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Epidemiology and Outcomes of out-of-Hospital Cardiac Arrest in Qatar: a nationwide observational study

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Conflict of interests

All authors declare no financial and personal relationships with other people or organisations that could inappropriately influence (bias) their work.

Key words:

Cardiac arrest

Cardiopulmonary resuscitation

Emergency Medical Services

Epidemiology

Middle East

Asia

ABSTRACT

Background:

Out-of-hospital cardiac arrest (OHCA) studies from the Middle East and Asian region are limited. This study describes the epidemiology, emergency health services and outcomes of OHCA in Qatar.

Methods:

This was a prospective nationwide population-based observational study on OHCA patients in Qatar according to Utstein style guidelines, from June 2012 to May 2013. Data was collected from various sources; the national emergency medical service, 4 emergency departments and 8 public hospitals.

Results:

The annual crude incidence of presumed cardiac OHCA attended by EMS was 23.5 per 100,000. The age-sex standardized incidence was 87.8 per 100,000 population.

Of the 447 OHCA patients included in the final analysis, most were male (n=360, 80.5%) with median age of 51 years (IQR = 39-66). Frequently observed nationalities were Qatari (n=89, 19.9%), Indian (n=74, 16.6%) and Nepalese (n=52, 11.6%). Bystander cardiopulmonary resuscitation (CPR) was carried out in 92 (20.6%) OHCA patients.

Survival rate was 8.1% (n=36) and multivariable logistic regression indicated that initial shockable rhythm (OR 13.4, 95% CI 5.4-33.3, p = 0.001) was associated with higher odds of survival while male gender (OR 0.27, 95% CI 0.1-0.8, p = 0.01) and advanced

cardiac life support (ACLS) (OR 0.15, 95% CI 0.04-0.5, p = 0.02) were associated with lower odds of survival.

Conclusions:

Standardized incidence and survival rates were comparable to Western countries. Although expatriates comprise more than 80% of the population, Qataris contributed 20% of the total cardiac arrests observed. There are significant opportunities to improve outcomes, including community-based CPR and defibrillation training.

Introduction

Globally, there is significant variation in the reported country-specific Out-of-hospital cardiac arrest (OHCA) incidence and survival rates. (1) (2) The incidence per 100,000 person years of EMS-treated OHCA of presumed cardiac cause was 25.7 in Europe, 53.2 in North America, 35.1 in Asia, and 41.3 in Australia. (1) The median reported rate of survival to hospital discharge was 10% (range 6–22%) in Europe, 6.8% (range 0.8-25%) in North America, 1.2% in Asia (range 0.6-3%) and 12.8% (range 6-13%) in Australia. (1) Variations in survival rates suggest disparities in the effectiveness and implementation of OHCA resuscitation interventions, management and guidelines. (3)

The majority of OHCA registries and studies utilizing standardized Utstein style of reporting of OHCA data come from developed countries in Europe and North America. (1) Apart from the recent PAROS study and some exceptions in East Asia; Japan, (4) China, (5) Thailand, (6) Taiwan, (7) Korea, (8) and Philippines, (9) there is limited OHCA data and epidemiological studies from Asia, the Middle East, and Africa. (1) (10) The ethnic, demographic and cultural orientation in Qatar is very different to previously reported studies in Asia. In this observational prospective study we collected and analyzed data on all OHCA patients resuscitated by Emergency Medical Services (EMS) in Qatar. To our knowledge, this is the first population-based nationwide epidemiological study on OHCA patients following Utstein guidelines, in the Middle East and wider Central and South Asia region.

Methods

This was an observational study with prospective enrollment of OHCA patients from 1st June 2012 to 31st May 2013. Data were collected in Qatar as part of the establishment of a national OHCA registry according to Utstein style guidelines, (11) from incident reporting and dispatch data, EMS pre-hospital care records, and patient medical records from 4 EDs and 8 hospitals. Follow-up was through access of hospital medical records and was censored at the date of death or up to 3 years from enrollment. The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a priori approval by the institution's human research committee. The study was approved and given waiver of informed consent by the Institutional Review Board of Hamad Medical Corporation (JIRB# 13-00071).

Qatar is a high income developing country located in Western Asia, on the northeastern coast of the Arabian Peninsula. (12) (13) There has been massive development and progress over the last few decades and in 2013 the population of Qatar was 2.169 million, though only a small proportion of this population is Qatari nationals, with over 80% of the population being expatriates. (14) The majority of expatriates are from the wider Middle East and South Asia region.

Hamad Medical Corporation (HMC) is the public (government) healthcare provider for Qatar and also operates the sole Emergency Medical Service (EMS) provider in Qatar - the Hamad Medical Corporation Ambulance Services (HMCAS). (15) Utilizing a hub and spoke model for Qatar, HMCAS currently has approximately 800 operational clinical staff and responds to an average of nearly 700 calls per day. Qatar has a three-tiered EMS

system with 3 units dispatched for a cardiac arrest incident; an ambulance, a supervisor unit, and a rapid response unit. There is a single emergency response activation telephone number (“999”). The caller is asked further questions and details by the Emergency Medical Dispatcher who is guided by a “PROQA” (priority questions and answers) system. As soon as the patient is deemed to be in cardiac arrest; that is, unconscious and not breathing– the caller is given pre-arrival instructions on how to conduct CPR and all three units; supervisor, ambulance, and Critical Care Paramedic (CCP) units are dispatched. They perform on-scene, Advanced cardiac life support (ACLS) using a modified American Heart Association protocol that incorporates the use of a mechanical chest compression device. HMCAS eventually takes all OHCA patients to one of four receiving public hospitals.

Data for the OHCA registry were collected on all OHCA patients resuscitated by EMS in Qatar. Patients with obvious signs of death termed as ‘undeniable death’ (decapitation, incineration, decomposition, rigor mortis, and dependent lividity) were excluded from data collection. Only adult (>18 years) OHCA patients with “presumed cardiac etiology” that were resuscitated by EMS in Qatar were included in this study. Presumed cardiac etiology was defined to be an arrest presumed to be of cardiac etiology as best determined by the rescuers unless it was known or likely to have been caused by a non-cardiac cause; asthma, terminal illness, cerebrovascular accident, drug overdose, suicide, drowning, trauma, or other non-cardiac causes. (16)

Demographic variables included patient sex, age, and nationality. Peri-cardiac arrest related variables included; location of arrest, presence of witness, bystander CPR and quality of CPR information, initial arrest rhythm, and defibrillation. The type of

bystander CPR performed was assessed by determining if bystander CPR included chest compressions and ventilation, chest compressions only, or ventilation only. Initial arrest rhythm was classified as 'shockable' for ventricular fibrillation/ventricular tachycardia and 'non-shockable' for asystole and pulseless electrical activity. ACLS interventions, airway management, and/or advanced cardiac life support medications data were also gathered. Time-related indicators (TRI) of EMS processes included response time (time from call received to arrival on scene), time at scene, and transport time (time from scene to hospital). The primary outcomes were "survival to hospital admission" defined as return of spontaneous circulation (ROSC) achieved and sustained on ED arrival, and "survival to hospital discharge." Secondary outcomes were "any ROSC" defined as ROSC, which represents a brief restoration of a palpable pulse (>30 seconds) and "neurological outcome at discharge" measured using the Cerebral Performance Category (CPC) score. (17) Neurological status by utilizing CPC scores was determined at hospital discharge, one month, one year, and three years from date of cardiac arrest.

Statistical Methods

Qatar's 2013 population census was used to calculate the crude age-sex specific incidence rates and these were standardized to the U.S. 2013 population to estimate age-sex-standardised incidence rates (ASIRs). Descriptive analyses were reported as frequencies and percentages for categorical variables. The central tendency of continuous variables was described using means with standard deviations for variables with normal distribution (as assessed by the Shapiro-Wilk test), and medians with interquartile ranges (IQR) for variables with non-normal distribution. Categorical variables were compared using chi-square and Fisher's exact test as appropriate. Continuous variables were

compared utilizing t-test for variables with normal distribution and Mann-Whitney non-parametric testing for variables with non-normal distribution. Logistic regression models were used to measure the association of demographic, peri-cardiac arrest, and emergency care characteristics with outcomes (ROSC and survival). Variables were selected based on previously reported associations with these outcomes in previous studies. For the multivariable analysis, potentially significant factors were considered for inclusion in the model, if the p-value was less than 0.1 in univariate analysis. Variables with missing observations more than ten percent were included in univariate analysis only and were not included in multivariate analysis. Age and gender variables were considered as confounders and included in multivariable analysis. Age was transformed into its natural log form to account for non-linearity in the multivariate analysis. A likelihood ratio was used to evaluate significance of individual covariates. After the model was built, discarded covariates were reintroduced to assess for effect modification (i.e. significant p value of covariate or interaction term) or confounding (i.e. substantial change in primary covariates' point estimates for effect, regardless of statistical significance). Model performance was evaluated by calculating the area under the receiver operator characteristic (ROC) curve for the model; this allowed for assessment of the discrimination performance of the model. The Hosmer-Lemeshow goodness-of-fit test (using deciles of estimated probability) was used to assess model fit. A correlation matrix was used to check for collinearity in independent variables before undertaking multivariate analysis. Statistical analysis was performed using SPSS (IBM SPSS Statistics version 22.0).

Results

During June 2012 to May 2013, a total of 770 patients without signs of circulation were assessed by EMS in Qatar. In 193 (25%) cases, resuscitation was not attempted by EMS because of signs of undeniable death. Qatar's HMCAS resuscitated 577 patients with OHCA during the study period. Of 577 OHCA patients, 471 had a cardiac etiology and 106 patients had a non-cardiac origin OHCA; trauma (80 patients), respiratory (7 patients), submersion (14 patients), and electrocution (5 patients). After excluding patients under 18 years of age (n = 24), a total of 447 presumed cardiac origin OHCA patients were included in the analysis.

The annual crude incidence of cardiac origin OHCA attended by EMS was 23.5 per 100,000. The age-sex standardized incidence was 87.8 per 100,000 population. The annual crude incidence was 25.9 per 100,000 population for males and 16.4 per 100,000 population for females. The age standardized incidence was 91.5 per 100,000 population for males and 84.3 per 100,000 population for females. The majority of cases were male (n=360, 80.5%) with a median age of 51 years (IQR = 39-66). Frequently observed ethnicities of OHCA patients were Qatari (n=89, 19.9%) and South Asians; Indian (n=74, 16.6%), Nepalese (n=52, 11.6%), and Pakistani (n=27, 6%). (Table 1 and 2)

Table 1: Characteristics of out-of-hospital cardiac arrest patients with ROSC at admission

	Total number of patients N = 447 (100%)	No ROSC at admission N = 389 (87.0%)	ROSC at admission N = 58 (13.0%)	p-value
Age (Mean ± SD) (Independent t-test) Missing N (%)	52.2 ± 17.2 21 (4.7)	51.9 ± 17.4	54.6 ± 16.2	0.27
Gender N (%)				0.19
Female	87 (19.5)	72 (18.5)	15 (25.9)	
Male	360 (80.5)	317 (81.5)	43 (74.1)	
Ethnicity N (%)				**0.003**
Qatari	89 (21.3)	79 (21.6)	10 (18.9)	
Arabs	65 (15.6)	53 (14.5)	12 (22.6)	
Caucasians	11 (2.6)	7 (1.9)	4 (7.5)	
Africans	21 (5.0)	20 (5.5)	1 (1.9)	
South Asians *Indian* *Nepalese* *Pakistan* *Bangladesh* *Sri Lanka*	189 (45.2) *74 (17.7)* *52 (12.4)* *27 (6.5)* *22 (5.3)* *14 (3.3)*	173 (47.4)	16 (30.2)	
Filipino	21 (5.0)	14 (3.8)	7 (13.2)	
Others	22 (5.3)	19 (5.2)	3 (5.7)	
Missing N (%)	29 (6.5)			
Location of OHCA N (%)				0.29
Home	274 (63.3)	242 (64.4)	32 (56.1)	

Work place	30 (6.9)	27 (7.2)	3 (5.3)	
Public place	129 (29.8)	107 (28.5)	22 (38.6)	
Missing N (%)	14 (3.1)			
Coronary Artery Disease N (%)	98 (21.9)	87(22.4)	11 (19.0)	0.56
Hypertension N (%)	103 (23.0)	87(22.4)	16 (27.6)	0.38
Respiratory disease N (%)	19 (4.3)	13 (3.3)	6 (10.3)	**0.014**
Diabetes N (%)	96 (21.5)	83 (21.3)	13 (22.4)	0.85
OHCA Witnessed N (%) Missing N (%)	170 (38.0) 9 (2.0)	143 (37.6)	27 (46.6)	0.19
Bystander CPR N (%) Missing N (%)	92 (20.6) 1 (0.2)	77 (19.8)	15 (25.9)	0.29
Initial Rhythm Shockable N (%) Missing N (%)	88 (20.1) 9 (2.0)	59 (15.5)	29 (50.0)	**<0.001**
Bystander Defibrillation N (%) (Fisher's exact test)	12 (2.7)	10 (2.6)	2 (3.4)	0.66
ACLS provided N (%)	426 (95.3)	375 (96.4)	51 (87.9)	**0.004**
Mechanical Chest compression device N (%)	314 (70.2)	278 (71.5)	36 (62.1)	0.14
EMS Time interval, in minutes (Median, IQR)				
Response time (Mann-Whitney U test)	8.7 (6.8-11.8)	8.8, (6.9-11.8)	8.6, (6.5-11.3)	0.69
Scene time(Mann-Whitney U test) Missing N (%)	37.9 (28.2-50.6) 8 (1.8)	39.1, (28.9-52.5)	32.1, 26.0-40.1	**0.008**
Transport time(Mann-Whitney U test) Missing N (%)	21.35 (13.7-31.5) 14 (3.1)	22.1, (14.4-32.1)	14.4, (7.9-24.5)	**0.04**

Table 2: Characteristics of out-of-hospital cardiac arrest patients with Survival to hospital discharge

	Total number of patients N = 443 (100%)	Not Survival to discharge N = 407 (91.9%)	Survival to discharge N = 36 (8.1%)	p-value
Age (Mean ± SD) (Independent t-test)	52.2 ± 17.3	52.1 ± 17.7	53.4 ± 11.0	0.66
Missing N (%)	19 (4.3)			
Gender N (%)				0.4
Female	87 (19.6)	78 (19.2)	9 (25.0)	
Male	356 (80.4)	329 (80.8)	27 (75.0)	
Ethnicity N (%)				**0.02**
Missing N (%)	28 (6.3)			
Qatari	89 (21.4)	84 (22.0)	5 (14.7)	
Arabs	64 (15.4)	57 (15.0)	7 (20.6)	
Caucasians	11 (2.7)	7 (1.8)	4 (11.8)	
Africans	21 (5.1)	19 (5.0)	2 (5.9)	
South Asians	188 (45.3)	177 (46.5)	11 (32.4)	
Indian	73 (17.6)			
Nepalese	*52 (12.5)*			
Pakistan	*27 (6.5)*			
Bangladesh	*22 (5.3)*			
Sri Lanka	*14 (3.4)*			
Filipino	20 (4.8)	17 (4.5)	3 (8.8)	
Others	22 (5.3)	20 (5.2)	2 (5.9)	
Location of OHCA N (%)				**0.03**

Missing N (%)	14 (3.2)			
Home	274 (63.9)	257 (65.2)	17 (48.6)	
Work place	30 (7.0)	29 (7.4)	1 (2.9)	
Public place	125 (29.1)	108 (27.3)	17 (48.6)	
Coronary Artery Disease N (%)	97 (21.9)	87 (21.4)	10 (27.8)	0.37
Hypertension N (%)	103 (23.3)	93(22.9)	10 (27.8)	0.50
Respiratory disease N (%)	19 (4.3)	18 (4.4)	1 (2.8)	0.64
Diabetes N (%)	96 (21.7)	89 (21.9)	7 (19.4)	0.74
OHCA Witnessed N (%) Missing N (%)	168 (38.7) 9 (2.0)	155 (38.9)	13 (36.1)	0.74
Bystander CPR N (%) Missing N (%)	90 (20.4) 1 (0.2)	82 (20.2)	8 (22.2)	0.77
Initial Rhythm Shockable N (%) Missing N (%)	85 (19.6) 9 (2.0)	62 (15.5)	23 (67.6)	**<0.001**
Bystander Defibrillation N (%) (Fisher's exact test)	10 (2.3)	10 (2.5)	0 (0)	1.00
ACLS provided N (%)	423 (95.5)	395 (97.1)	28 (77.8)	**<0.001**
Mechanical Chest compression device N (%)	312 (70.4)	294 (72.2)	18 (50.0)	**0.005**
EMS Time interval, in minutes (Median, IQR)				
Response time (Mann-Whitney U test)	8.7 (6.8-11.8)	8.8 (6.9-11.8)	8.7 (5.9-11.0)	0.18
Scene time (Mann-Whitney U test) Missing N (%)	37.9 (28.2-50.6) 8 (1.8)	39.1 (29.7-52.3)	28.1 (22.4-35.0)	**<0.001**
Transport time (Mann-Whitney U test) Missing N (%)	21.3, (13.7-31.5) 14 (3.2)	22.0, (13.8-31.7)	15.8, (11.0-24.3)	**0.03**

The majority of patients had a cardiac arrest at home (n=274, 63.3%) while 129 (29.8%) patients were in a public place, and 30 (6.9%) patients arrested in the workplace. Approximately half of the patients had unwitnessed cardiac arrests (n=268, 60%). There were 170 (38.8%) OHCAs witnessed by bystanders. Bystander CPR was performed in 92 (20.6%) OHCA patients. The type of bystander CPR performed was available for 88 patients; 46 (10.3%) involved compressions and ventilations, while 42 (9.4%) involved compressions only. The first monitored rhythm was non-shockable in 350 (78.3%) patients; asystole in 301 patients, and pulseless electrical activity in 49 patients on EMS arrival. A shockable rhythm was the initial rhythm in 88 (19.7%) patients; with ventricular fibrillation observed in 82 patients and ventricular tachycardia observed in six patients. Bystanders provided defibrillation using automated external defibrillators to 12 (2.7%) patients. EMS defibrillated 175 (39.1%) patients. ACLS defined as utilizing advanced airway and/or cardiac life support medications (adrenaline, amiodarone) according to 2005 European Resuscitation Council (ERC) guidelines was provided by EMS in 426 (95.3%) patients.(25)(26) A mechanical chest compression device for CPR was used by EMS for resuscitation in 314 (70.2%) patients. (Table 1 and 2) The median response time defined as the time duration between call received and first unit reaching the scene was 8.72 minutes (IQR = 6.8-11.8). The median scene time defined as the time spent on the scene resuscitating the patient was 37.9 minutes (IQR = 28.0-50.6). The median transport time defined as the time taken to transport the patient from scene to hospital was 21.4 minutes (IQR =13.7-31.5). (Table 1 and 2)

Over three quarters of patients (n=344, 76.9%) did not achieve a return of spontaneous circulation (ROSC), 40 (8.9%) patients had unsustained ROSC (defined as ROSC lasting

less than 20 consecutive minutes), and 58 (13%) patients achieved survival to hospital admission (ROSC lasting for 20 consecutive minutes or more and maintained till ED handover). Five (1.1%) patients had a cardiac re-arrest before reaching ED after achieving ROSC lasting for 20 consecutive minutes or more. In the univariate analysis, ethnicity (Caucasian and Filipino), respiratory disease, and having a shockable rhythm were associated with higher odds of ROSC while ACLS, increased scene time and longer transport time intervals were associated with lower odds of ROSC. (Table 3)

In the multivariable analysis, respiratory disease (OR 8.8, 95% CI 2.8-27.5, p = 0.001) and an initial shockable rhythm (OR 4.7, 95% CI 2.4-9.4, p = 0.001) were associated with higher odds of ROSC, while increased scene time (OR 0.98, 95% CI 0.96-1.0, p = 0.038) and transport time (OR 0.97, 95% CI 0.95-1.0, p = 0.022) intervals were associated with lower odds of ROSC. (Table 3) The area under the curve was 0.80 (95% CI: 0.73-0.85), for discriminating ROSC at admission in the model.

Table 3: Predictors of ROSC and survival to hospital discharge (n=367)

	Relative Odds of ROSC at ED Presentation (n=367)		**Relative Odds of Survival to Hospital Discharge**	
	Unadjusted Odds Ratio(95% CI) p-value	Adjusted Odds Ratio(95% CI) p-value	Unadjusted Odds Ratio(95% CI) p-value	Adjusted Odds Ratio(95% CI) p-value
Age (in years)	1.00 (0.99-1.02) p=0.27	-	1.00 (0.99-1.03) p=0.66	-
Sex				**0.27 (0.1-0.8)**
Female	*Reference*		*Reference*	**p=0.01**
Male	0.65 (0.3-1.2) p=0.19	-	0.71 (0.32-1.6) p=0.4	-
Ethnicity				
Qatari	*Reference*		*Reference*	
Arab	1.79 (0.7-4.4) p=0.21	-	2.10 (0.6-6.8) p=0.24	-
Caucasian	**4.51 (1.1-18.2) p=0.03**	-	**9.60 (2.1-44.1) p=0.04**	-
African	0.40 (0-3.3) p=0.39	-	1.77 (0.3-9.8) p=0.51	-
Filipino	**4.00 (1.3-12.1) p=0.02**	-	2.97 (0.6-13.6) p=0.16	-
South Asian	0.73 (0.3-1.7) p=0.46	-	1.04 (0.4-3.1) p=0.94	-
Others	1.25 (0.3-5.0)	-	1.68 (0.3-9.3)	-

	p=0.75		p=0.55	
Location of OHCA		-		-
Home	*Reference*		*Reference*	
Public place	1.56 (0.9-2.8)	-	**2.38 (1.2-4.8)**	-
	p=0.14		**p=0.02**	
Work place	0.84 (0.2-2.9)	-	0.52 (0.1-4.1)	-
	p=0.79		p=0.53	
Risk Factors				
Coronary Artery Disease	0.81 (0.4-1.6)	-	1.4 (0.7-3.0)	-
	p=0.56		p=0.38	
Hypertension	1.32 (0.7-2.5)	-	1.30 (0.6-2.8)	-
	p=0.38		p=0.50	
Respiratory Disease	**3.34 (1.2-9.2)**	**8.8 (2.8-27.5)**	0.62 (0.1-4.8)	-
	p=0.02	**p=0.001**	p=0.64	
Diabetes	1.07 (0.6-2.1)	-	0.86 (0.4-2.0)	-
	p=0.85		p=0.74	
OHCA Witnessed	1.44 (0.8-2.5)	-	0.89 (0.4-1.8)	-
	p=0.20		p=0.74	
Bystander CPR	1.40 (0.7-2.7)	-	1.13 (0.5-2.6)	-
	p=0.29		p=0.77	
Shockable initial rhythm	**5.44 (3.0-9.8)**	**4.7 (2.4-9.4)**	**11.4 (5.3-24.6)**	**13.4 (5.4-33.3)**
	p=0.001	**p=<0.001**	**p=<0.001**	**p=<0.001**
Bystander AED	1.35 (0.3-6.3)	-	0 (0)	-
	p=0.70		p=1.0	
ACLS provided	**0.27 (0.1-0.7)**	-	**0.11 (0-0.3)**	**0.15 (0.04-0.5)**

	p=0.01		**p=0.00**	**p=0.02**
Mechanical Chest Compression Device	0.65 (0.4-1.2) p=0.15	-	**0.38 (0.2-0.8) p=0.01**	-
EMS time intervals				
Response time	0.97 (0.9-1.0) p=0.24	-	0.94 (0.9-1.0) p=0.14	-
Scene time	**0.97(0.95-1.0) p=<0.001**	**0.98 (0.96-1.0) p=0.038**	**0.95 (0.93-0.98) p=<0.001**	-
Transport time	**0.97(0.95-1.0) p=0.01**	**0.97 (0.95-1.0) p=0.02**	0.98 (0.95-1.01) p=0.11	-

A total of 58 (13%) patients were admitted through ED and 36 (8.1%) patients survived to hospital discharge. Of these 36 patients, 24 (68.6%) patients had favorable cerebral performance (score of 1 or 2) at the time of discharge and 12 (34.3%) patients showed a poor cerebral performance (scores of 3 or 4) at the time of discharge. In univariate analysis, the variables ethnicity (Caucasian), location (public place), and initial shockable rhythm were associated with higher odds of survival to hospital discharge, while ACLS, mechanical chest compression device, and increased scene time intervals were associated with lower odds of survival. (Table 3) Multivariable logistic regression analysis showed that initial shockable rhythm (OR 13.4, 95% CI 5.4-33.3, p = 0.001) was associated with higher odds of survival while males (OR 0.27, 95% CI 0.1-0.8, p = 0.01) and ACLS (OR 0.15, 95% CI 0.04-0.5, p = 0.02) were associated with lower odds of survival. (Table 3) The area under the curve was 0.82 (95% CI: 0.75-0.90) for discriminating survival to hospital discharge in the model.

After 1 year follow-up of 36 (7.8%) survivors at discharge – one patient had died, 14 (38.9%) patients were lost to follow up (probably due to the transient nature of Qatar's expatriate population), and 21 (58.3%) were still alive. Of 21 patients alive at 1 year, 15 (71.4%) had favorable cerebral performance and 6 patients (28.6%) had poor cerebral performance. Of the 21 (4.7%) patients that survived the first year; there were 8 (38.1%) alive at three years, 10 (47.6%) were lost to follow-up, and 3 (14.3%) deaths were recorded. Of the 8 patients alive at follow up after 3 years; 6 (75%) patients had a favorable cerebral outcome and two (25%) patients had a poor cerebral and functional outcome. The mean (standard deviation) follow-up period was 1.2 (SD=5.4) months and the total follow-up period was 549 months.

Discussion

This is the first nationwide, population-based study to determine the epidemiology and outcomes of out-of-hospital cardiac arrest (OHCA) in the Middle East and wider South Asia region. The age-sex adjusted incidence was 87.8 per 100,000 population and comparable to the incidence reported in North American studies (range, 39.9-148.8 per 100,000 population). (1)(18)(19)(20) Survival (8.1%) was marginally lower than the survival rate reported from the US (9.6%) and a median survival estimate of 10.0% from 30 studies performed in Europe, but higher than other Asian reports (range 0.5-8.5%). (1)(5)(18)(19)(20)(21)(22)(23) The median age of 51 years (IQR = 39-66), was comparable to OHCA median ages of countries with a young population; United Arab Emirates (OHCA median age – 50 years), Thailand (OHCA median age – 57 years) and Malaysia (OHCA median age – 59 years). (22)(24)(25) Qataris make up around 20% of the total population but had the highest number of cardiac arrests, despite the larger

number of South Asian (India, Pakistan, Nepal, Sri Lanka, and Bangladesh) expatriates that contribute to nearly 45% of Qatar's total population. (12) Males had 72.7% lower odds of survival from OHCA. (Table 3) This finding is consistent with a meta-analysis of 13 studies by Bougouin et al. which reported that women had significantly increased odds of cardiac arrest survival to hospital discharge (OR 1.10, 95% CI 1.03–1.20, p = 0.006). (26)

Respiratory disease was independently associated as an independent risk factor for ROSC but had no effect on survival. It is possible that these patients could get better ROSC rates during pre-hospital resuscitation but because of compromised respiratory capacity and co-morbidities, do not survive to discharge. A bystander CPR rate of 20.6% in this study was higher than bystander CPR rates of 12% in Spain and 17% in Germany but lower than bystander CPR rates in the Netherlands (61%) and Sweden (59%). (27)(28). Bystander CPR was not associated with ROSC or survival in our study and is consistent with results of some East Asian OHCA studies. (7)(5) ACLS was associated with lower odds of survival since 95% of patients received ACLS by critical care paramedics and only stable patients with early ROSC at scene and better outcomes did not require ACLS intervention.

Survival rates have been reported to be independently associated with EMS response times, with longer EMS response intervals leading to poor outcomes. (29) The median EMS response time of 8.72 minutes (IQR = 6.8-11.8) in this study was better than the majority of response times reported globally. (30)(22) However, the median scene time of 37.9 minutes and median transport time of 21.35 minutes was high compared to other EMS, including recent data from the PAROS study. (22) Despite the long EMS scene and

transport times, survival rates were higher than those reported in the PAROS study. (22) The better than expected survival rates might be related to the combination of advanced life support on scene and a hub and spoke model of ambulance geographical locations that reduces response times. Once resuscitation was commenced, it was rarely ceased at scene and CPR was continued during transport - similar to the 'Scoop and Run' approach (death not declared at scene). Thus there were lengthy scene and transport times for patients who could have been declared dead at scene. A critical care paramedic was present on scene for every cardiac arrest patient ensuring complete ACLS provision on scene according to the 'Stay and Treat' model. (31)

Study limitations

The OHCAs are attended by a single government-sector Ambulance Service (HMCAS) which provides EMS for the entire country, including both urban and rural areas. As a result HMCAS standards including those for the reporting of data are uniform for all cardiac arrests making the results comparable to other population based studies. Data reporting by paramedics is also mandatory for all cardiac arrest patients minimizing data loss. Recall bias by participants (paramedics, bystanders) might affect data quality. After post- cardiac arrest rehabilitation, most of the expatriates leave Qatar, making follow-up difficult. The study did not explore the sociocultural norms and the population mix of many nationalities and languages spoken that may have been a barrier to early activation of EMS and bystander CPR.

Conclusions

The survival rate of 8.1% is close to European and American survival rates and higher than reported in other Asian studies. Although expatriates comprise more than 80% of the population, Qataris had the highest number of cardiac arrests observed. Bystander CPR was not associated with survival indicating ineffective CPR. Tailored community-based CPR and defibrillation training programs should be initiated and primary prevention should include risk stratification and optimization of risk factors for coronary artery disease and cardiac arrest, especially for Qataris and similar ethnicities.

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