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Original Research Article

A Study to Determine the Magnitude and Factors Associated with Inter-Hospital Outcome Variations for out of Hospital Cardiac Arrests

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Abstract:

Aim: The aim of the present study was to determine the magnitude and factors associated with inter-hospital outcome variations for out of hospital cardiac arrests.

Methods: This was a prospective, multi-centre cohort study of consecutive out of hospital cardiac arrests (OHCA) cases presenting at 5 restructured hospitals. 30 patients were selected in the study.

Results: Out of a total of 30 patients, 20 (66.66%) were male, and had ages ranging from 22 to 90, with a median age of 64.2 years. In terms of cause of arrest, the most common was cardiac, followed by respiratory and traumatic with frequencies of 21 (70%), 2 (6.66%), and 1 (3.33%) respectively. The most common first arrest rhythm was asystole, followed by PEA, VF, and then VT, with frequencies of 16 (53.33%), 8 (26.66%), 5 (16.66%), and 1 (3.33%) respectively. In terms of pre-hospital management, 17 (56.66%) were witnessed arrests, and 11 (36.66%) received bystander CPR. TTM and PCI usage varied significantly (P<0.001). Hospitals B, C, D had a lower survival to discharge or 30 days post arrest. Hospitals B, D had lower survival to discharge with good neurological function. After subsequent multivariate analysis to eliminate known confounders, it was noted that as compared to Hospital E the study benchmark, Hospitals B, C, and D had a lower survival to discharge or 30 days post-arrest. Survival to ED admission also varied from 15.0% to 23.8% with Hospitals B, C, D, and E experiencing lower survival to ED admission.

Conclusion: TTM and PCI usage, and OHCA outcomes vary between hospitals. This is associated with teaching status, bed number, and post-resuscitation care.

Keywords: Out-of-hospital cardiac arrests; percutaneous coronary intervention; survival; post-resuscitation care.

Introduction

Cardiac arrest is loss of mechanical activity of the heart confirmed by the absence of signs of circulation. [1] One third of cases occur without any prior recognized heart disease; half occur without any prodromal symptoms. [2] Out-of-hospital cardiac arrest (OHCA) is a global public health issue with large variations in incidence and disappointing survival and neurological outcomes across countries. [3] Out-of-hospital cardiac arrest (OHCA) have notoriously been a medical issue with high morbidity and mortality. [4] It is a multifaceted problem with a multitude of aetiologies, [5] and as such various factors influence the outcome of OHCA patients. According to the 2020 report of the International Liaison Committee on Resuscitation (ILCOR), the incidence of emergency medical service (EMS)-treated OHCA ranged from 30·0 to 97·1 per 100000 population, with survival to hospital discharge varying between 3·1% and 20·4% across the world. [6]

Survival increases significantly if the OHCA is quickly recognized and responded to with prompt activation of 9-1-1, bystander-initiated cardiopulmonary resuscitation (CPR), bystander and/or basic first responder application of an automated external defibrillator (AED) before arrival of other emergency medical services (EMS) providers on scene, advanced life support, and post-resuscitation care. [7] The American Heart Association (AHA) previously recommended implementation of cardiac resuscitation systems of care that consist of interconnected community, EMS, and hospital efforts to measure and improve the process and outcome of care for patients with cardiac arrest. [8]

Recent studies comparing inter-hospital OHCA outcomes have also highlighted several hospital-based factors—percutaneous coronary intervention (PCI) capability [whether specified as 24-hour emergency PCI [9,10], OHCA patient volume, [11] and expertise and ability. [12] Several other factors have also been associated with inter-regional variations in OHCA survival. [13,14] These include regional differences in OHCA risk, population density, socioeconomic and racial characteristics, bystander response, emergency cardiac care and importantly, post-resuscitation care [14,15,16] Developments in post-resuscitation care, including targeted temperature management (TTM) and early PCI, [17,18] are also key elements behind recent improvements in OHCA survival in the early 2000s, compared to the lack of significant survival improvement several decades earlier. [19]

The aim of the present study was to determine the magnitude and factors associated with inter-hospital outcome variations for out of hospital cardiac arrests.

Materials and Methods

This was a prospective, multi-centre cohort study of consecutive out of hospital cardiac arrests (OHCA) cases presenting at 5 restructured hospitals. 30 patients were selected in the study. Out of hospital cardiac arrests (OHCA) was determined by these criteria: absence of pulse, unresponsiveness, and apnea, regardless of aetiology and method of arrival. We excluded patients who are immediately pronounced dead and for whom resuscitation is not attempted.

In this study, all Singapore OHCA cases were extracted from the Pan-Asian Resuscitation Outcomes Study Clinical Research Network (PAROS CRN), an international prospective registry of OHCAs in the Asia-Pacific region. Relevant data collection processes for Singapore were reviewed and approved by Singhealth Centralised Institutional Review Boards (IRB) and National Healthcare Group Domain Specific Review Boards (DSRB) with waiver of informed consent. A data sharing agreement within PAROS CRN has also been put in place to protect the confidentiality of the study population. The primary outcome was survival to discharge or 30 days post-arrest, if not discharged. Secondary outcomes included survival to Emergency Department (ED) admission and survival with favourable neurological outcome, defined as a Glasgow- Pittsburgh Cerebral Performance Categories (CPC) ≤2 at hospital discharge, or 30 days post OHCA if not discharged. CPC are classified as follows: (I) good cerebral performance where patient is conscious and able to work and lead a normal life; (II) moderate cerebral disability where patient is conscious and able to work part-time in sheltered environments; (III) severe cerebral disability where patient is conscious but dependent on others for daily support; (IV) coma; (V) death by traditional criteria or certified brain dead. CPC grading was done through in- person assessments, clinical records, and via the telephone by trained personnel not directly involved in subject care or in this study.

Analysis

The effects of hospital-based resuscitative interventions and admitting hospital on outcome were compared using Chi-squared tests and multivariate logistic regression models respectively, using IBM SPSS Statistics 21 (IBM Corporation, Armonk, NY, USA). Hospitals were benchmarked against Hospital F, the oldest and largest restructured hospital in Singapore. The parameters eventually selected for the multivariate logistic regression models are known to current literature, and were first investigated using univariate logistic regression. These include age, gender, cause of arrest (cardiac/respiratory/ traumatic/others), witnessed arrest, bystander CPR, and first arrest rhythm [asystole/pulseless electrical activity (PEA)/ventricular tachycardia (VT)/ ventricular fibrillation (VF)/other]. We subsequently attempted to explain any dissimilarities in outcomes via Chi-squared tests on inter- hospital factors both proven in literature: PCI capability and OHCA patient volume, and otherwise: years in operation, teaching status, and bed number. In an attempt to explain variations in OHCA outcomes, five inter-hospital factors were analysed: PCI capability, years in operation, teaching status, bed number, and OHCA patient volume.

Results

Table 1: Patient demographics and OHCA characteristics

Variables	Total
Mean age in years	64.2 (16.0)
Male (%)	20 (66.66)
Cause of arrest (%)	
Presumed Cardiac	21 (70)
Respiratory	2 (6.66)
Trauma	1 (3.33)
Witness arrest (%)	17 (56.66)
Bystander CPR (%)	11 (36.66)

First arrest rhythm (%)	
Asystole	16 (53.33)
PEA	8 (26.66)
VF	5 (16.66)
VT	1 (3.33)

Out of a total of 30 patients, 20 (66.66%) were male, and had ages ranging from 22 to 90, with a median age of 64.2 years. In terms of cause of arrest, the most common was cardiac, followed by respiratory and traumatic with frequencies of 21 (70%), 2 (6.66%), and 1 (3.33%) respectively. The most common first arrest rhythm was asystole, followed by PEA, VF, and then VT, with frequencies of 16 (53.33%), 8 (26.66%), 5 (16.66%), and 1 (3.33%) respectively. In terms of pre-hospital management, 17 (56.66%) were witnessed arrests, and 11 (36.66%) received bystander CPR.

Table 2: Post-resuscitation interventions and OHCA outcomes

Variables	Total (n=30)	Hospital A (n=6)	Hospital B (n=6)	Hospital C (n=6)	Hospital D (n=6)	Hospital E (n=6)
Procedures (%)						
PCI	12	1	3	2	4	1
TTM	9	2	3	1	2	1
ED ROSC	8	3	1	1	1	2
Survival to admission (%)	5	1	1	1	1	1
Discharged alive	2	1	-	-	-	1
Remained alive at 30 days	1	-	-	-	1	-
Died	5	1	1	1	1	1
30-day mortality (%)	27	10	5	5	4	3
CPC (%)	1	-	-	1	-	-
≤2	2	1	-	-	1	-
>2	1	-	1	-	-	-

TTM and PCI usage varied significantly (P<0.001). Hospitals B, C, D had a lower survival to discharge or 30 days postarrest. Hospitals B, D had lower survival to discharge with good neurological function.

Table 3: Inter-hospital variability in OHCA outcomes

Outcomes	Unadjusted OR (95% CI)	Adjusted OR (95% CI)‡	P value
Survival to discharge or 30 days			
Hospital A	0.720 (0.293–1.759)	0.485 (0.180–1.293)	0.152
Hospital B	0.560 (0.374–0.849)	0.394 (0.229–0.671)	0.0007
Hospital C	0.944 (0.651–1.378)	0.494 (0.298–0.837)	0.009
Hospital D	0.962 (0.684–1.359)	0.497 (0.304–0.805)	0.004
Hospital E	1.058 (0.757–1.473)	0.656 (0.407–1.064)	0.080
Survival to admission			
Hospital A	1.176 (0.868–1.602)	0.792 (0.549–1.136)	0.207
Hospital B	0.816 (0.701–0.945)	0.587 (0.462–0.733)	<0.0001
Hospital C	0.945 (0.808–1.102)	0.600 (0.474–0.759)	<0.0001
Hospital D	1.096 (0.956–1.264)	0.676 (0.542–0.847)	0.0007
Hospital E	0.874 (0.755–1.008)	0.622 (0.494–0.777)	<0.0001
Survival to discharge with CPC ≤2			
Hospital A	0.788 (0.288–2.136)	0.626 (0.206–1.914)	0.414
Hospital B	0.534 (0.330–0.873)	0.392 (0.206–0.738)	0.005
Hospital C	1.044 (0.682–1.591)	0.572 (0.316–1.031)	0.068
Hospital D	0.864 (0.571–1.300)	0.447 (0.249–0.791)	0.007
Hospital E	1.075 (0.730–1.577)	0.725 (0.415–1.271)	0.268

After subsequent multivariate analysis to eliminate known confounders, it was noted that as compared to Hospital E the study benchmark, Hospitals B, C, and D had a lower survival to discharge or 30 days post-arrest. Survival to ED admission also varied from 15.0% to 23.8% with Hospitals B, C, D, and E experiencing lower survival to ED admission.

Discussion

Out-of-hospital cardiac arrests (OHCAs) are a global health concern and remain a leading cause of death. [20] Various demographic, etiological and

pre-hospital factors are well known to affect outcomes. Out-of-hospital cardiac arrest (OHCA) survival is often poor (<10%), [21] however, there is large variation in survival after OHCA between communities. [22,23] Some of these differences reflect differences in the structure and function of emergency medical services (EMS); others reflect differences in the method of measuring process and outcome. The Utstein template, which includes patient and EMS factors, was developed and promulgated to improve the comparability of intra- and inter-site reports of outcomes after OHCA. [24] Its components have been selected and refined through expert consensus but the template has undergone limited empiric validation. Therefore it is incompletely understood how accurately and completely the Utstein factors explain the variation in survival between communities.

Out of a total of 30 patients, 20 (66.66%) were male, and had ages ranging from 22 to 90, with a median age of 64.2 years. In terms of cause of arrest, the most common was cardiac, followed by respiratory and traumatic with frequencies of 21 (70%), 2 (6.66%), and 1 (3.33%) respectively. The most common first arrest rhythm was asystole, followed by PEA, VF, and then VT, with frequencies of 16 (53.33%), 8 (26.66%), 5 (16.66%), and 1 (3.33%) respectively. In terms of pre-hospital management, 17 (56.66%) were witnessed arrests, and 11 (36.66%) received bystander CPR. TTM and PCI usage varied significantly (P<0.001). Hospitals B, C, D had a lower survival to discharge or 30 days post arrest. Academic hospitals overseas have been reported to have a lower mortality rate from its medical and surgical interventions. [25] Academic hospitals were more likely to utilise contemporary technologies. [26] Hospitals without an academic status might have been less likely to offer the same level of guideline-directed care. [27] ED care in academic hospitals was associated with more effective CPR and earlier PCI commencement, which could have contributed to improved survival. [28]

Hospitals B, D had lower survival to discharge with good neurological function. After subsequent multivariate analysis to eliminate known confounders, it was noted that as compared to Hospital E the study benchmark, Hospitals B, C, and D had a lower survival to discharge or 30 days post-arrest. Survival to ED admission also varied from 15.0% to 23.8% with Hospitals B, C, D, and E experiencing lower survival to ED admission.

Conclusion

TTM and PCI usage, and OHCA outcomes vary between hospitals. This is associated with teaching status, bed number, and post-resuscitation care.

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