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## Article

# Emergency Medical Providers' Knowledge Regarding Disasters during Mass Gatherings in Saudi Arabia

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**Abstract:** The Hajj is a recurring annual mass gathering event with over three million attendants taking place at the same site for six days. During such events, major incidents and disasters can occur. It is crucial that Emergency Medical Services providers are sufficiently trained regarding disaster preparedness to respond appropriately. EMS-providers of the Saudi Red Crescent Authority who worked during the Hajj in 2016 were asked to complete a web-based survey, utilizing predetermined responses with 5-point Likert scale responses. Seven hundred respondents identified real disasters as the most common source of information about disaster preparedness and also indicated that a disaster management course was the most desired course for improving knowledge. The study has also highlighted a list of Life Support Courses providers feel should be offered as part of a disaster response training package. These findings highlight the importance of continuing education, which may be obtained through short, focused courses, or for small numbers of specialists through higher educational degrees, such as masters or doctorates. This study also examines the importance of media and its impact on increasing knowledge and awareness for EMS-providers. Consideration should be given to pairing novice providers with experienced personnel to disseminate knowledge and practical experience during Hajj missions. Simulated disaster drilling should be considered to introduce novices to the stress of mass casualty disaster response.

**Keywords:** disaster preparedness; disaster knowledge; emergency medical system; Saudi Red Crescent authority

## 1. Introduction

The Hajj is one of the few recurring annual mass gathering religious events which attract greater than 2 million attendees. This falls into the category of "Mega Mass Gathering" as proposed by Molloy in 2009 [1]. Such gatherings require tremendous forward planning even if they are recurring events [2]. Annual mass migration of pilgrims into Saudi Arabia from well over a hundred countries requires significant logistical efforts from a health security perspective. The Grand Mosque itself can hold at maximum 1.2 million pilgrims at one time for prayers [3]. The Hajj is a true pilgrimage in that millions of pilgrims migrate on foot during the event to visit a number of Holy sites from Arafat to the Grand Mosque

participating in ceremonies which can involve walking from 5–15 km daily over a 6-day period adding to the medical challenges involved in dealing with such large crowds. This can lead to crowd densities exceeding 5–6 per square meters for extended periods of time generally moving in the same direction which Al-Hadhira found can be a precursor and/or predictor of stampede occurrences [4].

Working during the Hajj in any capacity is a very unique and challenging situation due to the enormous crowds speaking multiple languages from different regions in the world, each with idiosyncrasies in hygiene, culinary habits, and other customs. Healthcare providers, in particular, are usually faced with an overload of admissions at any time. Since the Hajj is a once-in-a-lifetime and expensive religious obligation, many pilgrims are elderly and already sick [3]. It is sometimes difficult to find interpreters who understand the particular language of the patient [5]. As communication is key to helping the patient, this presents a challenge for medical staff. This wide diversity of the groups can also present additional problems, such as having to track outbreaks of certain diseases in pilgrims from certain regions. Since the event takes place outside in soaring temperatures, often in harsh conditions, and over several days, participants and staff can become ill. Patients frequently experience upper respiratory tract infections. Other illnesses such as asthma and chest pain are also frequent, creating further difficulties for medical staff who must treat multiple cases of severely ill people during the event while facing difficulties in transportation, re-supply, and refrigeration.

It should be noted that Hajj and Ramadan are seasons of special concern in Saudi Arabia. During the Hajj season, the sudden increase in Makkah's population can strain the city's health services. This may leave the city under-prepared to respond to a disaster occurring at this time.

Al-shareef and Alsulimani state that Makkah has been the site of multiple disaster incidents in recent decades highlighting room for improvement in most aspects of the region's hospital emergency operation plans [5]. This is not unique to Saudi Arabia as Higgins also found in Kentucky, USA in 2004 when he reviewed hospital preparedness for mass casualty incidents [6]. Dedicated health care services are essential during mass gathering events with specific additional emphasis on public health surveillance and response for infectious disease outbreaks [7]. Emergency Medical System (EMS) personnel should be trained appropriately for such events to facilitate effective response in an effort to minimize fatalities. Alrazeeni reported that Saudi EMS students felt unprepared to respond to disastrous events and remarked they felt unconfident in their abilities to respond adequately. Despite this EMS and its appropriate oversight has a vital role to play in disaster response [8].

The Saudi Red Crescent Authority (SRCA) is the sole provider of EMS within the Kingdom of Saudi Arabia directed by its president, Prince Faisal bin Abdullah bin Abdul-Aziz Al Saud. The National Guard, the Military, the Ministry of Health and other agencies, provide additional emergency and transportation resources for the event [3].

In 2016, the SRCA had established 110 ambulance stations in the holy sites (Arafat, Mizdalafah, and Mina) and along the roads leading to them [9]. Video surveillance crowd monitoring is used to identify critical incidents requiring an EMS response and an additional 290 ambulances and 25 motorbikes were used to provide fast services to pilgrims as well as mobile physician response teams. Leggio et al. outlined in his JEMS paper that in 2012 during Hajj, the SRCA dispatch service answered 57,420 calls for assistance, tasking 20,210 responses, providing medical care to 18,230 patients. Three of these 34% were transported to hospitals a number of which are just stood up for the 6-day event and require significant logistics to task, staff and support some 400–600 beds purely to service the Hajj event itself [10]. A treat and release program was sufficient to manage a further 39% of the over 18,000 cases mentioned above.

With the number of pilgrims growing annually to a current figure of almost 3 million Hajjees, this concentration of humanity in a relatively small area housed in temporary accommodation for the duration of the event requires intense crowd control management

to avoid recurrence of previous stampedes and crowd related disasters. Table 1 below with data sourced from numerous academic papers as well as BBC news unfortunately highlights how such large crowds can lead to significant mass casualty incidents resulting in death tolls in the thousands on occasion. A fire in the tented community resulted in 200 deaths in 1975, a similar fire in 1997 resulted in over 300 deaths. Due to the mass migration of millions over a predetermined path stampedes have been a significant challenge and resulted in large numbers of casualties and unfortunately deaths [7,8].

**Table 1.** Stampedes and Fires during Hajj.

Type of Incidents	Date of Incident	Deaths	Injuries
An exploding gas cylinder caused a fire in a tent community	December 1975	200 pilgrims	Data not available.
A stampede inside a pedestrian tunnel (Al-Ma'aism tunnel)	2 July 1990	1426 pilgrims	N/A
A stampede at the stoning of the Devil ritual	23 May 1994	270 pilgrims	N/A
A tent fire in Mina	15 April 1997	343 pilgrims	1500 injured
A stampede at Jamarat Bridge	9 April 1998	118 pilgrims	180 injured
A stampede at the stoning of the Devil ritual	5 March 2001	35 pilgrims	N/A
	11 February 2003	14 pilgrims	N/A
	1 February 2004	251 pilgrims	244 injured
A stampede at Jamarat Bridge	12 January 2006	346 pilgrims	289 injured
A stampede at Mina	24 September 2015	769 pilgrims	934 injured

The densely packed crowds make effective EMS response almost impossible as Ahmed, Arabi, and Memish found in researching the 1990 event. Their research highlighted that medical crews were unable to reach the injured as access to the sites was inadequate, which suggested a future emphasis on access for EMS and medical services at events [9]. The engineering challenges posed by such migrations has resulted in development of new pedestrian bridges with multiple levels to manage crowds more effectively. Khan in his reflection of the 2015 disaster, emphasized the vital importance of the planning process in order to apply lessons learned and engineer out obvious pinch points where possible to avoid bottlenecks of pilgrims [10–12].

Currently, there is a need for a comprehensive national plan for disaster management in Saudi Arabia. In addition, there is a paucity of literature on the provision of EMS during Hajj [13]. It is essential for EMS providers and other health care professionals to enhance their knowledge and skills in mass casualty incident management and disaster preparedness, which is a key concept in emergency and disaster management. At present, most healthcare workers in Saudi Arabia lack practical experience in disaster response and planning [14].

The aim of this study was to explore EMS providers mass gathering disaster preparedness information sources, and further to determine what educational materials providers feel should be developed and/or provided to them.

## 2. Materials and Methods

### 2.1. Sample Population

The survey was directed to 1550 SRC-EMS-providers and 100 physicians who worked at the 2016 Hajj. All respondents agreed to participate in the survey. All of the surveyed were men due to the Saudi Arabia restrictions where there are no Female EMS providers at the SRCA.

## 2.2. Study Design and Location

The study utilized an online Qualtrics survey instrument administered to EMS-provider participants from the Saudi Red Crescent Authority who worked during the 2016 Hajj. The survey was distributed to the prospective sample from March until May 2017.

For this study, a cross-sectional survey design was utilized. The quantitative research method is appropriate for the several reasons, as follow. First, quantitative methods in general afford a researcher a reliable objectivity, second, a cross-sectional survey is appropriate for analysis of data obtained from a large sample, third, it allows the researcher to generalize results to larger populations.

## 2.3. Questionnaire

In the first step of this study, all authors took part in a literature review to identify the critical dimensions for developing a questionnaire. For the review purpose, the following keywords: Disaster Preparedness; Knowledge; Emergency Medical System; Saudi Red Crescent Authority alone or in combination were used. The acquired data from WEB OF SCIENCE, PUBMED and SCOPUS were organized, categorized, and mapped.

In the second step, five experts in the fields of EMS who have worked with SRCA in Saudi Arabia in the areas of disaster preparedness, research, mass gatherings, and measures from University of Louisville reviewed the questionnaire's validity. A cover letter was attached to the questionnaire to explain the purpose of the study, the items on the questionnaire (including a reference list of reviewed literature) and a summary of the methodological procedure of the research. As well, the questionnaire's items were reviewed to ensure a comprehensive evaluation of the levels of knowledge disaster preparedness for mass gatherings among SRC-EMS providers in Hajj season 2016. To obtain reliability indicators, a Cronbach Alpha was computed for each of the items that target level of knowledge of disaster preparedness for mass gatherings among EMS providers in the Hajj season 2016. Higher scores correspond to more reliable scales. 0.7 is an accepted reliability coefficient, but lower thresholds are sometimes used in the literature.

The survey consisted of three questions: (1) What information source did the participant use to obtain their knowledge of disaster preparedness for mass gatherings, (2) which specific disaster preparedness materials and activities should be developed to enable EMS providers to prepare for future mass gathering disasters and (3) what kind of educational courses should be taken to prepare for mass gathering related disasters. These items were presented in Likert scale format 1–5 (1 = least useful to 5 = most useful).

## 2.4. Inclusion and Exclusion Criteria

To obtain the most transparent results the participants had to meet the following criteria: (1) Be 21 years old or older, (2) be currently licensed by the Saudi Health Commission as a certified EMS provider or as a Paramedic, and (3) be a full-time employee of SRCA. The participants were identified by convenience sampling from the 1650 SRC-EMS providers and were selected on availability rather than probability.

EMS-providers engaged by other agencies during the Hajj season, such as the Ministry of Health, the National Guard, and the Ministry of Defense were not eligible for inclusion as participants in this study due to the local law restriction (where authors couldn't get access to the data).

## 2.5. Data Collection

An online survey provided inexpensive and efficient access to a large population sample. For widely distributed populations such the SRC-EMS providers, who are recruited from across Saudi Arabia and who return to their home bases after Hajj season, prior research has shown benefits attached to online survey as compared to paper-based surveys, such as low cost and flexibility [7,9]. Social network technology and electronic communication were utilized to invite the SRC-EMS providers to be research participants. Prospective participants received the survey questions by e-mail or by receiving a broadcast link. To

encourage them to respond and participate, the link led to a Qualtrics survey in which data can be entered anonymously every two weeks. Participants received no financial reward or compensation for involvement in this study. One thousand, six hundred fifty participants were provided with the survey, and 700 completed it (42% response rate).

### 2.6. Statistical Analysis

The Statistical Package for the Social Sciences (SPSS-21.0 IBM) was used for data analysis. Frequency analysis, basic descriptive statistics, and one-way Analysis of Variance (or ANOVA) were used to evaluate the data.  $p$ -Value  $\leq 0.05$  was considered significant.

### 2.7. Ethical Considerations

The information included the study's purpose, the voluntary nature of their participation, and strict confidentiality and secure data storage. The survey responses were anonymous, and all respondents agreed to participate in the survey. Written consent was obtained from participants who completed the online questionnaire. The study complied with the ethical principles stipulated by the Kingdom of Saudi Arabia. Prior to data collection, approval (number: 17.0120) was obtained from the University of Louisville's Institution Review Board (IRB).

## 3. Results

The present study included 700 of 1650 participants (42%). Age, nationality, educational level, and EMS provider designation are shown in Table 2. Gender was not reported as there are no Female EMS providers at the SRCA. Saudi law does not permit unchaperoned women to go on the Hajj. As well, due to the existing law, women are not allowed to work at such an event. As shown in Table 2 below 52 (7.4%) had high school education, 23 (3.35%) had master MS level qualifications with the majority of respondents possessing diploma or bachelors level qualifications. The majority of respondents were Saudi nationals (98.6%).

**Table 2.** Level of education, experience, and EMS training level of participants.

		Frequency (n)	Percentage (%)
Nationality	Saudi	690	98.6
	Non-Saudi	10	1.4
EMS Provider Designation	First responder	62	8.9
	EMS-TECH	459	65.6
	EMS-Paramedic	158	22.6
	Physician	21	3
Level of Education	High school	52	7.4
	Diploma + 2 years	198	28.3
	Diploma + 3 yrs	253	36.1
	BS	169	24.1
	MS	23	3.3
	Other	5	0.7
Age	Less than 25 years	7	1
	25–29 years	215	30.7
	30–34 years	232	33.1
	35–39 years	135	19.3
	40–44 years	59	8.4
	45–49 years	28	4
	50 years and above	24	3.4

Table 3. Reveals information sources regarding disaster events. The most common information source for EMS providers was real disaster with a mean  $\pm$  SD of  $4.31 \pm 0.977$ , followed by drills practice with a mean  $\pm$  SD of  $4.25 \pm 1.046$ .

**Table 3.** Information Sources.

Source of Knowledge	Mean *	Std. Deviation	Rank
Real disaster	4.31	0.977	1
Drills practice	4.25	1.046	2
Continuing education	4.17	1.052	3
Co-workers, friends, or family	4.05	1.104	4
Institution or University courses	3.85	1.155	5
Media (TV, social media, radio, or internet)	3.03	1.184	6

\* Average of respondents' answers for every statement.

Table 4 outlines which form of specific disaster preparedness courses/materials respondents feel should be developed for EMS providers to prepare for future mass gathering disasters. The highest scoring item was disaster management course (mean  $\pm$  SD = 4.54  $\pm$  0.829), followed by drills practice (mean  $\pm$  SD = 4.44  $\pm$  0.9) with information pamphlets (mean  $\pm$  SD = 3.11  $\pm$  1.266) being the lowest scored item.

**Table 4.** Specific disaster preparedness courses/materials that should be developed for EMS providers.

Courses	Mean *	Std. Deviation	Rank
Disaster management courses	4.54	0.829	1
Drills practice	4.44	0.900	2
Disaster management protocol	4.31	0.952	3
Onsite visit	4.07	1.031	4
Information website	3.20	1.169	5
Information pamphlets	3.11	1.266	6

\* Average of respondents' answers for every statement.

Participants scored incident command system as the highest ranked course which should be taken in preparing for a disaster (mean  $\pm$  SD = 4.45  $\pm$  0.8) and the item ranked lowest was infection control (mean  $\pm$  SD = 3.98  $\pm$  1.128), as shown below in Table 5.

**Table 5.** Educational courses that should be taken in preparing for a disaster.

Educational Courses	Mean *	Std. Deviation	Rank
Incident command system	4.54	0.800	1
Field triage	4.50	0.787	2
Advance Trauma Life Support	4.47	0.811	3
Prehospital Trauma Life Support	4.30	0.879	4
Advance Cardiac Life Support	4.26	0.892	5
Basic Life Support	4.23	0.952	6
First Aid	4.19	1.026	7
Infection Control	3.98	1.128	8

\* Average of respondents' answers for every statement.

#### 4. Discussion

Lund and Turrís highlight how provision of mass gathering medical services at events such as concerts and large sports arenas can be a practical method of enhancing disaster preparedness in Canada [14]. Molloy has previously stated that planned mass gatherings should be treated as a form of organized disaster and regular involvement in planning such services will assist a regions ability to respond to true mass casualty events [1]. It is not unusual that SRCA EMS providers indicated that they feel real disasters or responding to an actual disaster event would be the best source of information for them. From the questionnaire it is not clear whether this means their personal involvement in real disasters as described by Lund et al or whether it means by reviewing case studies/reports of real disasters or in a worst-case scenario through their involvement in an actual response to a

disaster event [14]. Alsulimani demonstrated through his work examining hospital emergency operation plans in the Mecca region that Government hospitals were more likely to review their plans annually and drill more frequently than private hospitals [5]. Ciottone in his seminal textbook “Disaster Medicine” highlights the importance of frequent drilling to improve emergency preparedness, disaster response and team cohesiveness [15]. Ciottone also states “it is not the plan but an involved planning process” that is of vital importance for an institutions ability to effectively respond to threats, hazards and disasters. In this study we highlight how SRCA EMS personnel believe they gain knowledge from drills practice and how they also wish to be involved in further drilling, disaster management courses and disaster management protocols [15]. Local emergency management officers should take solace in this willingness to engage in further training and act upon this at the earliest opportunity to build momentum prior to the next Hajj event.

According to Gebbie, the first step towards preparedness for disaster is the identification of which health care providers should be knowledgeable about the risks, and also which role each provider is expected to play in case of a disaster [16]. Most of the studies about disaster preparedness concern health care providers, especially nurses [17–19]. There are many variables in the level of disaster preparedness of health care workers such training, types of training, providers’ experience, level of education, as well as the sources of any knowledge they might possess [20–22].

This study has highlighted a list of Life Support Courses providers feel should be offered as part of a disaster response training package. Consideration should be given to adding Major Incident Medical Management and Support (MIMMS) to that list also [23]. This is a 3-day practical course introducing field management principles gained over 25 years in the UK in the structure of similar life support courses like Advanced trauma life support (ATLS) and Advanced Cardiovascular Life Support (ACLS) [24]. Incident command was the top scoring item in the educational course category, and this has been flagged by many previous studies [25–32]. Numerous models exist and it would be appropriate for a country to decide which command system the country is using nationally prior to local agencies developing training policies and protocols [33–35].

Prior work by Wisniewski examined nursing familiarity with emergency response to large scale events found that continuing education, specific university courses and also the media contributed to their personal development [36]. Sarin and Ciottone in their review of emergency medicine residency programs found that even in the US there is no uniform approach to disaster medicine education among residency programs however drills and seminars were the most frequent methods used [37].

This study provides valuable insights into understanding predictive factors associated with better levels of general knowledge of disaster preparedness for mass gathering and disaster preparedness for the Hajj of 2016. These predictive factors determined the level of knowledge of disaster preparedness for SRC-EMS providers. The following characteristics for general knowledge of disaster preparedness should be included; highest level of education, EMS certification level of provider, number of times a provider has worked at the Hajj, number of workshops ever attended, time elapsed since last workshop, number of workshops and drills attended for disaster preparedness for mass gatherings [38].

These findings highlight the importance of continuing education, which may be obtained through short, focused courses, or for small numbers of specialists through higher educational degrees, such as masters or doctorates. This study also examines the importance of media and its impact on increasing knowledge and awareness for EMS-providers. As co-workers are also mentioned as a significant source of knowledge consideration should be given to pairing novice providers with experienced providers during the Hajj mission to facilitate such knowledge transmission and sharing of valuable experiences and lessons. Immersive simulation training should be considered where there are low risk/no risk consequences to incorrect medical triage decisions to improve skills and decision making in the disaster setting [39–45]. MIMMS offers such options with their practical exercises with casualties and through the training process. Regular tabletop drills

will also assist the decision-making process for large numbers of personnel at relatively low cost [46–49].

Finally, this study suggests potential recommendations for the Saudi government to improve SRCA EMS providers' knowledge of mass gathering disaster preparedness through focused topics for education and training. These recommendations can be applied by the Saudi government to improve their EMS system.

## 5. Strengths and Limitations

This study is the first empirical study examine the role of SRC-EMS providers in disaster preparedness for the Hajj season in Saudi Arabia. As such, it provides new valuable information on the perceived preparedness of SRCEMS providers during the Hajj against role standards as stated in the emergency plan of the SRCA. This study identified specific health education and training programs deemed appropriate and relevant by the SRC-EMS providers. Finally, this study is the first study to investigate predictive factors associated with increasing knowledge of disaster preparedness for the SRC-EMS providers.

This study was focused on assessing SRC-EMS providers for disaster preparedness for mass gatherings and found various different levels of knowledge among EMS providers. It will be beneficial if other studies assess other Saudi EMS providers who work for other agencies such MOH, Saudi National Guard, and Ministry of defense because all of them work in a second line capacity with SRCA when disasters happen during the Hajj.

In the questionnaire there was no space for free text thus respondents did not have the opportunity to add topics they felt of relevance. The prepared list of educational courses omitted to include MIMMS from the outset, a disaster specific short training course run on the same principles as ATLS/ACLS systems which medical and paramedical providers are very familiar with. There was no space for answers to be explained thus it is not clear where respondents indicate real disasters as their optimum source of information whether this relates to their personal experience in a real disaster, reading after action reports or journal articles or even viewing documentaries or television shows relating to real disaster events which have taken place.

## 6. Conclusions and Recommendations

This was the first Saudi study that explored information source types SRCA-EMS providers use for mass gathering related disasters. Real disasters were highlighted as the most frequent source of knowledge however it is not clear if this relates to personal involvement or reading reports or viewing video material from disaster events and further research is definitely required into this specific point. SRCA-EMS providers have a unique opportunity worldwide knowing that the Hajj takes place annually, the dates are known in advance and that significant operational planning takes place from the minute the current year's event ends. Knowing there will be an event the next year allows for incremental stepwise knowledge and experience gains to be leveraged unlike in single one-off mega mass gathering events. Consideration should be given to pairing novice providers with very experienced EMS providers to disseminate knowledge and experience [50–55]. Simulated disaster drilling should be considered to introduce novices to the stress of mass casualty disaster response [56–64].

Moreover, further research is required to determine whether sequential annual service provision leads to enhanced responder comfort level in their respective preparedness for mass gathering disasters as well as examination of the gap between having a plan and staff's familiarity. Although a necessary process, honest assessment of shortcomings is required. Finally, this study provides a basis for further research into disaster preparedness as a whole. The results for this specific population of SRC-EMS providers demonstrated a lack of knowledge of disaster preparedness for mass gatherings which highlights a significant capacity gap for collaborative planning and response for mass gathering events. It is recommended that qualitative and mixed methods approaches be taken to further identify outcome variables that may influence preparedness, response at mass gathering

events in general and at religious gatherings such as Haji. The influence of knowledge on individual preparedness for disasters should be studied and include experimental designs.

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**Data Availability Statement:** Datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

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