Emergency Medicine Australasia

Emergency Medicine Australasia (2018) **30**, 67–76

doi: 10.1111/1742-6723.12809

ORIGINAL RESEARCH

Effect of known history of heart disease on survival outcomes after out-of-hospital cardiac arrests

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Abstract

Objective: We aimed to investigate the effect of known heart disease on post-out-of-hospital cardiac arrest (OHCA) survival outcomes, and its association with factors influencing survival.

Methods: This was an observational, retrospective study involving an OHCA database from seven Asian countries in 2009–2012. Heart disease was defined as a documented diagnosis of coronary artery disease or congenital heart disease. Patients with non-traumatic arrests for whom resuscitation was attempted and with known medical histories were included. Differences in demographics, arrest characteristics and survival between patients with and without known heart disease were analysed. Multivariate logistic regression was performed to identify factors influencing survival to discharge.

Results: Of 19 044 eligible patients, 5687 had known heart disease. They were older (77 *vs* 72 years) and had more comorbidities like diabetes (40.9 *vs* 21.8%), hypertension (60.6 *vs* 36.0%) and previous stroke (15.2 *vs* 10.1%). However, they were not more likely to receive bystander cardiopulmonary resuscitation ($P = 0.205$) or automated external defibrillation ($P = 0.980$). On univariate analysis, known heart disease was associated with increased survival (unadjusted odds ratio 1.16, 95% confidence interval 1.03–1.30). However, on multivariate analysis, heart disease predicted poorer survival (adjusted odds ratio 0.76, 95% confidence interval 0.58–1.00). Other factors influencing survival corresponded with previous reports.

Conclusions: Known heart disease independently predicted poorer post-OHCA survival. This study may provide information to guide future prospective studies specifically looking at family education for patients with heart disease and the effect on OHCA outcomes.

Key findings

- A known history of heart disease independently predicted poorer survival to discharge during out-of-hospital cardiac arrest.
- Bystander CPR and AED rates were not higher in patients with known heart disease compared to those without.
- We suggest there is a role for education for family members of heart disease patients including CPR and AED training.

Key words: *cardiac arrest, heart disease, survival.*

Introduction

Out-of-hospital cardiac arrest (OHCA) is a global health concern. Each year, the global incidence of emergency medical services (EMS)-attended OHCAs is about 83.7 per 100 000 people.[1] Moreover, survival

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†Investigators are listed in the Acknowledgements section.

Accepted 8 April 2017

rates after OHCAs are poor. Worldwide, only about 7% survive to discharge, and this figure is 2.2% in Asia, lower than in North America, Europe or Australia.[1]

The 'chain of survival' is a sequence of events that promotes survival. It involves early access, early cardiopulmonary resuscitation (CPR), early defibrillation, early advanced care and post-resuscitation care.[2] Based on this, Utstein-style templates for standardised reporting of cardiac arrests have been developed.[3] Relationships between several Utstein elements and post-OHCA survival outcomes have been established,[4] but these only predict a modest proportion of variation in survival rates.[5] Identifying other factors influencing survival would support the development of OHCA prevention and management strategies.

Heart disease is a major risk factor for cardiac arrests. An estimated 70–85% of OHCAs are of presumed cardiac aetiology,[6] with the majority attributable to coronary artery disease.[7] One study demonstrated a seven-fold increased risk of OHCA in heart disease patients.[8] However, limited research has been done on the association of heart disease with survival outcomes. In USA, Stecker *et al.*[9] found that a history of coronary artery disease or myocardial infarction (MI) was associated with increased survival to discharge. No similar studies have been performed in an Asian population.

Several reasons could explain a possible association between heart disease and increased survival. Therapies for heart disease may play a role,[10] as may the possibility that EMS and advanced cardiac life support algorithms treat OHCAs more effectively in patients with heart disease.[9] Another possibility is that family members of heart disease patients may have increased knowledge about cardiac arrests and hence activate EMS earlier. They may also have higher take-up rates of CPR and automated external defibrillator (AED) training, resulting in higher bystander CPR performance and AED application rates among patients with known heart disease.

We aimed to describe the relationship between a known history of heart disease and survival outcomes in OHCA patients in Asia. We also aimed to analyse associations between known heart disease and factors recognised to affect survival outcomes, particularly bystander CPR and AED.

Methods

Study design and settings

This was an observational, retrospective, international, multicentre cohort study. Data from the Pan Asian Resuscitation Outcomes Study (PAROS) clinical research network[11] was analysed. Established in 2010, PAROS is an Asia-wide clinical research network that reports population-based OHCA events using common data definitions and collection methods. Variations in the characteristics of the populations and EMS systems in participating countries have been previously described.[12,13] This study used data collected from 10 sites in seven countries, namely Japan, Singapore, South Korea, Malaysia, Taiwan, Thailand and the United Arab Emirates, between 1 January 2009 and 31 December 2012. The study was approved by the national Institutional Review Boards of participating EMS sites and classified as minimal risk research.

Selection of participants

All OHCA patients submitted to PAROS during the study period, as confirmed by absence of pulse, unresponsiveness and apnoea, were included. Patients excluded were those immediately pronounced dead and for whom resuscitation was not attempted, including those with decapitation, rigor mortis or dependent lividity, patients with known 'do not resuscitate' orders, patients suffering traumatic arrests and patients with unknown medical histories. We thus excluded all patients from Tokyo and Aichi as medical history data was not collected at these sites.

Data collection and processing

Data was obtained from emergency dispatch records, ambulance patient case notes, ED records and inpatient and outpatient medical records, and entered into a standardised database. Disease conditions were recorded as 'absent' when either stated to be absent or not previously documented in medical records. In Japan, South Korea and Taiwan, data was extracted from existing national registries using an export field entry process that automatically populated the PAROS database. In other countries, data was entered into an online electronic data capture system. This had in-built quality assurance checks and validations that cross-checked data fields and ensured that mandatory fields were completed. Local coordinators verified the data before and after entering it into the system. Data from all sites were merged and each case was assigned a unique case identifier. Patient identifiers were not entered into the database.

Methods of measurement

To minimise bias, the taxonomy, case record form, data dictionary and study definitions were standardised across all participating countries. The variables measured followed Utstein recommendations[3] and included information on patient demographics, medical history, arrest circumstances, cardiac rhythm, EMS response times, pre- and in-hospital care, and survival outcomes. Patients were defined as having heart disease if they had a documented diagnosis of coronary artery disease, chronic arrhythmias or congenital heart disease, or had pacemakers inserted prior to the arrest. Response time was defined as the time of call to time of arrival of EMS at the scene. Shockable rhythm was defined as ventricular fibrillation, pulseless ventricular tachycardia or unknown shockable rhythm identified on AED, and non-shockable rhythm was defined as pulseless electrical activity, asystole or unknown non-shockable rhythm identified on AED. Besides heart disease, disease conditions specifically surveyed were diabetes mellitus, cancer, hypertension, renal disease, respiratory disease, hyperlipidaemia, stroke and HIV.

The primary outcome was survival to discharge, defined as being discharged from hospital alive after the arrest. Secondary survival outcomes were return of spontaneous circulation, survival to hospital admission and favourable Cerebral Performance Category and Overall Performance Category (OPC) scores of 1–2 at discharge. Other outcomes were bystander CPR performance and AED application.

Data analysis

Patients were grouped into those with and without known history of heart disease, and patient demographics and arrest characteristics were compared between these two groups using the Pearson's χ^2 test for categorical variables and the Mann–Whitney *U* test for continuous variables. Univariate and multivariate logistic regression analyses of survival outcomes were performed to identify if heart disease was an independent predictor for survival to discharge. The multivariate logistic regression adjusted for factors that were found to be significantly different between the two groups on univariate analysis, and took into account multicollinearity between factors (e.g. presence of disease comorbidities and number of comorbidities). Unadjusted and adjusted odds ratios (ORs) and 95% confidence intervals (CIs) were reported for each factor in univariate and multivariate regression analyses. Survival outcomes within subgroups of initial shockable rhythm, initial non-shockable rhythm, age 18 and above and arrests of presumed cardiac aetiology were also analysed using multivariate logistic regression analyses. All analyses were performed using SPSS version 21.0. A *P* value less than 0.05 was considered statistically significant.

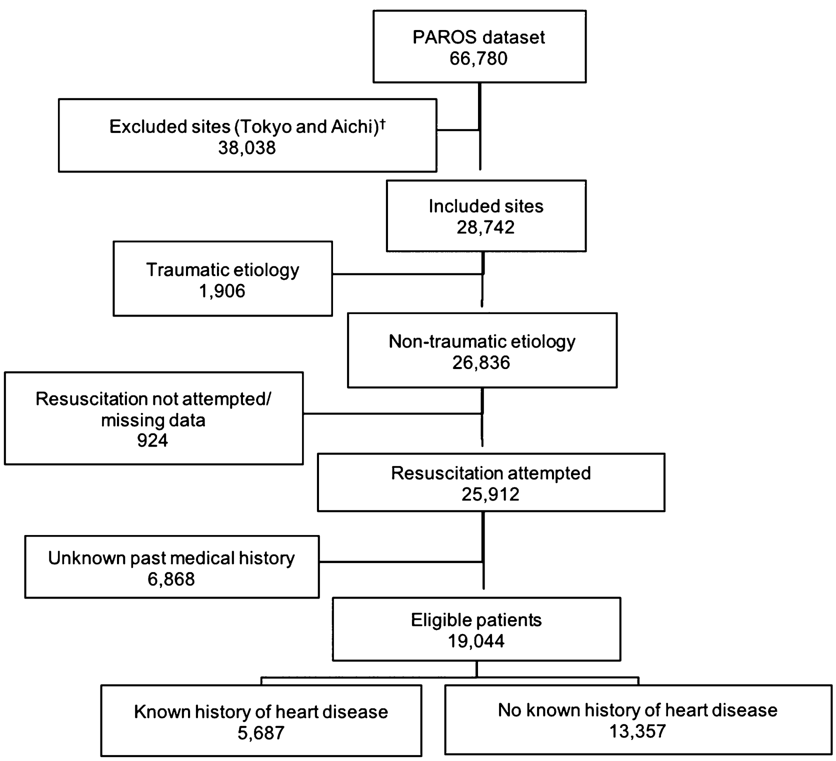

Figure 1. *Study cohort derivation and survival outcomes. Flow diagram illustrating selection of eligible patients from the PAROS dataset. †Results from PAROS sites in Tokyo and Aichi were excluded as data regarding past medical history was not collected at these sites.*

Results

Of the 66 780 patients recorded in the PAROS dataset (Fig. 1), 19 044 were eligible. Of these, 5687 (29.9%) had a known history of heart disease and 13 357 (70.1%) did not. Table 1 compares the demographics and OHCA characteristics of patients with and without known heart disease. Patients with heart disease were older (77 *vs* 72 years), more likely to have cardiovascular comorbidities of diabetes (40.9 *vs* 21.8%), hypertension (60.6 *vs* 36.0%) and previous stroke (15.2 *vs* 10.1%), and to have a higher number of these comorbidities ($P < 0.001$). A greater proportion of them had initial shockable rhythms (18.0 *vs* 9.8%, $P < 0.001$). No significant differences were found in bystander CPR ($P = 0.205$) and bystander AED ($P = 0.980$) rates.

Survival outcomes are compared in Table 2. On univariate analysis, heart disease was associated with higher rates of any return of spontaneous circulation (unadjusted OR [uOR] 1.16, 95% CI 1.09–1.24), survival to discharge (uOR 1.16, 95% CI 1.03–1.30), favourable Cerebral Performance Category scores (uOR 1.44, 95% CI 1.22–1.69) and favourable OPC scores (uOR 1.81, 95% CI 1.48–2.21). However, after adjusting for other variables, heart disease was associated with poorer survival to discharge (adjusted OR [aOR] 0.76, 95% CI 0.58–1.00), and was not significantly associated with other survival outcomes.

Table 3 describes the univariate and multivariate analysis of factors influencing survival to discharge, and Figure 2 presents the factors that remained significant after multivariate analysis. Besides heart disease, several factors were found significant on multivariate analysis. Of these, initial shockable rhythm was most strongly predictive of survival (aOR 5.05, 95% CI 3.05–8.33).

Table 4 compares survival outcomes of patients with and without known heart disease within the subgroups of initial shockable rhythm, initial non-shockable rhythm, age

TABLE 1. *Comparison of patient demographics and arrest characteristics between patients with and without known history of heart disease*

Characteristics	Total (*n* = 19 044)	Known history of heart disease (*n* = 5687)	No known history of heart disease (*n* = 13 357)	*P*-value
Age				
Median (interquartile range)	74.0 (60.0–83.0)	77.0 (66.0–85.0)	72.0 (58.0–82.0)	<0.001
>65 years (%)	12 747 (66.9)	4296 (75.5)	8451 (63.3)	<0.001
Gender (%)				
Male	11 395 (59.8)	3419 (60.1)	7976 (59.7)	0.601
Medical history (%)				
Diabetes	2340 (27.5)	1039 (40.9)	1301 (21.8)	<0.001
Hypertension	3710 (43.5)	1564 (60.6)	2146 (36.0)	<0.001
Stroke	954 (11.5)	356 (15.2)	598 (10.1)	<0.001
Other	3517 (42.2)	1229 (51.5)	2288 (38.4)	<0.001
Number of comorbidities† (%)				
0	3814 (46.2)	703 (30.4)	3111 (52.3)	<0.001
1	2549 (30.9)	779 (33.7)	1770 (29.8)	
2	1639 (19.8)	707 (30.5)	932 (15.7)	
3	258 (3.1)	126 (5.4)	132 (2.2)	
Location type (%)				
Home residence	13 843 (72.9)	3961 (69.8)	9882 (74.3)	<0.001
Healthcare facility‡	2902 (15.3)	968 (17.1)	1934 (14.5)	
Public	2233 (11.8)	744 (13.1)	1489 (11.2)	
Arrest witnessed by (%)				
Not witnessed	9895 (53.7)	2798 (50.4)	7097 (55.1)	<0.001
Bystander	7052 (38.3)	2265 (40.8)	4787 (37.2)	
Emergency medical service/ private ambulance	1485 (8.1)	484 (8.7)	1001 (7.8)	
Initial arrest rhythm (%)				
Ventricular fibrillation/ ventricular tachycardia	2246 (12.3)	990 (18.0)	1256 (9.8)	<0.001
Pulseless electrical activity/ asystole	16 061 (87.7)	4521 (82.0)	11 540 (90.2)	
Aetiology of cardiac arrest (%)				
Presumed cardiac	14 389 (75.7)	4985 (87.7)	9404 (70.5)	<0.001
Respiratory	818 (4.3)	160 (2.8)	658 (4.9)	
Drowning	269 (1.4)	25 (0.4)	244 (1.8)	
Others	3536 (18.6)	511 (9.0)	3025 (22.7)	
Time of call to arrival at scene ≤8 min (%)	14 770 (77.7)	4343 (76.5)	10 427 (78.2)	0.010
Pre-hospital intervention (%)				
Bystander cardiopulmonary resuscitation	7371 (38.8)	2164 (38.1)	5207 (39.1)	0.205
Bystander automated external defibrillator	270 (4.1)	82 (4.1)	188 (4.1)	0.980

TABLE 1. *Continued*

Characteristics	Total (n = 19 044)	Known history of heart disease (n = 5687)	No known history of heart disease (n = 13 357)	P-value
Pre-hospital defibrillation	3134 (16.5)	1296 (22.8)	1838 (13.8)	<0.001
Pre-hospital advanced airway	9642 (52.7)	3079 (55.5)	6563 (51.4)	<0.001
Pre-hospital drug administered	3078 (16.2)	1060 (18.6)	2018 (15.1)	<0.001

†Out of diabetes, hypertension and previous stroke. ‡Including nursing homes, emergency medical service/private ambulances and other healthcare facilities.

TABLE 2. *Comparison of survival outcomes between patients with and without known history of heart disease*

Survival outcomes	Known history of heart disease (%) (n = 5687)	No known history of heart disease (%) (n = 13 357)	Unadjusted OR (95% CI)†	Adjusted OR (95% CI)†‡
Any return of spontaneous circulation	2190/5687 (38.5)	4676/13 357 (35.0)	1.16 (1.09–1.24)	1.04 (0.92–1.17)
Survival to admission	1381/5606 (24.6)	3123/13 170 (23.7)	1.05 (0.98–1.13)	0.90 (0.76–1.05)
Survival to discharge	443/5604 (7.9)	909/13 166 (6.9)	1.16 (1.03–1.30)	0.76 (0.58–1.00)
Cerebral Performance Category 1–2 at discharge	240/5592 (4.3)	397/13 125 (3.0)	1.44 (1.22–1.69)	0.81 (0.55–1.18)
Overall Performance Category 1–2 at discharge	172/5456 (3.2)	226/12 792 (1.8)	1.81 (1.48–2.21)	1.29 (0.67–2.48)

†Reference category is no known history of heart disease. ‡Adjusted for age >65 years, gender, number of comorbidities, location, arrest witness status, initial cardiac rhythm, bystander cardiopulmonary resuscitation, pre-hospital defibrillation, pre-hospital advanced airway and time of call to arrival at scene. CI, confidence interval; OR, odds ratio.

18 years and above and presumed cardiac aetiology. In the group with initial shockable rhythm, heart disease was associated with lower rates of survival to discharge (OR 0.67, 95% CI 0.47–0.95). In patients aged 18 and above (to exclude patients more likely to have congenital heart disease), heart disease was significantly associated with poorer survival to admission (OR 0.84, 95% CI 0.72–0.98) and poorer survival to discharge (OR 0.71, 95% CI 0.54–0.93). No significant associations were found between heart disease and survival in the other two subgroups.

Discussion

Heart disease independently predicted poorer survival to discharge on multivariate analysis, despite an association between heart disease and improved survival to discharge on univariate analysis. This disparity is likely due to the confounding effect of initial shockable rhythms, which were significantly more common in heart disease patients (P < 0.001) and increased survival to discharge five-fold. Other factors identified to be associated with improved survival to discharge were younger age, arrests occurring in public or healthcare facilities, arrests witnessed by bystanders or EMS personnel, initial shockable rhythms, faster EMS response times, bystander CPR and pre-hospital defibrillation. These were consistent with findings from previous studies, with similar effect sizes.[4,5,14]

A possible explanation for why heart disease may decrease survival is that patients with heart disease may have a greater tendency to develop post-cardiac arrest myocardial dysfunction or have persistent acute coronary syndrome.[15] Our observations contrast with Stecker *et al.*'s[9] finding that a history of coronary artery disease or MI was associated with improved survival. The reasons for this difference are not immediately clear as the previous study did not analyse the association between heart disease and factors influencing survival. Differences in definitions of heart disease, population characteristics, EMS systems or prior treatments or interventions may have contributed to the disparity. Roth *et al.*[16] also demonstrated that anginal syndrome, a history of MI and congestive heart failure (CHF) were not associated with survival to discharge, but their findings may have been affected by the provision of electrocardiographic transmission and lidocaine to all patients, thus potentially improving pre-arrest monitoring and access to medical services.

TABLE 3. *Univariate and multivariate analysis of factors for survival to hospital discharge*

Characteristics	Survived to discharge, *n* (%) (*n* = 1352)	Did not survive to discharge, *n* (%) (*n* = 17 418)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Age >65 years	640 (47.3)	11 982 (68.8)	0.41 (0.37–0.46)	0.57 (0.45–0.74)
Male	926 (68.5)	10 281 (59.0)	1.51 (1.34–1.70)	0.88 (0.68–1.15)
Heart disease	443 (32.8)	5161 (29.6)	1.16 (1.03–1.30)	0.76 (0.58–1.00)
Number of comorbidities†				
0	295 (55.6)	3388 (45.2)	Reference	Reference
1	144 (27.1)	2334 (31.2)	0.71 (0.58–0.87)	1.04 (0.46–2.35)
2	82 (15.4)	1524 (20.3)	0.62 (0.48–0.80)	0.92 (0.41–2.09)
3	10 (1.9)	244 (3.3)	0.47 (0.25–0.90)	0.97 (0.42–2.25)
Location type				
Home residence	683 (50.7)	12 990 (74.8)	Reference	Reference
Healthcare facility‡	268 (19.9)	2497 (15.0)	1.96 (1.69–2.27)	1.57 (1.06–2.32)
Public	395 (29.3)	1776 (10.2)	4.23 (3.70–4.83)	2.07 (1.59–2.70)
Arrest witnessed by				
Not witnessed	300 (23.0)	9510 (56.3)	Reference	Reference
Bystander	759 (58.3)	6161 (36.5)	3.91 (3.40–4.48)	2.86 (1.88–4.34)
Emergency medical service/private ambulance	244 (18.7)	1211 (7.2)	6.39 (5.34–7.64)	1.70 (1.30–2.21)
Initial rhythm ventricular fibrillation/ventricular tachycardia	557 (43.6)	1618 (9.6)	7.25 (6.42–8.19)	5.05 (3.06–8.33)
Time of call to arrival at scene ≤8 min (%)	1128 (83.6)	13 422 (77.2)	1.51 (1.30–1.75)	1.88 (1.42–2.49)
Pre-hospital intervention				
Bystander cardiopulmonary resuscitation	584 (43.3)	6650 (38.3)	1.23 (1.10–1.38)	1.55 (1.22–1.97)
Pre-hospital defibrillation	655 (48.4)	2392 (13.7)	5.90 (5.26–6.62)	1.38 (0.83–2.29)
Pre-hospital advanced airway	492 (38.8)	9078 (54.1)	0.54 (0.48–0.60)	0.50 (0.39–0.63)

†Out of diabetes, hypertension and previous stroke. ‡Including nursing homes, emergency medical service/private ambulance and other healthcare facilities. CI, confidence interval; OR, odds ratio.

Comparisons to other studies of OHCA are limited. One study demonstrated an association between MI and poorer survival 1 year post-discharge,[17] while another found that MI and CHF were associated with poorer OPC scores at discharge and after 1 year.[18] On the other hand one study showed improved 1- and 5-year survival outcomes with MI and ischaemic heart disease,[19] and others found only univariate associations between angina pectoris[20] or CHF[21] and survival. Two studies demonstrated no significant association between heart disease and survival.[22,23] However, all these studies differed in patient selection by including only those with presumed cardiac aetiology, only those with ventricular fibrillation, only those defibrillated, only those successfully resuscitated, only those hospitalised alive, only those surviving to discharge or combinations of these.

Given that patients with heart disease are an easily identifiable high-risk group for OHCA, our findings suggest the need for targeted strategies to improve post-OHCA survival in these patients. Of particular concern was that bystander CPR and AED rates were not higher in patients with heart disease compared to those without. Similar observations have been made elsewhere.[14] Bystander CPR and AED use are well-recognised to improve survival[4,14,24] and it could be expected that family members of heart disease patients would be more likely to learn and perform CPR and AED application. That this was not the case indicates a role for CPR and AED training for family members of heart disease patients. The value of

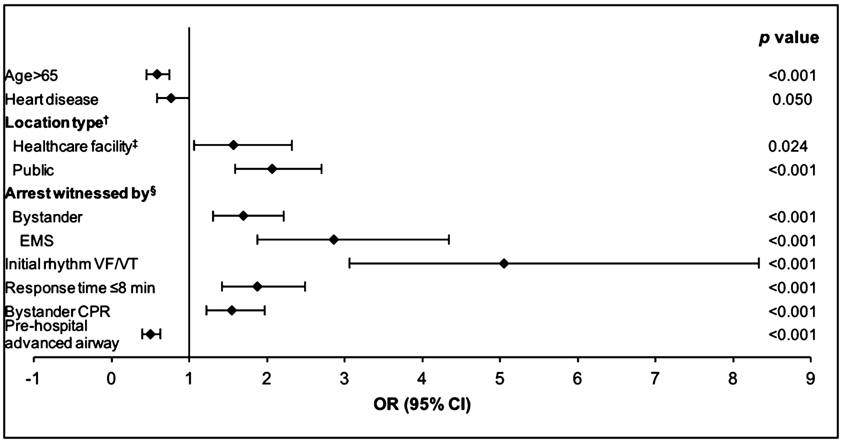

Figure 2. *Independent predictors of survival to hospital discharge. Chart illustrating the factors found to be significantly associated with survival to hospital discharge on multivariate analysis, and the strength of each association. †Reference category for healthcare facility and public locations is home residence. ‡Including nursing homes, EMS/private ambulance, and other healthcare facilities. §Reference category for arrest witnessed by bystander and EMS/private ambulance is unwitnessed arrest.*

training family members is further supported by the fact that despite 72.9% of patients in our study having arrests at home, these patients were more than four times less likely to survive to discharge compared to patients suffering arrests in public. Previous authors have also noted that patients with arrests occurring at home were less likely to receive bystander CPR.[25] Thus we suggest targeting CPR and AED training at family members of heart disease patients to increase bystander CPR and AED rates and improve survival.

In addition, this study highlights the importance of strict management of modifiable coronary artery disease risk factors in patients with known coronary artery disease, as this would likely decrease the incidence of OHCA. This includes optimally managing risk factors through lifestyle modifications including adopting a heart-healthy diet, weight control, regular exercise, smoking cessation, moderation of alcohol intake as well as controlling diabetes, hypertension and hyperlipidaemia.[26] Secondary prevention includes instituting appropriate pharmacological therapies in patients with prior acute coronary syndrome or left ventricular dysfunction,[26] early reperfusion therapy after MI[27] and implantable cardioverter-defibrillators in selected patients.[28]

Limitations

The study had some limitations. First, the countries were unevenly represented. Japan contributed 10 432 cases (54.8%), Korea, Singapore and Taiwan each contributed 2000–4000 cases and Malaysia, Thailand and the United Arab Emirates each contributed less than 200. The results may thus be skewed by variations in EMS and healthcare systems, population characteristics, socioeconomic factors and cultural practices between countries. Second, results may have been biased by the exclusion of patients with unknown medical histories. Third, due to the retrospective nature of this study, causal relationships could not be drawn from the associations observed. Fourth, the international multicentre nature of this study may have resulted in potential issues with data integrity and validity, but these were minimised by standardising the data collection tools. Finally, due to the limitations of national registry data, we did not have detailed data on patients' medical histories, medications or in-hospital management. Patients were identified as having coronary artery disease as long as they had a documented history of a clinical diagnosis of coronary artery disease in the ambulance or hospital notes. While detailed objective criteria would have been ideal, this was often not available. It is likely our study underestimates the prevalence of known heart disease in our data. We were also unable to categorise heart disease into different types or severities to identify specific high-risk groups for poor survival. We recommend that future studies focus on identifying these groups of patients to allow for the design of targeted interventions.

Conclusions

We found that a known history of heart disease independently predicted poor post-OHCA survival to discharge. Other factors associated with survival were consistent with previous studies. Despite heart disease patients being a high-risk group for OHCA, bystander CPR and AED rates were not significantly different between patients with and without known heart disease. This study may provide information to guide future prospective studies specifically looking at family education for patients with heart disease and the effect on OHCA outcomes.

Acknowledgements

We thank the PAROS Clinical Research Network participating site investigators, H Tanaka (Graduate School of Sport System, Kokushikan University, Tokyo, Japan), K Kajino (Critical Care Medical Center, Osaka National Hospital, Osaka, Japan), KJ Song (College of Medicine, Seoul National University, Seoul, Korea), KW Lee (Keimyung University Dongsan Hospital, Daegu, Korea), MHM Ma (National Taiwan University, Taipei, Taiwan), NAR Hisamuddin (School of Medical Sciences, Universiti Sains Malaysia, Kelantan, Malaysia), AK Sarah & MN Julina (Hospital Sungai Buloh, Selangor, Malaysia), AS Omer and T Yagdir (Dubai Corporation for Ambulance Services,

TABLE 4. *Comparing outcomes between those with and without known history of heart disease in subgroups of initial shockable rhythm, initial non-shockable rhythm, age 18 years and above and presumed cardiac aetiology*

Survival outcomes	Initial shockable rhythm (n = 2246)			Initial non-shockable rhythm (n = 16 060)			Age ≥18 (n = 18 758)			Presumed cardiac aetiology (n = 14 389)		
	Known history of heart disease, n (%) (n = 990)	No known history of heart disease, n (%) (n = 1256)	aOR (95% CI)†	Known history of heart disease, n (%) (n = 4521)	No known history of heart disease, n (%) (n = 11 540)	aOR (95% CI)†	Known history of heart disease, n (%) (n = 5666)	No known history of heart disease, n (%) (n = 13 092)	aOR (95% CI)†	Known history of heart disease, n (%) (n = 4985)	No known history of heart disease, n (%) (n = 9404)	aOR (95% CI)†
Any return of spontaneous circulation	574 (58.0)	709 (56.4)	1.05 (0.81–1.36)	1539 (34.0)	3748 (32.5)	1.05 (0.92–1.20)	2188 (38.6)	4594 (35.1)	1.04 (0.92–1.17)	1839 (36.9)	2954 (31.4)	1.12 (0.98–1.28)
Survival to admission	407 (42.6)	538 (44.1)	0.88 (0.66–1.17)	945 (21.1)	2460 (21.6)	0.92 (0.75–1.12)	1380 (24.7)	3063 (23.7)	0.84 (0.72–0.98)	1131 (23.0)	1782 (19.2)	1.06 (0.88–1.27)
Survival to discharge	208 (21.8)	349 (28.6)	0.67 (0.47–0.95)	217 (4.8)	503 (4.4)	0.96 (0.63–1.46)	443 (7.9)	886 (6.9)	0.71 (0.54–0.93)	399 (8.1)	608 (6.6)	0.84 (0.63–1.12)
Cerebral Performance Category 1–2 at discharge	138 (14.5)	234 (19.3)	0.74 (0.49–1.13)	92 (2.1)	138 (1.2)	1.23 (0.53–2.82)	240 (4.3)	387 (3.0)	0.74 (0.51–1.07)	230 (4.7)	321 (3.5)	0.82 (0.56–1.20)
Overall Performance Category 1–2 at discharge	95 (10.7)	122 (11.6)	1.30 (0.64–2.61)	76 (1.7)	99 (0.9)	0.93 (0.13–6.61)	172 (3.2)	222 (1.8)	1.18 (0.62–2.25)	164 (3.4)	175 (1.9)	1.30 (0.65–2.58)

†Odds ratios and confidence intervals are adjusted for age >65 years, gender, number of comorbidities, location, arrest witness status, initial cardiac rhythm, bystander cardiopulmonary resuscitation, pre-hospital defibrillation, pre-hospital advanced airway and time of call to arrival at scene. aOR, adjusted odds ratio; CI, confidence interval.

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Author contributions

All authors fulfilled the latest ICMJE criteria for authorship by making substantial contributions to the conception or design of the work, or to the acquisition, analysis or interpretation of data for the work; drafting the work or revising it critically for important intellectual content; giving final approval of the version to be published; and agreeing to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Competing interests

None declared.

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