



Clinical paper

Dispatcher instruction of chest compression-only CPR increases actual provision of bystander CPR[☆]



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ABSTRACT

Background: A preceding randomized controlled trial demonstrated that chest compression-only cardiopulmonary resuscitation (CPR) instruction by dispatcher was more effective to increase bystander CPR than conventional CPR instruction. However, the actual condition of implementation of each type of dispatcher instruction (chest compression-only CPR [CCCPR] or conventional CPR with rescue breathing) and provision of bystander CPR in real prehospital settings has not been sufficiently investigated.

Methods: This registry prospectively enrolled patients aged ≥ 18 years suffering an out-of-hospital cardiac arrest (OHCA) of non-traumatic causes before emergency-medical-service (EMS) arrival, who were considered as target subjects of dispatcher instruction, resuscitated by EMS personnel, and transported to medical institutions in Osaka, Japan from January 2005 through December 2012. The primary outcome measure was provision of CPR by a bystander. Multiple logistic regression analysis was used to assess factors that were potentially associated with provision of bystander CPR.

Results: Among 37,283 target subjects of dispatcher instruction, 5743 received CCCPR instruction and 13,926 received conventional CPR instruction. The proportion of CCCPR instruction increased from 5.7% in 2005 to 25.6% in 2012 (p for trend < 0.001). The CCCPR instruction group received bystander CPR more frequently than conventional CPR instruction group (70.0% versus 62.1%, $p < 0.001$). In the multivariable analysis, CCCPR dispatcher instruction was significantly associated with provision of bystander CPR compared with conventional CPR instruction (adjusted odds ratio 1.44, 95% CI 1.34–1.55).

Conclusions: CCCPR dispatcher instruction among adult OHCA patients significantly increased the actual provision of bystander CPR.

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1. Introduction

Out-of-hospital cardiac arrest (OHCA) of presumed cardiac origin is one of the major public health problems in the industrialized world,^{1–4} and approximately 70,000 such events occur every year in Japan,⁵ but the survival after OHCA remains still low.^{5,6} Although

early cardiopulmonary resuscitation (CPR) plays a key role of “chain of survival,”^{1–4} only one-third to one-half of OHCA patients receive bystander CPR before emergency-medical-service (EMS) personnel arrived in most communities including Japan.^{7–9}

One way to increase the proportion of bystander CPR is CPR instruction by dispatcher via telephone, and preceding studies demonstrated that dispatcher instructions increased the proportion of bystander CPR.^{10–12} Recently, successful implementation of chest compression-only CPR (CCCPR), which is easier to learn, perform, and remember,¹³ has been reported to increase bystander CPR and subsequent survival after OHCA from some communities.^{14,15} As for the dispatcher instruction, a randomized

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controlled trial demonstrated that CCCPR instruction was more effective to increase bystander CPR and survival after OHCA than conventional CPR instruction.¹⁶ However, actual condition of implementation of each type of dispatcher instruction (CCCPR or conventional CPR) and subsequent provision of bystander CPR in real prehospital settings has not been sufficiently investigated.

The Utstein Osaka Project is a large prospective population-based cohort study of OHCA in Osaka, Japan, which covered about 8.8 million residents.¹⁷ Using this database, we collected approximately 37,000 adult OHCA patients, who were target subjects of dispatcher instruction, from January 2005 through December 2012. The aim of this study was to describe the current condition of implementation of dispatcher instruction and subsequent provision of bystander CPR, and to evaluate the relationship between the type of dispatcher instruction (CCCPR or conventional CPR) and provision of bystander CPR for OHCA patients in Osaka.

2. Methods

2.1. Study design, setting, and population

The Utstein Osaka Project is a prospective, population-based registry of OHCA that is based on the standardized Utstein style.¹⁸ This registry enrolled patients aged ≥ 18 years suffering from OHCA of non-traumatic causes before EMS arrival, who were target subjects of dispatcher instruction and resuscitated by a bystander or EMS personnel, and then transported to medical institutions in Osaka Prefecture from January 1, 2005 through December 31, 2012. Osaka has approximately 8.8 million inhabitants in an area of 1892 km². The research protocol was approved by the institutional review board of Osaka University with the assent of the EMS authorities of the local governments in Osaka Prefecture. The individual informed consent requirement for the reviews of patient outcomes was waived by the Personal Information Protection Law and the national research ethics guidelines of Japan.

Cardiac arrest was defined as the cessation of cardiac mechanical activity as confirmed by the absence of signs of circulation.¹⁸ The arrest was presumed to be of cardiac origin unless it was caused by trauma, drowning, drug overdose, asphyxia, exsanguinations, or any other non-cardiac causes. These diagnoses were clinically determined by the physician in charge of collaboration with the EMS rescuers.

2.2. Emergency medical service systems in Osaka

Details of the EMS system in Osaka were described previously.¹⁷ In Osaka Prefecture, there are 34 fire stations with emergency dispatch centers. The EMS system is operated by the local fire stations. The free telephone emergency number 119 is used to call for an ambulance from anywhere in Japan. Emergency services are provided 24 h every day, the system is single-tiered in 32 stations and two-tiered in two stations. The latter uses medics followed by physicians. The most highly-trained prehospital emergency care providers are the Emergency Life-Saving Technicians (ELSTs). When called, an ambulance is dispatched from the nearest fire station. Usually, each ambulance has a crew of three emergency providers including at least one ELST. They were allowed to insert an intravenous line and an adjunct airway, and to use a semi-automated external defibrillator for OHCA patients during the study period. Specially trained ELSTs were permitted to insert tracheal tubes after July 2004 and administer intravenous epinephrine after April 2006. The use of automated external defibrillators by citizens was legally approved in July 2004. All EMS providers perform cardiopulmonary resuscitation (CPR) according to the Japanese CPR guideline.³ The 2005 CPR Guidelines have been

implemented in Japan since October 2006. In Japan, Layperson CPR training programs have mainly been conducted by local fire departments, and the program has been recommended by the FDMA and the Ministry of Health, Labour and Welfare based on the Japanese CPR guidelines.³ In Osaka, about 70,000 citizens per year participated in the CPR training programs, consisting of conventional CPR including chest compressions, mouth-to-mouth ventilation, and automated external defibrillator (AED) usage (generally provided by local fire departments).⁵

Do-not-resuscitate orders or living wills are not generally accepted in Japan. EMS providers are not permitted to terminate resuscitation in the field. Therefore, all patients with OHCA who were treated by EMS personnel were transported to the hospital and registered in this cohort, excluding cases of decapitation, incineration, decomposition, rigor mortis, or dependent cyanosis.

2.3. Dispatcher-instruction protocol in Osaka

The emergency telephone dispatchers in Japan are basically trained and ordered to give CPR instructions with conventional CPR before EMS arrival since 1999. First, telephone-assisted CCCPR instruction by dispatchers was conducted for untrained bystanders and conventional CPR instruction was conducted for trained lay-rescuers who were able to perform rescue breathing under the 2005 CPR guidelines since 2006.^{19,20} If they could not or did not wish to perform rescue breathing, CCCPR was next recommended by dispatchers. Based on the recommendation from FDMA, each fire station managed the uniquely-designed protocol for dispatcher CPR instruction developed by the local medical control council (MCC) which consisted of emergency care physicians and experts in each area.^{21,22} Most MCCs do not have detailed protocol for dispatcher-assisted CPR and just recommend dispatchers to encourage bystanders to provide CPR based on their uniquely-designed protocols. There were eight MCCs in Osaka Prefecture, which had an important role in securing the quality of care provided by EMS personnel in prehospital settings and conducted the follow-up assessments of EMS procedures.

2.4. Data collection and quality control

Data were prospectively collected using a form that included all core data recommended in the Utstein-style reporting guidelines for cardiac arrests.¹⁸ These data included sex, age, witness status, cause of cardiac arrests, first documented cardiac rhythm, location of arrests, activity of daily living before arrests, time course of resuscitation, type of bystander-initiated CPR, type of dispatcher instruction, public-access AED use, intubation, and epinephrine. A series of EMS times of call receipt, vehicle arrival at the scene, contact with patients, and hospital arrival were recorded automatically at the dispatch center. First documented rhythm was recorded and diagnosed by the EMS personnel with semi-automated defibrillators on the scene, and confirmed by the physician responsible for the on-line medical direction. Data on the collapse time or the initiation and type of bystander CPR was obtained by EMS observation and interview with the bystander before leaving the scene through the use of specific questions on the presence or absence of chest compressions and rescue breathing. Bystander CPR included CCCPR and conventional CPR.

Dispatcher instruction was conducted by dispatchers or EMS personnel who were on the way to the scene, and the type of dispatcher instruction was determined based on the on-scene situations. The type of dispatcher instruction was recorded by EMS personnel in cooperation with dispatchers after returning their fire departments.

The data form was filled out by the EMS personnel in cooperation with the physicians in charge of the patient, transferred to

the Information Center for Emergency Medical Services of Osaka, and then checked by the investigators. If the data sheet was incomplete, the relevant EMS personnel were contacted and questioned, and the data sheet was accordingly completed.

2.5. Outcome measures

The primary outcome measure was provision of chest compressions (either CCCPR or conventional CPR) by bystanders. The secondary outcome measure was the time interval from call receipt to CPR by bystanders.

2.6. Statistical analysis

Among adult OHCA patients receiving dispatcher instruction, patient and EMS characteristics and outcomes were compared between the two groups (the CCCPR instruction group and the

conventional CPR instruction group) by using chi-square test for categorical variables and Student *t*-test for continuous variables. Univariable logistic regression models were used for the trends in the implementation of type of dispatcher instruction. The proportion of dispatcher instruction and provision of bystander CPR according to the MCC was also calculated. Multiple logistic regression analysis assessed the factors associated with provision of bystander CPR, and odds ratios (ORs) and their 95% confidence intervals (CIs) were calculated. As potential confounders before EMS arrival, the following variables were included: age (adult aged 18–64 years old, elderly aged ≥ 65 years old), gender (men, women), location of arrest (homes, other), activities of daily living before arrests (good, poor), type of dispatcher instruction (CCCPR, conventional CPR), year of arrest, and MCC. All of the tests were 2-tailed and a *p* value of <0.05 was considered statistically significant. All statistical analyses were performed using PASW Statistical ver18.0J (IBM Corp. Armonk, NY).

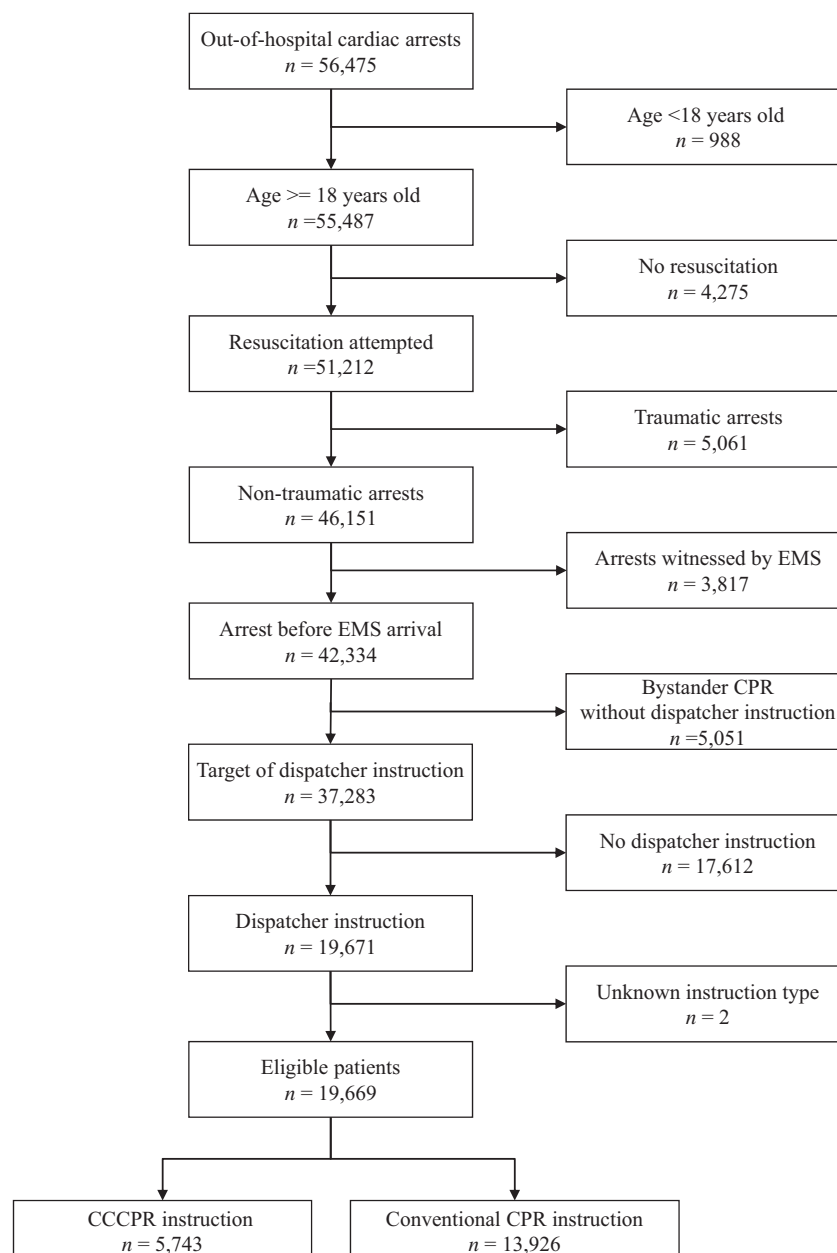


Fig. 1. Overview of EMS-treated cardiac arrests with an abridged Utstein template from January 1, 2005 through December 31, 2012. EMS, emergency medical service; CPR, cardiopulmonary resuscitation; CCCPR, chest-compression-only CPR.

3. Results

Fig. 1 shows an overview of the study patients based on the Utstein template. A total of 56,475 OHCA patients were registered during these eight years; 55,487 were adults aged ≥ 18 years old, and in 51,212 of them resuscitation was attempted. Excluding 5061 victims who had traumatic arrest, 3817 who had cardiac arrests after EMS arrival, and 5051 who received bystander CPR without dispatcher instruction, 37,283 were considered as target subjects of dispatcher instruction. Of them, 17,612 did not receive CPR instruction by dispatchers, and 19,671 did. Excluding two victims without instruction type information, 5743 (29.2%) received CCCPR instruction and 13,926 (70.7%) received conventional CPR instruction.

The proportions of dispatcher instruction implementation among target subjects by the type of instruction are noted in Table 1. The proportion of whole dispatcher instruction increased from 43.8% in 2005 to 58.2% in 2012 (p for trend <0.001), and CCCPR instruction increased from 5.7% in 2005 to 25.6% in 2012 (p for trend <0.001).

Table 2 shows the proportion of dispatcher instruction and subsequent provision of bystander CPR among target subjects according to the MCCs. The proportion of dispatcher instruction varied from 40.9% to 61.6% and CCCPR instruction also varied from 7.9% to 39.9%. The proportion of provision of bystander CPR among dispatcher instruction ranged differently from 57.8% to 73.9%.

Patient and EMS characteristics of OHCA patients receiving dispatcher instruction by the type of instruction are shown in Table 3. Mean age was similar between the groups. Patients in the CCCPR instruction group were more likely to be men, have good activities of daily living before arrest, and be at home, but less likely to be witnessed by a bystander, have cardiac origin, and receive intubation and epinephrine than those in the conventional CPR instruction group. The mean time interval from call to contact with a patient was somewhat longer in the CCCPR instruction group, but the mean time interval from call receipt to hospital arrival was similar between groups.

Table 4 denotes the proportion of provision of bystander CPR and the time to first CPR among OHCA patients receiving dispatcher instruction by the type of dispatcher instruction. The CCCPR instruction group was more likely to receive bystander CPR than the conventional CPR instruction group (70.0% versus 62.1%, $p < 0.001$). The mean time from call receipt to CPR by bystanders was somewhat longer in the CCCPR instruction group than the groups in the conventional CPR group (1.4 min versus 1.3 min, $p < 0.001$). Even in the conventional CPR instruction group, the proportion of actual provision of conventional CPR remained only 28.0%.

Factors associated with the provision of bystander CPR are shown in Table 5. CCCPR dispatcher instruction was significantly associated with increment in provision of bystander CPR compared with conventional CPR instruction (adjusted OR 1.44,

Table 1
Trends in proportion of dispatcher instruction by the type of instruction.

	2005 (n = 4185)	2006 (n = 4200)	2007 (n = 4371)	2008 (n = 4845)	2009 (n = 4665)	2010 (n = 4717)	2011 (n = 5043)	2012 (n = 5257)	P for trend
Dispatcher instruction, n (%)	1835 (43.8)	1888 (45.0)	2233 (51.1)	2593 (53.5)	2591 (55.5)	2648 (56.1)	2822 (56.0)	3059 (58.2)	<0.001
CCCPR	237 (5.7)	278 (6.6)	520 (11.9)	586 (12.1)	736 (15.8)	913 (19.4)	1128 (22.4)	1345 (25.6)	<0.001
Conventional CPR	1598 (38.2)	1610 (38.3)	1713 (39.2)	2007 (41.4)	1855 (39.8)	1735 (36.8)	1694 (33.6)	1714 (32.6)	

CCCPR indicates chest compression-only CPR; CPR, cardiopulmonary resuscitation.

Table 2
Difference in dispatcher instruction and subsequent provision of bystander CPR by the medical control council.

	Medical control council							
	A (%)	B (%)	C (%)	D (%)	E (%)	F (%)	G (%)	H (%)
Dispatcher instruction (%)	60.5	40.9	57.7	55.0	58.2	61.6	60.5	60.0
CCCPR	39.9	7.9	10.6	20.5	18.8	15.4	18.0	11.3
Conventional CPR	20.7	32.9	47.1	34.6	39.4	46.2	42.5	48.7
Bystander CPR, %	44.8	26.6	37.7	35.5	36.8	38.8	36.7	34.7
Bystander CPR/dispatcher instruction, %	73.9	65.1	65.4	64.5	63.3	63.1	60.7	57.8

CCCPR indicates chest compression-only CPR; CPR, cardiopulmonary resuscitation

Table 3
Patient and EMS characteristics according to the type of instruction.

	Dispatcher instruction		p
	CCCPR	Conventional CPR	
	(n = 5743)	(n = 13926)	
Age, yr, mean (SD)	74.8 (14.2)	75.1 (14.7)	0.212
Elderly aged ≥ 65 years, n (%)	4609 (80.3)	11,132 (79.9)	0.613
Men, n (%)	3196 (55.7)	7259 (52.1)	<0.001
Good activities of daily living, n (%)	3807 (66.3)	8522 (61.2)	<0.001
Witnessed by bystander, n (%)	1646 (28.7)	4319 (31.0)	0.010
Witnessed by family members, n (%)	1279 (22.3)	3078 (22.1)	0.796
Presumed cardiac origin, n (%)	4016 (69.9)	10,294 (73.9)	<0.001
Initial VF as first documented rhythm, n (%)	353 (6.2)	941 (6.8)	0.117
Home, n (%)	4818 (83.9)	10,980 (78.8)	<0.001
Intubation, n (%)	3189 (44.5)	9186 (66.0)	<0.001
Epinephrine administration, n (%)	407 (7.1)	1167 (8.4)	0.020
EMS response time (from call to EMS arrival), mean (SD)	7.8 (2.6)	7.6 (2.6)	<0.001
Hospital arrival time (from call to Hospital arrival), mean (SD)	27.7 (8.2)	27.9 (8.5)	0.222

CCCPR indicates chest compression-only CPR; CPR, cardiopulmonary resuscitation; SD, standard deviation; VF, ventricular fibrillation; EMS, emergency medical service.

Table 4
Actual proportion of CPR provision and time to first CPR by the type of instruction.

	Dispatcher instruction		p
	CCCPR (n = 5743)	Conventional CPR (n = 13,926)	
Chest compressions (CCCPR and conventional CPR), n (%)	4022 (70.0)	8655 (62.1)	<0.001
CCCPR	3880 (67.6)	4756 (34.2)	<0.001
Conventional CPR	142 (3.5)	3899 (28.0)	
Call receipt to CPR by bystanders, mean (SD)	1.4 (1.6)	1.3 (1.7)	<0.001

CPR indicates cardiopulmonary resuscitation; CCCPR, chest compression-only CPR; EMS, emergency medical service.

95%CI 1.34–1.55). Other factors positively associated with the bystander CPR implementation were adult (adjusted OR 1.10, 95%CI 1.02–1.19), women (adjusted OR 1.23, 95%CI 1.16–1.31), witness by a bystander (adjusted OR 1.32, 95%CI 1.23–1.41). Arrest at home was negatively associated with bystander CPR (adjusted OR 0.31, 95%CI 0.29–0.34). The ORs of provision of bystander CPR varied according to the eight MCCs (adjusted OR 1.06–1.82).

4. Discussion

In this prospective, population-based, OHCA registry covering 34 dispatch systems with 9 million residents, we demonstrated that CCCPR dispatcher instruction for adult non-traumatic OHCA patients significantly increased the actual provision of bystander CPR compared with conventional CPR dispatcher instruction. In line with a previous randomized trial,¹⁶ this large population-based observation in the real settings would reinforce the benefit of CCCPR instruction and provide important clues for increasing bystander CPR in communities.

Although our findings demonstrated CCCPR dispatcher instruction increased provision of CPR by bystanders, the proportion of bystander CPR in our study was lower than that in the trial regardless of the type of CPR (80.5% in the CCCPR instruction group and 70.5% in the conventional CPR instruction group).¹⁶ Because the trial usually enrolls EMS systems which were generally positive to improve the systems and have better performance than others, the baseline situation including quality of dispatcher's assistance might be different between that trial and ours. Dispatcher instruction was also implemented only for 50% of adult OHCA patients among target patients. Difficulties in recognition of sudden cardiac arrests, especially among those with agonal respiration, might be one of the possible explanations for this phenomenon.^{23–25} A previous report from the United States showed that sensitivity of

dispatchers to recognize OHCA over the telephone was about 65%.²⁶ This result is similar to ours and suggests that it would be difficult to recognize OHCA and implement dispatcher instruction irrespective of different EMS systems. Further efforts to improve cardiac arrest recognition by dispatchers are warranted to increase the implementation of dispatcher instruction.

This study observed that the proportion of CCCPR instruction among dispatcher instructions, significantly increased during the study period. Nevertheless, about two thirds of CPR instructions were still conventional CPR with rescue breathing and the type of dispatcher instruction differed by the MCC. As mentioned in the Methods, the MCCs controlled emergency care system including dispatcher instruction protocol in each region and managed the uniquely-designed instruction protocol based on the CPR guidelines.^{21,22} The differences in their protocol might have affected this result. As previous studies suggested, it would take time to implement new guidelines effectively into local EMS systems even in Japan where the EMS system is basically identical nationwide.^{27,28} Development and introduction of uniform instruction protocol across the MCCs serve to increase bystander CPR.

In multivariable analysis, CCCPR instruction was associated with an increase in bystander CPR provision. On the other hand, we previously reported that CCCPR provision by bystanders has been increased as CCCPR has been much more widely promoted to the public.²⁹ The increment of CCCPR provision by bystanders in Japan would be caused by the recent promotion of CCCPR to the public as well as the dissemination of the CCCPR instruction.²⁰ In addition, arrests at home were strongly associated with a decrease in bystander CPR. Because approximately two-thirds of OHCA occurred at home,^{30,31} it would be important to increase bystander CPR at home. Most of OHCA at home were witnessed by family members, and they were likely to panic and find it difficult to perform CPR.^{12,32} Measures must be taken to increase bystander CPR at home such as encouraging people with family members having a high OHCA-risk patients to receive CPR training³³ in addition to the population-based dissemination of the training in communities.^{15,34}

Importantly, even in a conventional CPR dispatcher instruction group, the proportion of conventional CPR with rescue breathing performed by a bystander was only 29.4%, which indicates that rescue breathing is too difficult to perform for laypersons even though they were instructed by dispatchers in the actual pre-hospital settings as already reported.^{35,36} In light of this study result demonstrating the benefit of CCCPR dispatch instruction to increase CPR provision by bystanders, difficulties to instruct rescue breathing, the proven effectiveness of chest compressions for survival after OHCA,^{1–4,8,15} and insufficient proportion of bystander

Table 5
Factors associated with actual provision of bystander CPR.

	Crude OR	(95% CI)	Adjusted OR	(95% CI)
Adult (vs Elderly)	1.05	(0.98–1.13)	1.10	(1.02–1.19)
Women	1.21	(1.14–1.28)	1.23	(1.16–1.31)
Poor activities of daily living	1.22	(1.15–1.30)	1.05	(0.98–1.12)
Witnessed by a bystander	1.39	(1.30–1.49)	1.32	(1.23–1.41)
Home (vs others)	0.31	(0.29–0.34)	0.31	(0.29–0.34)
CCCPR instruction (vs conventional CPR instruction)	1.42	(1.33–1.52)	1.44	(1.34–1.55)
Year (for one-year increment)	1.03	(1.02–1.04)	1.01	(0.99–1.02)
Medical control council (vs H)				
A	2.07	(1.83–2.36)	1.82	(1.59–2.08)
B	1.36	(1.23–1.51)	1.37	(1.23–1.52)
C	1.38	(1.22–1.57)	1.36	(1.20–1.55)
D	1.33	(1.18–1.49)	1.26	(1.12–1.43)
E	1.26	(1.10–1.44)	1.21	(1.06–1.39)
F	1.25	(1.11–1.41)	1.16	(1.03–1.32)
G	1.13	(0.99–1.29)	1.06	(0.93–1.21)

CPR indicates cardiopulmonary resuscitation; OR, odds ratio; CI, confidence interval; CCCPR, chest compression-only CPR.

CPR,^{1–4} the wider implementation of CCCPR dispatcher instruction is warranted.

This study has some inherent limitations. First, the characteristics of bystanders such as trained or not trained previous CPR training could not be examined.³⁷ In addition, there were no data indicating why the dispatcher did or could not instruct the lay rescuers. We are collecting detailed information regarding bystander characteristics and CPR instruction protocols in a designated area and will address the relationship between these data and bystander CPR.³⁸ Second, our study did not evaluate the relationship between the type of dispatcher instruction and survival outcome after OHCA. Survival outcome after OHCA was, of course, much affected by other factors such as witness status, first documented rhythm, and treatments by EMS personnel and medical institutions^{6,9,17} as well as the provision of bystander CPR. Hence, we considered that survival outcome was not appropriate as the outcome of this study. Third, our study would have a potential selection bias according to the type of dispatcher instruction. The longer time interval from collapse to CPR by bystanders in the CCCPR instruction groups might be caused by the bias that CCCPR was more frequently instructed for those who were not able to or did not wish to perform CPR and more bystanders who conventional CPR was instructed for those who were able to provide better and earlier CPR. In addition, bystanders with OHCA occurred at home were more likely to be old and less likely to have knowledge, experience, and implementation of CPR.³² Although the proportion of CCCPR instruction in this study was high at home, bystanders encountered OHCA at home were not able to administer CPR and CCCPR instruction would be more conducted by dispatchers. Finally, there might be unmeasured confounding factors influencing the association between type of dispatcher instruction and the bystander CPR provision.

In conclusion, from the large population-based OHCA registry in Osaka, we clearly demonstrated that CCCPR dispatcher instruction significantly increased the provision of bystander CPR compared with conventional CPR instruction among adult OHCA patients in the actual prehospital settings. Therefore, wider implementation of CCCPR instruction is needed to further increase bystander CPR.

Conflict of interest statement

The authors declare that they have no conflict of interest.

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