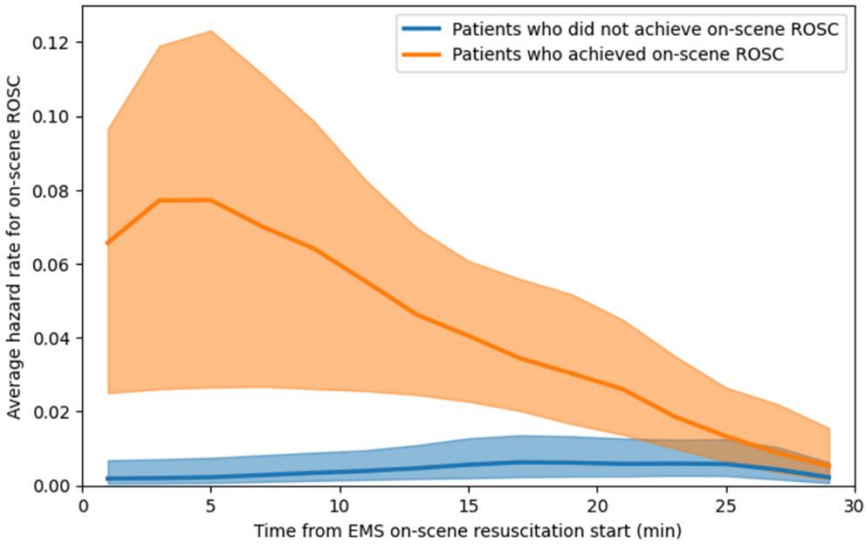
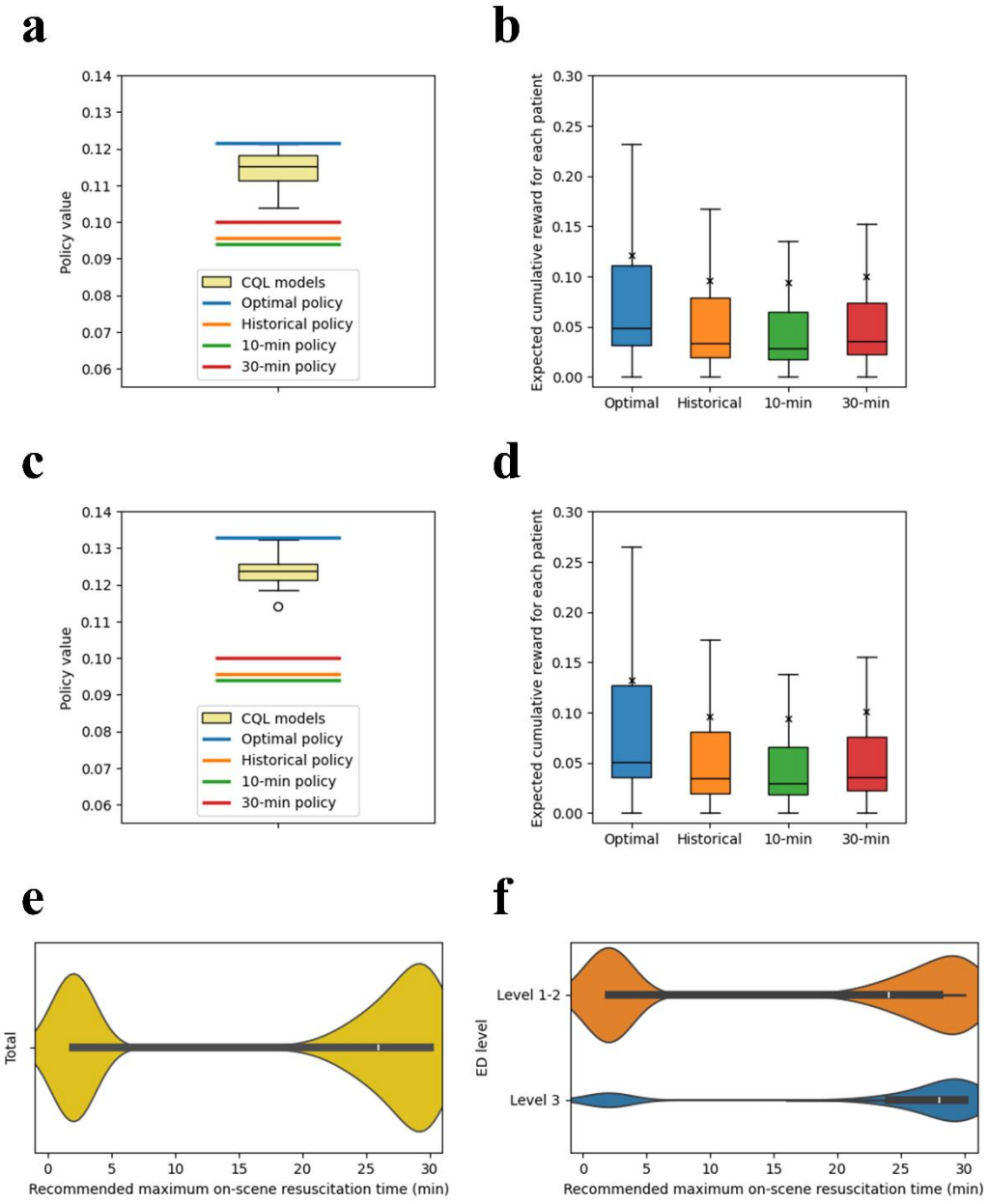


Supplementary Figure 1. Hazard rates for on-scene ROSC over time, stratified by achievement of on-scene ROSC.

The solid lines represent the average hazard rates, while the shaded areas denote the interquartile range. Abbreviations: EMS, emergency medical services; ROSC, return of spontaneous circulation.

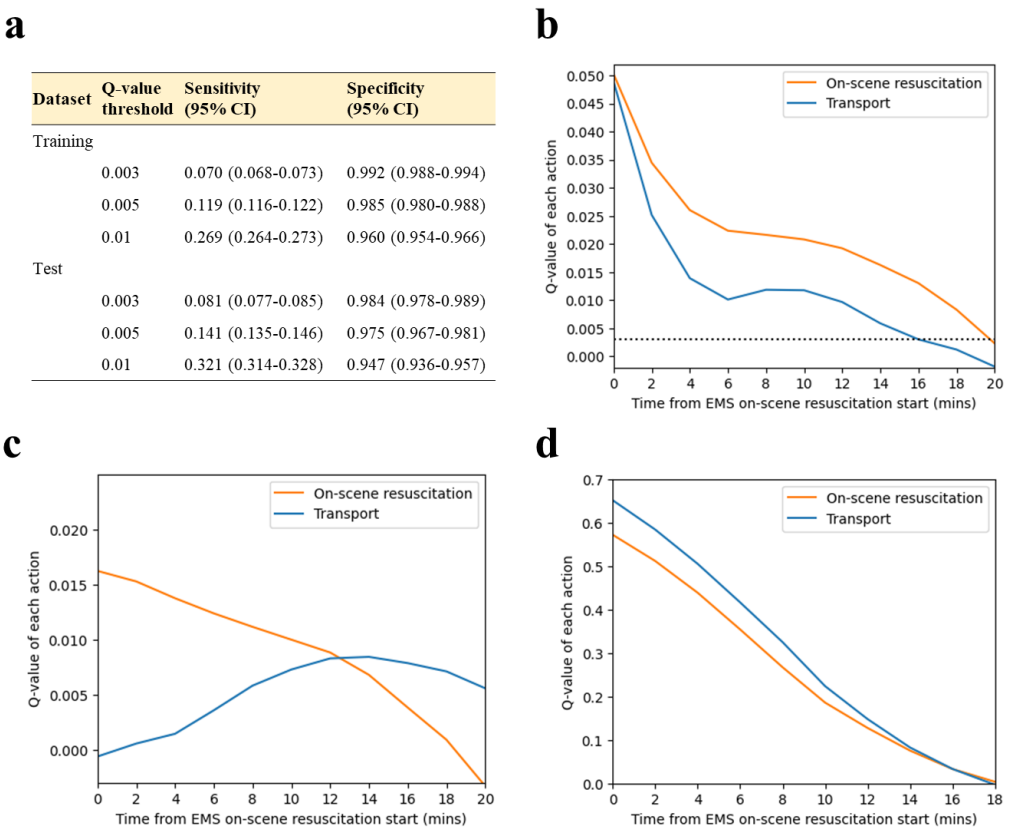


Supplementary Figure 2. Off-policy evaluation results in the ablation studies.

(a) Policy value distribution of 30 CQL models and the optimal, historical, 10-min, and 30-min policies using only Core Utstein variables. Policy values of the 30 CQL models are shown as a yellow box plot. **(b)** Distribution of expected cumulative rewards for patients under each policy when using only Core Utstein variables. Mean expected cumulative rewards under each policy are marked with "x". **(c)** Policy value distribution and **(d)** expected cumulative rewards distribution for the ablation study incorporating ED level as a variable. **(e)** Recommended maximum on-scene resuscitation times by the model incorporating ED level as a variable for all patients in the test set and **(f)** according to the receiving ED level. Abbreviations: CQL, conservative Q-learning; ED, emergency department.

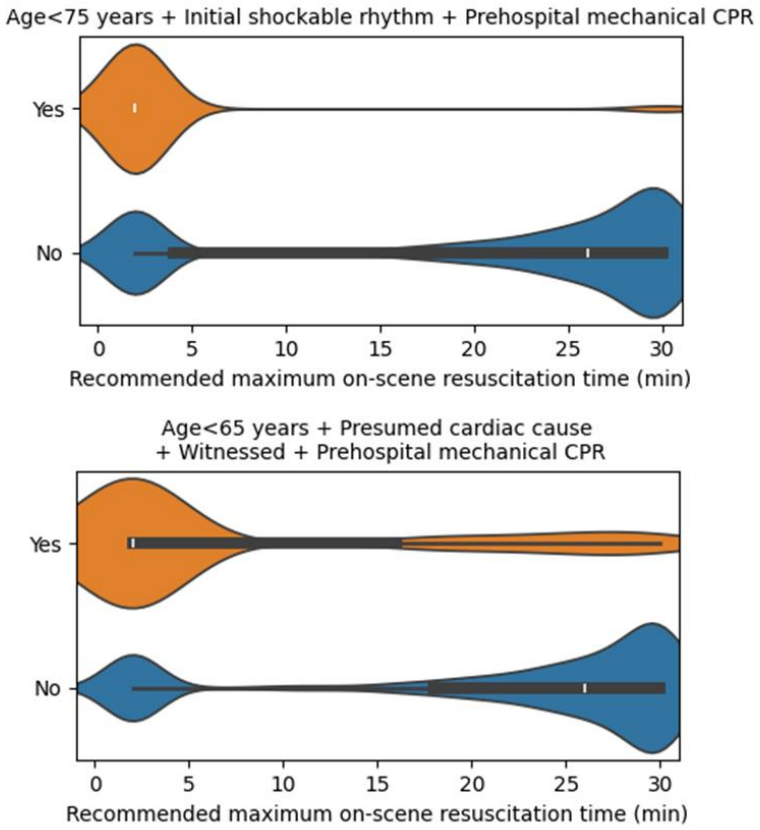
a

Dataset	Q-value threshold	Sensitivity (95% CI)	Specificity (95% CI)
Training			
	0.003	0.070 (0.068-0.073)	0.992 (0.988-0.994)
	0.005	0.119 (0.116-0.122)	0.985 (0.980-0.988)
	0.01	0.269 (0.264-0.273)	0.960 (0.954-0.966)
Test			
	0.003	0.081 (0.077-0.085)	0.984 (0.978-0.989)
	0.005	0.141 (0.135-0.146)	0.975 (0.967-0.981)
	0.01	0.321 (0.314-0.328)	0.947 (0.936-0.957)



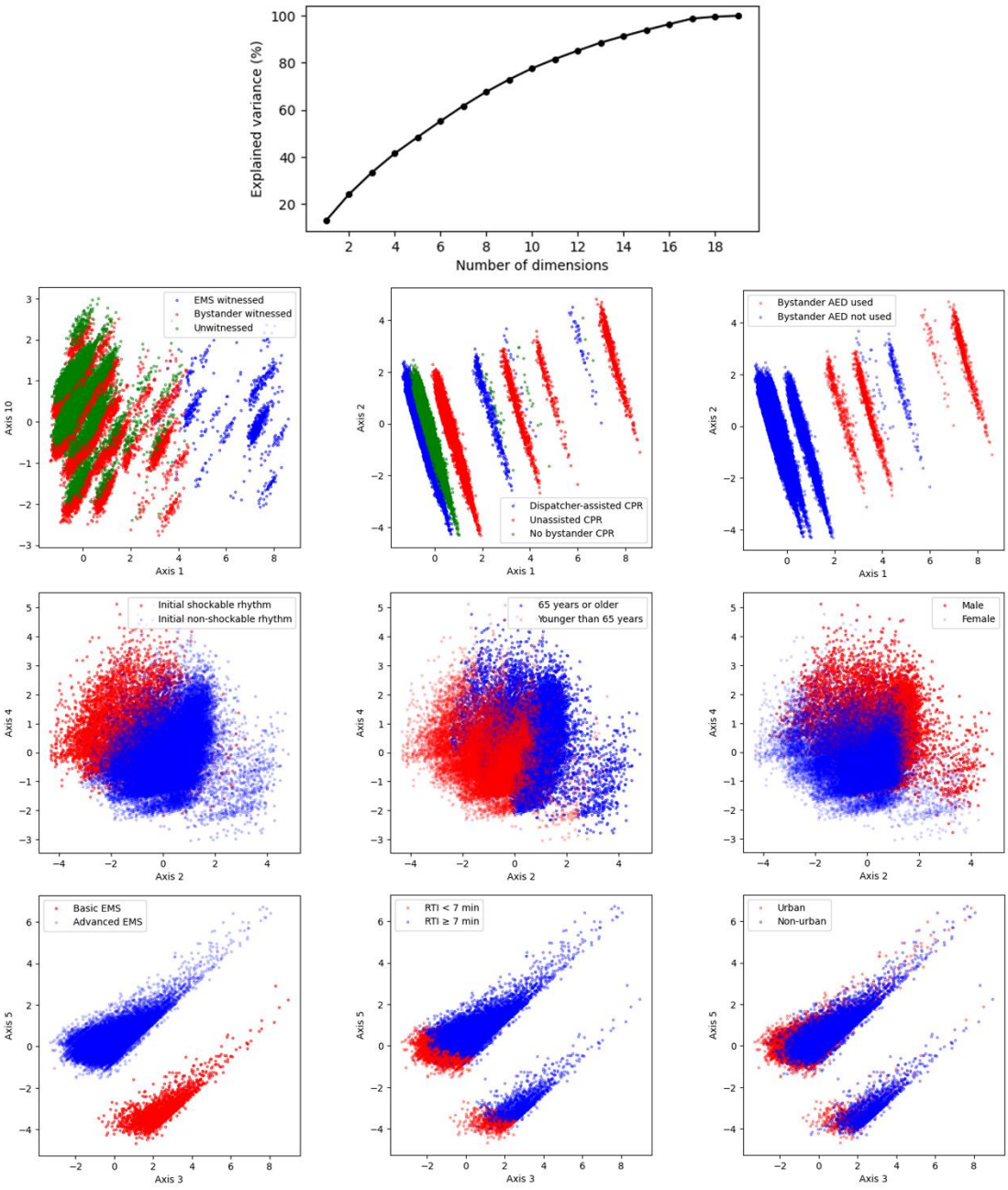
Supplementary Figure 3. Implications of the optimal policy for settings with and without TOR.

(a) We analyzed the Q-values of the optimal policy at the historical time of intra-arrest transport. Since Q-values are calibrated with survival rates, a low Q-value indicates a low probability of survival at that moment. Based on the finding that the specificity of performing TOR for patients with Q-values below 0.003 at the time of intra-arrest transport was 0.992, we established a Q-value-based TOR rule using this threshold. **(b)** A case of an 82-year-old patient with witnessed OHCA, no bystander CPR, and an initial non-shockable rhythm. Historically transported at 20 minutes, the optimal policy recommends transport after prolonged resuscitation for EMS settings without TOR. In EMS settings with TOR, termination could be recommended at 20 minutes where the Q-values for both actions fall below 0.005. **(c)** A case of an 80-year-old patient with unwitnessed OHCA, who received bystander CPR and had an initial non-shockable rhythm. Historically transported after 20 minutes, the optimal policy suggests transport at 14 minutes, when the Q-value for transport exceeds that of on-scene resuscitation. **(d)** A case of a 30-year-old patient who had a bystander-witnessed arrest, received bystander CPR, and had an initial shockable rhythm. Despite 18 minutes of on-scene resuscitation without ROSC, the patient survived after receiving ECPR in the hospital. The optimal policy recommends immediate intra-arrest transport after the initial rhythm check and defibrillation. Abbreviations: CI, confidence interval; EMS, emergency medical services; TOR, termination of resuscitation; ROSC, return of spontaneous circulation; CPR, cardiopulmonary resuscitation; ECPR, extracorporeal CPR; OHCA, out-of-hospital cardiac arrest.



Supplementary Figure 4. Violin plots of recommended maximum on-scene resuscitation times for patients in the test set who are potential ECPR candidates.

Among the 388 patients in the test set who were younger than 75 years, had an initial shockable rhythm, and received prehospital mechanical CPR, 369 (95.1%) were recommended an on-scene resuscitation time of less than 6 minutes. 378 (74.3%) of 509 patients who were younger than 65 years, with presumed cardiac cause of arrest, were witnessed, and received prehospital mechanical CPR were given the same recommendation. The recommended maximum on-scene resuscitation time is defined as the recommended duration of on-scene resuscitation in cases where a patient fails to achieve on-scene ROSC. The widths of the violin plots are proportional to the number of patients but are not normalized across violins. Abbreviations: CPR, cardiopulmonary resuscitation; ECPR, extracorporeal CPR.



Supplementary Figure 5. Information captured by each axis after employing Factor Analysis of Mixed Data.

The first axis predominantly captured data regarding witness and bystander resuscitation; the second and fourth focused on patient characteristics and initial rhythm; while the third axis concentrated on information pertinent to the EMS. Abbreviations: EMS, emergency medical services; CPR, cardiopulmonary resuscitation; AED, automated external defibrillator; RTI, response time interval.

Supplementary Table 1. Characteristics of patients in the test set according to recommended maximum on-scene resuscitation time

		Recommended maximum on-scene resuscitation time, min				
	Total	t<6	6≤t<15	15≤t<24	t≥24	p-value
Total	19,435	5,137 (26.4)	393 (2.0)	2,234 (11.5)	11,671 (60.1)	
Age						<0.001
<65 years	6,308	3,112 (49.3)	8 (0.1)	251 (4.0)	2,937 (46.6)	
≥65 years	13,127	2,025 (15.4)	385 (2.9)	1,983 (15.1)	8,734 (66.5)	
Sex						<0.001
Male	12,350	3,879 (31.4)	200 (1.6)	1,223 (9.9)	7,048 (57.1)	
Female	7,085	1,258 (17.8)	193 (2.7)	1,011 (14.3)	4,623 (65.3)	
Diabetes mellitus						<0.001
Yes	4,643	2,460 (53.0)	373 (8.0)	761 (16.4)	1,049 (22.6)	
No	14,792	2,677 (18.1)	20 (0.1)	1,473 (10.0)	10,622 (71.8)	
Hypertension						<0.001
Yes	7,155	2,493 (34.8)	298 (4.2)	1,093 (15.3)	3,271 (45.7)	
No	12,280	2,644 (21.5)	95 (0.8)	1,141 (9.3)	8,400 (68.4)	
Heart disease						<0.001
Yes	3,800	1,092 (28.7)	69 (1.8)	545 (14.3)	2,094 (55.1)	
No	15,635	4,045 (25.9)	324 (2.1)	1,689 (10.8)	9,577 (61.3)	
Time of day						<0.001
Daytime (6AM-6PM)	12,390	3,043 (24.6)	239 (1.9)	1,473 (11.9)	7,635 (61.6)	
Nighttime (6PM-6AM)	7,045	2,094 (29.7)	154 (2.2)	761 (10.8)	4,036 (57.3)	
Region, urban						<0.001
Urban	16,788	4,689 (27.9)	375 (2.2)	2,020 (12.0)	9,704 (57.8)	
Non-urban	2,647	448 (16.9)	18 (0.7)	214 (8.1)	1,967 (74.3)	
ECPR-capable district						<0.001
Yes	10,089	2,682 (26.6)	299 (3.0)	1,376 (13.6)	5,732 (56.8)	
No	9,346	1,624 (17.4)	150 (1.6)	1,006 (10.8)	6,566 (70.3)	
Presumed cardiac cause						<0.001
Yes	18,501	4,766 (25.8)	378 (2.0)	2,161 (11.7)	11,196 (60.5)	
No	934	371 (39.7)	15 (1.6)	73 (7.8)	475 (50.9)	
Place of arrest						<0.001
Public	3,267	1,285 (39.3)	11 (0.3)	227 (6.9)	1,744 (53.4)	
Non-public	16,168	3,852 (23.8)	382 (2.4)	2,007 (12.4)	9,927 (61.4)	
Witnessed status						<0.001
EMS witnessed	619	360 (58.2)	4 (0.6)	8 (1.3)	247 (39.9)	
Bystander witnessed	10,959	3,171 (28.9)	195 (1.8)	883 (8.1)	6,710 (61.2)	
Unwitnessed	7,857	1,606 (20.4)	194 (2.5)	1,343 (17.1)	4,714 (60.0)	
Bystander CPR						<0.001
Dispatcher-assisted	9,245	1,970 (21.3)	231 (2.5)	1,366 (14.8)	5,678 (61.4)	

Unassisted	3,941	1,614 (41.0)	32 (0.8)	120 (3.0)	2,175 (55.2)	
No CPR	6,249	1,553 (24.9)	130 (2.1)	748 (12.0)	3,818 (61.1)	
Bystander AED use						<0.001
Yes	851	573 (67.3)	3 (0.4)	54 (6.3)	221 (26.0)	
No	18,584	4,564 (24.6)	390 (2.1)	2,180 (11.7)	11,450 (61.6)	
Initial rhythm						<0.001
Shockable	3,180	1,201 (37.8)	0 (0.0)	5 (0.2)	1,974 (62.1)	
Non-shockable	16,255	3,936 (24.2)	393 (2.4)	2,229 (13.7)	9,697 (59.7)	
EMS team level						<0.001
Advanced	19,103	5,080 (26.6)	384 (2.0)	2,081 (10.9)	11,558 (60.5)	
Basic	332	57 (17.2)	9 (2.7)	153 (46.1)	113 (34.0)	
Prehospital mechanical CPR						<0.001
Yes	4,553	1,382 (30.4)	378 (8.3)	1,421 (31.2)	1,372 (30.1)	
No	14,882	3,755 (25.2)	15 (0.1)	813 (5.5)	10,299 (69.2)	
RTI						<0.001
<10 min	14,824	4,120 (27.8)	359 (2.4)	2,004 (13.5)	8,341 (56.3)	
≥10 min	4,611	1,017 (22.1)	34 (0.7)	230 (5.0)	3,330 (72.2)	
ECPR						<0.001
Yes	134	75 (56.0)	1 (0.7)	3 (2.2)	55 (41.0)	
No	19,301	5,062 (26.2)	392 (2.0)	2,231 (11.6)	11,616 (60.2)	
Immediate PCI						<0.001
Yes	722	245 (33.9)	3 (0.4)	9 (1.2)	465 (64.4)	
No	18,713	4,892 (26.1)	390 (2.1)	2,225 (11.9)	11,206 (59.9)	

Categorical variables are presented as numbers (row percentages) and continuous variables are presented as medians (interquartile ranges). Abbreviations: ECPR, extracorporeal cardiopulmonary resuscitation; EMS, emergency medical services; CPR, cardiopulmonary resuscitation; AED, automated external defibrillator; RTI, response time interval; PCI, percutaneous coronary intervention.