Title

Improved Outcomes for Out-of-Hospital Cardiac Arrest Patients Treated by Emergency Life-Saving Technicians Compared with Basic Emergency Medical Technicians: A JCS-ReSS Study Report

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Abstract

Background: Emergency life-saving technicians (ELSTs) are specially trained prehospital medical providers believed to provide better care than basic emergency medical technicians (BEMTs). ELSTs are certified to perform techniques such as administration of advanced airways or adrenaline and are considered to have more knowledge; nevertheless, ELSTs' effectiveness over BEMTs regarding out-of-hospital cardiac arrest (OHCA) remains unclear. We investigated whether the presence of an ELST improves OHCA patient outcomes.

Methods: In a retrospective study of adult OHCA patients treated in Japan from 2011 to 2015, we compared two OHCA patient groups: patients transported with at least one ELST and patients transported by only BEMTs. The primary outcome measure was one-month favorable neurological outcomes, defined as Cerebral Performance Category ≤ 2. A multivariable logistic regression model was used to calculate odds ratios (ORs) and their confidence intervals (CIs) to evaluate the effect of ELSTs.

Results: Included were 552,337 OHCA patients, with 538,222 patients in the ELST group and 14,115 in the BEMT group. The ELST group had a significantly higher odds of favorable neurological outcomes (2.5% vs. 2.1%, adjusted OR 1.39, 95% CI 1.17–1.66), one-month survival (4.9% vs. 4.1%, adjusted OR 1.37, 95% CI 1.22–1.54), and return of spontaneous circulation (8.1% vs. 5.1%, adjusted OR 1.90, 95% CI 1.72–2.11) compared with the BEMT group. However, ELSTs' limited procedure range (adrenaline administration or advanced airway management) did not promote favorable neurological outcomes.

Conclusions: Compared with the BEMT group, transport by the ELST group was associated with better neurological outcomes in OHCA.

Introduction

Out-of-hospital cardiac arrest (OHCA) is a leading public health concern [1][2][3]; favorable neurological outcomes remain low. Improvement in the health care system [4], public education [5], and advanced care in the receiving hospital [6] can ameliorate survival and neurological outcomes in OHCA. Prehospital medical providers play important roles worldwide [7][8]. In Japan, the Fire and Disaster Management Agency (FDMA) employs two levels of public prehospital medical providers, emergency life-saving technicians (ELSTs) and basic emergency medical technicians (BEMTs). ELSTs are certified and receive more prehospital emergency care education than BEMTs [9].

Japanese ambulances typically have three providers, including at least one ELST;

however, approximately 3% of cases are transported without ELSTs (only BEMTs). Legally, only ELSTs may administer advanced airways using tools like supraglottic devices in Japan; specially-trained ELSTs can perform endotracheal intubation (ETI) [9]. Another important potentially life-saving skill only specially trained ELSTs may perform is adrenaline administration. Considering their skills and knowledge, treatment and transport by advanced prehospital medical providers seem to be associated with improved survival [10][11][12]; however, the survival or neurological benefit of advanced prehospital medical providers remains controversial globally [13][14][15]. In addition, ELST skill maintenance requires costly efforts and training [9][16].

ELSTs' effectiveness over BEMTs in OHCA treatment and transport has not been fully elucidated. We conducted a large-scale, observational, population-based cohort study on OHCA patients treated by BEMTs and ELSTs and investigated whether presence of ELSTs improved OHCA patient outcomes.

Methods

Emergency Medical System (EMS) and Providers

Japan is a 378,000 km^2 area with 127 million people. In 2015, there were 750 local fire departments with 1,709 fire stations and 3,145 dispatch centers [17]; the EMS is available 24 hours daily. Ambulances respond to scenes from the nearest fire stations. Each ambulance commonly has three emergency personnel, including at least one ELST nationally certified and trained to provide prehospital emergency care. Since April 1991, the number of ELSTs has been increasing. However, only BEMTs are present for some cases.

Two levels of Japanese prehospital medical providers (BEMTs and ELSTs) have been previously described [12]. BEMTs are accredited by local EMS after 250 hours of medical education, perform basic life support (BLS), including bag-valve-mask (BVM) ventilation, and are encouraged to apply automated defibrillators. ELSTs are accredited in two ways: ① They must work as a BEMT in prehospital care and transportation for approximately five years, complete a half year of ELST education and training, and pass a national examination, or ② After two years of ELST education at an EMT school/college, they must pass a national examination. ELSTs perform Advanced Life Support, applying semi-automated defibrillators. When ELSTs have difficulty performing BVM ventilation, they may secure the airway using supraglottic devices (laryngeal tube, i-gel, laryngeal mask, combi-tube, etc.) for OHCA patients under direct telephone orders of a local medical consultant (emergency physician). Additionally, ELSTs who complete the additional training and perform 30 successful live intubations in the operating room are certified to perform ETI. ETI criteria include OHCA patients with asphyxia due to foreign-body airway obstruction without successful airway through a supraglottic device or judgement by a medical consultant on direct order. Similarly, ELSTs with additional training may establish intravenous (IV) lines (additional training, 10 successful IV placements, one adrenaline administration to a cardiac arrest patient under supervision). If return of spontaneous circulation (ROSC) doesn't occur after initial defibrillation, advanced ELSTs can administer adrenaline to pulseless electrical activity, asystole, or refractory ventricular fibrillation (VF)/ventricular tachycardia (VT) rhythms after giving shock. Adrenaline is administered via prefilled syringes every three to five minutes until ROSC or hospital arrival. Synchronized radio-controlled watches are used to record all procedures. ELSTs and BEMTs are legally banned from terminating resuscitation in the field. They may not attempt resuscitation in cases with definite deaths like incineration, decapitation, rigor mortis, decomposition, or "do not attempt resuscitation" orders [18].

Study Design and Data Collection

The Okayama University Ethics Committee approved the study (1806-012) and waived the requirement for written informed consent. This nationwide, retrospective, population-based, observational study used the All-Japan Utstein Registry database for OHCA patients run by the FDMA [5].

OHCA patient data were prospectively collected based on Utstein-style guidelines [19][20] by the local EMS and subsequently integrated into the national registry. Cardiac arrest was defined as stoppage of mechanical cardiac activity substantiated by lack of circulation signs. Cardiac arrest was assumed of cardiac origin unless caused by respiratory or cerebrovascular diseases; external causes, including hanging, trauma, drowning, asphyxia, and drug overdose; malignant tumors; or other non-cardiac causes. Diagnoses of cardiac or non-cardiac causes were clinically decided by in charge physicians in collaboration with EMS providers. Variables included gender, age, witness status, bystander-initiated cardiopulmonary resuscitation (CPR), initial electrocardiogram rhythm, resuscitation time-course, cardiac arrest region, cardiac or non-cardiac origin, ELST status, use of advanced airway, establishment of IV line, adrenaline administration, hospital admission, ROSC, one-month neurological status, and one-month survival. ROSC was defined as recovery of any spontaneous palpable pulse with any time duration confirmed with cardiac rhythm monitoring [18]. Cerebral Performance Category (CPC) scale was used to evaluate neurological outcomes [19][20].

Patient Selection and Endpoint

All 18-year-old or older patients with OHCA of cardiac and non-cardiac causes transported by the FDMA from January 1, 2011 through December 31, 2015 were included. Cases where resuscitation was not attempted and cases involving patients under 18, the presence of doctor during transport, and treatment by doctor before transport were excluded. We compared two OHCA patient groups, the ELST group (patients transported by EMS, including at least one ELST) and the BEMT group (patients transported only by BEMTs). The primary outcome measure was one-month favorable neurological outcome defined as CPC 1 or 2. Secondary outcome measures included one-month survival and ROSC. Additionally, advanced airway efficacy and adrenaline use were evaluated in the ELST group.

Data Analysis

Continuous variables were described using median with interquartile ranges (IQR). Categorical variables were described using percentages. The Mann-Whitney U-test was used to compare EMS contact to initial defibrillation times between the ELST and BEMT groups. For the primary outcome, univariable logistic regression was used to determine association between favorable neurological outcome and groups. Multivariable logistic regression was performed to adjust covariates (year of cardiac arrest, age, gender, initial recorded cardiac rhythm, estimated cardiac or non-cardiac origin, bystander CPR, dispatcher instruction for CPR, time from EMS call to hospital arrival, cardiac arrest region). Logistic regression analysis results were expressed using odds ratios (ORs) and 95% confidence intervals (CIs). For the secondary outcome, including effect of ELST on one-month survival and ROSC, univariable and multivariable logistic regression were used. Effectiveness of advanced treatments (airway management, adrenaline administration) only allowed by ELSTs is still conflicting; to identify advantages of ELSTs' technical procedure skills, univariable and multivariable logistic regression were also used in the ELST group to evaluate whether these advanced treatments contribute to the outcomes. Same variables were used for adjustment in multivariable logistic regression. Statistical analysis was performed using Stata version 15 (StataCorp LP, College Station, TX). *P*-values below 0.05 were considered statistically significant.

Results

Figure 1 shows an OHCA patient flow chart. The registry documented 629,471 OHCA patients from 2011 to 2015 in Japan. Patients meeting exclusion criteria (16,210 resuscitations not attempted; 7,687 under 18 years old; 18,951 transported with doctors; 34,286 treated by doctors) were excluded. Finally, 552,337 were included, 538,222 in the ELST group and 14,115 in the BEMT group.

Table 1 shows baseline ELST and BEMT group characteristics, prehospital procedure characteristics, and outcomes. The proportion of males (ELST group vs. BEMT group: 56.6 vs. 56.9%), age (median [IQRs]: 79 [67-86] vs. 79 [68-86] years), witnessed collapse (40.3 vs. 40.0%), and time from EMS call to hospital arrival (32 [26-39] vs. 31 [26-39] min) did not differ between the groups. Proportions of initial rhythm VF/VT (7.1 vs. 6.6%) and dispatcher instruction for CPR (53.0 vs. 50.0%) were higher in the ELST group, while estimated cardiac origin (59.5 vs. 62.2%) and bystander CPR (50.9 vs. 56.0%) were lower. The proportion of patients transported by BEMTs tended to decrease as the years progressed. The proportion of BEMTs tended to be higher in low population density regions. Time from EMS arrival to initial defibrillation did not differ between the ELST and BEMT groups (2 [1-3] vs. 2 [1-4] min, $p = 0.25$). Advanced airway management was conducted in 42.2% of ELST group patients (34.0% supraglottic airways; 7.3% ETI); adrenaline administration was conducted in 16.0% of the ELST group. Overall, there was a 2.5% incidence of favorable neurological outcomes, 4.9% of one-month survival, and 8.0% of ROSC.

In the univariable logistic regression (**Table 2**), all outcomes, including favorable neurological outcomes (2.5 vs. 2.1%, OR 1.19, 95% CI 1.06-1.34), one-month survival (4.9 vs. 4.1%, OR 1.21, 95% CI 1.12-1.32), and ROSC (8.1 vs. 5.1%, OR 1.65, 95% CI 1.53-1.78), were higher in the ELST group. Multivariable logistic regression was conducted to adjust for potential confounders (**Table 2**). ELST presence was significantly associated with favorable neurological outcomes (adjusted OR 1.39, 95%, CI 1.17-1.66), one-month survival (adjusted OR 1.37, 95% CI 1.22-1.54), and ROSC (adjusted OR 1.90, 95% CI 1.73-2.11).

We explored whether technical procedures (advanced airway management; adrenaline administration) limited to ELSTs promoted outcomes with univariable and multivariable logistic regression (**Table 3**). Use of advanced airways did not promote favorable neurological outcomes (adjusted OR 0.34, 95% CI 0.32-0.36) or one-month survival (adjusted OR 0.72, 95% CI 0.70-0.75). Administration of adrenaline did not promote favorable neurological outcomes (adjusted OR 0.33, 95% CI 0.31-0.35) or one-month survival (adjusted OR 0.84, 95% CI 0.80-0.87). However, both advanced airways (adjusted OR 1.08, 95% CI 1.05-1.11) and adrenaline (adjusted OR 3.73, 95% CI 3.64-3.83) increased ROSC.

Discussion

We examined the efficacy of ELST presence during treatment and transport for OHCA patient outcomes using a large national registry in Japan and found that patients treated by ELSTs had better neurological outcomes (adjusted OR of 1.39) than patients treated only by BEMTs. Adjusted one-month survival and ROSC were also better in the ELST group compared with the BEMT group. However, intervention skills such as advanced airway use or adrenaline administration did not fully explain ELSTs' contribution to favorable neurological outcomes. ELSTs' greater knowledge of pathophysiology and appropriate transport to receiving hospitals to treat OHCA patients may be their advantages.

Prehospital medical providers contribute to treating and transporting patients, including OHCA patients, all over the world [21][22]; their techniques and knowledge may vary widely by region. Since prehospital medical providers (in Japan, BEMTs or ELSTs) commonly play important roles in advising/helping first-contacted public BLS providers or treating and transporting OHCA patients to hospitals, their skills or knowledge can be decisive factors in OHCA patient outcomes. OHCA experience (case volume) of prehospital medical provider has been reported to predict ROSC [11]. Similarly, association between OHCA exposure of prehospital medical provider and patient survival has been reported. OHCA exposure during the preceding three years had a positive effect on patient survival; moreover, outcomes improved when it was less than six months since prehospital medical providers last treated OHCA patients [23]. In Osaka, Japan, Kajino et al. compared the efficacy of supraglottic devices vs. ETI; in their sub-analysis, the presence of an ETI-certified ELST was significantly associated with favorable neurological outcomes (adjusted OR of 1.86, 95% CI 1.04 to 3.34), similar to our results [24]. Our study did not address the number of EMTs or ELSTs; however, in the Osaka study, the presence of three ELSTs was associated with improved one-month survival with favorable neurological outcomes in OHCA compared with presence of one ELST [12]. In addition, an over 50% ratio of on-scene advanced EMTs was associated with improved survival in OHCA patients with witnessed, non-shockable rhythm in Taipei [10]. In their study, the presence of four EMTs with an advanced EMT ratio of over 50% was associated with the best outcomes. However, number of EMTs alone does not seem to improve outcomes. More EMTs in ambulances did not affect rates of ROSC, survival, or neurological favorable outcomes of OHCA patients in Tokyo [25]. Similarly, Eschmann et al. reported that in their two-tiered system, the presence of three or advanced EMTs at the scene was not associated with improved survival compared with one basic EMT and two advanced EMTs [13]. At least one well-trained and experienced prehospital medical provider such as an ELST seems to be needed on scene for decision-making to improve outcomes.

Whether advanced airways contribute to OHCA outcomes remains debatable; however, these skills are essential in some cases with a limited number of crews. However, the use of advanced airways did not promote ELST favorable neurological outcomes, implying that ELSTs' advantages extend beyond the technique. The results provided additional evidence of the limited impact of advanced techniques like advanced airways or adrenaline administration on neurological outcomes. Our results were consistent with those from previous studies showing no improved outcomes with advanced airway device use in Japan [14]. However, these skills may still potentially improve outcomes [26][27][28]. Proper indications for advanced airways are needed; moreover, outcomes may vary according to the prehospital medical provider's proficiency in performing the procedure. Adrenaline administration was conducted in fewer patients (16%) compared to the US [29] or UK [30]. Regional protocols for administering adrenaline have variations; some districts do not recommend adrenaline administration to unwitnessed asystole [31]. Moreover, the need for direct phone orders from a medical consultant physician to establish an intravenous access and a subsequent phone call to administer adrenaline may have resulted in decreased incidence or delayed adrenaline administration. Adrenaline administration increased ROSC; however, our data did not show efficacy of adrenaline administration for favorable neurological outcomes. Past studies have conflicting results: in one trial, prehospital epinephrine use was associated with higher chance of ROSC, but lower chance of survival and good neurological outcomes [15]. Contrarily, after accounting for time-dependent patient imbalance, Nakahara et al. reported higher proportions of overall and neurologically-intact survival among those with non-shockable rhythms in adrenaline administration [32]. In the recent randomized controlled trial, adrenaline use resulted in significantly higher survival, but a lower rate of good neurological outcome in those who survived [30]. Adrenaline timing [33][34] or dosing [35][36][37] and appropriate patients [38] should be further evaluated in prehospital settings.

BLS quality is crucial in OHCA outcomes; more educated prehospital medical providers may have performed better quality BLS. Other possible explanations for better neurological survival with ELSTs is that they performed better quality defibrillation. Shorter interruptions in chest compressions before and after defibrillatory shock is an independent predictor of survival from shockable OHCA [39]. Although EMS contact time to initial defibrillation time did not differ between groups, ELSTs with more experience/education and semi-automated defibrillator use may have facilitated faster defibrillation.

Results of multivariable logistic regression showed evidence supporting ELST presence. ELSTs' knowledge of factors other than skills/procedures like defibrillation or administration of advanced airways or adrenaline may have had more impact on outcomes. Receiving hospital characteristics may be associated with OHCA outcomes. Transport to Japanese nationally-certified critical care medical centers assumed to be high-volume independently predicted good neurological outcomes in OHCA without field ROSC [6]. Receiving hospital choice may have been better with more educated or experienced prehospital medical providers like ELSTs. In addition, ELSTs may have provided hospitals more precise meaningful information from the field to prepare for definitive treatment. Future research should determine these factors affecting the association between advanced prehospital medical providers' ability and improved outcomes.

Limitations

Our study has several limitations. First, we couldn't obtain information on several factors associated with outcomes in BEMT or ELST transport. We didn't address ELST education level (whether or not they are certified in ETI/adrenaline administration), number of BEMTs and ELSTs, or BEMTs/ELST experience. Second, the number of BEMTs was much smaller than the number of ELSTs. Moreover, there was some difference in characteristics between groups. For instance, ELST group showed higher rates of patients with VF/VT and lower rates of patients with estimated cardiac origin. This may attribute to regional variation for BEMT-only transport: (i.e., more frequent BEMT transport in rural areas). We tried to adjust the difference between the two groups using known factors potentially related to outcomes using factors obtained in the database. Third, other unmeasured confounding factors may have influenced outcomes, i.e. patient comorbidity, location of arrest, cardiac arrest etiology, receiving hospital information, hospital post-cardiac arrest management, CPR quality information. Finally, like with all epidemiological studies, data validity, integrity, and ascertainment bias were possible limitations. However, large sample size, population-based design to cover all OHCA in Japan, and uniform data collection based on Utstein-style guidelines for reporting cardiac arrest were intended to lessen these potential biases.

Conclusions

Compared with the BEMT group, treatment and transport by the ELST group was associated with improved favorable neurological outcomes for OHCA. EMS response to OHCA should include at least one advanced level prehospital provider.

Conflict of interest

Conflicts of interest: none.

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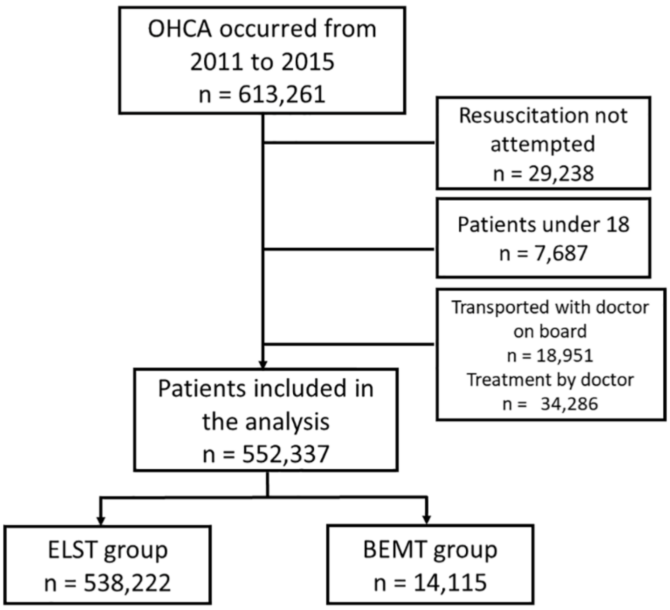
Figure Legends

Figure 1



Flow diagram of patients analyzed. The ELST group comprised patients transported by emergency medical service, including at least one ELST. The BEMT group comprised patients transported only by BEMTs. BEMT: basic emergency medical technician; CPR: cardiopulmonary resuscitation; ELST: emergency life-saving technician; OHCA: out-of-hospital cardiac arrest.

Tables

Table 1. Patient Characteristics and Outcomes of ELST and BEMT Groups

	All	ELST	BEMT
Patient characteristics			
Male sex	312,615/552,337 (56.6%)	304,590/538,222 (56.6%)	8,025/14,115 (56.9%)
Age – median [IQR]	79 [67-86]	79 [67-86]	79 [68-86]
Initial rhythm VF/VT	37,779/531,586 (7.1%)	36,879/517,989 (7.1%)	900/13,597 (6.6%)
PEA/Asystole	493,807/531,586 (92.9%)	481,110/517,989 (92.9%)	12,697/13,597 (93.4%)
Estimated cardiac origin	329,021/552,337 (59.6%)	320,239/538,222 (59.5%)	8,782/14,115 (62.2%)
Witnessed collapse	222,329/553,337 (40.3%)	216,685/538,222 (40.3%)	5,644/14,115 (40.0%)
Bystander CPR	246,326/482,684 (51.0%)	240,091/471,611 (50.9%)	6,235/11,073 (56.3%)
Dispatcher instruction for CPR	288,006/544,419 (52.9%)	281,129/530,670 (53.0%)	6,877/13,749 (50.0%)
Time from EMS call to hospital arrival – median [IQR]	32 [26-39] min	32 [26-39] min	31 [26-39] min
Year of cardiac arrest			
2011	116,911	113,687/116,911 (97.2%)	3,224/116,911 (2.8%)
2012	112,923	110,244/112,923 (97.6%)	2,679/112,923 (2.4%)
2013	106,714	104,267/106,714 (97.7%)	2,447/106,714 (2.3%)
2014	108,741	105,104/108,741 (96.7%)	3,637/108,741 (3.3%)
2015	107,048	104,920/107,048 (98.0%)	2,128/107,048 (2.0%)
Region			
Hokkaido	22,056/552,337 (4.0%)	21,532/538,222 (4.0%)	524/14,115 (3.7%)
Tohoku	47,322/552,337 (8.6%)	44,747/538,222 (8.3%)	2,575/14,115 (18.2%)
Kanto	186,808/552,337 (33.8%)	184,580/538,222 (34.3%)	2,228/14,115 (15.8%)
Chubu	102,970/552,337 (18.6%)	101,195/538,222 (18.8%)	1,775/14,115 (12.6%)
Kinki	88,715/552,337 (16.1%)	85,054/538,222 (15.8%)	3,661/14,115 (25.9%)
Chugoku	32,481/552,337 (5.9%)	31,683/538,222 (5.9%)	798/14,115 (5.7%)
Shikoku	18,518/552,337 (3.4%)	17,957/538,222 (3.3%)	561/14,115 (4.0%)
Kyushu	53,467/552,337 (9.7%)	51,474/538,222 (9.6%)	1,993/14,115 (14.1%)

Interventions			
Time from EMS arrival to initial defibrillation (VF/VT) – median [IQR]	2 [1-3] min	2 [1-3] min	2 [1-4] min
Use of advanced airways	N/A	220,135/522,001 (42.2%)	N/A
Supraglottic airways	N/A	183,098/538,222 (34.0%)	N/A
Endotracheal intubation	N/A	39,339/538,222 (7.3%)	N/A
Use of intravenous line and adrenaline			
Intravenous line establishment	N/A	172,371/538,998 (32.0%)	N/A
Administration of adrenaline	N/A	85,432/535,420 (16.0%)	N/A
Outcomes			
One-month favorable neurological outcome (overall)	13,536/552,334 (2.5%)	13,244/538,219 (2.5%)	292/14,115 (2.1%)
Initial rhythm VF/VT	6,877/37,779 (18.2%)	6,726/36,879 (18.2%)	151/900 (16.8%)
Initial rhythm PEA/Asystole	3,834/493,804 (0.78%)	3,746/481,107 (0.78%)	88/12,697 (0.69%)
One-month survival (overall)	26,829/552,337 (4.9%)	26,257/538,222 (4.9%)	572/14,115 (4.1%)
Initial rhythm VF/VT	10,036/37,779 (26.6%)	9,828/36,879 (26.7%)	208/900 (23.1%)
Initial rhythm PEA/Asystole	12,643/493,807 (2.6%)	12,360/481,110 (2.6%)	283/12,697 (2.2%)
ROSC	44,340/552,337 (8.0%)	43,625/538,222 (8.1%)	715/14,115 (5.1%)

Patient characteristics, interventions, and outcomes are shown. All patient characteristics variables were used to adjust for the outcomes in the multivariable logistic regression. BEMT: basic emergency technician, CPR: cardiopulmonary resuscitation, ELST: emergency life-saving technician, EMS: emergency medical service, IQR: interquartile range, N/A: not applicable, PEA: pulseless electrical activity, ROSC: return of spontaneous circulation, VF/VT: ventricular fibrillation/ventricular tachycardia

Table 2. Univariable and Multivariable Logistic Regression Comparing Favorable Neurological Outcomes, One-Month Survival, and ROSC

	Crude OR (95% CI)	Adjusted OR (95% CI)
One-month favorable neurological outcome		
Overall		
BEMT	1 (ref)	1 (ref)
ELST	1.19 (1.06-1.34)	1.39 (1.17-1.66)
VF/VT		
BEMT	1 (ref)	1 (ref)
ELST	1.11 (0.93-1.32)	1.41 (1.13-1.77)
PEA/Asystole		
BEMT	1 (ref)	1 (ref)
ELST	1.12 (0.91-1.39)	1.31 (1.01-1.73)
One-month survival		
BEMT	1 (ref)	1 (ref)
ELST	1.2 (1.12-1.32)	1.37 (1.22-1.54)
ROSC		
BEMT	1 (ref)	1 (ref)
ELST	1.65 (1.53-1.78)	1.90 (1.72-2.11)

Variables, including gender, age, initial shockable rhythm, estimated cardiac origin, witnessed collapse, bystander CPR, dispatcher instruction for CPR, time from EMS call to hospital arrival, cardiac arrest year, and region, were used to adjust for the outcomes in the multivariable logistic regression. CI: confidence interval, CPR: cardiopulmonary resuscitation, BEMT: basic emergency medical technician, ELST: emergency life-saving technician, EMS: emergency medical service, OR: odds ratio, PEA: pulseless electrical activity, ROSC: return of spontaneous circulation, VF/VT: ventricular fibrillation/ventricular tachycardia

Table 3. Univariable and Multivariable Logistic Regression Comparing the Presence or Absence of Technical Intervention on Favorable Neurological Outcomes, One-Month Survival, and ROSC in the ELST group

	Crude OR (95% CI)	Adjusted OR (95% CI)
Favorable neurological outcome		
Advanced airways	0.30 (0.29-0.32)	0.34 (0.32-0.36)
Adrenaline	0.50 (0.47-0.53)	0.33 (0.31-0.35)
One-month survival		
Advanced airways	0.60 (0.59-0.62)	0.72 (0.70-0.75)
Adrenaline	1.02(0.99-1.06)	0.84 (0.80-0.87)
ROSC		
Advanced airways	0.97 (0.95-0.99)	1.08 (1.05-1.11)
Adrenaline	3.89 (3.81-3.97)	3.73 (3.64-3.83)

Variables, including gender, age, initial shockable rhythm, estimated cardiac origin, witnessed collapse, bystander CPR, dispatcher instruction for CPR, time from EMS call to hospital arrival, cardiac arrest year, and region, were used to adjust for the outcomes in the multivariable logistic regression. CI: confidence interval, CPR: cardiopulmonary resuscitation, ELST: emergency life-saving technician, EMS: emergency medical service system, OR: odds ratio, ROSC: return of spontaneous circulation

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