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Selected Topics: Prehospital Care

ASSOCIATION OF THE EMERGENCY MEDICAL SERVICES–RELATED TIME INTERVAL WITH SURVIVAL OUTCOMES OF OUT-OF-HOSPITAL CARDIAC ARREST CASES IN FOUR ASIAN METROPOLITAN CITIES USING THE SCOOP-AND-RUN EMERGENCY MEDICAL SERVICES MODEL

Tae Han Kim, MD,* Kyungwon Lee, MD, PHD,† Sang Do Shin, MD, PHD,* Young Sun Ro, MD, DRPH,‡ Hideharu Tanaka, MD, PHD,§ Susan Yap, RN,|| Kwanhathai Darin Wong, MBCHB, MMED,¶ Yih Yng Ng, MD,# Thammapad Piyasuwankul, MD,** and Benjamin Leong, MD††

*Department of Emergency Medicine, Seoul National University College of Medicine, Seoul Metropolitan Government Seoul National University Boramae Medical Center, Seoul, Republic of Korea, †Department of Emergency Medicine, Inje University Seoul Paik Hospital, Seoul, Republic of Korea, ‡Laboratory of Emergency Medical Services, Biomedical Research Institute Seoul National University Hospital, Seoul, Republic of Korea, §Department of Emergency Medical System, Graduate School of Kokushikan University, Tokyo, Japan, ||Department of Emergency Medicine, Singapore General Hospital, Singapore, ¶Emergency Department, Hospital Pulau Pinang, Georgetown, Pulau Pinang, Malaysia, #Medical Department, Singapore Civil Defence Force, Singapore, Singapore, **Department of Emergency Medicine, Prince of Songkla University, Hat Yai, Thailand, and ††Emergency Medicine Department, National University Hospital, Singapore, Singapore

Reprint Address: Kyungwon Lee, MD, PHD, Department of Emergency Medicine, Inje University Seoul Paik Hospital, Mareunnae-ro 9, Jung-gu, Seoul, Republic of Korea, 04551

☐ Abstract—Background: Response time interval (RTI) and scene time interval (STI) are key time variables in the out-of-hospital cardiac arrest (OHCA) cases treated and transported via emergency medical services (EMS). Objective: We evaluated distribution and interactive association of RTI and STI with survival outcomes of OHCA in four Asian metropolitan cities. Methods: An OHCA cohort from Pan-Asian Resuscitation Outcome Study (PAROS) conducted between January 2009 and December 2011 was analyzed. Adult EMS-treated cardiac arrests with presumed cardiac origin were included. A multivariable logistic regression model with an interaction term was used to evaluate the effect of STI according to different RTI categories on survival outcomes. Risk-adjusted predicted rates of survival outcomes were calculated and compared with observed rate. Results: A total of 16,974 OHCA cases were analyzed after serial exclusion. Median RTI was 6.0 min (interquartile range [IQR] 5.0–8.0 min) and median STI was 12.0 min (IQR 8.0-16.1). The prolonged STI in the longest RTI group was associated with a lower rate of survival to discharge or of survival 30 days after arrest (adjusted odds ratio [aOR] 0.59; 95% confidence interval [CI] 0.42–0.81), as well as a poorer neurologic outcome (aOR 0.63; 95% CI 0.41–0.97) without an increasing chance of prehospital return of spontaneous circulation (aOR 1.12; 95% CI 0.88–1.45). Conclusions: Prolonged STI in OHCA with a delayed response time had a negative association with survival outcomes in four Asian metropolitan cities using the scoop-and-run EMS model. Establishing an optimal STI based on the response time could be considered. © 2017 Elsevier Inc. All rights reserved.

☐ Keywords—emergency medical services; cardiac arrest; cardiopulmonary resuscitation

INTRODUCTION

Out-of-hospital cardiac arrest (OHCA) has a higher mortality rate than in-hospital cardiac arrest and is a major health burden in most countries (1–4). As such,

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appropriate field management and the safe transport of OHCA patients are among the most important functions of an emergency medical services (EMS) system (5–7). Among the various prehospital factors of the EMS system related to the treatment of cardiac arrest patients, the response time interval (RTI) and scene time interval (STI) are the key time variables reflecting the characteristics, structure, and performance of an EMS system (8).

The Asian EMS system scoop-and-run model differs from the EMS systems of North America and Europe. Most of the Asian EMS systems are based on the single-tiered basic life support (BLS) system, where advanced cardiac life support (ACLS) is often not available at the scene and resuscitation termination by EMS providers is not allowed in the prehospital area (4,9–14). Therefore, the patients who are unresponsive to on-scene resuscitation have to be transported to the hospital with ongoing cardiopulmonary resuscitation (CPR) in the ambulance after a certain time period of on-scene resuscitative efforts. Previous studies tried to evaluate the effects of RTI and STI on the survival outcomes of cardiac arrest patients separately, but none of such studies used an interaction term between the two EMS time measurements. Although some EMS systems have a minimal recommended length of on-scene resuscitation time in their protocols, the evidence level of an adequate STI range is still weak, without the consensus of experts. Therefore, in most cases, the decision to leave the scene after performing CPR is based on the discretion of EMS personnel at the scene.

This study was conducted to evaluate the distribution of RTI and STI values of OHCA cases in four Asian metropolitan cities, as well as the interactive effect of RTI and STI on the survival outcomes of OHCA cases.

METHODS

Study Setting

This study was an analysis of the prospective OHCA cohort of the Pan-Asian Resuscitation Outcome Study (PAROS). The PAROS project is a prospective, international, multicenter OHCA cohort study consisting of 12 participating sites in seven Asian countries (15). The PAROS study was reviewed and approved by the Institutional Review Boards of the participating sites.

For this study, data from the four participating study sites (Seoul, Osaka, Singapore, and Taipei) were extracted and analyzed between January 2009 and December 2011. Each participating site contributed 1.5 to 2.5 years of OHCA data within the study period. Most of the EMS systems in the four sites (except Taipei) were public-based single-tiered systems with an intermediate-level emergency medical technician aboard the ambulance. The total number of ambulances and the number of destination hospitals varied across the study sites (Appendix Table 1) (9,16).

Data Collection

The data for all of the OHCA cases from the participating sites were collected using a standardized reporting form with common predesignated variables. Data entry was performed for each participating site using an electronic data capture system. The prehospital EMS data were extracted from the dispatch records and the ambulance run sheets completed by the EMS providers of each participating site. As three of the participating sites (Seoul, Osaka, and Taipei) had existing national EMS registries, the data from these sites were automatically exported to the PAROS central server. Every participating site had a designated local coordinator responsible for the consistency and accuracy of the data entry. If there were any queries regarding the data, or requests for data verification, the local coordinator responded to such queries or requests within 2 weeks. A detailed description of the PAROS project methodology along with the data collection and management process has been reported and published previously (15).

Study Population

All of the adult cardiac arrest patients with a presumed cardiac etiology in the four study sites (Seoul, Osaka, Singapore, and Japan) were included in the study. The cardiac arrest cases not treated via EMS, witnessed by the EMS personnel at the scene, and first recognized during hospital transport were excluded from the study. The patients with missing information on STI, RTI, and other key variables were also excluded.

Outcome Measures

The primary outcome of this study was survival to discharge or survival to day 30 after cardiac arrest for those who had not been discharged from the hospital by day 30 after cardiac arrest. The PAROS project collected these variable as the primary outcome data because it was the most consistently captured outcome across the participating countries (15). The secondary outcomes were a favorable neurologic outcome, defined as cerebral performance category score 1 or 2 upon hospital discharge or on day 30 after cardiac arrest if not discharged. All of the outcome measures were evaluated by reviewing the clinical medical records and through telephone calls and face-to-face interviews at each site, and were recorded.

Exposure Variable and Other Measurements

RTI was defined as the time interval from the emergency call to the ambulance arrival at the scene. STI was defined as the time from the arrival at the scene to the departure for the hospital. Both RTI and STI were categorized into three groups according to the cutoff time value, respectively, derived from previous reports (RTI: 0–4/5–7/≥ 8 min; STI: 0–8/9–15/≥ 16 min) (17,18).

All of the data variables were defined in the same manner as in the Utstein data report form. The variables included age, sex, location (public or private), bystander CPR, EMS defibrillation, EMS advanced airway, and initial electrocardiogram at the scene (shockable or non-shockable rhythm).

Statistical Analysis

The demographic variables and characteristics of the total study population and of the population from each participating site were summarized. For the categorical variables, the frequencies were presented as percentages, and for the continuous variables, the mean with standard deviation or median with interquartile range (IQR) were presented as appropriate. Distribution of patients according to RTI and STI categories for each site were plotted according to proportions of study population in each cell. Multivariable logistic regression analysis was conducted to estimate the effects of RTI and STI on the survival outcomes of the total study population. An interaction term of the RTI and STI categories was included in the multivariable logistic regression model used for estimating the different effects of each RTI and STI category on the survival outcome of a patient. The adjusted odd ratios (aORs) with 95% confidence intervals (CIs) were calculated after adjusting the possible confounders associated with RTI and STI. The risk-adjusted rates of 30-day survival, favorable neurologic outcome, and prehospital return of spontaneous circulation (ROSC) according to the STI and RTI groups were assumed based on the probability from a prediction model, and were compared with the actual observe rate. All statistical analyses were performed using SAS software, version 9.4 (SAS Institute Inc., Cary, NC).

RESULTS

The data of 27,375 OHCA cases were initially entered into the PAROS database from the four participating sites. The cases where the victim was younger than 19 years old (n = 467), the arrest cases presumed not to have had a cardiac origin (n = 7978), EMS-witnessed arrests or arrests during transport (n = 1466), arrests not treated via EMS (n = 344), and arrests with missing key data variables (n = 146) were excluded. A total of 16,974 OHCA cases were analyzed after the serial exclusion process (Figure 1). The demographic and basal characteristics of the total cohort and of each participating site are summarized in Table 1.

Median RTI was 6 min (IQR 5–8 min) in the total population, and differed from 5 to 8 min according to the study site. The median STI of the total population was 12 min (IQR 8–16.1 min), and the median STI was the shortest in Seoul (7 min) and the longest in Osaka (14 min). The proportional distributions according to the STI and RTI categories are shown in Table 1. Figure 2 shows distribution of the STI in Seoul was shifted to the left side of table with shorter STI, but that in Singapore was shifted to the right with longer STI. For RTI, different distribution was shown according to cities. The survival outcomes according to the RTI and STI groups are summarized in Table 2. In all of the RTI categories, the rate of survival to discharge or 30-day survival decreased, but the rate of prehospital ROSC increased as STI increased.

The results of the multivariable logistic model with an interaction term showed that the effect of STI on the survival outcome differed by RTI length. The group with 5–7 min RTI and 9–15 min STI was set as a reference. In the shortest-RTI group (RTI 0–4 min), prolonged STI (≥16 min) showed no significant association with the survival rate (aOR 0.88; 95% CI 0.64–1.21) and neurologic outcome (aOR 1.10; 95% CI 0.73–1.66) compared to the reference group. In the longest-RTI group (≥8 min), however, prolonged STI was associated with a lower rate of survival to discharge or survival after 30-day arrest (aOR 0.59; 95% CI 0.42–0.81) and a poorer neurologic outcome (aOR 0.63; 95% CI 0.41–0.97)

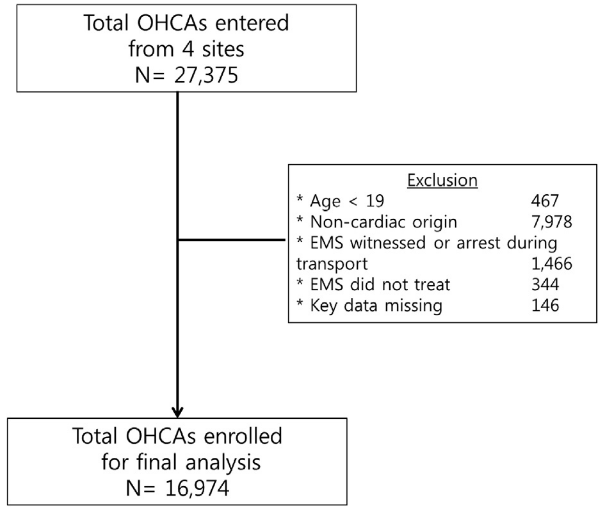

Figure 1. Flow of enrollment in the study. OHCA = out of hospital cardiac arrest; EMS = emergency medical service.

Table 1. Basal Demographics and Characteristics of Total Cohort and According to Study Site

Characteristic	Total	Osaka	Seoul	Singapore	Taipei
Total, n	16,974	7924	4877	2042	2131
Sex, n (%)					
Male	10,162 (62.5)	4525 (57.1)	3294 (67.5)	1411 (69.1)	1382 (64.9)
Age, y					
Mean (SD)	71.1 (15.6)	74.8 (14.4)	67.0 (15.6)	64.7 (15.1)	71.8 (16.3)
19–64 y, n (%)	5244 (30.9)	1672 (21.1)	1967 (40.3)	983 (48.1)	622 (29.2)
65+ y, n (%)	11,730 (69.1)	6252 (78.9)	2910 (59.7)	1059 (51.9)	1509 (70.8)
Place of arrest, n (%)					
Private	13,759 (81.1)	6644 (83.8)	3655 (74.9)	1614 (79.0)	1846 (86.6)
Public	2325 (13.7)	1025 (12.9)	673 (13.8)	399 (19.5)	228 (10.7)
Unknown	890 (5.2)	255 (3.2)	549 (11.3)	29 (1.4)	57 (2.7)
Witness, n (%)					
Yes	6706 (39.5)	2861 (36.1)	2272 (46.6)	1094 (53.6)	479 (22.5)
Bystander CPR, n (%)					
Yes	6521 (38.4)	3523 (44.5)	2035 (41.7)	495 (24.2)	468 (22.0)
RTI, min					
Median (IQR)	6.0 (5–8)	6.0 (5.0–8.0)	6.0 (5.0–7.0)	8.0 (6.0–10.4)	5.0 (4.0–7.0)
0–4 min, n (%)	3573 (21.0)	1553 (19.6)	1113 (22.8)	264 (12.9)	643 (30.2)
5–7 min, n (%)	8740 (51.5)	4292 (54.2)	2579 (52.9)	758 (37.1)	1111 (52.1)
≥8 min, n (%)	4661 (27.5)	2079 (26.2)	1185 (24.3)	1020 (50.0)	377 (17.7)
STI, min					
Median, IQR	12.0 (8.0–16.1)	14.0 (11.0–19.0)	7.0 (5.0–10.0)	14.1 (11.6–17.0)	14.0 (11.0–17.0)
0–8 min, n (%)	4432 (26.1)	828 (10.4)	3190 (65.4)	188 (9.2)	226 (10.6)
9–15 min, n (%)	7551 (44.5)	3706 (46.8)	1467 (30.1)	1192 (58.4)	1186 (55.7)
≥16 min, n (%)	4991 (29.4)	3390 (42.8)	220 (4.5)	662 (32.4)	719 (33.7)
Initial ECG at scene, n (%)					
Shockable	2602 (15.3)	855 (10.8)	1014 (20.8)	481 (23.6)	252 (11.8)
Non-shockable	13,78 0 (81.2)	7048 (88.9)	3495 (71.7)	1560 (76.4)	1677 (78.7)
Unknown	592 (3.5)	21 (0.3)	368 (7.5)	1 (0.0)	202 (9.5)
Prehospital EMS defibrillation, n (%)					
Yes	3589 (21.1)	1266 (16.0)	1427 (29.3)	608 (29.8)	288 (13.5)
Prehospital advanced airway, n (%)					
ETI	2638 (15.5)	2189 (27.6)	115 (2.4)	12 (0.6)	322 (15.1)
SGA or other advanced airway	5799 (34.2)	2979 (37.6)	693 (14.2)	1725 (84.5)	402 (18.9)
Not performed	8537 (50.3)	2756 (34.8)	4069 (83.4)	305 (14.9)	1407 (66.0)
Prehospital mechanical CPR device, n (%)					
Applied	188 (1.1)	0 (0)	0 (0)	188 (9.2)	0 (0)
Survival outcome, n (%)					
Any ROSC	5405 (31.8)	2337 (29.5)	1833 (37.6)	507 (24.8)	728 (34.2)
Prehospital ROSC	1231 (7.3)	604 (7.6)	237 (4.9)	90 (4.4)	300 (14.1)
Survival to discharge or survival to 30-d post arrest, n (%)	1189 (7.0)	534 (6.7)	456 (9.4)	60 (2.9)	139 (6.5)
Favorable neurologic outcome, n (%)	574 (3.4)	293 (3.7)	185 (3.8)	32 (1.6)	64 (3.0)

CPR = cardiopulmonary resuscitation; ECG = electrocardiogram; EMS = emergency medical services; ETI = endotracheal intubation; IQR = interquartile range; ROSC = return of spontaneous circulation; RTI = response time interval; SD = standard deviation; SGA = supraglottic airway; STI = scene time interval.

without increasing the rate of pre-hospital ROSC (aOR 1.12; 95% CI 0.88–1.45) (Table 3). The crude rates and risk-adjusted rates of each survival outcome are summarized in Table 4.

DISCUSSION

The analysis of the EMS-related time interval on the survival outcomes of the OHCA cases from the four Asian metropolitan cities that participated in this study showed that the increased length of STI had a different effect according to the length of RTI. One of the possible explanations of the study results could be that prehospital ACLS could not be provided by the EMS personnel in most of the participating sites (except Taipei) due to the single-tiered response system therein and, therefore, limited advanced care would have been delivered to the patients. Consequently, prolonged time of stay had the most negative effect in the field compared to its benefits, especially on the patients with delayed EMS RTI.

Several previous studies reported that RTI is associated with the survival outcome in OHCA, and this study showed the same results (19–22). The evidence has shown, however, that even with considerable efforts and interventions to reduce the response time, it could not be shortened under certain time limits due to

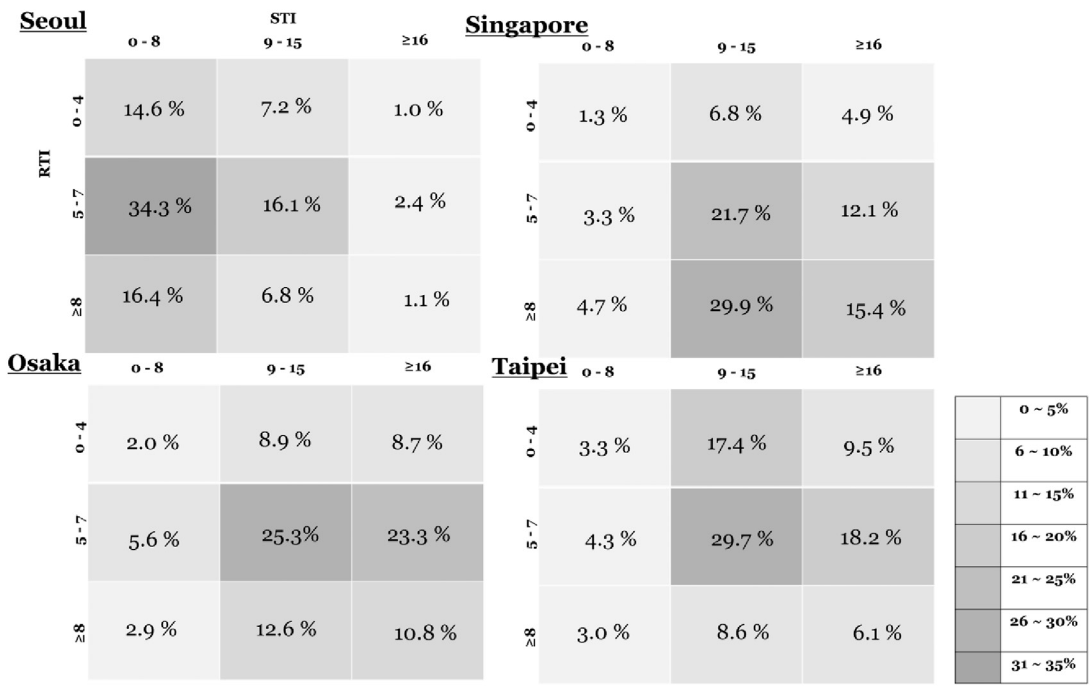

Figure 2. Distribution of out-of-hospital cardiac arrest (OHCA) population in each participating sites according to STI and RTI categories. RTI = response time interval; STI = scene time interval.

geographic barriers and limited resources (23). The effect of EMS STI in adult OHCA is complicated and has not been determined. A previous study that analyzed the witnessed OHCA cases in two Asian cities showed a positive association between intermediate STI (8–16 min) and a favorable neurologic outcome (17). Another report

Table 2. Survival Outcome According to Response Time Interval and Scene Time Interval Group

	Total		Prehospital ROSC		Survival to Discharge or Survival to 30 Days Post Arrest		Favorable Neurologic Outcome	
Variable	n	%	n	%	n	%	n	%
Any RTI								
STI								
Total	16,974	—	1231	7.3	1189	7.0	574	3.4
0–8 min	4432	26.1	263	5.9	459	10.4	208	4.7
9–15 min	7551	44.5	532	7.0	485	6.4	238	3.2
≥16 min	4991	29.4	436	8.7	245	4.9	128	2.6
RTI 0–4 min								
STI								
Total	3573	—	336	9.4	313	8.8	168	4.7
0–8 min	968	27.1	85	8.8	125	12.9	66	6.8
9–15 min	1562	43.7	143	9.2	133	8.5	69	4.4
≥16 min	1043	29.2	108	10.4	55	5.3	33	3.2
RTI 5–7 min								
STI								
Total	8740	—	612	7.0	614	7.0	286	3.3
0–8 min	2275	26.0	118	5.2	233	10.2	100	4.4
9–15 min	3864	44.2	267	6.9	242	6.3	120	3.1
≥16 min	2601	29.8	227	8.7	139	5.3	66	2.5
RTI ≥8 min								
STI								
Total	4661	—	283	6.1	262	5.6	120	2.6
0–8 min	1189	25.5	60	5.0	101	8.5	42	3.5
9–15 min	2125	45.6	122	5.7	110	5.2	49	2.3
≥16 min	1347	28.9	101	7.5	51	3.8	29	2.2

ROSC = return of spontaneous circulation; RTI = response time interval; STI = scene time interval.

Table 3. Odd Ratios of Scene Time Interval Category According to Response Time Interval Category for Predicting Survival Outcomes

Variable	STI, aOR* (95% CI)		
	0–8 min	9–15 min	≥16 min
Survival to discharge or survival to 30 d post arrest			
RTI			
0–4 min	1.57 (1.21–2.03)†	1.35 (1.07–1.70)†	0.88 (0.64–1.21)
5–7 min	1.33 (1.07–1.65)†	reference	0.85 (0.68–1.07)
≥8 min	1.01 (0.77–1.32)	0.85 (0.67–1.08)	0.59 (0.42–0.81)
Favorable neurologic outcome			
RTI			
0–4 min	1.78 (1.25–2.52)†	1.38 (1.01–1.91)†	1.10 (0.73–1.66)
5–7 min	1.22 (0.90–1.67)	reference	0.78 (0.57–1.08)
≥8 min	0.87 (0.59–1.28)	0.70 (0.49–1.00)†	0.63 (0.41–0.97)†
Prehospital ROSC			
RTI			
0–4 min	1.31 (0.99–1.74)	1.24 (0.99–1.54)	1.60 (1.25–2.05)†
5–7 min	0.82 (0.64–1.05)	reference	1.26 (1.04–1.53)†
≥8 min	0.74 (0.54–1.00)	0.88 (0.70–1.10)	1.12 (0.88 -1.45)

aOR = adjusted odds ratio; CI = confidence interval; ROSC = return of spontaneous; RTI = circulation; RTI = response time interval; STI = scene time interval.
* Adjusted for study site, sex, age, place of arrest, witness of arrest, bystander cardiopulmonary resuscitation.
† $p < 0.05$.

from the Resuscitation Outcome Consortium cardiac arrest database reported that the pediatric OHCA victims with 10–35 min STI showed the highest survival rate (24). In this study, prolonged STI was shown to have a negative association with survival and survival with a favorable neurologic outcome in the population where RTI was more than 9 min (Table 3), which might suggest that EMS providers should consider transporting OHCA victims to the hospital earlier if the time from the call to the EMS arrival at the scene was delayed.

Limiting the EMS provider's time of stay at the scene according to the response time might be a controversial

Table 4. Observed and Predicted Rate of Survival Outcome According to Response Time Interval and Scene Time Interval Category

Variable	STI					
	0–8 min		9–15 min		≥16 min	
	Unadjusted rate (95% CI)	Risk adjusted rate* (95% CI)	Unadjusted rate (95% CI)	Risk adjusted rate* (95% CI)	Unadjusted rate (95% CI)	Risk adjusted rate* (95% CI)
Survival to discharge or survival to 30-d post arrest						
RTI						
0–4 min	12.9 (10.8–15.0)	10.3 (9.4–11.1)	8.5 (7.1–9.9)	7.4 (6.8–7.9)	5.3 (3.9–6.6)	5.9 (5.4–6.5)
5–7 min	10.2 (9.0–11.5)	9.2 (8.7–9.7)	6.3 (5.5–7.0)	6.4 (6.1–6.7)	5.3 (4.5–6.2)	5.9 (5.6–6.2)
≥8 min	8.5 (6.9–10.1)	9.2 (8.5–9.8)	5.2 (4.2–6.1)	5.8 (5.4–6.1)	3.8 (2.8–4.8)	5.2 (4.7–5.6)
Favorable neurologic outcome						
RTI						
0–4 min	6.8 (5.2–8.4)	4.7 (4.1–5.2)	4.4 (3.4–5.4)	3.8 (3.4–4.2)	3.2 (2.1–4.2)	3.0 (2.6–3.4)
5–7 min	4.4 (3.6–5.2)	4.1 (3.8–4.5)	3.1 (2.6–3.7)	3.1 (2.9–3.4)	2.5 (1.9–3.1)	3.0 (2.7–3.3)
≥8 min	3.5 (2.5–4.6)	4.2 (3.7–4.6)	2.3 (1.7–2.9)	2.9 (2.6–3.2)	2.2 (1.4–2.9)	2.5 (2.2–2.8)
Prehospital ROSC						
RTI						
0–4 min	8.8 (7.0–10.6)	7.2 (6.6–7.9)	9.2 (7.7–10.6)	8.9 (8.3–9.4)	10.4 (8.5–12.2)	7.7 (7.2–8.2)
5–7 min	5.2 (4.3–6.1)	6.3 (6.0–6.6)	6.9 (6.1–7.7)	7.6 (7.3–7.8)	8.7 (7.6–9.8)	7.6 (7.3–8.0)
≥8 min	5 (3.8–6.3)	6.5 (6.0–6.9)	5.7 (4.8–6.7)	6.7 (6.3–7.0)	7.5 (6.1–8.9)	6.6 (6.2–7.0)

CI = confidence interval; ROSC = return of spontaneous circulation; RTI = response time interval; STI = scene time interval.
* Adjusted for study site, sex, age, place of arrest, witness of arrest, bystander cardiopulmonary resuscitation, initial electrocardiogram, emergency medical services defibrillation, prehospital advanced airway, emergency department level, and emergency department defibrillation.

issue. STI naturally represents the duration of resuscitation in the field but also represents the time interval for the provision of EMS to the patient at the appropriate position, and makes an initial evaluation of the patient after arriving at the scene (8). Therefore, limiting STI may compromise the essential initial process of EMS providers with the OHCA victims at the scene. Additionally, the quality of CPR is suspected to be lower when the patient is transported in a moving stretcher or ambulance than at the scene, with the patient not moving (25–27). Therefore, limiting the length of stay of the EMS personnel at the scene may cause additional problems, as mentioned earlier. The risk and benefit should be carefully balanced based on expert discussions and consensus meetings, with further evidence review regarding the optimal length of the optimal STI for OHCA patients in EMS systems based on the single-tiered BLS response system.

The distribution according to the STI and RTI groups as well as the rate of advanced airway placement and prehospital defibrillation differed by site (Table 2, Figure 2). This result implies that although the four participating Asian metropolitan cities had EMS systems with similar characteristics (Appendix Table 1), each community had a unique EMS system model, with minor differences in accordance with the local governance, policies, geographic features, available medical resources, and expectations of the community members, which cannot be quantified and surveyed. Therefore, to understand the difference, further researches should be conducted regarding the factors that influence the duration of EMS and its scene arrival time.

Limitations

Although the data that were used in this study were prospectively collected from all the participating sites, the 1.5- to 2.5-year data of each site had a different time period within the total study period, and did not span the whole study period. Therefore, the observation period might differ according to the participating site. This might have resulted in selection bias. There were no major changes in the EMS systems in all the four participating sites, however, within the study period.

To these authors' knowledge, PAROS is the first and largest multinational prospective cardiac arrest registry in Asia. To obtain the integrity of the database, all of the data variables were clearly defined before the prospective data collection, and the quality of the data was routinely checked (15). Despite the authors' efforts to gather all the necessary data, however, some of the variables had a few missing values and therefore could not be used in the data analysis. Another limitation is that we could not compare variables regarding hospital capacities and in-hospital intervention performed in hospital stage of treatment, such as percutaneous coronary intervention and therapeutic hypothermia, in these four cities because there was too many unknown and missing values.

CONCLUSIONS

Prolonged STI in OHCA with a delayed response time had a negative association with survival outcomes of the OHCA cases in four Asian metropolitan cities with the scoop-and-run EMS model. Establishing the optimal STI based on the response time can be considered.

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ARTICLE SUMMARY

1. Why is this topic important?

Optimal range of emergency medical services (EMS) scene time interval in out-of-hospital cardiac arrest (OHCA) is not clear. It has been suggested that effect of EMS scene time might be different according the length of EMS response time interval, especially in the scoop-and-run EMS model where mostly only basic life support is provided and termination of resuscitation on the scene is not allowed.

2. What does this study attempt to show?

To measure the interactive association of response time interval and scene time interval with the survival outcome of OHCA, data from a large prospectively collected cohort of OHCA patients in four Asian metropolitan cities were analyzed. Multivariable logistic regression model with an interaction term was conducted.

3. What are the key findings?

In our study result, prolonged scene time interval with a delayed response time had a negative association with the survival outcomes in OHCA.

4. How is patient care impacted?

These results suggest medical directors should consider establishing an optimal scene time interval protocol of EMS based on the response time interval.

APPENDIX

Appendix Table 1. Summary of Study Site Characteristics (9,15,28)

Characteristic	Seoul	Osaka	Singapore	Taipei
Country	Korea	Japan	Singapore	Taiwan
Population, n	9,895,217	8,860,280	4,987,000	2,607,428
Area, km^2	605	1,899	710	272
EMS operation	Fire-based	Fire-based	Fire-based	Fire-based
Highest service level	EMT-intermediate	EMT-intermediate	EMT-intermediate	EMT-paramedic
Tiered response	BLS single	BLS single	BLS single	BLS & ALS
Total no. of ambulances	117	285	40	76
No. of hospitals	63	282	7	22

ALS = advanced life support; BLS = basic life support; EMS = emergency medical services; EMT = emergency medical technician.