agree	198 (47.1)	111 (56.1)	87 (43.9)		
Cost of training is a barrier to pre-hospital ultrasound use					
Disagree or strongly disagree	112 (26.7)	80 (71.4)	32 (28.6)	18.9	< 0.001
Neutral	120 (28.6)	52 (43.3)	68 (56.7)		
Agree or strongly agree	188 (44.8)	101 (53.7)	87 (46.3)		
Lack of training is a barrier to pre-hospital ultrasound use					
Disagree or strongly disagree	136 (32.4)	111 (81.6)	25 (18.4)	57.0	< 0.001
Neutral	97 (23.1)	37 (38.1)	60 (61.9)		
Agree or strongly agree	187 (44.5)	85 (45.5)	102 (54.5)		
Difficulty of use in the ambulance is a barrier to pre-hospital ultrasound use					
Disagree or strongly disagree	115 (27.4)	104 (90.4)	11 (9.6)	83.1	< 0.001
Neutral	127 (30.2)	63 (49.6)	64 (50.4)		
Agree or strongly agree	178 (42.4)	66 (37.1)	112 (62.9)		

Lack of time is a barrier to pre-hospital ultrasound use					
Disagree or strongly disagree	61 (14.5)	48 (78.7)	13 (21.3)	22.8	< 0.001
Neutral	102 (24.3)	64 (62.7)	38 (37.3)		
Agree or strongly agree	257 (61.2)	121 (47.1)	136 (52.9)		
Overload of emergency cases is a barrier to pre-hospital ultrasound use					
Disagree or strongly disagree	59 (14.0)	41 (69.5)	18 (30.5)	6.1	0.048
Neutral	88 (21)	50 (56.8)	38 (43.2)		
Agree or strongly agree	273 (65)	142 (52)	131 (48)		
Shortage of personnel is a barrier to pre-hospital ultrasound use					
Disagree or strongly disagree	72 (17.1)	55 (76.4)	17 (76.4)	15.4	< 0.001
Neutral	87 (20.7)	44 (50.6)	43 (49.4)		
Agree or strongly agree	261 (62.1)	134 (51.3)	127 (48.7)		
Ultrasound is not an EMS task					
Disagree or strongly disagree	123 (29.3)	103 (83.7)	20 (16.3)	64.2	< 0.001
Neutral	128 (30.5)	68 (53.1)	60 (46.9)		
Agree or strongly agree	169 (40.2)	62 (36.7)	107 (63.3)		
Lack of regulations surrounding pre-hospital ultrasound is a barrier to its use					
Disagree or strongly disagree	49 (11.7)	38 (77.6)	11 (22.4)	10.9	0.004
Neutral	111 (26.4)	59 (53.2)	52 (46.8)		
Agree or strongly agree	260 (61.9)	136 (52.3)	124 (47.7)		
Lack of support from emergency management is a barrier to pre-hospital ultrasound use					
Disagree or strongly disagree	35 (8.3)	27 (77.1)	8 (22.9)	10.5	0.005
Neutral	116 (27.6)	54 (46.6)	62 (53.4)		
Agree or strongly agree	269 (64)	152 (56.5)	117 (43.5)		
Lack of communication with receiving hospitals is a barrier to pre-hospital ultrasound use					
Disagree or strongly disagree	114 (27.1)	79 (69.3)	35 (30.7)	12.3	0.002
Neutral	111 (26.4)	54 (48.6)	57 (51.4)		
Agree or strongly agree	195 (46.4)	100 (51.3)	95 (48.7)		

A prior understanding of the barriers is crucial to the implementation of any initiative. Our analysis revealed training and system barriers; however, incongruent with a comparative study that found that the cost of equipment and training to be the most significant barriers to implementing ultrasound [14], we did not note the cost of equipment as an essential factor, perhaps due to a lack of knowledge among our participants about its costs.

Although the cost of training emerged as a barrier, it did not negatively influence the participants' willingness to use such devices. The same was noted in relation to the other barriers; that is, lack of training, difficulty using ultrasound in the ambulance, overload of emergency cases, shortage of personnel, the disagreement that ultrasound is a task of first emergency responders, lack of regulations, and lack of support from management.

The lack of communication with the receiving hospital, as a barrier to pre-hospital ultrasound use, requires further explanation. An essential rationale for using pre-hospital ultrasound is the diagnosis of life-threatening conditions. Early detection of internal bleeding, evidenced by a positive focused assessment sonography of trauma (FAST), triggers the activation of the trauma team and blood bank, allowing for the timely and efficient management of the patient. However, where there is no means of communicating the ultrasound findings, its usefulness fades. Most hospitals have installed direct methods of communication with receiving hospitals to inform them of such findings before the patient's arrival, and such methods should also be imple mented within Saudi Arabia's EMS system.

Pre-hospital care in Saudi Arabia appears to involve treating the patient on the scene and then transporting them to the nearest hospital. Such findings align with a 'scoop and run' approach, although in this system, the patient receives some treatment prior to transfer [17]. Those who reported treating the patient without having to transfer them raise questions about the medical directive they follow: whether they have the autonomy of decision, or whether the treatment and discharge were directed by oversight. Further research on this point is crucial for quality assurance.

One future direction for pre-hospital ultrasound is its utilization in cases of cardiac arrest, to terminate resuscitation [8, 18]. A previous study concluded that, even with minimal training, paramedics could obtain a basic cardiac ultrasound, although it might result in longer pauses between chest compressions [19-21]. However, the lack of legislation regarding the announcement of patients' death on the scene using objective measures such as ultrasound and rhythm strip needs to be addressed both nationally and internationally.

This study is limited by a few factors that merit consideration. First, the descriptive cross-sectional nature of the study with a self-administered survey for data collection could not provide optimal reliability and may lead to recall bias. Also, our questionnaire was restricted to close-ended questions, which could mask the complexity of the topic under investigation. On the other hand, the response rate and the wide geographical distribution of the respondents argue for the generalisability of the findings.

V. CONCLUSION

Emergency medical services in Saudi Arabia should invest in awareness, training, and the establishment of regulations or the strengthening of existing ones. A feasibility study should be conducted to trial ultrasound inside the ambulance but should also be complemented by an evaluation of its usefulness. Furthermore, hospitals, being an integral part of the EMS system, need to invest in systems of communication with pre-hospital personnel. The quality of care provided must be considered from the scene, rather than from the point of triage.

Further measures should also be taken to implement training programmes in the use of pre-hospital ultrasound use.

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