# Outcomes of cardiopulmonary resuscitation in the emergency department of a tertiary hospital in Malaysia

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**ABSTRACT**

**Introduction: There are insufficient data available regarding the outcome of cardiac arrest (CA) resuscitated in the emergency department in Malaysia. This study aims to determine the incidence of CA, the return of spontaneous circulation (ROSC), survival to admission (STA), survival to discharge (STD) and factors influencing the overall outcome of CA.**

**Material and Methods: This is a retrospective observational study done in Hospital Sg Buloh (HSB), a tertiary referral centre in an urban area located north of Kuala Lumpur, Malaysia's capital city, from January until December 2018, involving 289 patients. All cases with CPR and a sustained return of spontaneous circulation (ROSC) were included in the study and followed up until discharged or died in the hospital.**

**Results: Out of 236 patients recruited, 25.8% achieved ROSC, 15.7% survived on admission, and 4.2% of patients were discharged alive. Of 74.1% of witnessed OHCA, only 17.5% received bystander CPR. Factors with favourable outcomes include CA in ED (p<0.001), the initial rhythm of ventricular fibrillation (p=0.003), defibrillation (p=0.024), OHCA witnessed by emergency medical services (EMS) (p=0.024) and intravenous adrenaline administration (p=0.001). When using multivariate regression analysis, positive outcomes were associated with the cardiac and respiratory cause of CA (Adjusted Odd Ratio (AOR) 3.66; 95% Confidence Intervals, 95%CI: 2.52 - 12.61 and AOR 8.76; 95%CI: 5.76- 15.46, respectively) as well as OHCA witnessed by EMS (AOR 10.81; 95%CI: 1.84- 19.52).**

**Conclusions: Despite being an upper-middle-income country and having advancements in the healthcare system, a relatively lower STD rate among survivors of CA in the ED was observed in this study. There was underutilization of the EMS among patients with CA. The bystander CPR rate among patients with CA in Malaysia is also worryingly low. Aggressive community participation in cardiac arrest awareness programmes is much required. Additionally, in achieving better outcomes, implementing standardized post-resuscitation care protocols with existing resources will be a challenge for physicians managing cardiac arrest cases.**

**KEYWORDS:**
*Cardiac arrest, Cardiopulmonary resuscitation, Emergency Department, Survival to discharge, In hospital cardiac arrest, Out of hospital cardiac arrest, middle-income country*

## INTRODUCTION

Since the introduction of modern cardiopulmonary resuscitation by Peter Safar in the 1950s, the resuscitation technique has improved with advanced development and protocols.[1] Over the years, with a better understanding of the best practice in resuscitation, many countries have advocated a standardised approach governed by respective societies and associations.

Malaysia has produced its version of cardiac arrest (CA) resuscitation protocol through the National Committee on Resuscitation Training (NCORT) based on the evidence from the International Liason Committee on Resuscitation (ILCOR) since 2006.[2] Since then, the hospitals in Malaysia have adopted the NCORT recommendation apart from the guidelines from American Heart Association.

The emergency department in Malaysia has developed rapidly, from an admission unit for the in-patient ward 20 years ago to advanced acute medical care provided by specialised doctors and equipped with the latest technologies. As a frontline, advanced critical care provider, cardiopulmonary resuscitation (CPR) and subsequent management are core elements in emergency department (ED). However, despite rigorous training among the healthcare staff on standard CPR and resuscitation techniques, there was no official nationwide registry to assess the outcome of post-cardiac arrest management in the emergency department. The PAROS database and many other studies concentrate on out-of-hospital cardiac arrest (OHCA) and their performances without much emphasis on the ED.[3,4]

In a small sample size study on the East Coast of Malaysia, the rate of return of spontaneous circulation (ROSC) post-CPR in the ED is 30.2%.[5] This is comparable to a study in China by Xue et al. (25.8%) and in Pakistan by Moosajee et al. (27.4%).[6,7] The survival to discharge (STD) ranges between 5.6 to 11% in studies outside Malaysia.[5-9] Unfortunately, there is no data on STD for post-cardiac arrest in the ED or in-hospital available in Malaysia.

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Amongst the factors affecting the outcome is the initial rhythm (shockable vs non-shockable), the aetiology (trauma vs non-trauma), witnessed arrest and bystander resuscitation, the age, and the interval between collapse and initiation of CPR. [5,7]

As the nation develops as a model of an upper-middle-income country in Asia, there is an urgent need to assess the overall outcome of CA and the factors affecting it in the local emergency department. This study aimed to examine this, consisting of out-of-hospital and in-department cardiac arrests.

## MATERIALS AND METHODS

This is a retrospective study done in Hospital Sg Buloh (HSB), a 620 bedded tertiary referral centre in an urban area located north of Kuala Lumpur, Malaysia's capital city. The ED receives nearly 13,000 patients in a month. Consultants and specialists were available 24 hours in the emergency department, with 36 beds in yellow, red and observation zones. The resuscitation equipment is complete and considered state-of-the-art. It also encompasses a pre-hospital and trauma fellowship training centre for emergency physicians and paramedics.

Data were retrieved from the hospital information system (HIS) electronic record from January until December 2018. A total of 289 patients that underwent CPR in ED during the study period were included. The inclusion criteria consisted of all cases of CA in the ED, aged 18 and above. This consists of those whose CA developed in the ED while undergoing treatment and those brought into the ED with active CPR ongoing. Cases with incomplete data, not-for-active-resuscitation (NAR) or existing do-not-resuscitate (DNR) advance directives and aged less than 18-years-old were excluded from this study. Thus, 236 patients fulfilled the inclusion criteria and were included in the study.

The data collected adhered to the Utstein template, which consisted of core elements of patients variables (demographic, comorbidities, initial CA rhythm, location of cardiac arrest), pre-event variables (presence of witnessed collapse, presence of bystander CPR), CA variables (initial CA rhythm, defibrillation, use of resuscitation medications) and outcome variables (return of spontaneous circulation [ROSC], survival to in-patient admission, and survival to discharge).[10] The supplemental elements consisted of the aetiology of cardiac arrest. All cases with CPR and a sustained ROSC for more than 30 minutes were considered positive outcomes. Those with a sustained ROSC of less than 30 minutes were considered negative results. The positive outcome was further divided into eventual death in the ED while awaiting transfer to the critical care unit or ward, death in the critical care unit or ward after admission and those who survived and were discharged alive from the hospital.

Emergency department cardiac arrest (EDCA) was defined as a CA in the ED. In contrast, OHCA were those with CA outside the hospital and brought into the ED with ongoing CPR or resuscitation by emergency medical system (EMS) transportation provided by the government (Ministry of Health, Ministry of Education, Ministry of Defense) and trained personnel from Red Cross Malaysia and St John Ambulance Malaysia or private ambulances from other modes.

The CA incidence rate was calculated by dividing that year's total number of cardiac arrests by the estimated total number of ED visits, multiplying by 1000. The estimated total number of ED visits is 154,00

Statistical Package for Social Sciences, version 25.0 (SPSS Inc, Chicago, IL) was used for data analysis. The descriptive statistics were presented using mean and standard deviation for the numerical variable, whereas the categorical variable was presented using frequency and percentage. The normality of the data was tested statistically using Kolmogorov-Smirnov Test. The Mann-Whitney U and chi-square tests were used to assess the p-values for continuous and categorical data, respectively.

The dependent variable was the status of ROSC, divided into yes and no ROSC. Patients with ROSC were further divided into discharged alive and died in the ward or the ED. The factors affecting the dependent variable of ROSC were analysed with univariable logistic regression analysis. Crude odds ratios (c OR) were reported with 95% confidence intervals (95% CI). A manual selection of covariates with a cut-off p-value of less than 0.25 were included in the multivariable models. Multivariable stepwise backward logistic regression models were created to control for confounding factors. p-value 0.05 (two-tailed) was set for statistical significance.

## RESULTS

This study included 236 patients who had CA with CPR in the ED of HSB in 2018. There were 61 ROSC (25.8%) after CPR. 83.6% of those with ROSC, or 21.6% of patients who received CPR, died in ED or the ward. Only 16.4% of those with ROSC, or 4.2% of total CPR, survived and were discharged alive from the hospital. These findings are described in detail in Figure 1. The incidence of CA, calculated based on yearly ED visits, is 1.9 for every 1000 visits.

The demographics, clinical and other CPR characteristics of the patient population with stratification by ROSC and no ROSC were described in Table I. There were more males than females with CA, with the mean age group equally distributed. The most frequent cause of CA was non-trauma, with the majority being cardiac or presumed cardiac causes. Most were OHCA cases compared to EDCA (70.3% vs 29.7%). During resuscitation, 13.6% had an initial shockable rhythm, and 19.5% had defibrillation at least once throughout CPR. Interestingly, only 87.3% received intravenous adrenaline.

When assessing CPR outcomes, those with CA in ED were associated with ROSC ($p < 0.001$). A similar significant association was seen in those with a history of defibrillation ($p = 0.019$) and those who received intravenous adrenaline ($p = 0.007$). There was no association between males and females and ROSC ($p = 0.9$). There was also no association between the mean age for those who attained ROSC and those who did not ($p = 0.900$).

**Table I: Characteristics of patients with cardiac arrest (CA) with or without return of spontaneous circulation (ROSC)**

| | No ROSC (n=175) | Outcome | | | *p* value |
|---|---|---|---|---|---|
| | | Discharged alive (n=10) | ROSC Died in ward (n=37) | Died in ED (n=14) | |
| Race: | | | | | |
| Malay | 101 (57.7%) | 6 (60.0%) | 25 (67.6%) | 9 (64.3%) | 0.812** |
| Chinese | 20 (11.4%) | 2 (20.0%) | 5 (13.5%) | 2 (14.3%) | |
| Indian | 37 (21.1%) | 2 (20.0%) | 5 (13.5%) | 1 (7.1%) | |
| Others | 17 (9.7%) | 0 (0.0%) | 2 (5.4%) | 2 (14.3%) | |
| Gender: | | | | | |
| Male | 122 (69.7%) | 6 (60.0%) | 25 (67.6%) | 9 (64.3%) | 0.900** |
| Female | 53 (30.3%) | 4 (40.0%) | 12 (32.4%) | 5 (35.7%) | |
| Age: | | | | | |
| Mean (SD) | 51.39 ± 15.86 | 50.40 ± 13.45 | 53.68 ± 15.37 | 52.21 ± 12.64 | 0.858# |
| Range | 18 - 85 | 29 - 79 | 22 - 80 | 21 - 69 | |
| Comorbidities: | | | | | |
| Less than 3 | 59 (61.5%) | 4 (57.1%) | 12 (46.2%) | 8 (72.7%) | 0.410** |
| 3 and more | 37 (38.5%) | 3 (42.9%) | 14 (53.8%) | 3 (27.3%) | |
| Initial rhythm during cardiac arrest: | | | | | |
| Arrest location | | | | | |
| ED | 36 (20.6%) | 7 (70.0%) | 17 (45.9%) | 10 (71.4%) | <0.001* |
| OHCA | 139 (79.4%) | 3 (30.0%) | 20 (54.1%) | 4 (28.6%) | |
| Any witness (OHCA)? (n = 166) | | | | | |
| Yes | 103 (74.1%) | 2 (66.7%) | 18 (90.0%) | 4 (100.0%) | 0.277** |
| No | 36 (25.9%) | 1 (33.3%) | 2 (10.0%) | 0 (0.0%) | |
| Who witnesses the arrest? (OHCA)(n = 127) | | | | | |
| Family | 74 (71.8%) | 2 (100.0%) | 10 955.6%) | 2 (50.0%) | 0.138** |
| EMS | 15 (14.6%) | 0 (0.0%) | 7 (38.9%) | 2 (50.0%) | |
| Layperson | 14 (13.6%) | 0 (0.0%) | 1 (5.6%) | 0 (0.0%) | |
| Bystander CPR performed for OHCA? (n = 72) | | | | | |
| EMS | 44 (61.1%) | 0 (0.0%) | 9 (100.0%) | 2 (100.0%) | 0.083 |
| Non EMS | 28 (38.8 %) | 1 (100.0%) | 0 (0.0%) | 0 (0.0%) | |

*Chi-Square, **Fisher Exact test, #NOVA
ROSC, Return of spontaneous circulation; ED ,Emergency Department ; SD ,Standard Deviation;PEA, Pulseless Electrical Activities ;VF , Ventricular Fibrillation ; VT,
Ventricular Tachycardia ; OHCA ,Out of hospital cardiac arrest ;CPR ,cardiopulmonary resuscitation;EMS ,Emergency medical services; CA – Cardiac arrest

Assessing for predictors of ROSC using a multivariate logistic regression model, the non-trauma cause, specifically cardiac (aOR 3.66; 95%CI: 2.52 12.61), respiratory cause of CA (aOR 8.76; 95%CI: 5.76 15.46) and OHCA initial arrest witnessed by EMS (aOR 10.81; 95%CI: 1.84 19.52) has a better chance of survival compared to other factors (Table II).

## DISCUSSION

In this study, the incidence of CA is comparable with the UK National Cardiac Arrest Audit data of 1.6 for every 1000 in-hospital patients.[11] The percentage of CA patients receiving CPR attaining ROSC in the ED is lower than the study by Chew et al. (30.2%) but almost similar to other studies by Xue et al. (25.8%) and Moosajee et al. (27.4%). However, only 4.2% of cases attained STD, lower than other studies in this region, where the STD ranges from 5.6 to 11%, but is similar to the cardiac arrest survivor rate in an ED in Brazil.[5–9,12]

A crucial data that needs further research is the mean age of patients with CA in this study, which is 51.3 years, contrasted with other studies of 66 years in the US and Brazil and 73.9 years in the UK.[12–14] A similar pattern of the high rate of natural deaths at 41-50 years was also reported in an autopsy study in Kuala Lumpur in 2007, but not much has been explored further ever since.[15] This might be linked to the younger age group in Malaysia diagnosed with coronary artery disease as reported in the National Cardiovascular Disease Database Registry and a study on East Coast.[16,17] Nevertheless there is need for further research on this, as it seems in paradox with the national aim of achieving high income nation.[18,19]

The ROSC rate was significantly better in EDCA compared to OHCA, with 1 ROSC for every 2 EDCA vs 1 ROSC for every 6 OHCA. The ratio for survival to discharge is also markedly better in EDCA (1:10 vs 1:55). The 10% rate of STD within EDCA is similar to studies conducted on in-hospital CA in Japan but lower than rates reported in the US and UK.[14-16] However, there is no available local data for comparison. Factors such as pre-hospital response time, early defibrillation, witnessed CPR and bystander CPR could have contributed to the better overall EDCA CPR outcome.[20]

As for OHCA, it is essential to examine the factors affecting this cohort since they comprise of the largest group. Only

**Table II: Univariate and multivariate analysis related to the return of spontaneous circulation (ROSC) among cardiac arrest patients in ED**

| Variables | ROSC achieved | | | |
|---|---|---|---|---|
| | *p* value | OR (95%CI) | *p* value | Adj. OR (95%CI) |
| Race: | | | | |
| Malay | 0.374 | 1.68 (0.53, 5.31) | | |
| Chinese | 0.344 | 1.91 (0.50, 7.33) | | |
| Indian | 0.901 | 0.92 (0.24, 3.47) | | |
| Others | Ref | Ref | | |
| Gender: | | | | |
| Male | 0.549 | 1.21 (0.65, 2.24) | | |
| Female | Ref | Ref | | |
| Age | | | | |
| 52 and above | 0.943 | 0.98 (0.55, 1.75) | | |
| Less than 52 | Ref | Ref | | |
| Comorbidities (n = 192): | | | | |
| 0 | Ref | 1 | | |
| 1–3 | 0.008* | 2.90 (1.32, 6.36) | | |
| More then 3 | 0.216 | 1.96 (0.68, 5.69) | | |
| Initial rhythm during cardiac arrest: | | | | |
| Asystole | Ref | Ref | | |
| PEA | 0.067 | 2.10 (0.95, 4.66) | | |
| VF | 0.003* | 3.86 (1.60, 9.32) | | |
| VT | 0.764 | 1.29 (0.25, 6.65) | | |
| Defibrillation performed: | | | | |
| Yes | 0.024* | 2.20 (1.11, 4.35) | | |
| No | Ref | Ref | | |
| Non-trauma cause of CA (n = 191): | | | | |
| Cardiac or presume cardiac | <0.001* | 4.24 (2.02, 8.92) | 0.003 | 3.66(2.52,12.61) |
| Respiratory | 0.001* | 5.59 (1.98, 15.79) | 0.001 | 8.76 (5.76,15.46) |
| Others | Ref | Ref | Ref | Ref |
| Arrest location: | | | | |
| ED | < 0.001* | 4.86 (2.61, 9.08) | | |
| OHCA | Ref | Ref | | |
| Any witness? (n = 169) (OHCA) | | | | |
| Yes | 0.109 | 2.80 (0.79, 9.84) | | |
| No | Ref | Ref | | |
| Who witnessed the arrest? (n = 127) (OHCA | | | | |
| Family | Ref | Ref | Ref | Ref |
| EMS | 0.024* | 3.17 (1.16, 8.66) | 0.008 | 10.81(1.84,19.52) |
| Layperson | 0.365 | 0.38 (0.05, 3.11) | 0.227 | 8.02(0.27,23.24) |

Multivariate analysis was done with the backward method, model fits well (Hosmer & Lemeshow test), Cox & Snell R2 = 0.314
ROSC, Return of spontaneous circulation; ED, Emergency Department ; SD ,Standard Deviation;PEA, Pulseless Electrical Activities ;VF , Ventricular Fibrillation ; VT, Ventricular Tachycardia ; OHCA ,Out of hospital cardiac arrest ;CPR ,cardiopulmonary resuscitation;EMS ,Emergency medical services; CA – Cardiac arrest; OR , Odds ratio, Adj OR , Adjusted odds ratio.

17.5% of OHCA received bystander CPR by non-EMS, which is at the lower end of the range 10.6 - 41.6% in other Pan Asian countries and much lower than 47.4% in Europe.[3,21] This might be attributed to the low willingness to perform CPR, as portrayed by a study on college students in Malaysia by Karuthan et al., which stated that respondents were not willing to perform hands-only CPR due to limited knowledge of CPR.[22] Additionally, there might be concerns about legal liability and lack of confidence while performing CPR.[23] As bystander CPR is the most amenable factor in improving the outcome of OHCA, there is an urgent need for public education on the importance and technique of CPR.[24]

Most cases were non-shockable as the initial documented rhythm was asystole and PEA compared to VF and VT. This is not much different from the studies on non-shockable rhythms in the East Coast of Malaysia (84%), the US (76 – 81%%) and Taiwan (87.4%).[5,13,25,26]

The low adrenaline administration rate is surprising as it is one of the core drugs and the standard management for all cardiac arrests. However, it is comparable to a study done in Sweden.[27] Perhaps a local study needs to be done to analyse compliance with all the standard cardiac arrest management and the factors affecting it.

Regarding the low rate of STD after ROSC, there might be a need for improvisation of care after cardiac arrest. The lack of standard protocolised post-cardiac-arrest management, as recommended by the American Heart Association in the chain of survival, mainly due to limited resources, might be one of the reasons for the low STD. The paramount issue in Malaysia's ED, i.e., the lack of acute beds and ED longboarding, might also hamper the ideal post-resuscitation care protocols.[28]

As this is a small study, we included and analysed the trauma and non-trauma cohorts together, as were the studies done in Sweden, the UK and Japan.[11,29,30] Future studies shall

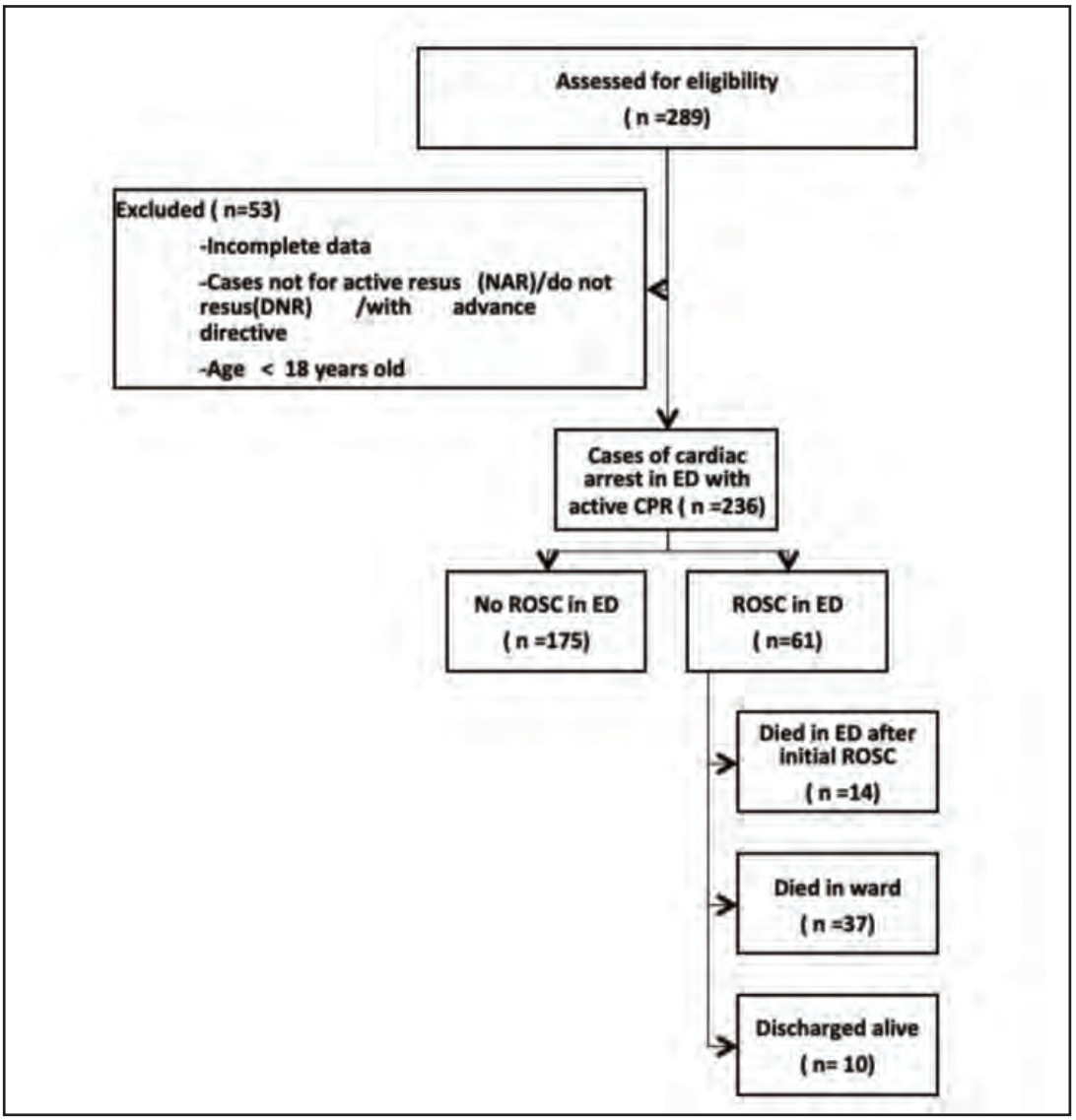


**Fig. 1:** Outcome of cardiopulmonary resuscitation of patients with cardiac arrest in the emergency department.

focus on examining each cohort separately with longer study periods and larger sample sizes to gain a better understanding. The majority of CA is caused by non-traumatic events, with 26.9% ROSC and 4.8% STD, whereas for trauma cases, 17% ROSC and none with STD. In contrast, the STD for post-traumatic CA in the PROPHET and Epistry Trauma registries is 6.8%.[31] This result is despite the study hospital being a trauma centre with the necessary subspecialist care available.

With univariable logistic regression analysis, CA in ED, VF as first rhythm, history of defibrillation, EMS attended CA and IV adrenaline administration were associated with a better chance of attaining ROSC. These findings are consistent with previous studies in the literature.[6,7,32–34]

Through multivariate analysis, independent predictors for ROSC were cardiac and respiratory causes of CA, and EMS attended CA. Due to the small number of STDs, we chose not to perform the multivariate analysis as the result might not be accurate.

Looking at it from a different perspective, during our research, we discovered that the main challenge we faced in gathering the data was the insufficient information recorded. Whilst the Utstein template was introduced in 1990 and revised in 2004, it was never widely adopted in Malaysia.[10] The variables, consisting of the patient variables, the hospital variables, the CA variables, and the outcome variables would be comprehensive for documentation and data retrieval purposes. Unfortunately, from our observation, until this article was written, there was no standard way of documenting a CA event, even within a single centre. This is the major reason for the variance in term definitions and the missing important data, including the details during the CA and the long-term neurological outcomes. Since this study is retrospective, we made every effort to maintain the accuracy of the data by adhering to the template. Future registry implementation based on this template will produce robust research comparisons between nations. For that, official policy and continuous administrative support is needed.

Although the research has reached its primary aims, there were unavoidable limitations. Our study was performed retrospectively in a single tertiary centre for a year. The data collected were limited based on the above reasoning. As more hospitals in Malaysia are not tertiary, the result should not be generalised. Hence, our results should be interpreted cautiously. We were also unable to ascertain the factors influencing the survival to discharge after the patients left the ED resuscitation area; thus, the patient's actual survival and neurological status were not captured.

There is a need to create a cardiac arrest registry in Malaysia. The ROSC and STD rate will directly imply the quality of the healthcare system and the gap to be addressed. The American Heart Association's Get With The Guidelines-Resuscitation (GWTG-R) registry and the Danish In-Hospital Cardiac Arrest Registry (DANARREST) can be emulated to be implemented in Malaysia.[35]

## CONCLUSION

Despite being an upper-middle-income country and having advancements in the healthcare system, a relatively lower STD rate among survivors of CA in the ED was observed in this study. There was underutilization of the EMS among patients with CA. The bystander CPR rate among patients with CA in Malaysia is also worryingly low. Aggressive community participation in cardiac arrest awareness programmes is much required. Additionally, in achieving better outcomes, implementing standardized post-resuscitation care protocols with existing resources will be a challenge for physicians managing cardiac arrest cases.

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## DECLARATION

This study was approved by the Malaysian Research Ethics Committee (MREC) (NMRR-19-1766-47833) and Universiti Teknologi MARA (UiTM) Research Ethics Committee (REC/334/19). All methods were performed according to the ICH Good Clinical Practice Guidelines, Malaysia Good Clinical Practice Guidelines and the Declaration of Helsinki.

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