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ORIGINAL ARTICLE

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Effects of cardiopulmonary resuscitation instructions on the outcomes of out-of-hospital cardiac arrest: An analysis of the JAAM-OHCA registry

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Abstract

Aim: To determine whether dispatcher-provided cardiopulmonary resuscitation (CPR) instructions improve the outcomes of out-of-hospital cardiac arrest (OHCA).

Methods: Cases registered in the Japanese Association for Acute Medicine Out-of-Hospital Cardiac Arrest (JAAM-OHCA) Registry between June 2014 and December 2019 were included. Cases in which the dispatcher provided CPR instructions to the bystander were included in the "Instructions" group", and cases without CPR instructions were included in the "No Instructions" group. The primary outcome was the proportion of patients with a favorable neurological outcome, defined as a Glasgow–Pittsburgh cerebral performance category scale of 1 to 2 at 1 month after OHCA.

Results: Overall, 51,199 patients with OHCA were registered in the JAAM-OHCA Registry during the study period. Of these, 33,745 were eligible for the study, with 16,509 in the Instructions group and 17,236 in the No Instructions group. The proportion of patients with a favorable neurological outcome at 1 month after OHCA was inferior in the Instructions group than in the No Instructions group (2.3% versus 3.0%, $p < 0.001$). After adjustment for patient background characteristics, no association was found between CPR instructions provided by a dispatcher and favorable neurological outcomes at 1 month after OHCA (adjusted odds ratio, 1.000; 95% confidence interval, 0.869–1.151, $p = 0.996$).

Conclusion: The present study found no clear clinical benefit of dispatcher-provided CPR instructions on the neurological outcomes of cases with OHCA.

KEYWORDS
cardiac arrest, cardiopulmonary resuscitation, emergency medical service communication system, out-of-hospital cardiac arrest, registry

INTRODUCTION

Out-of-hospital cardiac arrest (OHCA) occurs in approximately 126,000 patients per year in Japan. The 1-month survival rate is just 6%, which indicates very poor prognosis and shows that OHCA is a major problem in emergency medicine.[1] The importance of bystander cardiopulmonary resuscitation (CPR) is well established; the survival rate at 1 month is 1.9-fold higher among patients with witnessed OHCA who received bystander CPR. However, the rate of bystander CPR in Japan is reported to be around 50%.[1]

Consequently, the importance of bystander CPR is recognized worldwide and the clinical guidelines in many countries recommend that dispatchers provide CPR instructions

to the bystander.[2,3] Although CPR instructions provided by a dispatcher do not always result in CPR being performed, bystander CPR performed as a result of CPR instructions provided by a dispatcher (i.e., dispatcher-assisted CPR [DA-CPR]) was associated with better outcomes in patients with witnessed and suspected cardiogenic OHCA.[4–6] However, the effectiveness of CPR instructions by a dispatcher has not been fully examined.

Accordingly, the aim of this study was to determine whether CPR instructions by a dispatcher improve the outcomes of patients with OHCA by using data from a society-initiated OHCA registry.

METHODS

Patients

The Japanese Association for Acute Medicine Out-of-Hospital Cardiac Arrest (JAAM-OHCA) Registry has been organized by JAAM since 2014 with the aim of improving the survival of patients with OHCA by collecting and objectively validating data related to their resuscitation. The JAAM-OHCA Registry is described in more detail in a previous report.[7] As of September 2021, 101 hospitals, mainly teaching hospitals or core hospitals, throughout Japan are participating in the registry. The registry includes all cases of OHCA transported to participating facilities. Cases in which CPR was not performed by a physician after arrival at a hospital, cases transferred from another hospital, and cases in which the patient or family declined to participate in the registry are not eligible. The present study included all cases registered in the JAAM-OHCA Registry between June 2014 and December 2019, excluding cases ages <18 years, cases with inappropriate data regarding CPR instructions by dispatcher, cases in which cardiac arrest occurred after arrival of the emergency medical service (EMS), and cases in which CPR was initiated before the witness' call to the EMS. Cases where the dispatcher provided CPR instructions to the bystander were included in the Instructions group, and cases without CPR instructions were included in the No Instructions group.

Data collection

The JAAM-OHCA Registry contains post-hospital arrival data, including patient background characteristics recorded at hospital arrival, post-hospital treatment, and outcomes. Prehospital data were collected in the All-Japan Utstein Registry of the Fire and Disaster Management Agency of Japan and were merged with data from the JAAM-OHCA Registry by the JAAM. We used the merged data in the present study. Merged data were available for 90.8% of cases. The JAAM-OHCA Registry also contains the patient's neurological status at 1 and 3 months after OHCA, assessed using the Glasgow–Pittsburgh cerebral performance category (CPC) scale. This is a 5-category scale where category 1 represents good cerebral performance; category 2 represents moderate cerebral disability; category 3 represents severe cerebral disability; category 4 represents coma or vegetative state; and category 5 represents death or brain death. CPC was evaluated at 1 and 3 months after OHCA at each institution. In the current study, the primary outcome was the proportion of patients with a favorable neurological outcome, defined as a CPC score of 1 to 2 at 1 month after OHCA. Secondary outcome measures included bystander-initiated CPR, shock with a public-access automated external defibrillator (AED), first documented rhythm at EMS arrival, interval from the EMS call to bystander CPR, interval from the EMS call to hospital arrival, survival to hospital admission, 1-month survival, 3-month survival, and favorable neurological outcome at 3 months.

Statistical analysis

Data are presented as the median and interquartile range for continuous variables and as the value and percentage for categorical variables. Missing values were not computed. The Mann–Whitney *U* test was used to compare continuous variables between two groups, and Fisher's exact test was used for comparison of categorical variables. Generalized estimating equations and inverse probability of treatment weighting (IPTW) were used to examine the association between CPR instructions and favorable neurological outcomes at 1 month after OHCA and adjust for background variables. Age, gender, cause of cardiac arrest, and presence of a witness were used to calculate the propensity scores. Age, gender, cause, witness, and CPR instructions were entered into the generalized estimating equations to determine the association between CPR instructions and favorable neurological outcomes at 1 month after OHCA. Subgroup analyses were performed on predefined subgroups to determine the interaction between CPR instructions and subgroups, and calculate adjusted odds ratio (aOR) and 95% confidence interval (CI) for the association between CPR instructions and favorable neurological outcomes at 1 month after OHCA. *p*-values of <0.05 were considered statistically significant. Statistical analyses were performed using SPSS software version 27.0 (SPSS).

RESULTS

A total of 51,199 patients with OHCA were registered in the JAAM-OHCA Registry between June 2014 and December 2019 (Figure 1). A total of 33,745 patients were eligible, after excluding cases ages <18 years, cases with inappropriate data regarding CPR instructions by a dispatcher, cases with cardiac arrest after EMS arrival, and cases in which CPR was started before the EMS call. There were 16,509 patients in the Instructions group and 17,236 in the No Instructions group.

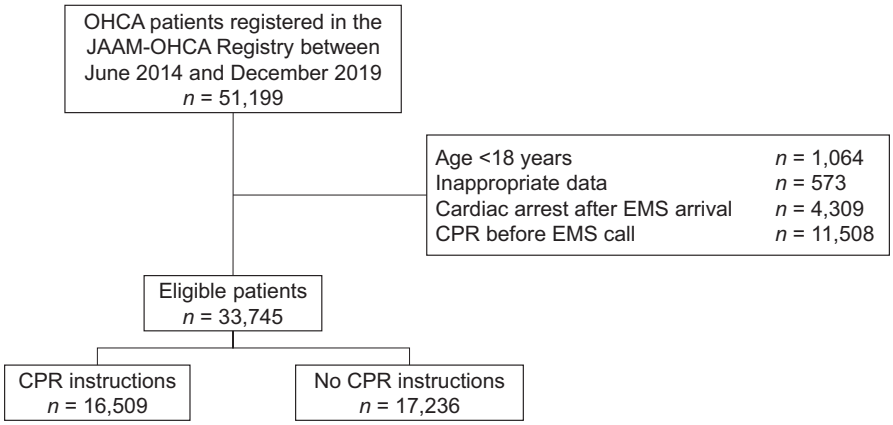

FIGURE 1 Flow diagram of patients included in this study. CPR, cardiopulmonary resuscitation; JAAM, Japanese Association for Acute Medicine; OHCA, out-of-hospital cardiac arrest.

TABLE 1 Patient characteristics.

Characteristic	Instructions *n* = 16,509	No instructions *n* = 17,236	Standardized difference
Age, years; median (IQR)	77 (66–85)	73 (59–83)	0.247
Male gender, *n* (%)	9736 (59.0)	11,076 (64.3)	0.109
Cause, *n* (%)			0.133
Cardiogenic	9271 (56.2)	8536 (49.5)	
Non-cardiogenic	7238 (43.8)	8700 (50.5)	
Witnessed OHCA, *n* (%)	5537 (33.5)	7655 (44.4)	0.224

Abbreviations: IQR, interquartile range; OHCA, out-of-hospital cardiac arrest.

The patient characteristics are provided in Table 1. The median age was 77 years in the Instructions group, and 73 years in the No Instructions group. There were 9736 (59.0%) men in the Instructions group and 11,076 (64.3%) men in the No Instructions group. The cause of cardiac arrest was cardiogenic in 9271 (56.2%) patients in the Instructions group and 8536 (49.5%) in the No Instructions group. There were 5537 (33.5%) witnessed cardiac arrests in the Instructions group and 7655 (44.4%) in the No Instructions group. Before IPTW, all of the variables were poorly balanced between the two groups.

The patient outcomes are provided in Table 2. Bystander CPR was more frequently performed in the Instructions group (53.3% versus 13.2%, $p < 0.001$) with a shorter interval from the EMS call to bystander CPR (2 versus 3 min, $P < 0.001$) compared with the No Instructions group; both of these outcomes are significantly different between the two groups (Table 2). The proportion of patients with ventricular fibrillation or pulseless ventricular tachycardia rhythms at EMS arrival was smaller in the Instructions group (7.9% versus 9.3%, $p < 0.001$), but the proportion of patients shocked using a public-access AED was similar in both groups (0.9% versus 1.0%, $p = 0.656$). The mortality rate in the emergency department (77.8% versus 75.0%, $p < 0.001$), the 1-month survival rate (5.1% versus 6.2%, $p < 0.001$), and the proportion of patients with a favorable neurological outcome at 1 month after OHCA (2.3% versus 3.0%, $p < 0.001$) were inferior in the Instructions group. However, the proportion of patients with a favorable neurological outcome at 3 months after OHCA was not significantly different between the two groups (2.3% versus 2.5%, $p = 0.136$).

The patient characteristics after applying IPTW are provided in Table 3. After IPTW, all variables were well balanced between the two groups. In a multivariable analysis, we found no association between CPR instructions by a dispatcher and a favorable neurological outcome at 1 month after OHCA, after adjustment for age, gender, cause, and witness (aOR, 1.000; 95% CI, 0.869–1.151; $p = 0.996$; Table 4).

The results of the subgroup analyses of age, gender, cause of cardiac arrest, and witnessed OHCA are shown in Figure 2. Gender and cause of cardiac arrest did not show an interaction with CPR instructions. CPR instructions were unfavorable in the non-witnessed subgroup, but were favorable in the witnessed subgroup.

DISCUSSION

We investigated whether CPR instructions improved the neurological outcomes of adults with OHCA in Japan. To our knowledge, this is the first report in Japan to examine whether CPR instructions improve the outcomes of adults

TABLE 2 Patient outcomes.

	Instructions	No instructions	
	n = 16,509	*n* = 17,236	*p*
Implementation of CPR, *n* (%)	8802 (53.3)	2268 (13.2)	<0.001
Shock by a public-access AED, *n* (%)	155 (0.9)	171 (1.0)	0.656
First documented rhythm at EMS arrival, *n* (%)			<0.001
VF/pulseless VT	1300 (7.9)	1605 (9.3)	
Others	15,209 (92.1)	15,631 (90.7)	
Interval from EMS call to bystander CPR, min; median (IQR)	2 (1–3); *n* = 8521	3 (2–5); *n* = 2146	<0.001
Interval from call to hospital arrival, min; median (IQR)	32 (27–39); *n* = 16,472	33 (27–40); *n* = 17,187	<0.001
Condition after hospital arrival, *n* (%)			<0.001
Admitted to ICU/ward	3669 (22.2)	4304 (25.0)	
Death at the ED	12,840 (77.8)	12,932 (75.0)	
1-month survival, *n* (%)	838 (5.1)	1063 (6.2)	<0.001
Favorable neurological outcome at 1 month after OHCA, *n* (%)	385 (2.3)	515 (3.0)	<0.001
3-month survival, *n* (%)	462 (3.9); *n* = 11,990	567 (4.4); *n* = 12,913	0.036
Favorable neurological outcome at 3 months after OHCA, *n* (%)	270 (2.3); *n* = 11,994	329 (2.5); *n* = 12,912	0.136

Abbreviations: AED, automated external defibrillator; CPR, cardiopulmonary resuscitation; ED, emergency department; EMS, emergency medical service; ICU, intensive care unit; IQR, interquartile range; VF, ventricular fibrillation; VT, ventricular tachycardia.

TABLE 3 Patient characteristics after IPTW.

	Instructions	No instructions	
	n = 33,746	*n* = 33,737	Standardized difference
Age, years; median (IQR)	75 (62–84)	75 (62–84)	0.017
Male gender, *n* (%)	20,807 (61.7)	20,810 (61.7)	<0.001
Cause, *n* (%)			0.002
Cardiogenic	17,812 (52.8)	17,855 (52.9)	
Non-cardiogenic	15,924 (47.2)	15,891 (47.1)	
Witnessed OHCA, *n* (%)	13,230 (39.2)	13,229 (39.2)	<0.001

Abbreviations: IPTW, inverse probability of treatment weighting; IQR, interquartile range; OHCA, out-of-hospital cardiac arrest.

TABLE 4 Multivariable analysis of favorable neurological outcomes at 1 month after OHCA (*n* = 33,745).

	aOR	(95% CI)	*p*
CPR instructions	1.000	(0.869–1.151)	0.996
Age, years	0.956	(0.953–0.960)	<0.001
Male gender	1.375	(1.167–1.619)	<0.001
Cardiogenic cause	6.907	(5.601–8.518)	<0.001
Witnessed	6.016	(5.083–7.120)	<0.001

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; CPR, cardiopulmonary resuscitation; OHCA, out-of-hospital cardiac arrest.

with OHCA. CPR instructions were given to approximately half of the cases, and the rate of bystander CPR was approximately four times higher in the Instructions group than in the No Instructions group. However, the proportion of patients with a favorable neurological outcome at 1 month after OHCA was inferior in the Instructions group compared with the No Instructions group. After adjusting for patient background characteristics in the multivariable analysis, we found no association between CPR instructions and favorable neurological outcomes at 1 month after OHCA.

In this study, CPR instructions for adult patients with OHCA failed to improve the neurological outcomes. An earlier study of children ages <18 years examined whether CPR instructions is associated with the outcome of patients with witnessed OHCA in Japan.[8] In that study, CPR instructions improved the 1-month survival rate but, like the present study, CPR instructions did not improve the neurological outcomes at 1 month after OHCA. Although prior studies have not compared the outcomes of CPR with or without instructions, one study compared the outcomes before and after the introduction of a DA-CPR protocol in adult patients

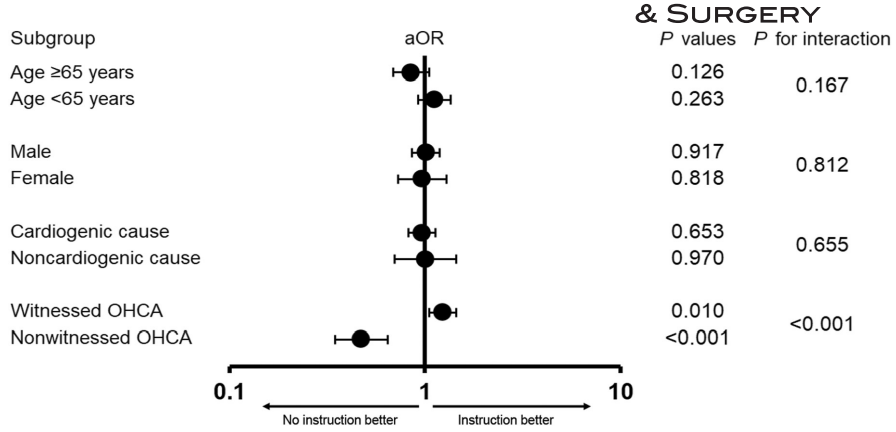

FIGURE 2 Subgroup analyses of primary outcomes. The forest plot shows the difference in the adjusted odds ratio for favorable neurological outcomes at 1 month after OHCA. aOR, adjusted odds ratio; OHCA, out-of-hospital cardiac arrest.

with OHCA in South Korea.[9] Another study compared the outcomes of patients with suspected cardiogenic OHCA before and after the introduction of a DA-CPR training program for dispatchers in Singapore.[10] The former study reported improvements in the discharge survival rate and neurological outcomes of patients with OHCA after the introduction of a DA-CPR protocol. The latter study reported improved survival at 30 days after the introduction of a DA-CPR training program. However, the background characteristics vary among countries. Therefore, it is unsurprising that different results were obtained in other countries.

A meta-analysis[11] showed that DA-CPR was associated with better survival and neurological outcomes at 1 month compared with patients without bystander CPR. It also found no difference in the neurological outcomes at 1 month when DA-CPR was compared with spontaneous CPR, and that DA-CPR may provide a survival benefit at 1 month. However, in the present study, CPR instructions failed to improve the outcomes, although the rate of CPR in the Instructions group was almost four times higher than that in the No Instructions group. Various factors could explain this, one of which being the patient population. Previous studies reported better neurological outcomes with DA-CPR versus without bystander CPR,[4–6,8] but the patients included in those studies differed. Some studies only included patients with witnessed cardiac arrest,[4–6] and the other only included children.[8] The results of the current study suggest that the effectiveness of CPR instructions is dependent on the presence of a witness. It is possible that the effectiveness of CPR instructions could not be shown because of differences in the patient characteristics.

Another possible cause is spontaneous CPR, which was performed in 13.2% of patients in the No Instructions group. Lower compression depth than recommended is frequently observed in DA-CPR,[12,13] and spontaneous CPR was reported to be of higher quality than DA-CPR.[14] Although the differences in the beneficial effects of DA-PCR and spontaneous CPR on the neurological outcomes of OHCA are still inconclusive, some reports have indicated better neurological outcomes in patients who underwent spontaneous CPR compared with DA-CPR.[15,16] Therefore, the effectiveness of spontaneous CPR possibly masked the effectiveness of CPR instructions.

Although the present study failed to demonstrate an effect of CPR instructions on improving neurological outcomes, it should not be assumed that CPR instructions are unnecessary. As described above, meta-analyses have shown that DA-CPR improves the outcomes of OHCA, at least compared with that of patients without bystander CPR. The proportion of cases who undergo CPR with instructions in Japan increased year-by-year between 2005 (32%)[4] and 2015 (54.7%).[17] Our study included the years 2014 to 2019, in which the rate remained steady at 49%. Although this rate is not markedly different to that in other countries,[17,18] it is possible that CPR instructions are not given to enough cases where DA-CPR is effective. Further investigations are therefore considered necessary.

There are several limitations to this study. First, this was an observational study and there may be unmeasured or unknowable confounders. Second, the study also included patients who suffered cardiac arrest after the call to the EMS. Although the dispatcher protocol includes continuing communication with the bystander for as long as possible, until the EMS reaches the patient, there may be a bias in cases where it was difficult to provide CPR instructions because of cardiac arrest occurring after the EMS call. Third, the registry did not record why the dispatcher did not provide CPR instructions. Hence, we used data from the OHCA registry, rather than the All-Japan Utstein registry data, to exclude cases that were deemed unsuitable for CPR after hospital arrival; for example, those cases in which instruction was refused or that were not eligible for instruction. Fourth, because the study was conducted in Japan, the EMS system and basic life support education system differ from those in other countries. Finally, only cases transported to facilities participating in the registry were included. Therefore, it is unclear whether the results of this study can be generalized to all facilities in Japan.

CONCLUSION

We investigated whether CPR instructions by a dispatcher improve the neurological outcomes of adult patients with

OHCA in Japan. This study did not demonstrate the efficacy of CPR instructions on neurological outcomes, but some efficacy could be seen for witnessed OHCA. Further research is needed to improve the outcomes of patients with OHCA.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The JAAM-OHCA Registry data belong to JAAM and are not available to the public.

ETHICS STATEMENT

Approval of the Research Protocol: The protocol was approved by the Ethics Committee of the responsible center, Kyoto University. The ethics committees of all participating hospitals, including ours, approved the JAAM-OHCA Registry protocol.
Informed Consent: The requirement for informed consent from the patients was waived by the Ethics Committees.
Registry and the Registration No. of the Study/Trial: N/A.
Animal Studies: N/A.

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