Impact of Dispatcher-Assisted Bystander Cardiopulmonary Resuscitation on Neurological Outcomes in Children With Out-of-Hospital Cardiac Arrests: A Prospective, Nationwide, Population-Based Cohort Study

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***Background*—**The impact of dispatcher-assisted bystander cardiopulmonary resuscitation (CPR) on neurological outcomes in children is unclear. We investigated whether dispatcher-assisted bystander CPR shows favorable neurological outcomes (Cerebral Performance Category scale 1 or 2) in children with out-of-hospital cardiac arrest (OHCA).

***Methods and Results*—**Children (n=5009, age<18 years) with OHCA were selected from a nationwide Utstein-style Japanese database (2008–2010) and divided into 3 groups: no bystander CPR (n=2287); bystander CPR with dispatcher instruction (n=2019); and bystander CPR without dispatcher instruction (n=703) groups. The primary endpoint was favorable neurological outcome at 1 month post-OHCA. Dispatcher CPR instruction was offered to 53.9% of patients, significantly increasing bystander CPR provision rate (adjusted odds ratio [aOR], 7.51; 95% confidence interval [CI], 6.60 to 8.57). Bystander CPR with and without dispatcher instruction were significantly associated with improved 1-month favorable neurological outcomes (aOR, 1.81 and 1.68; 95% CI, 1.24 to 2.67 and 1.07 to 2.62, respectively), compared to no bystander CPR. Conventional CPR was associated with increased odds of 1-month favorable neurological outcomes irrespective of etiology of cardiac arrest (aOR, 2.30; 95% CI, 1.56 to 3.41). However, chest-compression-only CPR was not associated with 1-month meaningful outcomes (aOR, 1.05; 95% CI, 0.67 to 1.64).

***Conclusions*—**In children with OHCA, dispatcher-assisted bystander CPR increased bystander CPR provision rate and was associated with improved 1-month favorable neurological outcomes, compared to no bystander CPR. Conventional bystander CPR was associated with greater likelihood of neurologically intact survival, compared to chest-compression-only CPR, irrespective of cardiac arrest etiology. **(*J Am Heart Assoc*. 2014;3:e000499 doi: 10.1161/JAHA.113.000499)**

Key Words: cardiopulmonary resuscitation • epidemiology • heart arrest • pediatrics • resuscitation

Out-of-hospital cardiac arrest (OHCA) is an increasing public health concern in industrial countries with aging populations.[1,2] In Japan, ≥100 000 OHCA cases occur annually, and nationwide improvements in favorable neurological outcomes after cardiac arrest have been observed after connecting the links in the "chain of survival."[1,3,4] These links are as follows: immediate recognition of cardiac arrest and activation of an emergency response system; early cardiopulmonary resuscitation (CPR); rapid defibrillation; effective advanced life support; and integrated post–cardiac arrest care.[5] The early links (immediate emergency activation and early bystander CPR) are likely to increase the probability of survival of an OHCA. In fact, Sasson et al.[2] reported that any bystander CPR can increase the likelihood of survival by 2- or 3-fold. The role of dispatcher CPR instruction is crucial in increasing the rate of bystander CPR provision and improving the quality of CPR provided after OHCA. In adults with OHCA, dispatcher CPR instruction increased bystander CPR provision rates and showed a trend toward increased survival rates.[6,7] However, only a few studies have reported on the impact of dispatcher-assisted bystander CPR on neurological outcomes for children with OHCA.[8,9]

We investigated whether dispatcher CPR instruction for children with OHCA would increase the rate of bystander CPR

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provision and show an association with favorable neurological outcomes, in comparison to OHCA incidences in which no bystander provided CPR. We also assessed the relationship between neurological outcomes and conventional CPR (chest compression plus rescue breathing), compared to chest-compression-only CPR.

Methods

Study Design

The present investigation was a nationwide population-based observational study of all pediatric patients (age<18 years) for whom resuscitation had been performed after OHCA in Japan between January 1, 2008, and December 31, 2010. Cardiac arrest was defined as the cessation of cardiac mechanical activities, as confirmed by the absence of signs of circulation.[1] Etiology of an arrest was presumed to be cardiac unless evidence suggested an external etiology (trauma, hanging, drowning, drug overdose, or asphyxia), respiratory disease, cerebrovascular disease, malignant tumors, or any other noncardiac etiology. Physicians in charge and emergency medical services (EMS) personnel determined whether the arrest was of noncardiac or cardiac etiology. This study was approved by the ethical committee of Kanazawa University (Kanazawa, Japan). The requirement for written informed consent was waived.

Study Setting

Japan has nearly 127 million residents in an area of 378 000 km^2, approximately two thirds of which is uninhabited mountainous terrain.[1] Details of the Japanese EMS system have been described previously.[1,3,4,8] Briefly, municipal governments provide EMS through approximately 800 fire stations with dispatch centers. The Fire and Disaster Management Agency (FDMA) of Japan supervises the nationwide EMS system, whereas the local fire stations operate each local EMS system. Since October 2006, all EMS providers perform CPR according to the Japanese CPR guidelines,[10] which are based on the 2005 American Heart Association (AHA) guidelines.[11] Because EMS personnel in Japan are legally prohibited from terminating resuscitation in the field, most patients with OHCA undergo CPR by EMS providers and are transported to hospitals, except for cases in which fatality is certain. The FDMA provided a standard outline for dispatcher CPR instructions and recommended that local fire departments modify the content of telephone dispatcher assistance according to the actual circumstances of the local area.[12] Dispatcher-assisted bystander CPR is offered when dispatchers determine that they must advise a bystander to aid the resuscitation of a child experiencing OHCA. Generally, the dispatcher offers CPR instruction for chest compression plus rescue breathing (conventional) or chest-compression-only CPR, depending on the skill or knowledge of the bystander. Precise dispatcher CPR instruction manuals vary between local fire departments.[13,14] Dispatcher assistance for bystander CPR is not offered in cases in which cardiac arrest is uncertain during the call or if a bystander does not perform CPR because of barriers, such as panic, fear of liability or performing CPR incorrectly, an unsafe setting, or disability.

Data Collection and Quality Control

The FDMA launched a prospective population-based observational study involving all patients with OHCA who received EMS in Japan.[1] EMS personnel at each center recorded data for patients with OHCA by cooperating with the physician in charge, using an Utstein-style template.[15] The data were transferred to the individual fire stations and subsequently integrated into the registry system on the FDMA database server. The data were checked for consistency by the computer system and confirmed by the FDMA. If the data form was incomplete, the FDMA returned it to the respective fire station, and the form was completed.[1] All data were transferred and stored in the nationwide database developed by the FDMA for public use. We analyzed this database with the permission of the FDMA, who provided all anonymous data to our research group.

The main variables included in the data set were as follows: sex; age; etiology of arrest (dichotomously coded as presumed cardiac origin or not); bystander witness status; initially identified cardiac rhythm; bystander-witnessed category (ie, if there was a bystander, whether the bystander was a family member, a layperson other than family, or EMS personnel); presence and maneuvers of bystander CPR; time of collapse recognition; time of emergency call; time of vehicle arrival at the scene; time of CPR initiation; 1-month survival; and neurological outcome at 1 month after cardiac arrest. The neurological outcome was defined using the Cerebral Performance Category (CPC) scale: category 1, good cerebral performance; category 2, moderate cerebral disability; category 3, severe cerebral disability; category 4, coma or vegetative state; and category 5, death.[15] CPC categorization was determined by the physician in charge. Call-to-response time was calculated as the time from the emergency call to the time of vehicle arrival at the scene. We coded bystander CPR into 3 categories: chest compression only; rescue breathing only; and conventional (chest compression plus rescue breathing). Type of bystander CPR was obtained by EMS observation and interviewing the bystander before leaving the scene; this included specific questions on the presence or absence of chest compressions and rescue breathing. All interviews were recorded on a recording medium for the EMS reports as a written record or as audio recording. All EMS providers perform and teach CPR according to the Japanese CPR guidelines.[10] In Japan, approximately 1.6 million citizens per year participate in conventional CPR training programs consisting of chest compressions and mouth-to-mouth ventilation. Chest-compression-only CPR was not taught as the recommended technique in any resuscitation training program during the study period, but it was first recommended as “acceptable” for those who were not able to, or did not wish to, perform rescue breathing according to the 2005 CPR guidelines.[10] Emergency telephone dispatchers in Japan are given basic training and required to provide CPR instructions for conventional CPR before EMS arrival. However, it is permissible to encourage bystanders to provide chest-compression-only CPR if it is difficult for them to administer rescue breathing.[16]

Study Endpoints

The primary study endpoint was a favorable neurological outcome (defined as a CPC of 1 or 2) at 1 month. The secondary endpoint was a 1-month survival time after OHCA.

Statistical Analysis

To determine the association between outcomes and dispatcher CPR instruction, we divided participants into 2 study cohorts. One of the cohorts was based on the intention-to-treat (ITT) analysis; participants who did not receive intervention before the dispatcher was contacted were divided into 2 groups according to whether or not dispatcher CPR instruction was offered. Another cohort was based on the per-protocol (PP) analysis; participants were divided into 3 groups according to the dispatcher CPR instruction actually received (or not) as follows: no bystander CPR; bystander CPR with dispatcher instruction; and bystander CPR without dispatcher instruction. We compared outcomes between dispatcher CPR instruction-offered and not-offered groups for the ITT analysis and then among no bystander, bystander CPR with dispatcher instruction, and bystander CPR without dispatcher instruction groups for the PP analysis. We performed Kolmogorov–Smirnov Lilliefors tests to evaluate the distributions of continuous variables and found that all continuous variables were not normally distributed (all Ps<0.01). Therefore, we used the Kruskal-Wallis test for analysis of continuous variables followed by the Dunn post-hoc test. Chi-squared tests for categorical variables were performed to compare the characteristics or outcomes between groups. Further, we performed univariate regression analyses to clarify the temporal trends in the incidence of bystander CPR and dispatcher CPR instruction. A multivariable logistic regression analysis of 6 variables was performed to assess characteristics associated with bystander CPR provision preceding EMS arrival. We also performed multivariable logistic regression analyses of 6 variables to assess the relations between outcomes and dispatcher CPR instruction for bystander CPR in 2 study cohorts (ITT and PP analyses). Moreover, multivariable logistic regression analyses of 7 variables were performed to assess the relationship among outcomes, etiology, and type of bystander CPR. Continuous variables were expressed as median and 25th to 75th percentiles, whereas categorical variables were expressed as percentages. As an estimate of effect size and variability, we report odds ratios (ORs) with 95% confidence intervals (CIs). All statistical analyses were performed using the JMP statistical package (version 10; SAS Institute Inc., Cary, NC). All tests reported were two-tailed, and statistical significance was established as $P<0.05$.

Results

During the 3-year study period, details of 5659 children were documented in the database. We considered 5009 children (88.5%) eligible for enrolment in this study. Figure shows the exclusion and grouping criteria for subjects in the present study. Table 1 shows the temporal trends in the incidence of bystander CPR and dispatcher CPR instruction (instruction offered by dispatcher or performed CPR with dispatcher instruction). The proportion of children receiving bystander CPR increased significantly, from 52% in 2008 to 56.7% in 2010 (P=0.006). Similar patterns were observed with regard to the proportions of dispatcher CPR instruction offered by dispatcher and performed CPR with dispatcher instruction.

Table 2 shows the baseline characteristics of the groups for the ITT analysis. The children in cases for which bystanders were offered dispatcher CPR instruction were found to be younger, with unwitnessed arrest, presumed cardiac etiology, and bystander CPR, compared to those in the not-offered group (all $P<0.0001$). Median time of collapse-to-CPR initiation for the dispatcher CPR instruction-offered group was significantly shorter than that for the not-offered group ($P<0.0001$). Table 3 shows the baseline characteristics of the study groups for the PP analysis. The cardiac arrests in children who received bystander CPR without dispatcher instruction were found to be witnessed arrests with shockable initial rhythms, compared to those in the other groups. Among the witnessed arrests, the median time of collapse-to-CPR initiation time for the bystander CPR with dispatcher CPR instruction group was 1 minute longer than that for the bystander CPR group without dispatcher CPR instruction ($P<0.0001$). The proportion of bystander CPR maneuvers significantly differed between the 2 bystander CPR groups

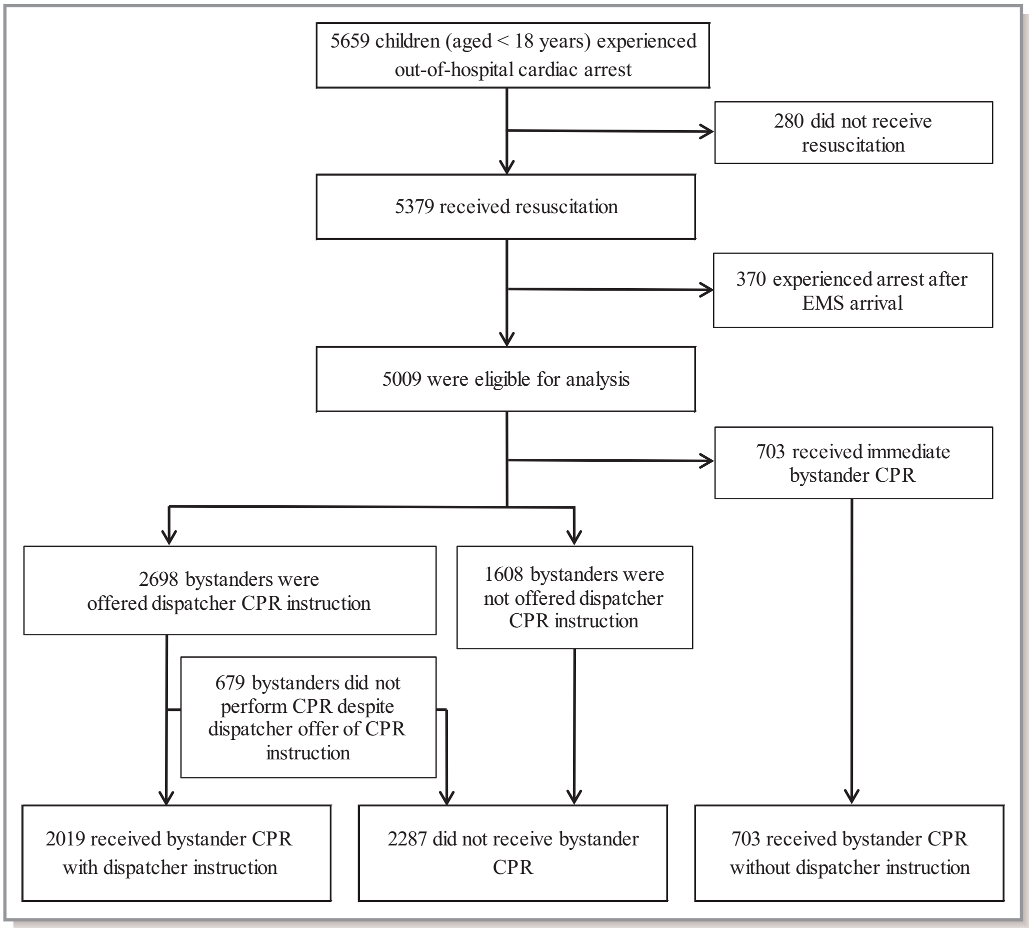

Figure. Study profile. CPR indicates cardiopulmonary resuscitation; EMS, emergency medical services.

($P<0.0001$). In the bystander CPR with dispatcher instruction group, the proportion of chest-compression-only bystander CPR was higher than that of others. However, in the bystander CPR without dispatcher instruction group, the proportion of conventional bystander CPR was higher than that in other groups.

Table 4 shows the results of the multivariable logistic regression analysis of 6 variables that was used to determine characteristics associated with bystander CPR provision. The following factors were significantly associated with performance of bystander CPR: age of 1 to 17 years; arrest witnessed by a nonfamily member; presumed cardiac etiology; and dispatcher CPR instruction. Table 5 shows the 1-month outcomes of the study participants according to the groups of the ITT analyses. The overall 1-month survival and 1-month CPC 1 to 2 rates were 10.5% (528/5009) and 3.5% (175/

Table 1. Temporal Trends in Incidence of Bystander Cardiopulmonary Resuscitation and Dispatcher Cardiopulmonary Resuscitation Instruction

		Dispatcher CPR Instruction	
Year n=5009	Bystander CPR n=2722 (54.3%)	Instruction Offered by Dispatcher n=2698 (53.9%)	Performed CPR With Dispatcher Instruction n=2019 (40.3%)
2008, n=1938	1008/1938 (52.0)	993/1938 (51.2)	738/1938 (38.1)
2009, n=1509	829/1509 (54.9)	825/1509 (54.7)	613/1509 (40.6)
2010, n=1562	885/1562 (56.7)	880/1562 (56.3)	668/1562 (42.8)
P value	0.006	0.003	0.005

Values are reported as n (%). CPR indicates cardiopulmonary resuscitation.

Table 2. Characteristics of All Participants According to Study Group for the Intention-to-Treat Analysis

Characteristics	Dispatcher CPR Instruction	
	Offered n=2698	Not Offered n=1608
Age, y	1 (0 to 8)	2 (0 to 13)
<1 year	1318 (48.9)	660 (41.0)
Male	1634 (60.6)	1000 (62.2)
Witnessed arrest	565 (20.9)	535 (33.3)
Family member	422 (15.6)	288 (17.9)
Nonfamily member	143 (5.3)	247 (15.4)
Presumed cardiac etiology	968 (35.9)	464 (28.9)
Shockable initial rhythm	102 (3.8)	74 (4.6)
Call-to-response time, min, n=4293 (99.7%)	7 (5 to 8)	6 (5 to 9)
Collapse-to-call time, min, n=1079* (25.1%)	2 (0 to 5)	2 (0 to 5)
Collapse-to-CPR initiation time, min, n=1058* (24.6%)	4 (1 to 9)	11 (7 to 16)
Bystander CPR	2019 (74.8)	Not available
Type of bystander CPR		
Chest compression only	1101 (40.8)	Not available
Rescue breathing only	63 (2.3)	Not available
Conventional	855 (31.7)	Not available

Values are reported either as n (%) or median (25th to 75th percentiles). CPR indicates cardiopulmonary resuscitation.
*Among witnessed arrest.

5009), respectively. There were no significant differences between the 2 groups in rates of 1-month survival and 1-month CPC 1 to 2. Merely offering dispatcher CPR instruction was associated with improved 1-month survival, but not associated with improved 1-month neurological outcomes, in the multivariable logistic regression analyses.

Table 6 shows the 1-month outcomes in the study groups for the PP analyses. In uni- and multivariable analyses, bystander CPR with and without dispatcher instruction were associated with increased odds of 1-month survival and 1-month CPC 1 to 2, compared to those obtained without bystander CPR. No significant differences in 1-month survival and 1-month CPC 1 to 2 were found between the bystander CPR with and without dispatcher assistance (adjusted OR [aOR] for 1-month survival and 1-month CPC 1 to 2, 1.01 and 1.08; 95% CI, 0.78 to 1.33 and 0.70 to 1.68, respectively).

Table 7 presents the results of the multivariable logistic regression analyses for 7 variables associated with 1-month outcomes. Age, witnessed arrest, rescue-breathing-only bystander CPR, conventional bystander CPR, and shockable initial rhythm were significantly associated with increased odds of 1-month survival and 1-month CPC 1 to 2. However, chest-compression-only bystander CPR was not associated with increased odds of 1-month outcomes, compared to no bystander CPR. Although there was no association between causes of OHCA and 1-month CPC 1 to 2, respiratory and external etiologies were significantly associated with increased odds of 1-month survival, compared to presumed cardiac etiology.

Discussion

The present analyses revealed that dispatcher CPR instruction was associated with a substantial increase in the bystander CPR provision rate and improvement in 1-month favorable neurological outcomes and 1-month survival in children with OHCA, compared to those who received no bystander CPR. Moreover, conventional CPR was associated with greater likelihood of neurologically intact survival, compared to chest-compression-only CPR.

The chain of survival from the current guidelines of AHA for pediatric cardiac arrest highlights 5 elements of survival: prevention; early CPR; call for help; rapid implementation of pediatric advance life support; and aggressive postresuscitation care.[17] Bystander CPR is one of the key elements to increase survival from OHCA, yet only one third to one half of

Table 3. Characteristics of All Participants According to Study Group for the Per-Protocol Analysis

Characteristics	No Bystander CPR n=2287, 45.7%	Bystander CPR With Dispatcher Instruction n=2019, 40.3%	Bystander CPR Without Dispatcher Instruction n=703, 14.0%
Age, y	1 (0 to 12)	1 (0 to 9)	3 (0 to 13)
<1 year	1027 (44.9%)	951 (47.1%)	244 (34.7%)
Male	1402 (61.3%)	1232 (61.0%)	402 (57.2%)
Witnessed arrest	673 (29.4%)	427 (21.2%)	294 (41.8%)
Family member	396 (17.3%)	314 (15.6%)	125 (17.8%)
Nonfamily member	277 (12.1%)	113 (5.6%)	169 (24.0%)
Presumed cardiac etiology	708 (31.0%)	724 (35.9%)	258 (36.7%)
Shockable initial rhythm	89 (3.9%)	87 (4.3%)	70 (10.0%)
Call-to-response time, min, n=4993 (99.7%)	6 (5 to 8)	7 (5 to 9)	7 (5 to 9)
Collapse-to-call time, min, n=1366* (27.3%)	2 (0 to 5)	2 (1 to 5)	2 (0 to 5)
Collapse-to-CPR initiation time, min, n=1335* (26.7%)	11 (7 to 15)	2 (0 to 5)	1 (0 to 5)
Dispatcher CPR instruction offered, n=2698 (53.9%)	679 (29.6%)	2019 (100%)	Not available
Type of bystander CPR			
Chest compression only	Not available	1101 (54.5%)	301 (42.8%)
Rescue breathing only	Not available	63 (3.1%)	42 (6.0%)
Conventional	Not available	855 (42.4%)	360 (51.2%)

Values are reported either as number of patients (%) or median (25th to 75th percentiles). CPR indicates cardiopulmonary resuscitation.
*Among the witnessed arrests.

children are provided with bystander CPR.[18,19] In accordance with the 2005 CPR guidelines,[10,11] all Japanese fire stations with dispatch centers became more active in ensuring that dispatchers relay CPR instructions to citizens performing CPR under the FDMA in collaboration with the medical control system of each community.[12,13,20] In adults with OHCA in Japan, the prevalence of dispatcher CPR instruction and the incidence of overall bystander CPR increased from 35.4% in 2006 to 43.5% in 2010 and 39.9% in 2006 to 47.1% in 2010, respectively.[20] During our 3-year study period, the prevalence

Table 4. Results of the Multivariable Logistic Regression Analysis for Characteristics Associated With Bystander Cardiopulmonary Resuscitation Provision

Characteristics	All the Patients n=5009	Adjusted OR (95% CI)
Age 1 to 17 years (vs. age <1 year)	2787 (55.6%)	1.29 (1.13 to 1.48)
Male (vs. female)	3036 (60.6%)	0.92 (0.81 to 1.05)
Witnessed arrest (vs. unwitnessed arrest)		
Family member	835 (16.7%)	1.00 (0.84 to 1.19)
Nonfamily member	559 (11.2%)	1.57 (1.27 to 1.93)
Presumed cardiac etiology (vs. noncardiac etiology)	1690 (33.7%)	1.27 (1.11 to 1.46)
Call-to-response time*, min, n=4993	7 (5 to 8)	0.99 (0.98 to 1.02)
Dispatcher CPR instruction (vs. no instruction)	2698 (53.9%)	7.51 (6.60 to 8.57)

Values are reported either as number of patients (%) or median (25th to 75th percentiles), except for the data on the adjusted ORs. CI indicates confidence interval; OR, odds ratio.
*Adjusted odds ratio is reported for unit odds.

Table 5. One-Month Outcomes of Children With Out-of-Hospital Cardiac Arrest According to Study Groups for the Intention-to-Treat Analysis

Group	1-Month Survival			1-Month CPC 1 to 2		
	n (%)	Crude OR (95% CI)	Adjusted OR* (95% CI)	n (%)	Crude OR (95% CI)	Adjusted OR* (95% CI)
Dispatcher CPR instruction offered, n=2698	279 (10.3)	Reference	Reference	83 (3.1)	Reference	Reference
Dispatcher CPR instruction not offered, n=1608	144 (9.0)	0.85 (0.69 to 1.05)	0.70 (0.56 to 0.88)	48 (3.0)	0.97 (0.67 to 1.38)	0.69 (0.46 to 1.02)

CI indicates confidence interval; CPC, cerebral performance category; CPR, cardiopulmonary resuscitation; OR, odds ratio.
*Adjusted variables for potential confounders were included age, sex, presumed cardiac etiology, shockable initial rhythm, witnessed by a family member, and call-to-response time.

of dispatcher CPR instruction for children with OHCA increased from 51.2% in 2008 to 56.3% in 2010. In addition, the incidence of overall bystander CPR and performed CPR with dispatcher CPR instruction increased from 52.0% in 2008 to 56.7% in 2010, and from 38.1% in 2008 to 42.8% in 2010 (Table 1). Prevalence of dispatcher CPR instruction for children with OHCA may influence and improve the overall 1-month survival rate (10.5%), compared to the previous Japanese study by Kitamura et al. (9.2%), based on a nationwide Japanese database from 2005 to 2007 (chi-squared test, $P<0.05$).[19] However, although 53.9% (2698/5009) bystanders of children with OHCA were offered dispatcher CPR instruction, 25.2% (679/2698) did not perform CPR. Merely offering dispatcher CPR instruction may not affect outcome, particularly if a significant number of bystanders do not perform CPR despite the offer. Future efforts should strive to engage the more than 25% of bystanders that did not perform CPR despite the dispatchers' offers. In addition, efforts should focus on increasing early recognition of cardiac arrest so that dispatcher CPR instruction can be offered to bystanders of the substantial proportion of cardiac arrest victims who remain unidentified.

The increasing provision of bystander CPR and 1-month survival rates shown in the present study are consistent with the findings of a previous study by Akahane et al.[8] that included data from a nationwide Japanese database (2005–2008) of children (age<20 years) with only witnessed OHCA. Their study also demonstrated an association between dispatcher-assisted bystander CPR and increased odds of 1-month survival by the ITT analysis: Participants were divided into 2 groups, whether dispatcher-assisted CPR was offered or not, and outcomes after OHCA were compared. In our study, we included all children (age<18) with not only witnessed, but also unwitnessed OHCAs and analyzed the data using not only the ITT analysis, but also the PP analysis according to the group classification of Rea et al.[6]: Participants were divided into 3 groups according to actual bystander CPR performed with or without dispatcher CPR instruction. Essentially, the ITT analysis is a strategy for analyzing of randomized, controlled trials that compares patients in groups to which they were originally randomly assigned.[21] ITT analysis is most suitable for pragmatic trials of effectiveness, rather than explanatory investigations of efficacy (PP analysis).[21,22] Therefore, to compare the efficacy of dispatcher CPR instruction for children with OHCA, a pre-protocol analysis for randomized, controlled trials is desirable. Although we performed a retrospective cohort study, we used the terms "intention-to-treat analysis" and "per-protocol

Table 6. One-Month Outcomes of Children With Out-of-Hospital Cardiac Arrest According to Study Groups for the Per-Protocol Analysis

Group	1-Month Survival			1-Month CPC 1 to 2		
	n (%)	Crude OR (95% CI)	Adjusted OR* (95% CI)	n (%)	Crude OR (95% CI)	Adjusted OR* (95% CI)
No bystander CPR, n=2287	191 (8.4)	Reference	Reference	57 (2.5)	Reference	Reference
Bystander CPR with dispatcher instruction, n=2019	232 (11.5)	1.42 (1.17 to 1.74)	1.63 (1.32 to 2.02)	74 (3.7)	1.49 (1.05 to 2.12)	1.81 (1.24 to 2.67)
Bystander CPR without dispatcher instruction, n=703	105 (14.9)	1.92 (1.49 to 2.48)	1.62 (1.23 to 2.11)	44 (6.3)	2.61 (1.74 to 3.90)	1.68 (1.07 to 2.62)

CI indicates confidence interval; CPC, cerebral performance category; CPR, cardiopulmonary resuscitation; OR, odds ratio.
*The adjusted variables for potential confounders included age, sex, presumed cardiac etiology, shockable initial rhythm, witnessed by a family member, and call-to-response time.

Table 7. Results of the Multivariable Logistic Regression Analyses for Variables Associated With 1-Month Outcomes

Variables	Adjusted OR (95% CI)	
	1-Month Survival	1-Month CPC 1 to 2
Age 1 to 17 years (vs. <1 year)	1.37 (1.11 to 1.70)	1.98 (1.34 to 3.00)
Male (vs. female)	0.85 (0.70 to 1.03)	0.95 (0.68 to 1.34)
Witnessed arrest (vs. unwitnessed arrest)		
Family member	2.51 (1.99 to 3.15)	5.08 (3.36 to 7.76)
Nonfamily member	2.24 (1.70 to 2.92)	6.59 (4.25 to 10.3)
Causes (vs. presumed cardiac etiology)		
Respiratory etiology	1.94 (1.37 to 2.73)	1.31 (0.72 to 2.30)
Internal etiology other than cardiac nor respiratory etiology	1.20 (0.91 to 1.56)	0.74 (0.45 to 1.19)
External etiology	1.32 (1.03 to 1.70)	0.65 (0.41 to 1.00)
Bystander CPR (vs. no bystander CPR)		
Chest compression only	1.10 (0.86 to 1.42)	1.05 (0.67 to 1.64)
Rescue breathing only	2.52 (1.45 to 4.21)	3.04 (1.18 to 6.78)
Conventional	2.14 (1.71 to 2.69)	2.30 (1.56 to 3.41)
Shockable initial rhythm (vs. non-shockable rhythm)	4.22 (3.07 to 5.78)	5.80 (3.82 to 8.76)
Call-to-response time, min*	0.93 (0.90 to 0.96)	0.92 (0.86 to 0.97)

CI indicates confidence interval; CPC, cerebral performance category; CPR, cardiopulmonary resuscitation; OR, odds ratio.
*Adjusted odds ratios are reported for unit odds.

analysis" to clarify the differences in classification of the study groups. It is plausible that the observed difference between the Akahane et al.[8] study and the present study can be accounted for by the different exclusion criteria used between the 2 studies. In the present study, the median time from collapse to CPR initiation was approximately 1 minute longer in cases where dispatch CPR instructions were given, compared to cases where CPR was performed by a bystander without dispatcher CPR instruction (Table 3). This finding is consistent with a previous study of adults with OHCA conducted by Rea et al.[6] They also indicated that, in cases where call-to-response times were longer (>5 minutes), aORs for survival to hospital discharge were similar between the bystander CPR with dispatcher instruction group (aOR, 1.87; 95% CI, 1.4 to 2.5) and the bystander CPR without dispatcher instruction group (aOR, 1.94; 95% CI, 1.5 to 2.6).[6] This is also consistent with the present study. In our study of children with OHCA, the call-to-response times in the bystander CPR with dispatcher instruction and the bystander CPR without dispatcher instruction groups were >5 minutes (median, 7 minutes; 25th to 75th percentiles, 5 to 9 minutes for the 2 groups); aORs of the 2 groups for 1-month survival were also similar (Table 6).

Michiels et al.[23] recently demonstrated that the rates of hospital discharge and pediatric CPC 1 (good overall performance) or 2 (mild overall disability) (PCPC)[24] and the proportion of PCPC 1 or 2 to survival at hospital discharge in children with OHCA were 5.4% (91/1683), 2.1% (35/1683), and 48.6% (35/72), respectively. However, in our present study, the rates of 1-month survival and 1-month CPC 1 or 2 and the proportion of CPC 1 or 2 to survival at 1 month were 10.5% (528/5009), 3.5% (175/5009), and 33.1% (175/528), respectively. Although study endpoints and measurement scales of neurological outcomes in the Michiels et al. study were different from those used in the present study, there exists a considerable discrepancy between Michiels et al. and the present studies in the proportion of meaningful outcomes to survival. Some of the reasons for this discrepancy could be attributable to differences in prehospital EMS systems and rates for shockable initial rhythm (Michiels et al., 33% [28/85]; present study, 4.9% [246/5009]) and witnessed arrest (Michiels et al., 77% [59/77]; present study, 27.8% [1394/5009]).

Michiels et al.[23] also observed that long-term survival was generally favorable: Approximately 80% of OHCA children discharged from the hospital and all OHCA children with PCPC 1 or 2 at discharge survived at least 10 years after hospital discharge. These findings suggest that functional status at hospital discharge provides a meaningful prediction of long-term survival. In our study, prehospital variables associated with 1-month CPC of 1 or 2 included age and bystander CPR, in addition to witnessed arrest and shockable initial rhythm, according to the multivariable logistic regression analysis (Table 7). Although chest-compression-only bystander CPR was not associated with functional outcomes, conventional bystander CPR was associated with increased odds of 1-month CPC 1 or 2 irrespective of etiology. These results support the current guidelines for pediatric resuscitation that include chest compression and rescue breathing.[17] However, our results were inconsistent with the Kitamura et al.[19] study regarding the relation between the type of bystander CPR and cause of cardiac arrest. Kitamura et al. stated that either conventional or chest-compression-only CPR were similarly effective for children with OHCA of cardiac etiology based on subgroups analyses.[19] A possible reason for this difference is the different participants used between the studies. Accordingly, bystander CPR by chest compression and rescue breathing should be more heavily emphasized in addition to the pediatric chain of survival[17] to achieve long-term survival of cardiac arrest in children with OHCA, irrespective of etiology.

Limitations

The potential limitations of the current observational analyses are as follows. First, we did not use the recently published uniform reporting template for data on OHCA to evaluate the dispatch process,[25] which may be useful for quality improvement in dispatcher CPR instruction. Second, we did not evaluate in detail the in-hospital treatments, such as induced hypothermia,[26] extracorporeal CPR,[27] and administration of drugs, such as epinephrine, which may affect the results. We assumed that the children with OHCA received standard advanced life support according to the Japanese CPR guidelines[10] based on the 2005 AHA guidelines.[11] Third, we did not evaluate the precise reasons why bystanders did not perform dispatcher-assisted bystander CPR or the number of cases of unrecognized cardiac arrest. Nevertheless, our results would be useful for improving dispatcher-assistance services. Fourth, we did not have data on the precise instruction manuals for dispatcher-assisted bystander CPR performed in each area and the quality of bystander CPR provided before EMS arrival. Fifth, although we used a uniform data-collection procedure based on Utstein-style guidelines for reporting cardiac arrest, a large sample size, and a population-based design, we cannot exclude the possibility of uncontrolled confounders, such as those outlined above. Because we did not have sufficient data for patients with out-of-hospital cardiac arrest (such as underlying disease, the location where cardiac arrest occurred, and the quality of bystander CPR), we could not include these data in our analyses. Therefore, a randomized, controlled trial may be required to confirm the present results. Sixth, as with all epidemiological studies, the integrity, validity, and ascertainment bias of the data were potential limitations.

Conclusions

In children with OHCA, dispatcher CPR instruction increased the rate of bystander CPR provision and was associated with improved 1-month favorable neurological outcomes, compared to that in cases of no bystander CPR. Conventional CPR was associated with a greater likelihood of favorable neurological outcomes, compared to chest-compression-only bystander CPR, for children with OHCA, irrespective of cardiac arrest etiology. Future efforts should strive to engage the significant number of bystanders that did not perform CPR despite offers of instruction from the dispatchers.

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Disclosures

None.

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Impact of Dispatcher-Assisted Bystander Cardiopulmonary Resuscitation on Neurological Outcomes in Children With Out-of-Hospital Cardiac Arrests: A Prospective, Nationwide, Population-Based Cohort Study

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