Austin Emergency Medicine

Open Access

Austin Publishing Group

Research Article

Dispatcher Assistance Worsened Outcomes of Unwitnessed Out-of Hospital Cardiac Arrest: An Observational Study with Component Analysis of Rescue Breath Combination and Dispatcher Assistance

Ito Y*, Inaba H, Ushimoto T, Morita H, Murasaka K and Wato Y
Department of Emergency Medicine, Kanazawa Medical University, Japan

***Corresponding author:** Yoshinori Ito, Department of Emergency Medicine, Kanazawa Medical University, 920-0265, University1-1, Uchinada-cho, Kahoku-gun, Ishikawa Prefecture, Japan

Received: February 28, 2022; **Accepted:** March 29, 2022; **Published:** April 05, 2022

Abstract

Objectives: This study aimed to analyze the effects of combinations of rescue breathing and chest compression in CPR performed by a bystander (BCPR) on the outcomes of out-of-hospital cardiac arrest (OHCA) events. Particular attention was paid to unwitnessed case by bystander.

Methods: This retrospective study analyzed the prospectively collected data of 212,003 unwitnessed and 117,920 bystander-witnessed OHCA cases between 2014 and 2016 in Japan. BCPR classification was based on two clinical components: whether or not DA was provided, and whether standard CPR (with breaths) or compression-only CPR was performed.

Main Outcome Measures: A neurologically favorable outcome at one month.

Results: Univariate analysis showed that, in unwitnessed cases, there was no significant association between the provision of BCPR and a neurologically favorable outcome (BCPR *vs*. no-BCPR: 0.65% (686/106,152) *vs*. 0.66% (694/105,851)). In bystander-witnessed cases, the rates were 5.6% (3,538/62,814) *vs*. 3.5% (1,911/55,106). After classifying BCPR according to the two clinical components, the outcomes of unwitnessed cases were improved for standard BCPR with DA and compression-only, for standard BCPR without DA, but not for compression-only BCPR with DA. Multivariate logistic regression analysis focusing on the two clinical components in unwitnessed BCPR cases showed worse neurologically favorable outcomes with DA provision but better outcomes for standard BCPR, without significant interaction. In bystander-witnessed cases, DA provision was associated with better outcomes, with significant interaction.

Conclusions: Compared with no-BCPR, compression-only BCPR with DA does not improve neurologically favorable outcomes. Standard BCPR without DA resulted in the best outcomes in unwitnessed OHCA cases.

Keywords: Out-of-hospital cardiac arrest (OHCA); Dispatcher-assist (DA); Bystander cardiopulmonary resuscitation (BCPR); Compression-only CPR; Standard CPR

Abbreviations

OHCA: Out-of-Hospital Cardiac Arrest; DA: Dispatcher-Assist; CPR: Cardiopulmonary Resuscitation; BCPR: Bystander Cardiopulmonary Resuscitation

Introduction

The current basic life support guidelines recommend compression-only cardiopulmonary resuscitation (CPR) for untrained rescuers [1,2]. Previous observational studies of out-of-hospital cardiac arrest (OHCA) have compared the effects of standard (rescue breathing and chest compression) bystander-CPR (BCPR, this is defined as chest compression, with and without rescue breathing, provided to an OHCA victim before EMS contact.) with those of compression-only BCPR. Although these studies used large cohorts, most of them studied bystander-witnessed cases only [3-7]. The outcomes of unwitnessed OHCA cases are considerably worse than those of bystander-witnessed cases [8]; and more OHCA cases are unwitnessed, particularly in residential locations [9]. Dispatcher-assisted CPR (DA-CPR) is more frequently attempted in unwitnessed cases than in witnessed cases [10], presumably because of the greater incidence of apparent signs of cardiac arrest and lesser incidence of agonal breathing, which interferes with the recognition of cardiac arrest. DA is the giving of verbal instructions for performing BCPR.

Theoretically, rescue breathing is less important than chest compression during the first few minutes of OHCA, because blood oxygen levels remain high at this time. Compression-only CPR may

Citation: Ito Y, Inaba H, Ushimoto T, Morita H, Murasaka K and Wato Y. Dispatcher Assistance Worsened Outcomes of Unwitnessed Out-of Hospital Cardiac Arrest: An Observational Study with Component Analysis of Rescue Breath Combination and Dispatcher Assistance. Austin Emerg Med. 2022; 8(1): 1078.

be more effective for an OHCA that is witnessed, especially in a community with a short emergency medical service (EMS) response time. Standard CPR is preferred for an unwitnessed OHCA or for an OHCA that occurs in a community with a long EMS response time [7,11].

There have been few investigations into the advantages or disadvantages of compression-only BCPR with and without DA. One previous study [12] classified BCPR into four groups based on CPR type (standard or compression-only) and initiation (with or without DA) and reported the advantages of standard CPR without DA in bystander-witnessed cases in remote areas with long EMS response times.

No previous studies have used large data sets to focus on unwitnessed OHCAs. We undertook this study because we questioned the current guidelines, especially for unwitnessed OHCA cases.

This study aimed to analyze the effects of combinations of rescue breathing and chest compression in BCPR, with and without DA, on the outcomes of unwitnessed and bystander-witnessed OHCA cases, and to check the effectiveness of the current guidelines, especially for unwitnessed OHCA cases. We compared the outcomes of four BCPR groups (compression-only with DA, standard with DA, compression-only without DA, and standard without DA) with those of the no-BCPR group. Then, we conducted a component analysis in BCPR cases to reveal the effects of CPR type and DA.

Methods

Study design and setting

After obtaining consent from the Japanese Fire and Disaster Management Agency (FDMA), we retrospectively analyzed their OHCA data, which we prospectively collected between 2014 and 2016 using a nationwide, population-based, all-Japan registry system. Because the database was anonymized and secondary, informed consent was waived, according to Japanese guidelines [13]. This research used only existing material, which had been de-linked and anonymized; it did not require ethical review. A person designated in advance by the Ethics Committee has determined that the research plan meets certain requirements and does not need to be referred to the committee.

The Japanese EMS responds to all requests for ambulance dispatch. EMS generally provides DA according to the FDMA protocol [14]. In this protocol, dispatchers are recommended to instruct bystanders to perform compression-only CPR when they are unskilled or unwilling to perform rescue breathing. BCPR does not start until instructed by DA, at which point the bystander is considered to have had DA provided. Instructions are given for performing chest compressions only if the person does not have the skill or willingness to perform rescue breathing. Paramedics working in ambulance teams may use several resuscitation methods, including semi-automated external defibrillation, suprapharyngeal airway device insertion, and Ringer's lactate solution infused via the peripheral vein. For OHCA patients aged ≥8 years, authorized paramedics have been able to insert tracheal tubes and to administer intravenous epinephrine under online medical direction since 2004 and 2006, respectively. Since 2014, they may also perform fluid resuscitation for patients in shock and those with suspected crush syndrome. EMS personnel are not allowed to terminate resuscitation until their arrival at hospital.

Data selection

The FDMA database included the following data, based on the Utstein recommendations [15]: patient age, sex, witness status, OHCA etiology (presumed cardiac or non-cardiac), initial electrocardiogram rhythm (shockable or non-shockable), public access defibrillation (PAD), any prehospital defibrillation, time of day for emergency call (night time [10:00 PM-5:59 AM] or other), advanced airway management, tracheal intubation, physician in ambulance, advanced life support (ALS) by physician, time interval between emergency call and first CPR performed by a bystander or EMS personnel, time interval between emergency call and EMS contact with patient (EMS response time), time interval between EMS contact with patient and arrival at hospital, BCPR type, DA provision, recorded time of BCPR initiation, emergency call, EMS vehicle arrival, EMS contact to patient, EMS CPR initiation, and neurologically favorable outcome at 1 month (cerebral performance category [CPC] = 1 or 2) [16]. Of a total 372,926 OHCAs recorded in 2014-2016, we excluded 4,665 unconfirmed arrest cases, including those with return of spontaneous circulation before EMS contact with the patient. We then excluded 29,987 EMS-witnessed cases, 5,665 cases with an incomplete time record, and 2,686 cases of child OHCA (<8 years). We finally included 212,003 unwitnessed cases and 117,920 bystander-witnessed cases (Fig. 1). Main outcome measures was a neurologically favorable outcome, which was defined as a CPC score of 1 or 2 [16] at one month (1-M). The secondary was 1-M survival. The CPC score is a simple and widely used measure to assess the quality of life of the injured person. It is the part of The Glasgow-Pittsburg Outcome Categories that are used to assess the subsequent quality of life of an injured person after resuscitation, using the Utstein style.

Classification of BCPR

BCPR was classified into the following four groups, according to the combination of rescue breathing and chest compression (standard or compression-only) and DA provision (with or without DA): 1) Compression-only CPR with DA, 2) Standard CPR with DA, 3) Compression-only CPR without DA, and 4) Standard CPR without DA.

Statistical analysis

Background and clinical characteristics between groups were compared using the Chi-squared test or Fisher's exact test, for nominal variables, and the Mann–Whitney U test, for continuous variables. Multivariate logistic regression analyses were used to assess the associations between BCPR and outcomes. The following factors were included, which were known to be associated with outcomes: patient characteristics, including age, sex, witness status, OHCA etiology (presumed cardiac or non-cardiac), initial electrocardiogram rhythm (shockable or non-shockable), any prehospital defibrillation, time of day for emergency call (night time or other), advanced airway management, epinephrine administration, and time interval between emergency call and EMS contact with patient (EMS response time). Other variables were included in the analysis when one or more of them lowered the value of Akaike information Criterion: physician in ambulance, ALS by physician, time interval between emergency call and first CPR (either by bystander or EMS), and time interval between EMS contact with patient and arrival at hospital. All

statistical analyses were performed using JMP® Pro 15 software (SAS Institute, Cary, NC, USA). Using the profile likelihood, we calculated odds ratios (OR) and 95% confidence intervals (CI). All tests were two-tailed. A P value of <0.05 was considered statistically significant.

Patient and public involvement

No patients were involved in the design and conduction of this study.

Results

Beneficial effects of BCPR on outcomes

Our results reiterate the validity of BCPR itself. BCPR improved overall outcomes, and had a significant interaction with witness status (Table 1). The outcomes of bystander-witnessed cases were considerably better than those of unwitnessed cases. BCPR significantly improved the outcomes mainly in bystander-witnessed cases.

Overview of DA and BCPR

DA was provided more often in unwitnessed cases (62.6%) than in bystander-witnessed cases (52.3%): unadjusted OR (95% CI): 1.53 (1.50-1.55) (Figure 1). Regardless of DA provision, bystander-witnessed cases (72.4% with DA, 32.0% without DA) more frequently received BCPR than unwitnessed cases (65.7% with DA; 23.9% without DA): OR, 1.39 (1.36-1.43) *vs.* OR, 1.50 (1.46-1.53), respectively. In the groups with BCPR provision, unwitnessed cases (91.1% with DA; 81.7% without DA) more frequently received compression-only BCPR than bystander-witnessed cases (88.2% with DA; 77.1% without DA), regardless of DA provision: OR, 1.37 (1.32-1.42) *vs.* OR, 1.33 (1.26-1.40), respectively.

Comparisons of the outcomes of the four BCPR groups with no-BCPR in unwitnessed and bystander-witnessed cases

In unwitnessed cases, lower rates of neurologically favorable outcomes (0.52% *vs.* 0.66%, adjusted OR, 0.88 (0.76-1.01)) and lower 1-M survival rates (1.5% *vs.* 1.8%; OR, 0.89 (0.81-0.97)) were observed in compression-only BCPR with DA, compared with those of no-BCPR cases (Figure 2A). The rates of neurologically favorable outcomes and 1-M survival were highest for standard BCPR without DA (1.2% and 2.5%, respectively).

In bystander-witnessed cases, higher rates of neurologically favorable outcomes and 1-M survival were observed in all four BCPR groups, compared with the no-BCPR group (Figure 2B). The rates of neurologically favorable outcomes and 1-M survival were highest in standard BCPR with DA (6.6% and 10.9%, respectively).

Component analyses of the combinations of rescue breathing and chest compression with DA provision in OHCA cases receiving BCPR

When the characteristics of unwitnessed OHCA cases receiving BCPR were compared between groups in which DA was provided or not (Table 2; Left), the differences were remarkable (unadjusted OR <0.8, for nominal variables, or >1.25, for medians of continuous variables) in terms of age, PAD, any prehospital defibrillation, advanced airway management, ALS by physician, and time interval between emergency call and first CPR. Cases with DA were younger and less frequently had PAD, prehospital defibrillation, and ALS by physician than those without DA. They more frequently had advanced airway management than those without DA. However, BCPR initiation was delayed in cases with DA.

When the characteristics of unwitnessed OHCA cases receiving BCPR were compared between compression-only and standard BCPR groups (Table 2; Right), cases with compression-only BCPR were younger and less frequently had PAD, prehospital defibrillation, and ALS in ambulance than those with standard BCPR. However, BCPR initiation was delayed in cases with compression-only BCPR.

Some characteristics of bystander-witnessed cases differed between the BCPR groups. Notably, the incidence of shockable rhythm in bystander-witnessed cases was higher in the groups

Table 1: Associations between bystander CPR and outcomes of OHCA.

Characteristic and outcomes	Bystander CPR (Chest compressions with and without rescue breathing by bystanders)		Unadjusted OR (95% CI) with no bystander CPR as reference	Adjusted OR with no bystander CPR as reference[a]
	Not provided by bystanders	Provided by bystanders		
Overall (N = 329,923)				
N	160,957	168,966		
1-M survival, % (N)	3.9 (6,179)	4.9 (8,214)	1.28 (1.24-1.32)	1.11 (1.06-1.15)[b]
Neurologically favorable outcome, % (N)	1.6 (2,605)	2.5 (4,224)	1.56 (1.48-1.64)	1.23 (1.16-1.31)[c]
Unwitnessed OHCAs (N = 212,003)				
N	105,851	106,152		
1-M survival, % (N)	1.8 (1,900)	1.8 (1,858)	0.97 (0.91-1.04)	0.90 (0.64-1.28)
Neurologically favorable outcome, % (N)	0.66 (694)	0.65 (686)	0.99 (0.89-1.10)	1.13 (0.99-1.29)
Bystander-witnessed OHCAs (N = 117,920)				
N	55,106	62,814		
1-M survival, % (N)	7.8 (4,279)	10.1 (6,356)	1.34 (1.28-1.39)	1.29 (1.21-1.38)
Neurologically favorable outcome, % (N)	3.5 (1,911)	5.6 (3,538)	1.66 (1.57-1.76)	1.46 (1.36-1.57)

Abbreviations: OHCA: Out-of-Hospital Cardiac Arrest; CPR: Cardiopulmonary Resuscitation; OR: Odds Ratio; CI: Confidence Interval; DA-CPR: Dispatcher-Assisted CPR; 1-M: One Month.

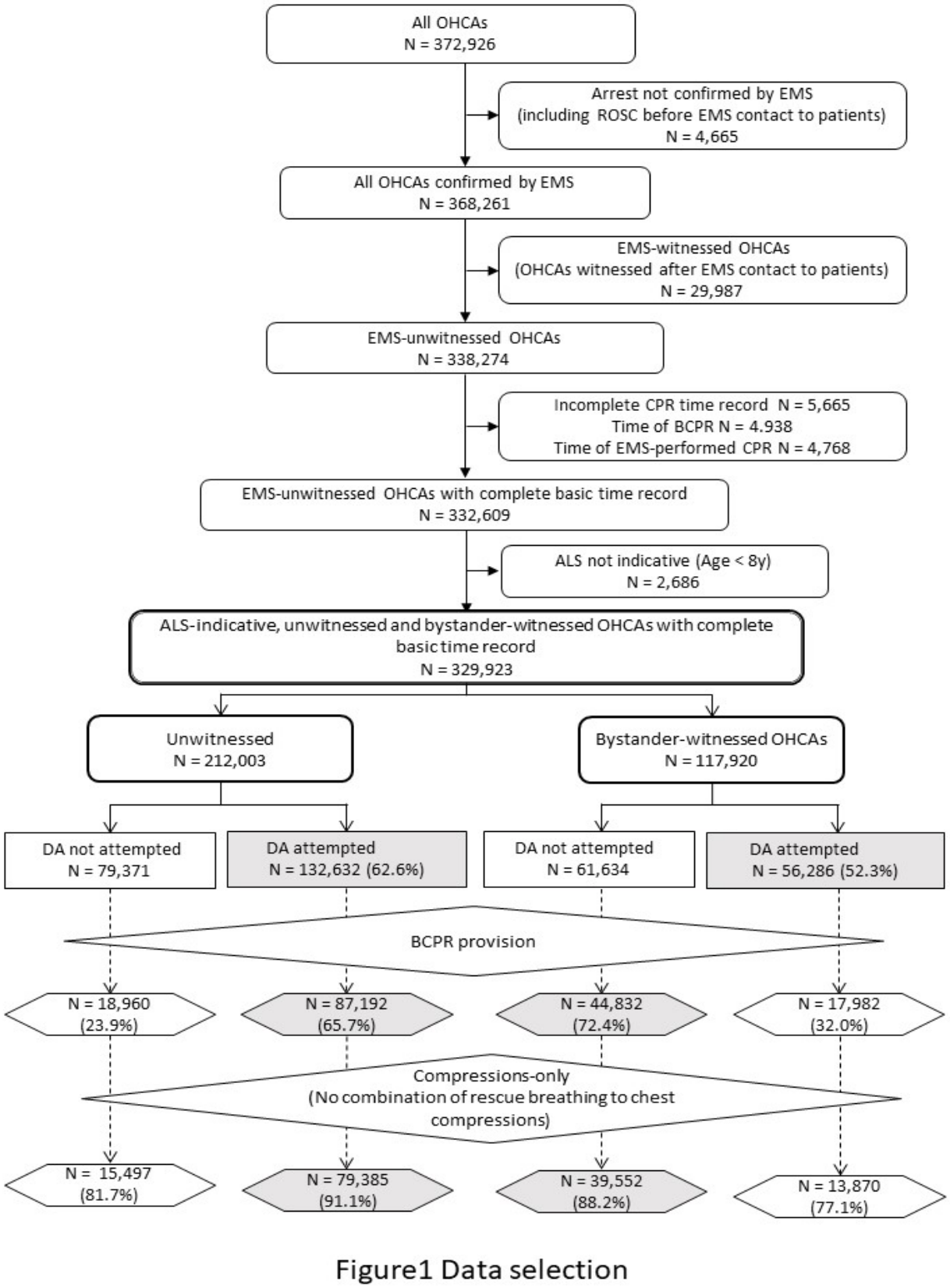

Figure 1: Final Data Selection BCPR.

Table 2: Association between clinical characteristics of BCPR and OHCA in unwitnessed cases with BCPR.

Clinical characteristics and outcomes	Characteristics of bystander CPR					
	DA			Combination of ventilations with chest compressions in BCPR		
	BCPR with DA	BCPR without DA	Unadjusted OR (95% CI) with BCPR without DA as reference or P value	Standard	Compression-only	Unadjusted OR (95% CI) with compression-only BCPR as reference or P value
N	87,192	18,960		11,270	94,882	
Male, % (N)	51.60% (44,978)	50.80% (9,627)	1.03 (1.01-1.07)	45.50% (5,131)	52.10% (49,474)	0.77 (0.74-0.80)
Age, y, median (IQR)	81 (70-87)	82 (70-88)	<0.01	82 (70-88)	81 (70-87)	<0.01
Emergency call during nighttime (10:00 p.m.-5:59 a.m.), % (N)	21.90% (19,058)	22.00% (4,162)	0.99 (0.96-1.03)	21.40% (2,408)	21.90% (20,812)	0.97 (0.93-1.01)
Of presumed cardiac etiology, % (N)	64.20% (55,978)	62.60% (11,872)	1.07 (1.04-1.11)	63.10% (7,113)	64.00% (60,706)	0.96 (0.92-1.08)
Shockable initial rhythm, % (N)	3.10% (2,693)	3.80% (718)	0.81 (0.74-0.88)	3.70% (411)	3.20% (3000)	1.16 (1.04-1.29)
Any prehospital defibrillation, % (N)	6.10% (5,324)	8.20% (1,545)	0.73 (0.69-0.78)	9.00% (1,018)	6.20% (5,891)	1.51 (1.41-1.62)
Public access defibrillation, % (N)	0.90% (818)	2.90% (557)	0.31 (0.28-0.35)	3.70% (412)	1.00% (963)	3.70 (3.29-4.16)
Advanced airway management, % (N)	42.70% (87,192)	35.90% (18,960)	1.33 (1.29-1.38)	40.90% (4,604)	41.60% (39,470)	0.97 (0.93-1.01)
Tracheal intubation, % (N)	7.70% (6,673)	7.50% (1,423)	1.02 (0.96-1.08)	8.10% (912)	7.60% (7,184)	1.07 (1.00-1.15)
Prehospital epinephrine administration, % (N)						
No	85.90% (74,912)	86.80% (16,463)	<0.01	84.40% (9,512)	86.30% (81,863)	<0.01
Early single administration	2.30% (2,020)	2.20% (422)		2.90% (328)	2.20% (2,114)	
Other administrations	11.80% (2,075)	10.90% (2,075)		12.70% (1,430)	11.50% (10,905)	
Physician in ambulance, % (N)	2.40% (2,082)	2.90% (555)	0.81 (0.74-0.89)	3.60% (401)	2.40% (2,236)	1.53 (1.37-1.70)
ALS by physician, % (N)	8.00% (6,970)	10.60% (2,000)	0.74 (0.70-0.78)	10.10% (1,138)	8.30% (7,832)	1.25 (1.17-1.33)
Time intervals, min, median (IQR)						
Emergency call-to-BCPR (first CPR)	1 (0-2)	0 (-2-2)	<0.01	0 (-3-1)	1 (0-2)	<0.01
EMS response time interval	9 (7-11)	9 (7-11)	0.85	9 (7-11)	9 (7-11)	0.54
EMS contact to patient-to-arrival at hospitals	22 (17-28)	22 (17-29)	<0.01	22 (17-28)	22 (17-28)	0.62

Abbreviations: OHCA: Out-of-Hospital Cardiac Arrest; CPR: Cardiopulmonary Resuscitation; OR: Odds Ratio; CI: Confidence Interval; DA-CPR: Dispatcher-Assisted CPR; 1-M: One Month.

receiving BCPR with DA and compression-only BCPR, whereas the incidence in unwitnessed cases was slightly higher in the groups receiving BCPR without DA or standard BCPR (Table 3).

According to simple binominal logit analyses with an interaction test, BCPR with DA was associated with fewer neurologically favorable outcomes and worse 1-M survival in unwitnessed cases. Standard BCPR was associated with better outcomes in both unwitnessed and bystander-witnessed cases receiving BCPR (Table 4). A significant interaction was found between DA provision and standard BCPR for 1-M survival in unwitnessed cases (P=0.01) and for neurologically favorable outcomes in bystander-witnessed cases (P=0.01).

Multivariate analysis of neurologically favorable outcomes (Figure 3) revealed that BCPR with DA was associated with worse outcomes in unwitnessed cases (adjusted OR, 0.76 (0.60-0.97)) and better outcomes in bystander-witnessed cases (adjusted OR, 1.28 (1.14-1.43)). However, standard BCPR was associated with better outcomes only in unwitnessed cases (adjusted OR, 1.27 (1.01-1.600). In terms of 1-M survival, standard BCPR was associated with higher survival rates in both unwitnessed cases (adjusted OR, 1.06 (1.02-1.38)) and bystander-witnessed cases (adjusted OR, 1.16 (1.07-1.26)). However, DA was associated with higher survival rates (adjusted OR, 1.16 (1.07-1.26)) only in bystander-witnessed cases (Figure 4). Other major common factors associated with neurologically favorable outcomes were: age, initial shockable rhythm, any prehospital defibrillation, and response time. Interestingly, an early single administration of epinephrine was associated with a higher 1-M survival rate but not with a better neurologically favorable outcome.

Discussion

We compared the outcomes of OHCA cases who received BCPR, categorized into four groups, with the outcomes of those who did not receive BCPR. Compression-only BCPR with DA was associated with better neurologically favorable outcomes than no-BCPR in bystander-witnessed cases, but not in unwitnessed cases. Component analyses of unwitnessed cases revealed significant associations between rescue breathing and better neurologically favorable outcomes, and between the provision of DA and worse outcomes, with no significant interaction between the two components. The analyses in bystander-witnessed cases did disclose a significant interaction between the two components, and confirmed that DA provision is associated with better neurologically favorable outcomes.

Table 3: Association between clinical characteristics of BCPR and OHCA in bystander-witnessed cases with BCPR.

Clinical characteristics and outcomes	Characteristics of bystander CPR					
	DA			Combination of ventilations with chest compressions in BCPR		
	BCPR wit DA	BCPR without DA	Unadjusted OR (95% CI) with bystander CPR without DA as reference or P value	Standard	Compression-only	Unadjusted OR (95% CI) with CC + V bystander CPR as reference or P value
N	44,832	17,982		9,422	53,392	
Male, % (N)	57.00% (25,553)	54.80% (9,861)	1.09 (1.05-1.13)	50.90% (4,800)	57.30% (30,614)	0.77 (0.74-0.81)
Age, y, median (IQR)	80 (69-88)	80 (68-88)	0.63	82 (68-89)	80 (69-88)	<0.01
Emergency call during nighttime (10:00 p.m.-5:59 a.m.), % (N)	18.00% (8,0520)	13.70% (2,463)	1.37 (1.31-1.45)	12.00% (1,131)	17.60% (9,384)	0.64 (0.60-0.68)
Of presumed cardiac etiology, % (N)	59.30% (26,574)	62.20% (11,184)	0.88 (0.85-0.92)	60.40% (5,690)	60.10% (32,068)	1.01 (0.97-1.06)
Shockable initial rhythm, % (N)	14.60% (6,550)	13.90% (2,499)	1.06 (1.08-1.11)	29.90% (1,261)	34.60% (7,788)	0.90 (0.85-0.96)
Any prehospital defibrillation, % (N)	20.20% (5,324)	21.30% (1,545)	0.93 (0.90-0.98)	22.20% (2,094)	20.20% (10,771)	1.13 (1.07-1.19)
PAD, % (N)	2.90% (1,301)	6.90% (1,242)	0.40 (0.37-0.44)	8.90% (839)	3.20% (1,704)	2.97 (2.72-3.23)
Advanced airway management, % (N)	46.00% (20,612)	37.20% (6,683)	1.44 (1.39-1.49)	40.00% (3,770)	41.10% (23,525)	0.84 (0.81-0.89)
Tracheal intubation, % (N)	10.50% (4,715)	8.60% (1,423)	1.25 (1.18-1.33)	9.70% (914)	10.00% (5,346)	0.97 (0.90-1.04)
Prehospital epinephrine administration, % (N)						
No	70.10% (31,417)	75.50% (13,568)	<0.01	73.10% (6,888)	71.40% (38,097)	<0.01
Early single administration	14.00% (6,265)	10.20% (1,839)		12.10% (1,140)	13.00% (6,964)	
Other administrations	16.00% (7,150)	14.30% (2,575)		14.80% (1,394)	15.60% (8,331)	
Physician in ambulance, % (N)	4.50% (2,029)	6.20% (1,106)	0.72 (0.67-0.78)	8.20% (772)	4.40% (2,363)	1.93 (1.77-2.10)
ALS by physician, % (N)	10.40% (4,661)	13.40% (2,405)	0.74 (0.70-0.78)	15.40% (1,447)	10.50% (5,619)	1.54 (1.45-1.64)
Time intervals, min, median (IQR)						
Emergency call-to-BCPR (first CPR)	1 (0-2)	0 (-2-2)	<0.01	1 (0-2)	0 (-3-1)	<0.01
EMS response time interval	9 (7-11)	9 (7-11)	0.36	9 (7-11)	9 (7-11)	0.92
EMS contact to patient-to-arrival at hospitals	23 (18-30)	23 (17-30)	0.09	23 (17-30)	23 (18-30)	0.25

Table 4: Associations between clinical characteristics of bystander CPR and outcomes of OHCA.

Outcomes of OHCA	Characteristics of bystander CPR						Interaction of the two bystander CPR characteristics
	DA			Combination of rescue breaths with chest compressions in BCPR			
	BCPR with DA	BCPR without DA	Adjusted OR (95% CI) with BCPR without DA as reference	Standard	Compression-only	Adjusted OR (95% CI) with Compression-only BCPR as reference	
Unwitnessed OHCA							
N	18,960	87,192		11,270	94,882		
1-M survival	1.6% (1,406)	2.4% (452)	0.78 (0.68-0.90)	2.4% (274)	1.7% (1,584)	1.30 (1.13-1.50)	P=0.01
Neurologically favorable outcome	0.56% (484)	1.1% (202)	0.61 (0.49-0.76)	0.98% (110)	0.61% (576)	1.39 (1.12-1.72)	P=0.07
Witnessed OHCA							
N	44,832	17,982		9,422	53,392		
1-M survival, % (N)	10.1% (4,525)	10.2% (1,831)	1.01 (0.94-1.09)	10.8% (1,017)	10.0% (5,339)	1.08 (1.01-1.17)	P=0.61
Neurologically favorable outcome, % (N)	5.5% (2,467)	6.0% (1,071)	1.00 (0.91-1.10)	6.3% (595)	5.5% (2,943)	1.11 (1.01-1.22)	P=0.01

A simple binominal logit analysis with an interaction test. Adjusted OR was calculated by binominal analysis including DA-CPR and the combination of rescue breaths with chest compressions in BCPR. BCPR: Bystander CPR; DA: Dispatcher Assistance; **Abbreviations:** OHCA: Out-of-Hospital Cardiac Arrest; CPR: Cardiopulmonary Resuscitation; OR: Odds Ratio; CI: Confidence Interval; 1-M: One Month.

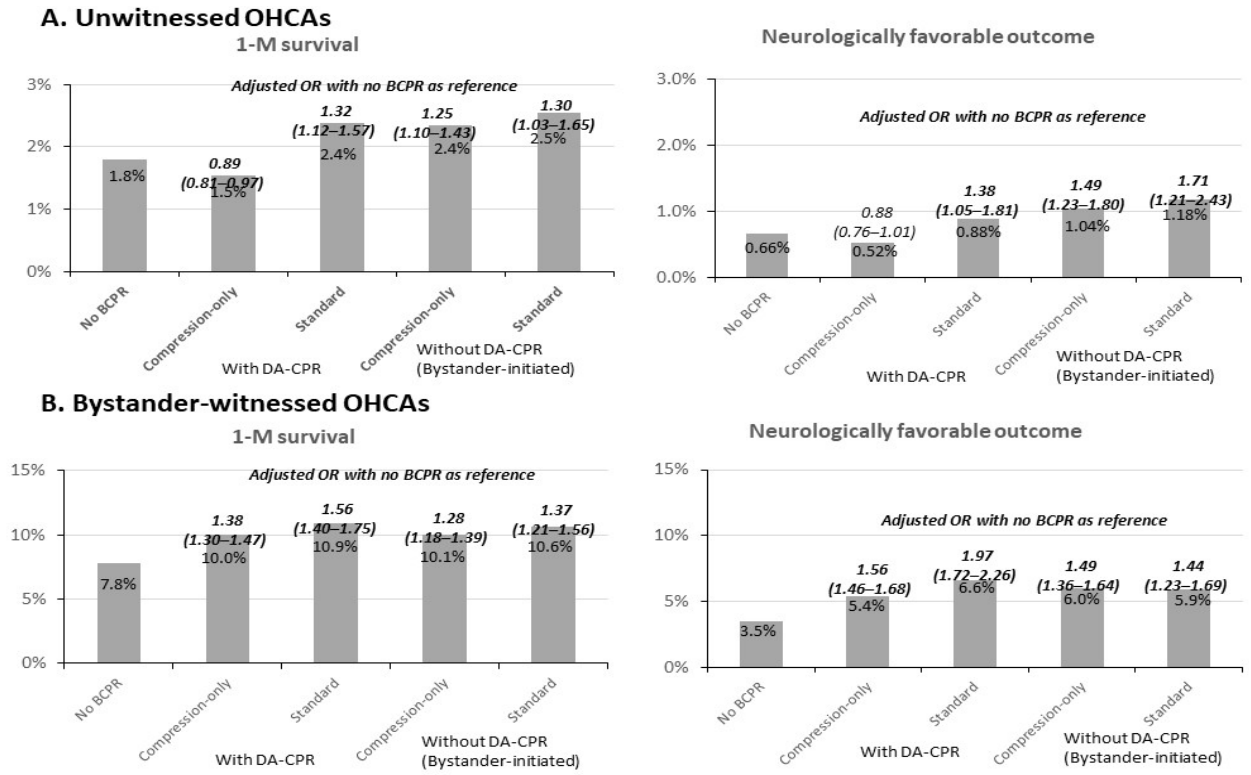

Figure 2. Comparisons of the outcomes of the four BCPR groups with no-BCPR in unwitnessed and bystander-witnessed cases

Figure 2: Final Outcomes.

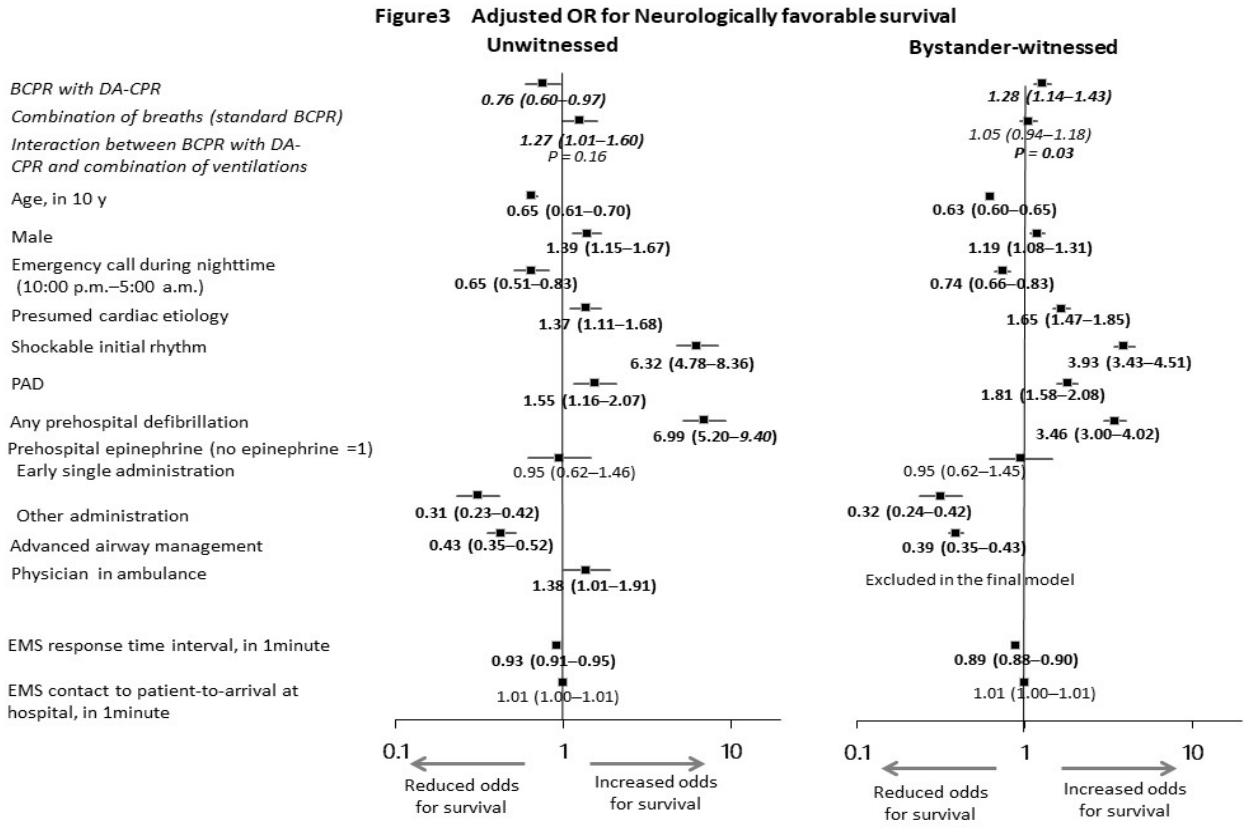

Figure 3: Final Yesterday bi-line prognosis multivariate component analysis.

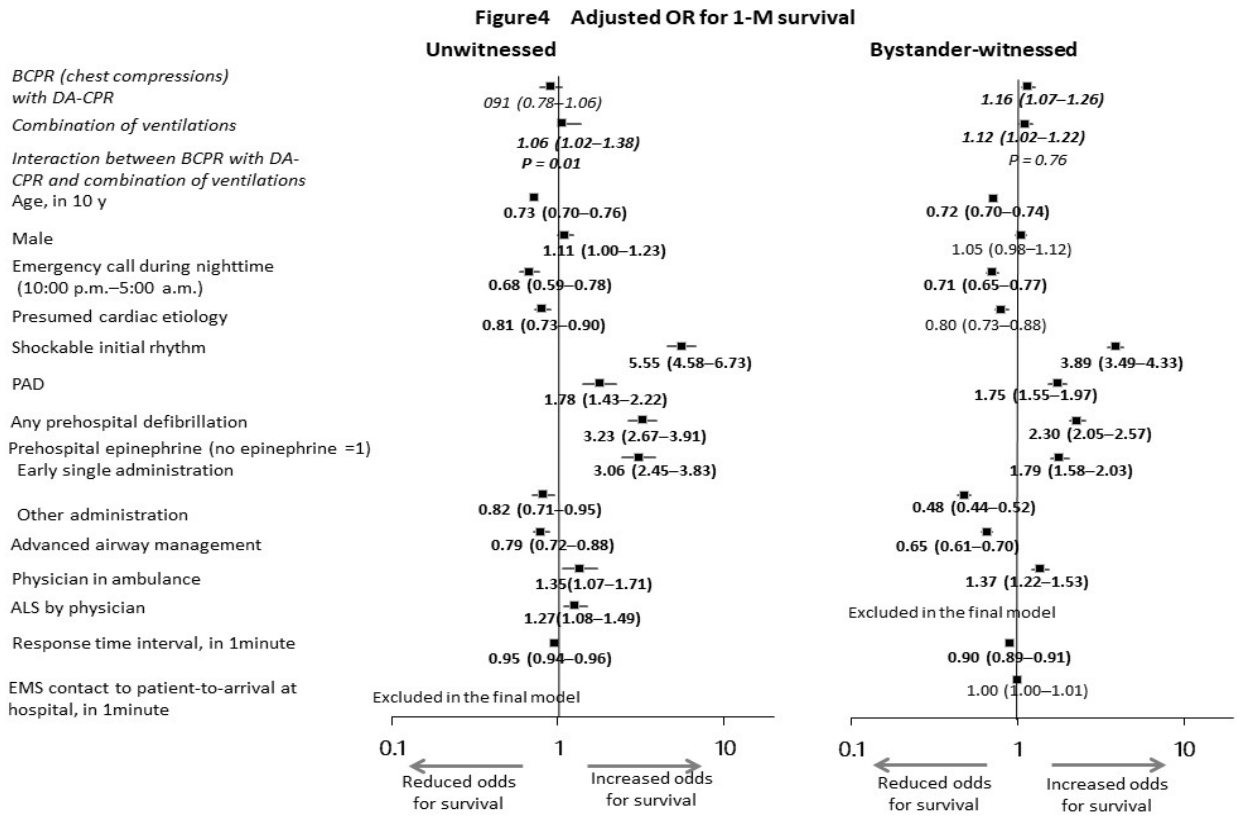

Figure 4: Final 1M Prognosis Multivariate component analysis.

The overall outcomes of OHCA may be slightly influenced by BCPR intervention in unwitnessed OHCA cases with extremely poor outcomes [8]. However, as reported previously [10], DA was attempted more frequently in unwitnessed cases. Numerous unwitnessed cases are found by family members in residential locations; they are mostly untrained for CPR [11,17]. Therefore, it is important to know the effectiveness of compression-only CPR with DA in unwitnessed cases. Our study shows that compression-only CPR with DA does not improve prognosis. Compression-only CPR may have little effect because of the long time to initiation of CPR and the progression of hypoxemia in unwitnessed cases. Witnessed cases also had lesser progression of hypoxaemia and a shorter time to initiation of CPR, which suggests that the quality of CPR, as directed by the dispatcher, may be related to better outcomes.

The significant associations of rescue breathing with better neurologically favorable outcomes, and of DA provision with worse outcomes, suggests that standard BCPR without DA was superior in unwitnessed cases who had terminal depletion of blood and tissue oxygen levels, as reported previously in bystander-witnessed OHCA cases with long EMS response times [12] and delayed BCPR [6]. In addition to reduced oxygenation, a combination of factors, such as delayed initiation of CPR and poor quality of CPR, mean that compression-only BCPR with DA do not improve outcomes in unwitnessed cases.

Effectiveness, in terms of outcomes and BCPR performance, has been compared between compression-only and standard CPR in previous observational [3-6] and randomized, controlled studies [18]. Although results varied among observational studies, the differences in outcome were not remarkable; compression-only BCPR usually improved OHCA outcomes, compared with no-BCPR [2]. However, these analyses were performed in bystander-witnessed cases, or subgroups of presumed cardiac etiology; they did not focus on unwitnessed cases. Furthermore, these previous studies did not evaluate interactions between rescue breathing and DA provision. In a randomized, controlled study conducted in Sweden, no significant difference was found in 30-day survival. But this study considered only cases with DA provision [18]. Our analysis included all these factors, and more, with a particular focus on unwitnessed cases.

Our study has several strengths. First, we focused on the effectiveness of BCPR in unwitnessed cases, in view of the considerable interaction between witness status and BCPR provision. Second, we classified BCPR into four groups, according to combinations of rescue breathing and DA provision. These groups were subjected to component analyses with an interaction test. Third, our data are based on a national registry.

It may be difficult to increase the provision of standard BCPR without DA in unwitnessed cases, considering that unwitnessed OHCAs are usually discovered by untrained bystanders, such as family members. The COVID-19 pandemic might also increase any reluctance to perform rescue breathing [19]. EMS provision is one strategy to resolve this issue, along with community interventions, such as recruiting trained volunteers to initiate standard BCPR [20]. It

is also recommended to teach standard CPR, with high-quality rescue breathing and chest compression, to staff in public facilities, such as care facilities, schools, and universities. There is no clear definition of being trained. However, training is compulsory for obtaining driving licenses and for high school courses. The majority of citizens have taken a CPR course at least once; it is important that they do so more often. In unwitnessed OHCA cases, dispatchers should instruct to give artificial respiration, if possible. The widespread use and improvement of face shields for artificial respiration may also be effective in improving future outcomes. Education regarding standard CPR and chest compression-only CPR, as an option, should be maintained in order to improve the outcomes of unwitnessed OHCA cases. It may also still be necessary to instruct in rescue breathing when providing DA-CPR.

This study has limitations. Simple statistical analysis may not be sufficient to draw conclusions. Feature Extraction methods (Machine Learning or Deep Learning) can be implemented to find out the correlation between the facts and outcomes, more scientifically. Because, qualification of bystanders or BCPR conducting persons' is a major factor. There are other factors in unwitnessed BCPR, in other words more parameters are needed for the numerical analysis. Unwitnessed BCPR data can be highly unreliable. These are issues that need to be further addressed in future research.

Conclusion

Compared with no-BCPR, compression-only BCPR with DA does not improve neurologically favorable outcomes. Standard BCPR without DA resulted in the best outcomes in unwitnessed OHCA cases. Education on standard CPR and chest compression-only CPR, as an option, should be maintained, as numerous OHCA cases are not witnessed by bystanders. It may also be necessary to provide instructions for rescue breathing when providing DA.

Acknowledgment

We would like to thank the EMS personnel and the FDMA in Japan for their great cooperation in collecting and managing the Utstein style database.

References

1. Kleinman ME, Goldberger ZD, Rea T, Swor RA, Bobrow BJ, Brennan EE, et al. 2017 American Heart Association focused update on adult basic life support and cardiopulmonary resuscitation quality: an update to the American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation. 2018; 137: e7-13.
2. Olasveengen TM, de Caen AR, Mancini ME, Maconochie IK, Aickin R, Atkins DL, et al. 2017 International consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations summary. Resuscitation. 2017; 121: 201-214.
3. Riva G, Ringh M, Jonsson M, Herlitz J, Claesson A, Djärv T, et al. Survival in out-of-hospital cardiac arrest after standard cardiopulmonary resuscitation or chest compressions only before arrival of emergency medical services: nationwide study during three guideline periods. Circulation. 2019; 139: 2600-2609.
4. Kitamura T, Kiyohara K, Nishiyama C, Kiguchi T, Kobayashi D, Kawamura T, et al. Chest compression-only versus conventional cardiopulmonary resuscitation for bystander-witnessed out-of-hospital cardiac arrest of medical origin: a propensity score-matched cohort from 143,500 patients. Resuscitation. 2018; 126: 29-35.
5. SOS-KANTO study group. Cardiopulmonary resuscitation by bystanders with chest compression only (SOS-KANTO): an observational study. Lancet. 2007; 369: 920-926.
6. Ogawa T, Akahane M, Koike S, Tanabe S, Mizoguchi T, Imamura T. Outcomes of chest compression only CPR versus conventional CPR conducted by lay people in patients with out of hospital cardiopulmonary arrest witnessed by bystanders: nationwide population based observational study. BMJ. 2011; 342: c7106.
7. Kitamura T, Iwami T, Kawamura T, Nagao K, Tanaka H, Berg RA, et al. Time-dependent effectiveness of chest compression-only and conventional cardiopulmonary resuscitation for out-of-hospital cardiac arrest of cardiac origin. Resuscitation. 2011; 82: 3-9.
8. Kuisma M and Jaara K. Unwitnessed out-of-hospital cardiac arrest: is resuscitation worthwhile? Ann Emerg Med. 1997; 30: 69-75.
9. Okabayashi S, Matsuyama T, Kitamura T, Kiyohara K, Kiguchi T, Nishiyama C, et al. Outcomes of patients 65 years or older after out-of-hospital cardiac arrest based on location of cardiac arrest in Japan. JAMA Netw Open. 2019; 2: e191011.
10. Tanaka Y, Taniguchi J, Wato Y, Yoshida Y, Inaba H. The continuous quality improvement project for telephone-assisted instruction of cardiopulmonary resuscitation increased the incidence of bystander CPR and improved the outcomes of out-of-hospital cardiac arrests. Resuscitation. 2012; 83: 1235-12341.
11. Eisenberg MS. How your community can improve survival from sudden cardiac arrest. "Resuscitate! 2nd edition University of Washington Press. 2013.
12. Takei Y, Kamikura T, Nishi T, Maeda T, Sakagami S, Kubo M, et al. Recruitments of trained citizen volunteering for conventional cardiopulmonary resuscitation are necessary to improve the outcome after out-of-hospital cardiac arrests in remote time-distance area: a nationwide population-based study. Resuscitation. 2016; 105: 100-108.
13. Ministry of Health, Labor and Welfare (in Japan).
14. Fire and Disaster Management Agency (in Japan).
15. Jacobs I, Nadkarni V, Bahr J, Berg RA, Billi JE, Bossaert L, et al. Nol, Cardiac arrest and cardiopulmonary resuscitation outcome reports: update and simplification of the Utstein templates for resuscitation registries: a statement for healthcare professionals from a task force of the International Liaison Committee on Resuscitation. Circulation. 2004; 110: 3385-3397.
16. Safar P. "Resuscitation after brain ischemia". Brain Fail Resusc. 1981: 155-184.
17. Nishi T, Maeda T, Takase K, Kamikura T, Tanaka Y, Inaba H. Does the number of rescuers affect the survival rate from out-of-hospital cardiac arrests? Two or more rescuers are not always better than one. Resuscitation. 2013; 84: 154-161.
18. Svensson L, Bohm K, Castrèn M, Pettersson H, Engerström L, Herlitz J, et al. Compression-only CPR or standard CPR in out-of-hospital cardiac arrest. N Engl J Med. 2010; 363: 434-442.
19. Covid I: 19 Practical Guidance for implementation.
20. Ringh M, Rosenqvist M, Hollenberg J, Jonsson M, Fredman D, Nordberg P, et al. Mobile-phone dispatch of laypersons for CPR in out-of-hospital cardiac arrest. N Engl J Med. 2015; 372: 2316-2325.