Modifiable Factors Associated With Survival After Out-of-Hospital Cardiac Arrest in the Pan-Asian Resuscitation Outcomes Study

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Study objective: The study aims to identify modifiable factors associated with improved out-of-hospital cardiac arrest survival among communities in the Pan-Asian Resuscitation Outcomes Study (PAROS) Clinical Research Network: Japan, Singapore, South Korea, Malaysia, Taiwan, Thailand, and the United Arab Emirates (Dubai).

Methods: This was a prospective, international, multicenter cohort study of out-of-hospital cardiac arrest in the Asia-Pacific. Arrests caused by trauma, patients who were not transported by emergency medical services (EMS), and pediatric out-of-hospital cardiac arrest cases (<18 years) were excluded from the analysis. Modifiable out-of-hospital factors (bystander cardiopulmonary resuscitation [CPR] and defibrillation, out-of-hospital defibrillation, advanced airway, and drug administration) were compared for all out-of-hospital cardiac arrest patients presenting to EMS and participating hospitals. The primary outcome measure was survival to hospital discharge or 30 days of hospitalization (if not discharged). We used multilevel mixed-effects logistic regression models to identify factors independently associated with out-of-hospital cardiac arrest survival, accounting for clustering within each community.

Results: Of 66,780 out-of-hospital cardiac arrest cases reported between January 2009 and December 2012, we included 56,765 in the analysis. In the adjusted model, modifiable factors associated with improved out-of-hospital cardiac arrest outcomes included bystander CPR (odds ratio [OR] 1.43; 95% confidence interval [CI] 1.31 to 1.55), response time less than or equal to 8 minutes (OR 1.52; 95% CI 1.35 to 1.71), and out-of-hospital defibrillation (OR 2.31; 95% CI 1.96 to 2.72). Out-of-hospital advanced airway (OR 0.73; 95% CI 0.67 to 0.80) was negatively associated with out-of-hospital cardiac arrest survival.

Conclusion: In the PAROS cohort, bystander CPR, out-of-hospital defibrillation, and response time less than or equal to 8 minutes were positively associated with increased out-of-hospital cardiac arrest survival, whereas out-of-hospital advanced airway was associated with decreased out-of-hospital cardiac arrest survival. Developing EMS systems should focus on basic life support interventions in out-of-hospital cardiac arrest resuscitation. [Ann Emerg Med. 2017;■:1-10.]

Please see page XX for the Editor's Capsule Summary of this article.

0196-0644/$-see front matter

http://dx.doi.org/10.1016/j.annemergmed.2017.07.484

INTRODUCTION

Background

The incidence of out-of-hospital cardiac arrest ranges from 50 to 60 per 100,000 person-years globally.[1] Out-of-hospital cardiac arrest registries in the United States[2,3] and Europe[4,5] have reported survival rates ranging from 7.5% to 10.8%. However, out-of-hospital cardiac arrest survival in Asia is lower. The Pan-Asian Resuscitation Outcomes Study (PAROS) registry has observed an out-of-hospital cardiac arrest survival rate of only 5.4%.[6] This finding implies that survival can be improved further in out-of-hospital cardiac arrest systems in Asia.

North American studies have identified several modifiable factors in the chain of survival[7] (eg, bystander cardiopulmonary resuscitation [CPR], defibrillation) associated with out-of-hospital cardiac arrest survival.[8] The importance of these factors in Asian communities is unknown. For example, although countries such as Japan, Korea, Singapore, and Taiwan have well-established emergency medical services (EMS)

†All investigators are listed in the Appendix.

Editor's Capsule Summary

What is already known on this topic

Out-of-hospital cardiac arrest survival in Asia is low.

What question this study addressed

What modifiable factors are associated with improved out-of-hospital cardiac arrest survival in Asian communities?

What this study adds to our knowledge

In this analysis of 56,765 out-of-hospital cardiac arrests from communities of the Pan-Asian Resuscitation Outcomes Study network, bystander cardiopulmonary resuscitation, response time less than or equal to 8 minutes, and out-of-hospital defibrillation were associated with improved out-of-hospital cardiac arrest survival. Out-of-hospital advanced airway was associated with decreased out-of-hospital cardiac arrest survival.

How this is relevant to clinical practice

These results highlight potential targets for improving out-of-hospital cardiac arrest survival in Asia.

systems (availability of dispatcher-assisted CPR, first responders, universal dispatch, etc), they are still lacking in advanced life support (ALS) capabilities, such as administration of amiodarone and intubation by the paramedics. Public awareness of and provision of CPR also lags behind those of Western nations. Hence, the elements pertinent to out-of-hospital cardiac arrest survival in Asia likely differ from those reported by previous North American studies.

Importance

In a limited-resource setting, countries will need to prioritize where to invest efforts to improve their out-of-hospital cardiac arrest systems. For example, it is not clear whether developing countries should focus on developing ALS capabilities or improving community CPR training.[9] An improved understanding of the relative influence of these factors on out-of-hospital cardiac arrest outcomes could influence public policy and guide these countries to the best strategies for improving out-of-hospital cardiac arrest outcomes.

Goals of This investigation

The objective of this study was to identify the relative importance of major systemic, modifiable factors associated with out-of-hospital cardiac arrest survival in the communities of the PAROS consortium.

MATERIALS AND METHODS

Study Design

We analyzed out-of-hospital cardiac arrest data from the PAROS network. The study was approved by the local ethics committees of the participating PAROS communities.

Setting

PAROS is a clinical research network established by EMS and emergency medicine experts for the purpose of conducting research in out-of-hospital emergency care in the Asia-Pacific. The network has identified out-of-hospital cardiac arrest as its main focus and aims to improve out-of-hospital cardiac arrest survival through the establishment of baseline data, understanding of EMS capabilities, interventions or factors associated with improved survival, etc. The network is composed of communities from Japan, Singapore, South Korea, Malaysia, Taiwan, Thailand, and the United Arab Emirates (Dubai). More information about the network can be found at http://www.scri.edu.sg/crn/pan-asian-resuscitation-outcomes-study-paros-clinical-research-network-crn/about-paros/.

The PAROS network includes a range of communities, including more urbanized populations such as Tokyo (Japan) and Seoul (Korea); more rural populations such as Kota Bahru (Malaysia) and Songkla (Thailand); and mixed urban-rural populations in Klang Valley (Malaysia), Aichi, Pinang (Malaysia), and Dubai (United Arab Emirates).[6] The population density of PAROS communities ranges from 474.8/km^2 to 19,014.4/km^2, with ambulance-to-population ratios ranging from 1:14,000 to 1:218,000. The total population of PAROS communities is approximately 55.9 million.

Although most EMS systems of the participating PAROS communities are single tiered and fire department based,[10] the EMS systems in Thailand and Malaysia are hospital based. The majority of the ambulances in these countries have basic life support (BLS) capabilities, whereas some have a mix of both BLS and ALS or ALS-only capabilities. Although most ambulances are staffed by emergency medical technicians–intermediate or paramedics, in Thailand the ambulances are staffed by nurses and physicians.[11] The average ambulance response time (the time from when the call is received to the time the ambulance arrives at the scene) varies from 5 to 15.2 minutes. Airway management (eg, intubation, laryngeal mask airway) and drug administration (eg, epinephrine,

methoxyflurane) practices vary across participating EMS systems.[12]

In 2010, PAROS established a registry to collect out-of-hospital cardiac arrest data from participating communities. The PAROS Clinical Research Network shares a common taxonomy and case record form (Appendix E1, available online at http://www.annemergmed.com). To participate in PAROS, the community must be able to contribute all the core variables (eg, bystander CPR, out-of-hospital defibrillation, cause of arrest, return of spontaneous circulation in the ED) of the study, including information from both EMS and participating hospitals. Noncore variables collected by the registry include postresuscitation information such as hypothermia therapy and patients' outcomes such as neurologic status on hospital discharge or 30 days of hospitalization. Data that were abstracted from dispatch records, ambulance forms, and emergency department (ED) and inhospital case records were entered into ePAROS, an electronic data capture platform.

For communities with existing national cardiac arrest registries such as Taiwan, Korea, and Japan, data were contributed through an export field entry process, which autopopulated the PAROS registry. Each community contributed 1.5 to 2.5 years of out-of-hospital cardiac arrest data from January 2009 to December 2012 (see Appendix E1, available online at http://www.annemergmed.com, for data collection period for each community). Collected data were verified by designated coordinators in each participating community before and after entry into the electronic data capture. The coordinator was responsible for ensuring the accuracy of data entry. Additional checks were conducted by the trial coordinating center for completeness, as well as data range and logic checks. Data errors, missing values, and internal logical inconsistencies were resolved through source data verification with the corresponding communities by the trial coordinating center.

The detailed methodology, data variables, and additional information such as cities and number of participating EMS agencies in each community contributing to PAROS can be found in previously published articles and in Appendix E1, available online at http://www.annemergmed.com.[6,10]

Selection of Participants

The PAROS registry collected all reported out-of-hospital cardiac arrest cases, defined by absence of pulse, unresponsiveness, and apnea. Out-of-hospital cardiac arrest cases in which resuscitation was not attempted and patients were immediately pronounced dead (because of decapitation, rigor mortis, dependent lividity, and do-not-resuscitate orders) were not collected by the registry. For Malaysia and Thailand, cases in which resuscitation was attempted but patents were subsequently pronounced dead in the field were included in the registry. Arrests caused by trauma (as assessed either by EMS or emergency physicians), patients who were not transported by EMS, and pediatric out-of-hospital cardiac arrest cases were excluded from this analysis.

Outcome Measures

The primary outcome was the earlier of survival to hospital discharge or 30-day hospital survival. The secondary outcome was neurologically favorable survival (Cerebral Performance Category scores 1 and 2), determined at hospital discharge or 30 days of hospitalization.

Primary Data Analysis

All cases with missing outcome values were classified as nonsurvivors for the analysis. Response time was dichotomized into 8 minutes or less and more than 8 minutes; this cutoff was based on the Ontario Prehospital Advanced Life Support study.[8]

We compared modifiable factors and out-of-hospital cardiac arrest survival rates across the participating communities. We fit a multivariable model with survival to discharge (or 30-day survival) as the primary outcome. For the predictors, we included factors that have been reported to be associated with out-of-hospital cardiac arrest survival, including age, bystander-witnessed arrest, shockable rhythm, bystander CPR, out-of-hospital defibrillation, advanced airway and drug administration, and response time.[7,8] We used multilevel mixed-effects logistic regression models (melogit) with a random intercept at the community level to account for the clustering effect of individuals within the community. In a sensitivity analysis, we repeated the modeling, using survival with good neurologic function as the primary outcome.

We conducted 2 key sensitivity analyses. First, because of the large number of cases contributed by Japan, we repeated the analysis for Japan alone and all other PAROS communities combined. Among the PAROS communities, there were 3 general EMS systems configurations: hospital based (Malaysia and Thailand), fire department based (Japan and Korea), and mixed (Singapore, Taiwan, and the United Arab Emirates). Thus, we also repeated the analysis stratified by EMS system configuration.

All analyses were performed with Stata (version 14.0; StataCorp, College Station, TX).

RESULTS

Of 66,780 out-of-hospital cardiac arrest cases reported between January 2009 and December 2012, we excluded 10,015 trauma, non-EMS, and pediatric (<18 years) cases, leaving 56,765 cases in the analysis (Figure 1). The mean age of the population was 72.7 years; 59.6% were men (Table 1). Approximately 10.1% of the patients had heart disease. Most out-of-hospital cardiac arrests occurred at home (68.8%) and were unwitnessed (57.1%). The initial arrest rhythm was mostly nonshockable (87.6%). More than one third (39.3%) of the study population received bystander CPR. Few patients (0.6%) received bystander defibrillation. The majority of the arrests were of presumed cardiac origin (71.5%). Among modifiable resuscitation factors, out-of-hospital advanced airway and drug administration rates were 38.4% and 11.3%, respectively. The median response time was 6.0 minutes (interquartile range 5 to 8), median time spent at the scene was 12.6 minutes (interquartile range 8 to 17), and median time en route was 6 minutes (interquartile range 4 to 10).

Overall out-of-hospital cardiac arrest survival was 5.8%. Out-of-hospital cardiac arrest survival across the PAROS communities varied from 1.6% to 9.8% (Table 2). For witnessed ventricular fibrillation arrests of cardiac cause, out-of-hospital cardiac arrest survival varied from 0% to 33%.

Nonmodifiable factors independently associated with survival to discharge or 30 days of hospitalization included aged 65 years or younger (adjusted odds ratio [OR] 2.09; 95% confidence interval [CI] 1.91 to 2.29), witnessed arrest by bystanders (OR 3.18; 95% CI 2.89 to 3.50), and initial shockable rhythm (OR 2.9; 95% CI 2.45 to 3.42) (Figure 2). Modifiable factors independently associated with survival included bystander CPR (OR 1.43; 95% CI 1.31 to 1.55), response time less than or equal to 8 minutes

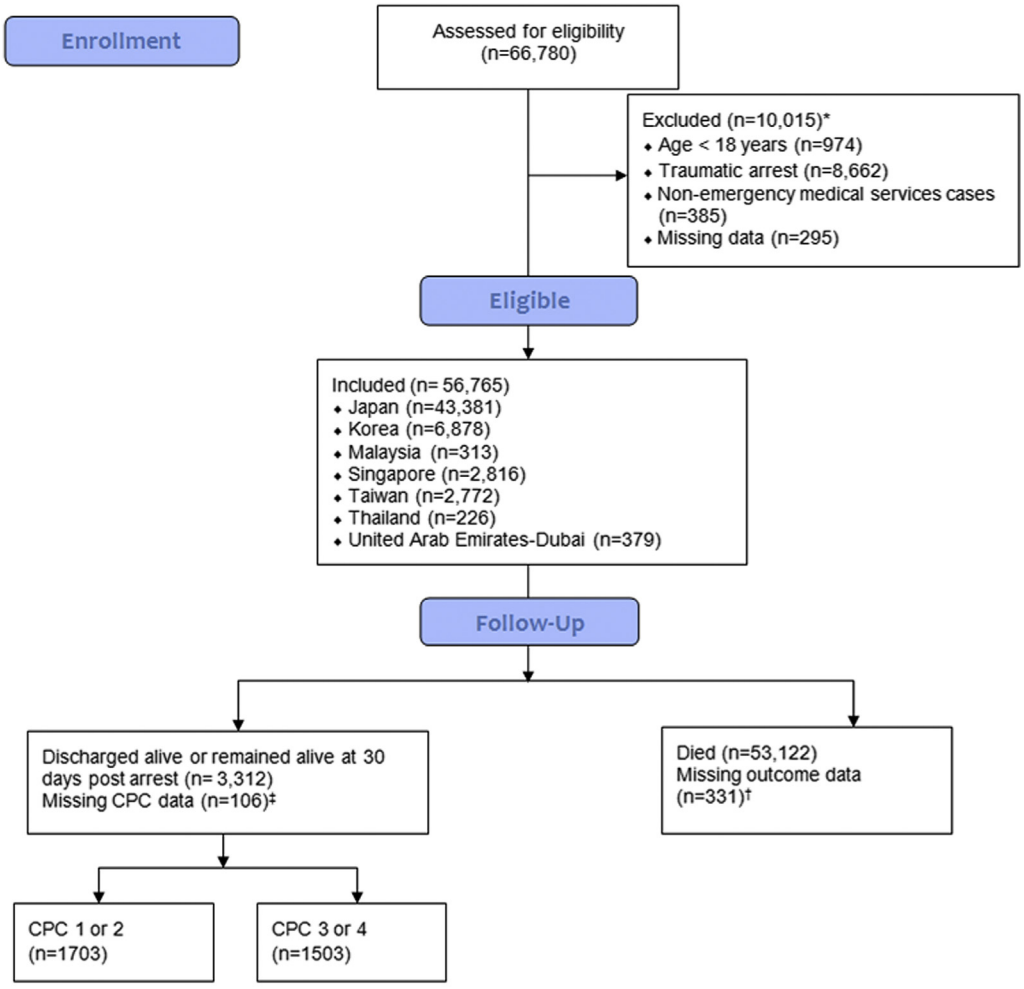

Figure 1. Patient flow diagram. *CPC*, Cerebral performance category; *UAE*, United Arab Emirates.

Table 1. Patient demographics and clinical characteristics.

Characteristics	Japan (n=43,381)	Korea (n=6,878)	Malaysia (n=313)	Singapore (n=2,816)	Taiwan (n=2,772)	Thailand (n=226)	UAE-Dubai (n=379)	Overall (n=56,765)
Age, mean (SD), y	74.6 (15.0)	66.1 (16.6)	59.1 (16.1)	65.5 (15.6)	72.6 (16.5)	62.6 (18.9)	51.8 (16.1)	72.7 (15.9)
Median (IQR)	77.0 (19.0)	69.0 (24.0)	60.0 (21.0)	66.0 (22.0)	77.0 (24.0)	65.0 (32.0)	50.0 (23.0)	76.0 (21.0)
Sex, No. (%)								
Male	25,036 (57.7)	4,486 (65.2)	219 (70.0)	1,864 (66.2)	1,766 (63.8)	144 (63.7)	314 (82.8)	33,829 (59.6)
Medical history, No. (%)*								
Present (at least 1 disease)	2,933 (23.6)	4,171 (60.6)	203 (64.9)	2,266 (80.5)	1,947 (70.2)	165 (73.0)	123 (32.5)	11,808 (20.8)
Heart disease	2,933 (23.6)	820 (11.9)	74 (23.6)	1,063 (37.7)	731 (26.4)	43 (19.0)	49 (12.9)	5,713 (10.1)
Hypertension	Not collected	2,268 (33.0)	97 (31.0)	1,400 (49.7)	891 (32.1)	70 (31.0)	49 (12.9)	4,775 (8.4)
Diabetes	Not collected	1,531 (21.9)	94 (30.0)	867 (30.1)	543 (19.6)	34 (15.0)	57 (15.0)	3,078 (5.4)
Stroke	Not collected	637 (9.3)	19 (6.1)	322 (11.4)	288 (10.4)	18 (8.0)	6 (1.6)	1,290 (2.3)
Cancer	Not collected	771 (11.2)	18 (5.8)	261 (9.3)	292 (10.5)	18 (8.0)	3 (0.8)	1,363 (2.4)
Renal	Not collected	266 (3.9)	27 (8.6)	285 (10.1)	210 (7.6)	16 (7.1)	7 (1.8)	811 (1.4)
Respiratory	Not collected	264 (3.8)	14 (4.4)	344 (12.2)	174 (6.3)	20 (8.8)	7 (1.8)	823 (1.4)
Hyperlipidemia	Not collected	76 (1.1)	3 (1.0)	814 (28.9)	38 (1.4)	9 (4.0)	4 (1.1)	944 (1.7)
HIV	Not collected	3 (0.04)	2 (0.6)	2 (0.1)	3 (0.1)	1 (0.4)	1 (0.3)	12 (0.02)
Others	Not collected	0	28 (8.9)	1,005 (35.7)	347 (12.5)	40 (17.7)	8 (2.1)	1,428 (2.5)
Unknown	9,486 (76.4)	1,399 (20.3)	86 (27.5)	235 (8.3)	491 (17.7)	45 (19.9)	245 (64.6)	11,987 (21.1)
Location type, No. (%)*								
Home residence	8,229 (66.3)	4,601 (68.6)	235 (75.1)	2,039 (72.4)	2,127 (77.0)	175 (77.4)	210 (55.4)	17,616 (68.8)
Health care facility	49 (0.4)	120 (1.8)	7 (2.2)	104 (3.7)	0	6 (2.7)	6 (1.6)	292 (1.1)
Public/commercial building	873 (7.0)	387 (5.8)	34 (10.9)	233 (8.3)	62 (2.2)	17 (7.5)	47 (12.4)	1,653 (6.5)
Nursing home	1,551 (12.5)	278 (4.1)	6 (1.9)	109 (3.9)	238 (8.6)	4 (1.8)	0	2,186 (8.5)
Street/highway	493 (4.0)	138 (2.1)	13 (4.2)	99 (3.5)	110 (4.0)	9 (4.0)	65 (17.2)	927 (3.6)
Industrial place	0	63 (0.9)	1 (0.3)	54 (1.9)	54 (2.0)	1 (0.4)	16 (4.2)	189 (0.7)
Transport center	0	95 (1.4)	1 (0.3)	30 (1.1)	2 (0.1)	1 (0.4)	0	129 (0.5)
Place of recreation	0	159 (2.4)	1 (0.3)	53 (1.9)	52 (1.9)	3 (1.3)	23 (6.1)	291 (1.1)
In EMS/private ambulance	782 (6.3)	328 (4.9)	8 (2.6)	61 (2.2)	0	9 (4.0)	0	1,188 (4.6)
Other	442 (3.6)	539 (8.0)	7 (2.2)	34 (1.2)	116 (4.2)	1 (0.4)	12 (3.2)	1,148 (4.5)
Arrest witnessed by, No. (%)								
Not witnessed	25,609 (59.0)	2,712 (45.9)	154 (49.2)	1,211 (43.0)	1,791 (68.4)	79 (35.0)	191 (50.4)	31,747 (57.1)
Bystander	14,588 (33.6)	2,811 (47.5)	136 (43.5)	1,399 (49.7)	566 (21.6)	133 (58.8)	176 (46.4)	19,809 (35.6)
EMS/private ambulance	3,184 (7.3)	391 (6.6)	23 (7.3)	206 (7.3)	261 (10.0)	14 (6.2)	12 (3.2)	4,091 (7.4)
First arrest rhythm, No. (%)								
Shockable rhythm	3,733 (8.6)	1,159 (16.9)	8 (3.9)	542 (19.2)	279 (10.1)	14 (7.7)	79 (20.8)	5,814 (10.3)
Nonshockable rhythm	39,612 (91.3)	5,027 (73.1)	129 (63.5)	2,272 (80.7)	2,128 (76.8)	111 (60.7)	300 (79.2)	49,579 (87.6)
Unknown rhythm	36 (0.1)	692 (10.1)	66 (32.5)	2 (0.1)	365 (13.2)	58 (31.7)	0	1,219 (2.2)

Table 1. Continued.

Characteristics	Japan (n=43,381)	Korea (n=6,878)	Malaysia (n=313)	Singapore (n=2,816)	Taiwan (n=2,772)	Thailand (n=226)	UAE-Dubai (n=379)	Overall (n=56,765)
Bystander CPR, No. (%)†	16,716 (41.6)	2,619 (40.4)	72 (24.8)	635 (24.3)	549 (22.2)	48 (22.6)	39 (10.6)	20,687 (39.3)
Bystander defibrillation, No. (%)†	304 (0.7)	16 (0.2)	Not collected	24 (0.9)	Not collected	0	3 (0.8)	347 (0.6)
Out-of-hospital defibrillation	5,080 (11.7)	1,672 (24.3)	9 (2.9)	682 (24.2)	332 (12.0)	27 (11.9)	140 (36.9)	7,942 (14.0)
Out-of-hospital advanced airway	17,336 (40.0)	1,067 (15.5)	72 (23.0)	2,323 (82.5)	893 (32.2)	105 (46.5)	28 (7.4)	21,824 (38.4)
Out-of-hospital drug administration	3,989 (9.2)	54 (0.8)	42 (13.4)	1,371 (48.7)	536 (19.3)	117 (51.8)	306 (80.7)	6,415 (11.3)
Cause of cardiac arrest, No. (%)‡								
Presumed cardiac	29,681 (68.4)	5,560 (80.8)	92 (86.8)	2,191 (77.8)	2,369 (88.1)	75 (62.0)	357 (94.2)	40,325 (71.5)
Respiratory	2,256 (5.2)	63 (0.9)	6 (5.7)	219 (7.8)	190 (7.1)	25 (20.7)	4 (1.1)	2,763 (4.9)
Electrocution	0	0	0	2 (0.1)	0	4 (3.3)	2 (0.5)	8 (0.01)
Drowning	295 (0.7)	88 (1.3)	2 (1.9)	16 (0.6)	13 (0.5)	2 (1.7)	9 (2.4)	425 (0.8)
Other	11,149 (25.7)	1,167 (17.0)	6 (5.7)	388 (13.8)	118 (4.4)	15 (12.4)	7 (1.8)	12,850 (22.8)

*Data not collected by Tokyo and Aichi.
†Excludes arrests witnessed by EMS/private ambulance.
‡For Malaysia, Thailand, if patient was pronounced dead at the scene, the cause of arrest was that reported by EMS. If the patient was transported to the ED, the cause of arrest is that reported by the ED.

Table 2. Patient outcomes.

Characteristics	Japan (n=43,381)	Korea (n=6,878)	Malaysia (n=313)	Singapore (n=2,816)	Taiwan (n=2,772)	Thailand (n=226)	UAE-Dubai (n=379)	Overall (n=56,765)
All attempted resuscitations, No. (%)								
EMS ROSC	3,831 (8.8)	326 (4.7)	7 (2.2)	145 (5.1)	353 (12.7)	39 (17.3)	14 (3.7)	4,715 (8.3)
ED ROSC	4,182 (9.6)	2,449 (35.6)	20 (6.4)	736 (26.1)	845 (30.5)	54 (23.9)	22 (5.8)	8,308 (14.6)
Admitted	3,557 (8.2)	1,483 (21.6)	13 (4.2)	466 (16.5)	663 (23.9)	39 (17.3)	30 (7.9)	6,251 (11)
Alive on hospital discharge or 30 days of hospitalization	2,390 (5.5)	673 (9.8)	5 (1.6)	89 (3.2)	131 (4.7)	11 (4.9)	13 (3.4)	3,312 (5.8)
CPC score 1 or 2	1,331 (3.1)	225 (3.3)	Not collected	50 (1.8)	80 (2.9)	6 (2.7)	11 (2.9)	1,703 (3)
Witnessed VF arrests of cardiac cause, No. (%)								
Total	1,748	615	1	334	135	5	42	2,880
EMS ROSC	682 (39)	160 (26)	0	41 (12.3)	42 (31.1)	1 (20)	5 (11.9)	931 (32.3)
ED ROSC	0	267 (43.4)	1 (100)	105 (31.4)	70 (51.9)	1 (20)	7 (16.7)	451 (15.7)
Admitted	0	277 (45)	0	95 (28.4)	63 (46.7)	1 (20)	9 (21.4)	445 (15.5)
Alive on hospital discharge or 30 days of hospitalization	522 (29.9)	203 (33)	0	45 (13.5)	25 (18.5)	0	7 (16.7)	802 (27.8)
CPC score 1 or 2	376 (21.5)	124 (20.2)	Not collected	30 (9)	22 (16.3)	0	6 (14.3)	558 (19.4)

ROSC, Return of spontaneous circulation; *VF*, ventricular fibrillation.
*Data not collected by Tokyo and Aichi.

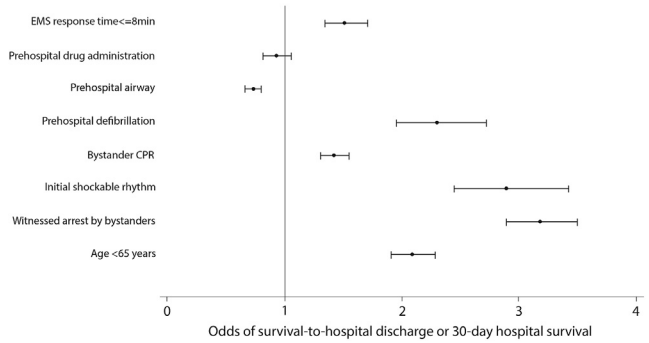

Figure 2. Multivariate factors associated with survival to hospital discharge or 30 days of hospitalization.

(OR 1.52; 95% CI 1.35 to 1.71), and out-of-hospital defibrillation (OR 2.31; 95% CI 1.96 to 2.72) and were associated with improved survival. Conversely, out-of-hospital advanced airway (OR 0.73; 95% CI 0.67 to 0.80) was negatively associated with survival. Out-of-hospital drug administration was negatively associated with survival in the "others" subgroup, but not in the overall cohort (Table 3).

On sensitivity analysis, the positive association of modifiable factors with out-of-hospital cardiac arrest survival remained consistent when stratified by community (Japan versus other communities) and EMS configuration (hospital based, fire department based, and mixed) (Table 3). When repeating the analysis with neurologically favorable survival as the outcome, we observed similar results (Table 4).

LIMITATIONS

This was not a prospective interventional trial. Cases from Japan made up 75% of the study population, but we observed consistent results when separately assessing Japan and the remaining PAROS communities. Although a small portion of cases (0.58%) were missing survival outcome data, this did not affect our results in the sensitivity analysis.

Because the PAROS registry is EMS based, we may have missed patients not receiving EMS care, a situation that often occurs in Thailand and Malaysia. Although the chain of survival includes postresuscitation care, such as hypothermia therapy, we did not have consistent postarrest care data in the PAROS registry. The administration of therapeutic hypothermia was low in the PAROS participating communities, ranging from 0.3% to 8.5%.

Although we posited that the negative association of advanced airway insertion and drug administration and survival or survival with good neurologic outcomes could be due to these procedures detracting EMS providers from delivering good BLS, we are not able to support this

Table 3. Multivariate factors associated with survival to hospital discharge or 30 days of hospitalization.

Variable	OR (95% CI)					
	All Communities (n = 56,765)	**Japan (n = 43,381)**	**Others (n = 13,384)**	**Malaysia, Thailand* (n = 539)**	**Singapore, Taiwan, UAE-Dubai* (n = 5,967)**	**Japan, Korea* (n = 50,259)**
≤65 y	2.09 (1.91–2.29)	2.07 (1.87–2.29)	2.05 (1.71–2.45)	0.53 (0.12–2.32)	1.40 (1–1.96)	2.16 (1.97–2.37)
Bystander-witnessed arrest	3.18 (2.89–3.50)	3.85 (3.44–4.30)	1.77 (1.48–2.12)	1.27 (0.30–5.43)	1.84 (1.29–2.60)	3.29 (2.98–3.63)
Initial rhythm						
Nonshockable rhythm	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Shockable rhythm	2.90 (2.45–3.42)	2.54 (2.09–3.08)	3.88 (2.79–5.40)	9.33 (0.52–168.76)	6.13 (2.62–14.34)	2.77 (2.34–3.29)
Bystander CPR	1.43 (1.31–1.55)	1.50 (1.36–1.65)	1.44 (1.21–1.72)	0.43 (0.08–2.27)	1.88 (1.33–2.64)	1.41 (1.29–1.54)
Out-of-hospital defibrillation	2.31 (1.96–2.72)	2.77 (2.29–3.36)	1.43 (1.02–1.99)	0.20 (0.01–3.62)	1.26 (0.53–2.97)	2.38 (2.01–2.81)
Out-of-hospital advanced airway	0.73 (0.67–0.80)	0.68 (0.61–0.75)	0.78 (0.64–0.94)	4.05 (0.31–52.7)	0.64 (0.45–0.90)	0.73 (0.66–0.80)
Out-of-hospital drug administration	0.93 (0.82–1.06)	0.88 (0.77–1.02)	0.54 (0.41–0.70)	3.53 (0.27–46.70)	0.68 (0.47–0.98)	0.94 (0.83–1.08)
EMS response time ≤8 min	1.52 (1.35–1.71)	1.47 (1.28–1.68)	2.03 (1.61–2.57)	3.64 (0.56–23.70)	2.26 (1.51–3.39)	1.48 (1.31–1.68)

*Communities were grouped according to similarities in EMS systems.

Table 4. Multivariate factors associated with favorable postarrest cerebral performance category (Cerebral Performance Category score 1 or 2).

	OR (95% CI)		
Variable	**The Entire Eligible Cohort (n=56,659)***	**Japan (n=43,340)**	**Others (n=13,319)**
≤65 y	2.60 (2.30–2.96)	2.60 (2.26–2.99)	2.56 (1.89–3.48)
Bystander-witnessed arrest	3.55 (3.07–4.10)	4.20 (3.56–4.95)	1.82 (1.35–2.45)
Initial rhythm			
Nonshockable rhythm	1 [Reference]	1 [Reference]	1 [Reference]
Shockable rhythm	3.25 (2.58–4.10)	2.55 (1.98–3.28)	9.52 (5.21–17.39)
Bystander CPR	1.98 (1.75–2.24)	1.97 (1.72–2.26)	1.87 (1.43–2.46)
Out-of-hospital defibrillation	3.56 (2.81–4.51)	4.11 (3.18–5.31)	1.88 (1.01–3.50)
Out-of-hospital advanced airway	0.41 (0.36–0.47)	0.37 (0.32–0.44)	0.60 (0.44–0.81)
Out-of-hospital drug administration	0.48 (0.40–0.59)	0.45 (0.36–0.56)	0.67 (0.45–1.01)
EMS response time ≤8 min	1.59 (1.34–1.88)	1.57 (1.30–1.90)	1.80 (1.26–2.57)

*Missing data: Japan 41, Korea 56, Malaysia 5, Thailand 3, UAE-Dubai 1.

observation with data such as chest compression continuity during airway insertion or time taken to deliver intravenous drugs such as epinephrine.

DISCUSSION

In this study of out-of-hospital cardiac arrest treated in the PAROS communities, we found that bystander CPR, out-of-hospital defibrillation, and EMS response time less than or equal to 8 minutes were positively associated with out-of-hospital cardiac arrest outcomes, whereas out-of-hospital advanced airway and drug administration were negatively associated with out-of-hospital cardiac arrest survival. These associations remained consistent in sensitivity analyses. Our results are similar to those found by North American registries such as the Cardiac Arrest Registry to Enhance Survival,[13,14] Resuscitation Outcomes Consortium,[15,16] and Ontario Prehospital Advanced Life Support.[7,8]

The findings of this study highlight opportunities for improving out-of-hospital cardiac arrest care in the PAROS communities. A potential area for targeted improvement in the study communities is investment in community-based and systemic efforts to increase bystander CPR and defibrillation rates. This would require concerted public health efforts to educate and train the population to perform CPR. Although such strategies would seem to be relatively costly,[17] the advent of dispatcher-assisted CPR has great potential to lower barriers to CPR by laypersons and may also prove to be a cost-effective approach that developing countries can adopt.[18] The PAROS network is currently conducting an implementation trial of dispatcher-assisted CPR in the Asia-Pacific.[19] The rate of automated electronic defibrillator usage in our population was low, at 0.6%, which suggests that there is potential to further increase the rate of out-of-hospital defibrillation through the implementation of a comprehensive public access defibrillators program.

In contrast to previous US studies, EMS response time in PAROS appeared to have stronger association with survival, which is not consistent in US studies.[20-23] In Asia, ambulance response times are relatively long, frequently exceeding the North American recommendations of less than 8 minutes in 90% of cases,[24] compared with that in most North American or European settings.[11] Strategies to improve response times may potentially include optimizing dispatch, deploying appropriate numbers of ambulances, using advanced ambulance deployment algorithms,[25] and using motorcycle- or fire department-based first responders.[26,27]

ALS EMS is the standard of care for many North American and European communities. Yet there is relatively little evidence for the effectiveness of ALS in out-of-hospital cardiac arrest, and procedures such as advanced airway insertion and drug administration might actually distract from providing good BLS. In general, all PAROS communities that used advanced airways would mainly use supraglottic devices, which were applied fairly early in the resuscitation according to the protocol (airway, breathing, and circulation), and no country used delayed airway management protocol (Arizona style). Our study adds to the existing literature supporting the relative importance of BLS compared with ALS in out-of-hospital cardiac arrest outcomes.[28-30]

An important observation is that out-of-hospital cardiac arrest survival varied across PAROS communities, ranging from 1.6% (Malaysia) to 9.8% (Korea). Previous studies underscored the variations in out-of-hospital cardiac arrest outcomes across communities in North America.[1,31] There are many potential reasons for variations across communities, including differences in bystander CPR rates, EMS response times, etc. Although our analysis was not designed to elicit the reasons for out-of-hospital cardiac arrest survival variation across PAROS communities, this variation is not surprising, given the differences in ambulance staffing, EMS systems, community CPR

training, availability of automated electronic defibrillators in the community, postresuscitation protocols, public knowledge and attitudes toward CPR, etc, across the study communities. The implementation of measures to improve out-of-hospital cardiac arrest survival will clearly need to consider the differences of these community populations, health resources, and practice settings.

In communities with limited resources, decisionmakers must determine the best approach to organized out-of-hospital cardiac arrest care. We hope our study results will inform policy and help prioritize resources in Asia and guide national initiatives to improve bystander CPR, increase public access defibrillators, and reduce EMS response times.

In the PAROS cohort, bystander CPR, out-of-hospital defibrillation, and response time less than or equal to 8 minutes were positively associated with increased out-of-hospital cardiac arrest survival, whereas out-of-hospital advanced airway was associated with decreased out-of-hospital cardiac arrest survival. Developing EMS systems should focus on BLS interventions in out-of-hospital cardiac arrest resuscitation.

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Author contributions: HT, MEHO, MH-MM, and SDS conceived the study objectives and methodology and prepared the study protocol. All authors gave input to the design of the study, including the development of the study variables, data dictionary, and case record form. HT, MEHO, MH-MM, HK, KWL, KK, C-HL, HNG, OA, PK, NHR, NED, and SDS assisted in preparation and administration of the study and data acquisition. All authors assisted in data clarification and writing and review of the article. FJS and PA were responsible for all statistical analyses. HT had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. All authors endorse the data and conclusions. HT takes responsibility for the paper as a whole.

All authors attest to meeting the four ICMJE.org authorship criteria: (1) Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND (2) Drafting the work or revising it critically for important intellectual content; AND (3) Final approval of the version to be published; AND (4) Agreement 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.

Funding and support: By *Annals* policy, all authors are required to disclose any and all commercial, financial, and other relationships in any way related to the subject of this article as per ICMJE conflict of interest guidelines (see www.icmje.org). Dr. Ong reports funding from the Zoll Medical Corporation for a study involving mechanical cardiopulmonary resuscitation devices; grants from the Laerdal Foundation, Laerdal Medical, and Ramsey Social Justice Foundation for funding of the Pan-Asian Resuscitation Outcomes Study; an advisory relationship with Global Healthcare Singapore, a commercial entity that manufactures cooling devices; and funding from Laerdal Medical on an observation program to their Community CPR Training Centre Research Program in Norway. This study was supported by grants from the National Medical Research Council (Singapore), Ministry of Health, Singapore, and Korea Centers for Disease Control and Prevention. This study is supported by grants from the National Medical Research Council (Singapore), Ministry of Health, Singapore, and Korea Centers for Disease Control and Prevention.

Publication dates: Received for publication February 23, 2017. Revisions received May 17, 2017, and July 13, 2017. Accepted for publication July 24, 2017.

Presented as an abstract at the Singapore Cardiac Society annual scientific meeting, April 2015, Singapore; European Resuscitation Council, October 2015, Prague, Czech Republic; Asian Conference for Emergency Medicine, November 2015, Taipei, Taiwan; and the Society for Emergency Medicine in Singapore annual scientific meeting, International Resuscitation Science Symposium, February 2016, Singapore.

The funders had no involvement in the study design; in the collection, analysis, and interpretation of data; in the writing of the article; and in the decision to submit the article for publication.

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APPENDIX

PAROS Clinical Research Network

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Appendix E1. Data collection period for each participating site.

Country	Sites	No. of Participating EMS Agencies	Jan 2009	Apr 2009	Jul 2009	Oct 2009	Jan 2010	Apr 2010	Jul 2010	Oct 2010	Jan 2011	Apr 2011	Jul 2011	Oct 2011	Jan 2012	Apr 2012	Jul 2012	Oct 2012
Japan	Osaka	33	X	X	X	X	X	X	X	X								
	Tokyo	1																
	Aichi	36																
Singapore	Singapore	1						X	X	X	X	X	X	X	X	X		
Malaysia	Penang	5						X*	X	X	X	X	X	X	X	X	X	X
	Kota Bahru	4																
	Klang Valley	2																
Taiwan	Taipei	1						X*	X	X	X	X	X	X				
Thailand	Bangkok	1							X*	X	X	X	X	X	X	X	X	
	Songkla	4																
Korea	Seoul	24									X	X	X	X	X	X	X	X
UAE	Dubai	1									X*	X	X	X	X	X	X	X

*Data were collected in the latter half of the month.

Core and noncore variables.

S/N	Variable	Core	Noncore
	EMS agency		
1	Mode of transport	●	
2	Date of incident	●	
3	Location of incident (optional)		●
4	Location type		●
5	Date of birth/age	●	
6	Sex	●	
7	Race (optional)		●
8	Medical history		●
9	Time call received at dispatch center	●	
10	Time FR dispatched		●
11	Time ambulance dispatched		●
12	Time FR arrived at scene		●
13	Time ambulance arrived at scene*	●	
14	Time EMS arrived at patient's side*	●	
15	Time ambulance left scene	●	
16	Time ambulance arrived at ED	●	
17	Estimated time of arrest		●
18	Arrest witnessed by	●	
19	Bystander CPR	●	
20	First CPR initiated by		●
21	Bystander AED applied		●
22	Resuscitation attempted by EMS/private ambulance	●	
23	First arrest rhythm	●	
24	Time CPR started by EMS/private ambulance		●
25	Time AED applied by EMS/private ambulance		●
26	Out-of-hospital defibrillation	●	
27	Defibrillation performed by		●
28	Mechanical CPR device used by EMS/private ambulance		●
29	Out-of-hospital advanced airway		●
30	Out-of-hospital drug administration		●
31	ROSC at scene/en route	●	
32	CPR discontinued at scene/en route		●
33	Final status at scene	●	
34	Cause of arrest (only for patients pronounced dead at scene by EMS)	●	
35	Level of destination hospital		●
36	Destination hospital		●
37	Patient's status at ED arrival	●	

Continued.

S/N	Variable	Core	Noncore
	Hospital (ED)		
38	Date of arrival at ED	●	
39	Time of arrival at ED		●
40	Patient status on arrival at ED: pulse or breathing		●
41	Cardiac rhythm on arrival at ED		●
42	ED defibrillation performed		●
43	Mechanical CPR device used at ED		●
44	Advanced airway used at ED		●
45	Drug administered at ED		●
46	ROSC at ED	●	
47	Emergency PCI performed		●
48	Emergency CABG performed		●
49	Hypothermia therapy initiated		●
50	ECMO therapy initiated		●
51	Cause of arrest	●	
52	Reason for discontinuing CPR at ED		●
53	Outcome of patient	●	
54	Patient status	●	
55	Date of discharge or death		●
56	Patient neurologic status on discharge or at 30th day postarrest		●
57	EQ-5D Health Dimensions–Mobility		●
58	EQ-5D Health Dimensions–Self-care		●
59	EQ-5D Health Dimensions–Usual activities		●
60	EQ-5D Health Dimensions–Pain/discomfort		●
61	EQ-5D Health Dimensions–Anxiety/depression		●
62	EQ-5D visual analog scale		●

FR, First responder; *AED*, automated external defibrillator; *PCI*, percutaneous coronary intervention; *CABG*, coronary artery bypass graft; *ECMO*, extracorporeal membrane oxygenation; *EQ-5D*, European Quality of Life–5 Dimensions.
*Participating sites decided whether this was a core or noncore variable for their site.

PAROS taxonomy.

Data Field	Definition
Patient enrollment information	
Country	2-alphabet country code: Australia, AU Japan, JP Korea, KR Malaysia, MY Singapore, SG Taiwan, TW Thailand, TH Turkey, TR United Arab Emirates, AE
City/EMS district	3-alphabet code: PAROS administrator will create the city/EMS district code.
Site number	3-digit code: PAROS administrator will create the site number for participating sites/hospitals. This will be given to the respective site/hospital coordinator after completion of site registration.
Patient's name* (optional)	Provide patient's name as recorded in ID. It acts as an identifier for tracing the out-of-hospital and ED data. If the patient's name is unknown, indicate unidentified male patient as "unknown male" or unidentified female patient as "unknown female."
ID/site survey number*	Provide patient's ID or site survey number. It also acts as an identifier for tracing the out-of-hospital and ED data. If ID is not available, use the medical record number that was issued during registration at the ED.
Date of arrival at ED	Provide the date when the patient arrived at the ED. There is a possibility that patients had previous incidents recorded in the database. This is essential to prevent wrong data entries or mismatch of data. Enter date as dd/mm/yyyy.
Case number will be autogenerated when the above 6 fields are entered into the system. It will subsequently appear as a unique case number for each record.	

*All patients' identifiers will be subsequently removed from the database after outcome information from the hospital has been traced and data entry is completed.

EMS and Hospital Data **(The preferred source of data is the EMS patient case record and ED or hospital patient case record.)**	
Mode of transportation	
1. Patient brought in by	Indicate "EMS" or "non-EMS." Brought in by EMS refers to patient who was conveyed by ambulance that was dispatched by EMS dispatch center. Brought in by non-EMS refers to patient who was conveyed by private ambulance, own/private transport, or public transport. Private ambulance is defined as ambulance that was not dispatched by EMS dispatch center. Own/private transport includes family member's or relative's/neighbor's/passerby's vehicle. Public transport includes taxi, bus, or other modes of public transport.
Incident information	
2. Date of incident	Provide the date when the cardiac arrest occurred. Enter date as dd/mm/yyyy.
3. Location of incident	Record the zip or postal code of the location where patient was found.
(optional)	Indicate "unknown" if unable to obtain any information.
4. Location type	Indicate type of location where the patient was found. Check only one that applies from the list provided. Home residence: defined as residential home, including inside or nearby surrounding of the home/apartment. Health care facility: includes government outpatient clinic/polyclinic, primary health care clinic, specialist outpatient clinic, dialysis center, and other private health care facilities. Public/commercial building: includes office premises, government offices, shopping mall, educational institution (school), hotel, restaurant, etc. Nursing home: includes home for the aged, assisted living institution, community hospital, sheltered home for mentally ill, hospice center, day rehabilitation center, and elderly day care center. Street/highway: includes all vehicular road, public road, highway, and street pavement. Industrial place: includes industrial premise, construction site, factory, warehouse, shipyards, and wharf. Transport center: includes bus station/terminal, train/subway station, ferry terminal, and airport. Place of recreation: includes gym, stadium, sports complex, park, public swimming complex, golf course, soccer field, entertainment places (eg, bar, lounge, club), and other places for recreation/sport. In EMS/private ambulance: refers to patients who collapsed in the ambulance while en route to the hospital. Others: refers to locations that are not included above. State the location in the space provided.
Patient information	
5. Date of birth	Provide patient's date of birth and enter date as dd/mm/yyyy. If the date of birth is unknown or not available, proceed to enter patient's estimated age in the "age" box.
6. Age	This component will be autogenerated if the date of birth has been entered. If the date of birth is unknown or not available, enter patient's estimated age and select the appropriate units for the recorded age in the field.
7. Sex	Indicate "male" or "female."
8. Race	Indicate the race of the patient.
(optional)	Check only one that applies from the list provided.
9. Medical history	Check all that apply from the list of medical histories provided. Indicate "unknown" if unable to obtain any medical history from bystander.
Dispatch information **(Enter time as hh:mm:ss [24-h clock]. Dispatch time information from EMS records should be used only as a final option.)** **(This section is not applicable for non-EMS cases.)** **FR is defined as the rapid responder who is also dispatched by the emergency call center but does not transport the patient, eg, firefighter, motorcycle/bicycle medic.** **Ambulance is defined as the responding vehicle that is used to transport patients.**	
No FR dispatched	Select this if FR was not dispatched for the incident.
10. Time call received by dispatch center	Time of the earliest call received at the dispatch center (emergency call center). The recorded time of call received should be the first ring at the dispatch center (emergency call center). The time of call received has to be obtained from dispatch records.

Continued.

EMS and Hospital Data **(The preferred source of data is the EMS patient case record and ED or hospital patient case record.)**	
11. Time FR dispatched	Time when the responding FR was notified by the EMS dispatch center. The time of dispatch has to be obtained from dispatch records. Select "no first responder" box if FR was not dispatched.
12. Time ambulance dispatched	Time when the responding ambulance was notified by the EMS dispatch center. The time of dispatch has to be obtained from dispatch records.
13. Time FR arrived at scene	Time FR arrived at scene is defined as the time FR vehicle stopped moving at the scene. The time of arrival has to be obtained from dispatch records rather than EMS records.
14. Time ambulance arrived at scene	Time ambulance arrived at scene is defined as the time ambulance stopped moving at the scene. The time of arrival has to be obtained from dispatch records rather than EMS records.
15. Time EMS arrived at patient's side	Time EMS arrived at patient's side refers to the timing of the first EMS personnel, either FR or ambulance crew, who reached the patient's side. This may not be the same as "time FR or ambulance arrived at scene." It is the time when either the FR or ambulance crew physically arrived at the patient's side. For example, ambulance crew arrived at scene at 12:30:35, and they arrived at patient's side at 12:32:00 after climbing 5 stories to where the patient was physically located.
16. Time ambulance left scene	Time when the patient was transported from the scene to the designated ED, ie, when ambulance started moving. The time when ambulance left scene has to be obtained from dispatch records.
17. Time ambulance arrived at ED	Time when the ambulance arrived at the ED, ie, when the ambulance stopped moving. The time of ambulance arrived at the hospital has to be obtained from dispatch records.
Out-of-Hospital Event and Resuscitation Information **(EMS team defined as the FR or ambulance crew that was activated for the incident.)**	
18. Estimated time of arrest	The onset of the cardiac arrest, ie, patient is unconscious, not breathing, and has no pulse.) If the patient responded to bystander's CPR or defibrillation and has ROSC before EMS arrival but later rearrest in front of EMS, the time of arrest would not be the rearrest timing. It should be the first arrest timing before EMS arrival. Enter time as hh:mm:ss (24-h clock). Indicate "unknown" if unable to obtain the estimated time of arrest.
19. Arrest witnessed by	Check only one that applies from the list provided. Not witnessed is defined as the arrest event's being neither seen nor heard by anyone. Arrest witnessed is defined as the arrest's being seen or heard by another person. A bystander is defined as any person who responded and was not on duty with the EMS team or private ambulance crew at the arrest. If the patient responded to bystander's CPR or defibrillation and has ROSC before EMS team or private ambulance arrival, but later rearrests in front of EMS team or private ambulance, the arrest would not be considered witnessed by EMS team or private ambulance. Bystanders include passerby, lay person, member of the public, family member, police, private general practitioner, health care provider from nursing home/dialysis center, etc. Bystander–health care provider is defined as bystander medical personnel who are not part of the EMS team. This option does not take into consideration whether the health care provider is a family member or relative of the patient. Bystander–family is defined as the person who is known to be a family member or relative of the patient who is not a health care provider. Bystander–lay person is defined as other bystander who is a nonrelative/family member and a non–health care provider. When there are overlaps between the subcategories of bystander, the option should be selected in the following order: (1) bystander–health care provider; (2) bystander–family; and then (3) bystander–lay person. Sites that did not distinguish the 3 subcategories of bystanders should enter their data into "bystander–lay person."
20. Bystander CPR	Indicate yes or no. Indicate whether CPR (chest compressions with/without ventilations) was attempted by a bystander before arrival of EMS team. Bystander includes passerby, lay person, member of the public, family member, police, private general practitioner, health care provider from nursing home/dialysis center, etc.

Continued.

EMS and Hospital Data **(The preferred source of data is the EMS patient case record and ED or hospital patient case record.)**	
21. First CPR initiated by	Check only one that applies from the list provided. This is to identify the initial person who performs CPR. If CPR was not initiated by any bystander or EMS team/private ambulance crew, indicate "no CPR initiated." For example, a case in which there is obvious sign of death (rigor mortis, lividity, or decapitation) and resuscitation was not attempted. Bystander–health care provider defined as bystander medical personnel who are not part of the EMS team. This option does not take into consideration whether the health care provider is a family member or relative of the patient. Bystander–family is defined as a person who is known to be a family member or relative of the patient and who is not a health care provider. Bystander–lay person is defined as other bystander who is a nonrelative/family member and a non–health care provider. When there are overlaps between the subcategories of bystander, the option should be selected in the following order: (1) bystander–health care provider; (2) bystander–family; and then (3) bystander–lay person. Indicate "unknown" if unable to obtain any information.
22. Bystander AED applied	Indicate yes or no. Indicate whether AED was applied by a bystander before arrival of EMS team/private ambulance. If arrest was witnessed by EMS team/private ambulance, this field will be not applicable.
23. Resuscitation attempted by EMS/private ambulance	Indicate yes or no. Indicate whether EMS team/private ambulance attempted to resuscitate the patient. A resuscitation attempt is defined as the act of attempting to maintain or restore life by establishing or maintaining airway (or both), breathing, and circulation through CPR, defibrillation, and other related emergency care techniques. Attempted resuscitation can further be defined as postresuscitative care after a successful resuscitation by bystander. Patients with do-not-resuscitate directive, obvious signs of death (rigor mortis, lividity, or decapitation), or resuscitation was not required or confirmed death at scene without any resuscitation will be classified as resuscitation not attempted.
24. First arrest rhythm	Defined as the first cardiac arrest rhythm captured by EMS team/private ambulance after placement of defibrillator pads or electrodes. Check only one that applies from the list provided. Abbreviations: *VT*, ventricular tachycardia; *PEA*, pulseless electrical activity If the first arrest rhythm was captured by an AED without ECG display, select either "unknown shockable rhythm" or "unknown unshockable rhythm" where applicable. Sites that did not distinguish the shockable rhythm of VF and VT by default should enter their data into "VF." Indicate "unknown" if unable to obtain any information.
25. Time CPR started by EMS/private ambulance	Time when the first chest compression applied by the EMS team/private ambulance. Standardize the practice of using the power on the AED when EMS team/private ambulance arrives at patient's side as a timer for time CPR started by EMS. Enter time as hh:mm:ss (24-h clock). Indicate "unknown" if unable to obtain any information.
26. Time AED applied by EMS/private ambulance	Time when the AED pads were placed on the patient by the EMS team/private ambulance. The source of this timing should be the time captured by the AED when the pads were applied to the patient. Enter time as hh:mm:ss (24-h clock). Indicate "unknown" if unable to obtain any information.
27. Out-of-hospital defibrillation	Out-of-hospital defibrillation defined as defibrillation delivered by bystander or EMS team or private ambulance. Indicate yes or no. Indicate whether shocks were delivered to patient. If shocks were delivered, indicate the time of the first shock given. The source of this timing should be obtained from the AED. Enter time as hh:mm:ss (24-h clock). Indicate "unknown" if unable to obtain any information.

Continued.

EMS and Hospital Data **(The preferred source of data is the EMS patient case record and ED or hospital patient case record.)**	
28. Defibrillation performed by	Check all that applies from the list provided. Indicate whether defibrillation was performed by FR, ambulance crew, or bystander. Bystander–health care provider is defined as bystander medical personnel who are not part of the EMS team. This option does not take into consideration whether the health care provider is a family member or relative of the patient. Bystander–family is defined as the person who is known to be a family member or relative of the patient and who is not a health care provider. Bystander–lay person is defined as other bystander who is a nonrelative/family member and a non–health care provider. When there are overlaps between the subcategories of bystander, the option should be selected in the following order: (1) bystander–health care provider; (2) bystander–family; and then (3) bystander–lay person. If out-of-hospital defibrillation was not performed, this field will not be applicable.
29. Mechanical CPR device used by EMS/private ambulance	Indicate yes or no. Indicate whether mechanical CPR device was used during the course of resuscitation. If mechanical CPR device was used, indicate which type of device was applied. Check only one that applies from the list provided. Example of load-distributing band device: AutoPulse. Example of active compression decompression device: Lucas. Example of mechanical piston device: Life-Stat and Heart Lung Resuscitator HLR 601. Indicate "other" if the device used is not listed above.
30. Out-of-hospital advanced airway	Indicate yes or no. Indicate whether advanced airway was used during the course of resuscitation. If advanced airway was used, indicate which type of airway was inserted. Check only one that applies from the list provided. Abbreviations: *ET*, intubation; *LMA*, laryngeal mask airway Please note that oropharyngeal (also known as oral airway, OPA, or Guedel airway) and nasopharyngeal airways are not advanced airways but are only airway adjuncts. Cricothyrotomy and tracheotomy are classified as advanced airways. These data should be entered into "other." Any advanced airways used by private general practitioner or health care provider before EMS team arrival should be included as out-of-hospital resuscitation.
31. Out-of-hospital drug administration	Indicate yes or no. If drug was administered during the course of resuscitation, indicate which of the listed drugs were administrated. Check all that apply from the list provided. Drug administration before EMS team arrival should be included too (for example, drugs administered by private general practitioner or health care provider from nursing home).
32. ROSC at scene/en route	Indicate yes or no. ROSC refers to the regaining of palpable pulse. If there was any ROSC (transient or sustained) before or after the arrival of EMS team, indicate the time of the first ROSC detected. Enter time as hh:mm:ss (24-h clock). Indicate "unknown" if unable to obtain any information.
33. CPR discontinued at scene/en route	Indicate yes or no. If CPR was discontinued at scene, indicate the reason. Check only one that applies from the list provided. Abbreviation: *DNAR*, do not attempt resuscitation
Disposition	
34. Final status at scene	Indicate the patient's status at the end of the out-of-hospital care, whether patient was conveyed to ED or was pronounced dead at scene.

Continued.

EMS and Hospital Data **(The preferred source of data is the EMS patient case record and ED or hospital patient case record.)**	
35. Cause of arrest	Indicate whether the cause of arrest was trauma or nontrauma. Trauma: defined as out-of-hospital injury (eg, blunt or penetrating trauma, burns) resulting in traumatic arrest. Nontrauma: defined as out-of-hospital cardiac arrest not associated with any trauma. If the cause of arrest is nontrauma, indicate it by selecting one of the options provided. An arrest is presumed to be of cardiac cause unless it is known or likely to have been caused by a noncardiac cause, eg, asthma, terminal illness, cerebrovascular accident, drug overdose, suicide, drowning, trauma. Respiratory: underlying respiratory disease or a respiratory mechanism as the primary cause of arrest, eg, patient with known medical history of asthma had acute respiratory problem before the arrest. Electrocution: primary cause of arrest is electric shock, ie, by a source of high-voltage current. Drowning: submersion in water with no evidence of other contributing factors such as drug poisoning or trauma before falling into the water. Other: only to be used if the cause of arrest is known and documented but is not one of the available options (presumed cardiac cause, respiratory, drowning, or electrocution). If patient was conveyed to ED, this field will not be applicable.
36. Level of destination hospital	Indicate what level of destination hospital the patient was conveyed to. Tertiary hospital refers to a major hospital that has a full complement of services that provides a 24-hour ED staffed by emergency physicians, ability to provide the highest level of definitive care, and hypothermia or ECMO may be available. Community hospital refers to a hospital that provides initial care and stabilization of patient, and can handle common medical emergencies.
37. Destination hospital	Select the receiving ED or hospital from the list provided.
38. Patient's status at ED arrival	Indicate "NA" if information is not available. Indicate the patient's status at ED arrival. ROSC refers to patient regained palpable pulse while at scene/en route to ED or on arrival at ED, and no CPR in progress. Ongoing resuscitation refers to efforts of resuscitation in progress (eg, CPR in progress) on arrival at ED. Transported without resuscitation refers to a patient who is transported with no pulse but no resuscitation was in progress on arrival at the ED.
ED Resuscitation Information **(Not applicable for patients who were pronounced dead at scene.)**	
39. Date of arrival at ED	Provide the date when the patient arrived at the ED. Enter date as dd/mm/yyyy.
40. Time of arrival at ED	Provide the time when the patient arrived at the ED. Enter time as hh:mm:ss (24-h clock).
41. Patient status on arrival at ED	This refers to patient's initial status on arrival at ED, whether patient has spontaneous breathing or circulation. Indicate yes or no for both items. The presence of circulation is indicated by a palpable pulse and CPR has stopped. The presence of breathing is indicated as patient is breathing on his/her own without aid of advanced airway.
42. Cardiac rhythm on arrival at ED	Defined as the patient's cardiac rhythm on arrival at ED. Check only one that applies from the list provided. Sinus or other perfusing rhythm refers to cardiac rhythm with a palpable pulse.
43. ED defibrillation performed	Indicate yes or no. Indicate whether shocks were delivered to patient during resuscitation in the ED.
44. Mechanical CPR device used at ED	Indicate yes or no. Indicate whether mechanical CPR device was used during the course of resuscitation at ED. If mechanical CPR device was used, indicate which type of device was applied. Check only one that applies from the list provided. Example of load-distributing band device: AutoPulse. Example of active compression decompression device: Lucas. Example of mechanical piston device: Life-Stat and Heart Lung Resuscitator HLR 601. Indicate "other" if the device used is not listed above.

Continued.

EMS and Hospital Data **(The preferred source of data is the EMS patient case record and ED or hospital patient case record.)**	
45. Advanced airway used at ED	Indicate yes or no. If advanced airway was used, indicate which type of airway was applied during ED resuscitation. Check only one that applies from the list provided. Note that oropharyngeal (also known as oral airway, OPA, or Guedel airway) and nasopharyngeal airways are not advanced airways but are only airway adjuncts. Cricothyrotomy and tracheotomy are classified as advanced airways. These data should be entered in "other."
46. Drug administration at ED	Indicate yes or no. Check all that apply from the list provided. Indicate which of the listed drugs were administrated during ED resuscitation.
47. ROSC at ED	Indicate yes or no. ROSC refers to the regaining of palpable pulse. If there was any ROSC (transient or sustained) during ED resuscitation, indicate the time of the first ROSC detected. Enter time as hh:mm:ss (24-h clock). Indicate "unknown" if unable to obtain any information.
48. Emergency PCI performed	Indicate yes or no. Indicate whether emergency PCI was performed after patient had ROSC.
49. Emergency CABG performed	Indicate yes or no. Indicate whether emergency CABG was performed after patient had ROSC.
50. Hypothermia therapy initiated	Indicate yes or no. Indicate whether hypothermia procedures (eg, external cooling [ice packs or cooling blankets/pads] and internal cooling [cold IV infusion or invasive catheter lines for internal cooling]) were performed in ED.
51. ECMO therapy	Indicate yes or no. Indicate whether ECMO procedure was performed in ED.
52. Cause of arrest	Indicate whether the cause of arrest was trauma or nontrauma. Trauma: defined as out-of-hospital injury (eg, blunt or penetrating trauma, burns) resulting in traumatic arrest. Nontrauma: defined as out-of-hospital cardiac arrest that is not associated with any trauma. If the cause of arrest is nontrauma, indicate it by selecting one of the options provided. An arrest is presumed to be of cardiac cause unless it is known or likely to have been caused by a noncardiac cause, eg, asthma, terminal illness, cerebrovascular accident, drug overdose, suicide, drowning, trauma. Respiratory: underlying respiratory disease or a respiratory mechanism as the primary cause of arrest, eg, patient with known medical history of asthma had acute respiratory problem before the arrest. Electrocution: primary cause of arrest is electric shock, ie, by a source of high-voltage current. Drowning: submersion in water with no evidence of other contributing factors such as drug poisoning or trauma before falling into the water. Other: only to be used if the cause of arrest is known and documented but is not one of the available options (presumed cardiac cause, respiratory, drowning, or electrocution).
53. Reason for discontinuing CPR at ED	Provide the reason why CPR was discontinued at ED. Death: resuscitation was futile and patient was pronounced dead. ROSC: patient regained palpable pulse. ECMO therapy: ECMO therapy/cardiac bypass was initiated.
54. Outcome of patient	Indicate the patient's status at the end of the ED resuscitation, whether patient was admitted to the hospital, transferred to another hospital, or died in ED. Indicate "unknown" if unable to obtain any information.
Hospital Outcome **(For patients who survived to admission)**	
55. Patient status	Indicate the patient's status, whether patient was discharged alive, remained in hospital at 30th day postarrest, or died in hospital.
56. Date of discharge or death	Indicate the date of discharge (if patient was discharged alive) or date or death (if patient died in hospital). Enter date as dd/mm/yyyy.

Continued.

EMS and Hospital Data **(The preferred source of data is the EMS patient case record and ED or hospital patient case record.)**	
57. Patient neurologic status on discharge or at 30th day postarrest	Glasgow-Pittsburgh cerebral performance and overall performance categories are used to assess the patient's neurologic status at discharge or at the 30th day postarrest. The CPC evaluates cerebral performance capabilities. The overall performance category reflects cerebral plus noncerebral status and evaluates general performance.
Patient Health and Quality of Life **(For patient who is alive on discharge or at 30th day postarrest)**	
58–62 EQ-5D Health Dimensions	EQ-5D is a standardized instrument used in measuring quality of life. It provides a descriptive profile of patient's health status in 5 dimensions. For each dimension, ie, mobility, self-care, usual activities, pain/discomfort, or anxiety/depression, patient will be asked to describe levels of health problems. Each item has 3 possible response options (no problems, some or moderate problems, or extreme problems) that allow the patient to rate his or her current state with respect to each of the 5 dimensions. Thus, the descriptive system is able to identify 243 unique health states.
63. EQ-5D visual analog scale (VAS)	Enter the VAS score, ranging from 0 to 100.

PAROS case record form.

PAROS

Case number ☐☐☐☐☐☐☐☐☐☐

Mode of Transportation

#1 **Patient brought in by** ☐1 EMS ☐2 Non-EMS

If non-EMS, please specify ☐1 *Private ambulance* ☐2 *Own/private transport* ☐3 *Public transport*

Incident Information

#2 **Date of incident** ☐☐☐☐☐☐☐☐ (dd/mm/yyyy)

#3 **Location of incident** (Optional)_____

(enter Zip/Postal code) _____ ☐☐☐☐☐☐ ☐ *Unknown*

#4 **Location type** ☐1 Home residence ☐2 Health care facility ☐3 Public/commercial building

☐4 Nursing home ☐5 Street/highway ☐6 Industrial place

☐7 Transport center ☐8 Place of recreation ☐9 In EMS/private ambulance

☐10 Other, specify _____

Patient Information

#5 **Date of birth** ☐☐☐☐☐☐☐☐ (dd/mm/yyyy) **Age** ☐☐☐ ☐ Days ☐ Months ☐ Years

#6 **Sex** ☐1 Male ☐2 Female

#7 **Race** (optional) ☐1 Chinese ☐2 Malay ☐3 Indian ☐4 Eurasian ☐5 Other

#8 **Medical history** O1 No O2 Unknown O3 Heart disease

O4 Diabetes O5 Cancer O6 Hypertension

O7 Renal disease O8 Respiratory disease O9 Hyperlipidemia

O10 Stroke O11 HIV O12 Other

Dispatch Information (not applicable for non-EMS case)

#9	**Time call received at dispatch center**	(hh:mm:ss)	
#10	**Time FR dispatched**	(hh:mm:ss)	☐ *No* FR dispatched
#11	**Time ambulance dispatched**	(hh:mm:ss)	
#12	**Time FR arrived at scene time**	(hh:mm:ss)	
#13	**Time ambulance arrived at scene**	(hh:mm:ss)	
#14	**Time EMS arrived at patient side**	(hh:mm:ss)	
#15	**Time ambulance left scene**	(hh:mm:ss)	
#16	**Time ambulance arrived at ED**	(hh:mm:ss)	

Out-of-hospital Event and Resuscitation Information

#17 **Estimated time of arrest** (hh:mm:ss) ☐ *Unknown*

#18 **Arrest witnessed by**
- ☐$_1$ Not witnessed
- ☐$_2$ EMS/private ambulance
- ☐$_3$ Bystander-health care provider
- ☐$_4$ Bystander-lay person
- ☐$_5$ Bystander-family

#19 **Bystander CPR** ☐$_1$ Yes ☐$_2$ No

#20 ***First* CPR initiated by**
- ☐$_1$ No CPR initiated
- ☐$_2$ FR
- ☐$_3$ Ambulance crew
- ☐$_4$ Bystander-health care provider
- ☐$_5$ Bystander-lay person
- ☐$_6$ Bystander-family
- ☐$_7$ Unknown

#21 **Bystander AED applied** ☐$_1$ Yes ☐$_2$ No

#22 **Resuscitation attempted by EMS/private ambulance** ☐$_1$ Yes ☐$_2$ No

#23 **First arrest rhythm** ☐$_1$ VF ☐$_2$ VT ☐$_3$ PEA ☐$_4$ Asystole ☐$_5$ Unknown *shockable* rhythm ☐$_6$ Unknown *unshockable* rhythm ☐$_7$ Unknown

#24 **Time CPR started by EMS/private ambulance** ☐☐☐☐☐☐ (hh:mm:ss) ☐ *Unknown*

#25 **Time AED applied by EMS/private ambulance** ☐☐☐☐☐☐ (hh:mm:ss) ☐ *Unknown*

#26 **Out-of-hospital defibrillation** ☐$_1$ Yes ☐$_2$ No

If yes, time of first shock given ☐☐☐☐☐☐ *(hh:mm:ss)* ☐ *Unknown*

#27 **Defibrillation performed by** ○$_1$ FR

○$_2$ Ambulance crew

○$_3$ Bystander-health care provider

○$_4$ Bystander-lay person

○$_5$ Bystander-family

#28 **Mechanical CPR device used by EMS/private ambulance** ☐$_1$ Yes ☐$_2$ No

If yes, please specify ☐$_1$ *Load-Distributing Band*

☐$_2$ *Active compression-decompression*

☐$_3$ *Mechanical piston* ☐$_4$ *Other*

#29 **Out-of-hospital advanced airway** ☐$_1$ Yes ☐$_2$ No

If yes, please specify ☐$_1$ *Oral/nasal ET* ☐$_4$ *King airway*

☐$_2$ *Combitube* ☐$_5$ *Other*

☐$_3$ *LMA*

#30 **Out-of-hospital drug administration** ☐$_1$ Yes ☐$_2$ No

If yes, select drugs given ○$_1$ *Epinephrine* ○$_5$ *Lidocaine*

○$_2$ *Atropine* ○$_6$ *Dextrose*

○$_3$ *Amiodarone* ○$_7$ *Other*

○$_4$ *Bicarbonate*

#31 **ROSC at scene/en route** ☐$_1$ Yes ☐$_2$ No

If yes, specify time ☐☐☐☐☐☐ *(hh:mm:ss)* ☐ *Unknown*

#32 **CPR discontinued at scene/en route** ☐$_1$ Yes ☐$_2$ No

If yes, please specify ☐$_1$ *DNAR*

☐$_2$ *ROSC*

☐$_3$ *Medical control order*

☐$_4$ *Obvious signs of death*

☐$_5$ *Protocol/policy requirements completed*

Disposition

#33 **Final status at scene**	☐1 Conveyed to ED		☐2 Pronounced dead at scene	
#34 **Cause of arrest**	☐1 Trauma		☐2 Nontrauma	
If nontrauma, please specify	☐1 *Presumed cardiac etiology*		☐2 *Respiratory*	
	☐3 *Electrocution*	☐4 *Drowning*	☐5 *Other*	
#35 **Level of destination hospital**	☐1 Tertiary		☐2 Community	
#36 **Destination hospital**	☐1 AH	☐2 CGH	☐3 KKH	☐4 KTPH
	☐5 NUH	☐6 TTSH	☐7 SGH	☐8 NA
#37 **Patient's status at ED arrival**	☐1 ROSC			
	☐2 Ongoing resuscitation			
	☐3 Transported without resuscitation			

ED Resuscitation Information (not applicable for patients who were pronounced dead at scene)

#38 **Date of arrival at ED**	☐☐☐☐☐☐☐☐ (dd/mm/yyyy)			
#39 **Time of arrival at ED**	☐☐☐☐☐☐ (hh:mm:ss)			
#40 **Patient status on arrival at ED**	Pulse	☐1 Yes	☐2 No	
	Breathing	☐1 Yes	☐2 No	
#41 **Cardiac rhythm on arrival at ED**	☐1 VF	☐2 VT	☐3 PEA	
	☐4 Asystole	☐5 Sinus or other perfusing rhythm		
#42 **ED defibrillation performed**	☐1 Yes	☐2 No		
#43 **Mechanical CPR device used at ED**	☐1 Yes	☐2 No		
If yes, please specify	☐1 *Load-Distributing Band*			
	☐2 *Active compression decompression*			
	☐3 *Mechanical piston*	☐4 *Other*		
#44 **Advanced airway used at ED**	☐1 Yes	☐2 No		
If yes, please specify	☐1 *Oral/nasal ET*	☐4 *King airway*		
	☐2 *Combitube*	☐5 *Other*		
	☐3 *LMA*			

#45	**Drug administered at ED**	☐1 Yes	☐2 No	
	If yes, select drugs given	O1 *Epinephrine*	O5 *Lidocaine*	
		O2 *Atropine*	O6 *Dextrose*	
		O3 *Amiodarone*	O7 *Other*	
		O4 *Bicarbonate*		
#46	**ROSC at ED**	☐1 Yes	☐2 No	☐3 NA
	If yes, specify time	☐☐☐☐☐☐ *(hh:mm:ss)*	☐ *Unknown*	
#47	**Emergency PCI performed**	☐1 Yes	☐2 No	
#48	**Emergency CABG performed**	☐1 Yes	☐2 No	
#49	**Hypothermia therapy initiated**	☐1 Yes	☐2 No	
#50	**ECMO therapy initiated**	☐1 Yes	☐2 No	
#51	**Cause of arrest**	☐1 Trauma	☐2 Nontrauma	
	If nontrauma, please specify	☐1 *Presumed cardiac cause*	☐2 *Respiratory*	
		☐3 *Electrocution*	☐4 *Drowning*	☐5 *Other*
#52	**Reason for discontinuing CPR at ED**	☐1 Death	☐3 ROSC	
		☐2 DNAR	☐4 ECMO therapy	
#53	**Outcome of patient**	☐1 Admitted	☐3 Died in ED	
		☐2 Transferred to another hospital	☐4 Unknown	

Hospital Outcome *(for patient who survived to admission)*

#54	**Patient status**	☐1 Discharged alive	
		☐2 Remained in hospital at 30th day postarrest	
		☐3 Died in hospital	
#55	**Date of Discharge or Death**	☐☐☐☐☐☐☐☐ (dd/mm/yyyy)	
#56	**Patient neurologic status on discharge or at 30th day postarrest**	Cerebral Performance Category ☐	
		Overall Performance Category ☐	
		☐ Unknown	

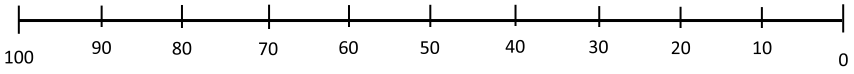
Patient Health and Quality of Life ☐ **Unknown**

(for patient who is discharged alive or alive on 30th day post arrest)

EQ-5D Health Dimensions

#57	Mobility	☐1 No problem	☐2 Some problems	☐3 Confined to bed
#58	Self-care	☐1 No problem	☐2 Some problems	☐3 Unable to wash or dress
#59	Usual activities	☐1 No problem	☐2 Some problems	☐3 Unable to perform
#60	Pain/discomfort	☐1 None	☐2 Moderate	☐3 Extreme
#61	Anxiety/depression	☐1 None	☐2 Moderate	☐3 Extreme

#62 **EQ-5D visual analog scale**



**100 (best imaginable health state) and 0 (worst imaginable health state)*