Sudden cardiac arrest is a major public health problem in the industrialized world. Survival after out-of-hospital cardiac arrest (OHCA) has been increasing as the chain of survival improves, but it is still low. Cardiopulmonary resuscitation (CPR) by bystanders plays a key role in increasing survival after OHCA. However, despite the proven effectiveness of CPR by bystanders and communities’ efforts to increase CPR, the proportion of CPR performed by bystanders is still low in most of the world.

Background—The best cardiopulmonary resuscitation (CPR) technique for survival after out-of-hospital cardiac arrests (OHCAs) has been intensively discussed in the recent few years. However, most analyses focused on comparison at the individual level. How well the dissemination of bystander-initiated chest compression–only CPR (CCCPR) increases survival after OHCAs at the population level remains unclear. We therefore evaluated the impact of nationwide dissemination of bystander-initiated CCCPR on survival after OHCA.

Methods and Results—A nationwide, prospective, population-based, observational study covering the whole population of Japan and involving consecutive OHCA patients with resuscitation attempts was conducted from January 2005 through December 2012. The main outcome measure was 1-month survival with favorable neurological outcome. The incidence of survival with favorable neurological outcome attributed to types of bystander CPR (CCCPR and conventional CPR with rescue breathing) was estimated. Among 816,385 people experiencing OHCAs before emergency medical services arrival, 249,970 (30.6%) received CCCPR, 100,469 (12.3%) received conventional CPR, and 465,946 (57.1%) received no CPR. The proportion of OHCA patients receiving CCCPR or any CPR (either CCCPR or conventional CPR) by bystanders increased from 17.4% to 39.3% (P for trend <0.001) and from 34.6% to 47.3% (P for trend <0.001), respectively. The incidence of survival with favorable neurological outcome attributed to CCCPR per 10 million population significantly increased from 0.6 to 28.3 (P for trend =0.010), and that by any bystander-initiated CPR significantly increased from 9.0 to 43.6 (P for trend =0.003).

Conclusion—Nationwide dissemination of CCCPR for lay-rescuers was associated with the increase in the incidence of survival with favorable neurological outcome after OHCAs in Japan. (Circulation. 2015;132:415-422. DOI: 10.1161/CIRCULATIONAHA.114.014905.)

Key Words: cardiopulmonary resuscitation ◼ death, sudden ◼ epidemiology ◼ heart arrest ◼ out-of-hospital cardiac arrest

Clinical Perspective on p 422

The combination of chest compressions and rescue breathings has been a standard part of CPR. Recently, many experimental and clinical studies have shown the importance of continuous chest compressions and the effectiveness of chest compression–only CPR (CCCPR). The 2010 CPR guidelines encourage all lay-rescuers to perform at least chest compressions and recommends CCCPR for untrained lay-rescuers and dispatcher-assisted CPR. However, most analyses on the effectiveness of each type of CPR focused on comparison at the individual level.

The Japanese 2010 CPR guidelines recommend that communities train citizens in CCCPR to further disseminate CPR on the basis of the consensus that any CPR would be better than no CPR. However, there is a concern that developing CCCPR training might decrease the survival chance of victims.
for whom conventional CPR with rescue breathing could be more effective than CCCPR, and whether wider dissemination of bystander-initiated CCCPR increases survival after OHCA at the population level remains unclear.

The Fire and Disaster Management Agency (FDMA) of Japan launched a prospective, nationwide, population-based registry of OHCA victims in January 2005. Using this registry, we aimed to evaluate whether nationwide dissemination of CCCPR for lay-rescuers contributed to increase the incidence of survival with favorable neurological outcome after OHCA.

**Methods**

**Study Design and Settings**

The All-Japan Utstein Registry of the FDMA is a prospective, nationwide, population-based registry system of OHCA based on the standardized Utstein style. This observational study enrolled all patients experiencing OHCA before emergency medical services (EMS) arrival who were resuscitated by bystanders or EMS personnel and then transported to medical institutions from January 1, 2005, through December 31, 2012. The Ethics Committee of the Kyoto University Graduate School approved this study. The requirement of written informed consent was waived.

Cardiac arrest was defined as the cessation of cardiac mechanical activity as confirmed by the absence of signs of circulation. The requirement of written informed consent was waived.

**EMS Systems in Japan**

Japan has an area of ≈378,000 km², and its population was ≈127 million in 2005. There were 770 fire stations with dispatch centers in 2012, and EMS is provided by municipal governments. Usually, each ambulance has a crew of 3 emergency providers, including at least 1 emergency life-saving technician, a highly-trained prehospital emergency care provider. Emergency life-saving technicians are allowed to insert an intravenous line and an adjunct airway and to use semi-automated external defibrillators for OHCA patients. Specially trained emergency life-saving technicians are permitted to insert tracheal tubes and to administer intravenous epinephrine. Citizen use of an automated external defibrillation (AED) has been legally permitted since July 2004. Details of the EMS system in Japan were described previously.

**Systemic CPR Training for the General Public and Dispatcher-Assisted CPR**

In Japan, CPR training programs have been conducted mainly by local fire departments, and the program has been recommended by the FDMA and the Ministry of Health, Labor and Welfare on the basis of the Japanese CPR guidelines. In 2012, local fire departments trained ≈1.4 million citizens in conventional 3-hour CPR training programs consisting of chest compressions, mouth-to-mouth ventilation, and AED use. The Japanese Red Cross, other organizations such as local nonprofit organizations, and driver’s training schools have also provided CPR training. In total, it is expected that ≈3 million people are trained in CPR annually in Japan. The 45- to 90-minute CCCPR training was recommended beginning in September 2013. In addition, the Ministry of Education, Culture, Sports, Science and Technology has recommended training in CPR and AED use in junior high schools and high schools. Temporal trends in the number and proportion of people receiving each type of CPR training by local fire departments are shown in Table 1.

The emergency telephone dispatchers in Japan are basically trained and are ordered to give CPR instructions with conventional CPR before EMS arrival. Telephone-assisted CPR by dispatchers was changed from conventional CPR to CCCPR in 2006, and dispatchers started to encourage bystanders to provide CCCPR if it is difficult for them to administer rescue breathing.

**Data Collection and Quality Control**

The prospectively collected data included origin of arrest, sex, age, type of bystander-witnessed status, first documented cardiac rhythm, time course of resuscitation, type of bystander-initiated CPR, dispatcher instruction, public-access AED shock, administration of intravenous fluid and epinephrine, and advanced airway management, as well as prehospital return of spontaneous circulation, 1-month survival, and neurological status 1 month after the event. A series of EMS times, including call receipt, vehicle arrival at the scene, contact with patients, initiation of CPR, defibrillation by EMS, and hospital arrival, were recorded with the clock used by each EMS system. When laypersons delivered shocks using a public-access AED, the victim’s first documented rhythm was regarded as ventricular fibrillation. Both bystander-initiated CCCPR and conventional CPR with rescue breathing were considered bystander CPR. Data on the initiation and type of bystander CPR were obtained by EMS through 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.

**Table 1. Trends in the Number and Proportion of Each Type of CPR Training During the Study Period in Japan**

<table>
<thead>
<tr>
<th>Type of CPR Training</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n=127,768,000)</td>
<td>(n=127,901,000)</td>
<td>(n=128,033,000)</td>
<td>(n=128,084,000)</td>
<td>(n=128,032,000)</td>
<td>(n=128,057,000)</td>
<td>(n=127,799,000)</td>
<td>(n=127,515,000)</td>
</tr>
<tr>
<td>Conventional 3-h CPR training programs</td>
<td>1,147,704</td>
<td>0.9</td>
<td>1,388,212</td>
<td>1.1</td>
<td>1,499,485</td>
<td>1.2</td>
<td>1,541,459</td>
<td>1.2</td>
</tr>
<tr>
<td>Conventional 8-h CPR training programs</td>
<td>68,081</td>
<td>0.1</td>
<td>78,922</td>
<td>0.1</td>
<td>72,843</td>
<td>0.1</td>
<td>77,660</td>
<td>0.1</td>
</tr>
<tr>
<td>45- to 90-min CCCPR training programs</td>
<td>…</td>
<td>…</td>
<td>…</td>
<td>…</td>
<td>…</td>
<td>…</td>
<td>…</td>
<td>3402</td>
</tr>
<tr>
<td>Other CPR training programs</td>
<td>2,005,146</td>
<td>1.6</td>
<td>2,192,795</td>
<td>1.7</td>
<td>2,427,543</td>
<td>1.9</td>
<td>2,611,750</td>
<td>2.0</td>
</tr>
<tr>
<td>Total</td>
<td>3,311,131</td>
<td>2.6</td>
<td>3,659,929</td>
<td>2.9</td>
<td>3,999,871</td>
<td>3.1</td>
<td>4,230,869</td>
<td>3.3</td>
</tr>
</tbody>
</table>

CCCPR indicates chest compression-only cardiopulmonary resuscitation; and CPR, cardiopulmonary resuscitation.
All survivors were followed up for up to 1 month after the event by the EMS providers in charge. Neurological outcome was determined by a follow-up interview 1 month after successful resuscitation with the Cerebral Performance Category 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.5,13,17,18

The data form was filled out by the EMS personnel in cooperation with the physicians in charge of the patients transferred to their fire stations, and the data were integrated into the registry system on the FDMA database server. They were logically checked by the computer system and were confirmed by the implementation working group. If the data form was incomplete, the FDMA returned it to the respective fire station, and the data were confirmed.

End Points
The primary outcome measure was 1-month survival with favorable neurological outcome, which was defined as Cerebral Performance Category 1 or 2.22,23 Secondary outcome measures included return of spontaneous circulation before hospital arrival and 1-month survival.

Statistical Analysis
Analyses were conducted for patients with OHCAs before EMS arrival. Patient and EMS characteristics and outcomes by the type of bystander-initiated CPR were evaluated with analysis of variance for numeric variables and χ² test for categorical variables. Trends in categorical values were tested with univariable regression models. Multivariable analysis with the use of logistic regression models was used to assess the contribution of bystander-initiated CPR to 1-month survival with favorable neurological outcome; odds ratios (ORs) and their 95% confidence intervals were calculated. Factors that were biologically essential and considered to be associated with clinical outcomes were included in the multivariable analyses as potential confounders.5,13,17,18 These variables included origin of arrest (cardiac, noncardiac), sex (male, female), age (0–17, 18–74, ≥75 years), type of bystander-witnessed status (yes, no), first documented rhythm (ventricular fibrillation, non–ventricular fibrillation), public-access AED shock (yes, no), dispatcher instruction (yes, no), intravenous fluid (yes, no), epinephrine (yes, no), advanced airway management (yes, no), and EMS response time (time interval from call to contact with a patient). The incidence of survival with favorable neurological outcome per 10 million population attributed to bystander-initiated CPR was estimated annually as follows: number of OHCA patients receiving CPR×(proportion of favorable neurological outcomes among OHCA patients receiving CPR–proportion among those without CPR)/10 million people from the 2005 Japanese census population. These trends were also tested with Poisson regression models. Subgroup analyses for respiratory causes or children for potential harm of CCCPR were also conducted. All statistical analyses were performed with the SPSS statistical package version 21.0J (IBM Corp, Armonk, NY). All tests were 2 tailed, and values of P<0.05 were considered statistically significant.

The authors had full access to and take responsibility for the integrity of the data. All authors have read and agree to the manuscript as written.

Results
A total of 925,223 OHCAs were documented during 8 years (Figure 1). Of 911,596 OHCAs with resuscitation attempts, 835,402 had arrests before EMS arrival. After the exclusion of patients without information on bystander-initiated CPR and first documented rhythm and those with bystander-initiated rescue breathing–only CPR, 816,385 were eligible for our analyses. Among them, 249,970 (30.6%) received CCCPR, 100,469 (12.3%) received conventional CPR, and 465,946 (57.1%) received no CPR.

Trends in the proportion of bystander-initiated CPR are shown in Figure 2. The proportion of OHCA patients receiving any bystander-initiated CPR (CCCPR or conventional CPR) increased from 34.6% in 2005 to 47.3% in 2012 (P for trend <0.001), and the proportion of those receiving CCCPR increased from 17.4% to 39.3% during this period (P for trend <0.001).

Patient and EMS characteristics and outcomes of OHCA patients by the type of bystander-initiated CPR are noted in Table 2. The causes of cardiac arrests were similar among the groups. The conventional CPR group was more likely to be female or children 0 to 17 years of age, to have their OHCA witnessed by bystanders, to have ventricular fibrillation as the first documented rhythm, and to receive shocks with public-access AEDs than the CCCPR and no CPR groups. The proportion of those who received dispatcher CPR instruction was significantly greater in the CCCPR group than in the other.

![Figure 1. Flowchart of the study. CPR indicates cardiopulmonary resuscitation; and EMS, emergency medical service.](https://example.com/figure1.png)
groups. EMS resuscitation times were similar among the groups. The proportion of 1-month survival with favorable neurological outcome after OHCA was 1.9% in the CCCPR group, 2.7% in the conventional CPR group, and 1.2% in the no CPR group. In a multivariate analysis, both CCCPR (1.38; 95% confidence interval, 1.31–1.44) and conventional CPR (1.49; 95% confidence interval, 1.40–1.57) were similarly more effective than no CPR after adjustment for prehospital confounding factors.

Table 3 shows trends in 1-month survival with favorable neurological outcome after OHCA by types of bystander-initiated CPR. Better neurological outcome gradually increased regardless of the type of bystander-initiated CPR during the study period. In 2005, the conventional CPR group (OR, 1.68; 95% confidence interval, 1.41–2.00) had a significantly higher OR for 1-month survival with favorable neurological outcome after OHCA than the no CPR group, whereas the CCCPR group did not (OR, 1.08; 95% confidence interval, 0.88–1.33).

In the last few years, both the CCCPR and conventional CPR groups had similar ORs compared with the no CPR group. Figure 2 shows the incidence of attributable survival with favorable neurological outcome per 10 million population after OHCA by bystander-initiated CPR. The incidence of survival with favorable neurological outcome attributed to any bystander-initiated CPR (either CCCPR or conventional CPR) increased significantly from 9.0 in 2005 to 43.6 in 2012 (P for trend=0.003), and survivors with CCCPR sharply increased from 0.6 to 28.3 (P for trend=0.010). The temporal trend in the incidence of attributable survival with favorable neurological outcome per 10 million population after OHCA by bystander-initiated CPR of adult OHCAs with cardiac origin (Figure I in the online-only Data Supplement) was almost the same as that for all OHCAs (Figure 3). The incidence of survival with favorable neurological outcome attributed to bystander-initiated CPR was about zero regardless of the type of CPR among adult OHCAs of noncardiac origin or pediatric OHCAs (Figures II–IV in the online-only Data Supplement).

**Discussion**

Using the nationwide registry of OHCA, we successfully demonstrated that wider dissemination of CCCPR was associated with the increase in bystander-initiated CPR and the incidence of OHCA survival with favorable neurological outcome at the population level. The challenge of the Japanese CPR guideline to increase bystander CPR and survival after OHCA by the use of CCCPR and the continuous national registry enabled the elucidation of the effectiveness of wider dissemination of CCCPR in increasing survival after an OHCA in Japan.

Recommending CCCPR and implementing CCCPR training for citizens increased the proportion of CPR (either CCCPR or conventional CPR) performed by bystanders. CCCPR, which is easier to learn and perform, would make it possible for many lay-rescuers to learn and provide CPR. An Arizona group launched a statewide effort to encourage bystanders to perform CCCPR, leading to a significant increase in the proportion of bystander CPR. The American Heart Association is now leading the Hands-Only CPR campaign across the United States to increase CPR by bystanders. This study exhibiting the success of a nationwide dissemination of CCCPR will reinforce this strategy and help other communities promote these programs.

Most analyses of the effectiveness of each type of CPR have focused on comparison between CCCPR and conventional CPR at the individual level, so how well the dissemination of bystander-initiated CCCPR increases survival after OHCA at the population level remains unclear. The effectiveness of CPR for individual OHCA cases would differ by many factors, including origin of cardiac arrests, age of the victims, timing, and duration of cardiac arrests. Different from the comparison at the individual level, for communities, the best CPR technique should be discussed as a total balance of clinical effectiveness to increase the chance of survival at the individual level and educational and implemented effectiveness to increase provision of CPR by bystanders in the community. An increase in survival in the population level is important. The most important result from this nationwide registry of OHCA is not the comparison of ORs between CCCPR and conventional CPR but the increase in the total incidence of survival with favorable neurological outcome attributed to either type of bystander CPR.

Notably, although the proportion of conventional CPR by bystanders decreased as that of CCCPR increased, the incidence of survival attributed to conventional bystander-initiated CPR remained about the same. These data are important for addressing the concern that developing CCCPR training might reduce the chance of survival for victims for whom conventional CPR would be more effective than CCCPR. Well-trained rescuers such as off-duty medical professionals who can perform rescue breathing might successfully provide conventional CPR for those who need it, as the public endorsement of CCCPR in Arizona successfully demonstrated. In addition, in adults, survival after OHCAs of noncardiac origin and long-duration cardiac arrests is similarly low, regardless of the type of CPR. Conventional CPR would be more effective than CCCPR for pediatric cardiac arrests of non-cardiac origin, but their incidence is relatively low. Our subgroup analyses demonstrated that the incidence of survival with favorable neurological outcome attributed to bystander-initiated CPR was about zero regardless of the type of CPR among adult OHCAs of noncardiac origin or pediatric OHCAs that might be harmed by CCCPR dissemination (Figures II–IV in the online-only Data Supplement). These data suggest
that although some OHCA victims need rescue breathing, the number is probably small.

The effectiveness of a wider dissemination of CCCPR in the community would depend on some conditions, including the proportion of bystander CPR, the level of the EMS system and hospital care, the development of a public-access defibrillation program, and survival after OHCA in the region. Today, Japan has a well-organized and -trained EMS system, along with one of the most developed public-access defibrillation programs.\textsuperscript{21,32} We previously reported, using this Japanese OHCA registry, that CCCPR was more effective than conventional CPR for witnessed OHCA patients.

### Table 2. Patient and EMS Characteristics and Outcomes From OHCA By the Type of Bystander CPR

<table>
<thead>
<tr>
<th></th>
<th>CCCPR (n=249,970)</th>
<th>Conventional CPR (n=100,469)</th>
<th>No CPR (n=465,946)</th>
<th>P Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cause, n (%)</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cardiac</td>
<td>146,255 (58.5)</td>
<td>59,407 (59.1)</td>
<td>252,187 (54.1)</td>
<td></td>
</tr>
<tr>
<td>Noncardiac</td>
<td>103,715 (41.5)</td>
<td>41,062 (40.9)</td>
<td>213,759 (45.9)</td>
<td></td>
</tr>
<tr>
<td>External cause</td>
<td>10,864 (4.3)</td>
<td>4,451 (4.4)</td>
<td>19,120 (4.1)</td>
<td></td>
</tr>
<tr>
<td>Respiratory disease</td>
<td>15,428 (6.2)</td>
<td>6,398 (6.4)</td>
<td>24,036 (5.2)</td>
<td></td>
</tr>
<tr>
<td>Cerebrovascular</td>
<td>7,805 (3.1)</td>
<td>1,926 (1.9)</td>
<td>17,091 (3.7)</td>
<td></td>
</tr>
<tr>
<td>Malignant tumor</td>
<td>39,248 (15.7)</td>
<td>15,825 (15.8)</td>
<td>93,520 (20.1)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>30,370 (12.1)</td>
<td>12,462 (12.4)</td>
<td>59,992 (12.9)</td>
<td></td>
</tr>
<tr>
<td>Male, n (%)</td>
<td>139,047 (55.6)</td>
<td>50,992 (50.8)</td>
<td>283,267 (60.8)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Age, median (Q1–Q3), y</td>
<td>79 (67–86)</td>
<td>79 (65–87)</td>
<td>76 (63–84)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Age group, n (%)</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>0–17 y</td>
<td>3298 (1.3)</td>
<td>3186 (3.2)</td>
<td>5851 (1.3)</td>
<td></td>
</tr>
<tr>
<td>18–74 y</td>
<td>94,124 (37.7)</td>
<td>36,216 (36.0)</td>
<td>211,398 (45.4)</td>
<td></td>
</tr>
<tr>
<td>≥75 y</td>
<td>152,548 (61.0)</td>
<td>61,067 (60.8)</td>
<td>248,697 (53.4)</td>
<td></td>
</tr>
<tr>
<td>Bystander witness, n (%)</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>None</td>
<td>162,432 (65.0)</td>
<td>58,286 (58.0)</td>
<td>309,298 (66.4)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>87,538 (35.0)</td>
<td>42,163 (42.0)</td>
<td>156,648 (33.6)</td>
<td></td>
</tr>
<tr>
<td>Family member</td>
<td>52,797 (21.1)</td>
<td>16,941 (16.9)</td>
<td>111,413 (23.9)</td>
<td></td>
</tr>
<tr>
<td>Friend</td>
<td>3224 (1.3)</td>
<td>1815 (1.8)</td>
<td>6187 (1.3)</td>
<td></td>
</tr>
<tr>
<td>Colleague</td>
<td>3042 (1.2)</td>
<td>1420 (1.4)</td>
<td>5277 (1.1)</td>
<td></td>
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<tr>
<td>Passerby</td>
<td>3477 (1.4)</td>
<td>1416 (1.4)</td>
<td>10,207 (2.2)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>24,998 (10.0)</td>
<td>20,591 (20.5)</td>
<td>23,564 (5.1)</td>
<td></td>
</tr>
<tr>
<td>First documented rhythm, n (%)</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>VF</td>
<td>21,853 (8.7)</td>
<td>12,160 (12.1)</td>
<td>30,194 (6.5)</td>
<td></td>
</tr>
<tr>
<td>PEA</td>
<td>42,665 (17.1)</td>
<td>20,823 (20.7)</td>
<td>97,629 (21.0)</td>
<td></td>
</tr>
<tr>
<td>Asystole</td>
<td>185,452 (74.2)</td>
<td>67,468 (67.2)</td>
<td>338,123 (72.6)</td>
<td></td>
</tr>
<tr>
<td>Shock by public-access AEDs, n (%)</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Dispatcher instruction, n (%)</td>
<td>3031 (1.2)</td>
<td>3705 (3.7)</td>
<td>47 (0.01)</td>
<td></td>
</tr>
<tr>
<td>Intra Venous fluid, n (%)</td>
<td>68,497 (27.4)</td>
<td>24,484 (24.4)</td>
<td>113,317 (24.3)</td>
<td></td>
</tr>
<tr>
<td>Epinephrine, n (%)</td>
<td>24,999 (10.0)</td>
<td>8,256 (8.2)</td>
<td>35,864 (7.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Advanced airway management, n (%)</td>
<td>115,176 (46.1)</td>
<td>47,282 (47.1)</td>
<td>195,333 (41.9)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>EMS resuscitation times, median (Q1–Q3), min †</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EMS response time (call to contact with a patient)</td>
<td>8 (7–10)</td>
<td>8 (7–11)</td>
<td>8 (6–10)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hospital arrival time (call to hospital arrival)</td>
<td>30 (24–37)</td>
<td>30 (24–37)</td>
<td>30 (24–38)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Outcomes, n (%)‡</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prehospital ROSC</td>
<td>15,818 (6.3)</td>
<td>7962 (7.9)</td>
<td>24,163 (5.2)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>1-mo survival</td>
<td>10,685 (4.3)</td>
<td>5717 (5.7)</td>
<td>16,636 (3.6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>CPC 1 or 2</td>
<td>4846 (1.9)</td>
<td>2690 (2.7)</td>
<td>5762 (1.2)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

AED indicates automated external defibrillator; CCCPR, chest compression–only cardiopulmonary resuscitation; CPC, Cerebral Performance Category; CPR, cardiopulmonary resuscitation; EMS, emergency medical service; OHCA, out-of-hospital cardiac arrest; PEA, pulseless electric activity; Q1–Q3, first to third quartile; ROSC, return of spontaneous resuscitation; and VF, ventricular fibrillation.

*Comparison among the 3 groups was evaluated with ANOVA for numeric variables and \( \chi^2 \) test for categorical variables.

† The 1913 EMS response time and 1900 hospital arrival time were missing.

‡ Three prehospital ROSC, 8 one-month survival, and 82 CPC 1 or 2 were missing.
Most dispatch systems do not have a detailed protocol for lines or new strategies in an EMS system, as reported.34,35 but instead it shows the difficulty of implementing new guide-
such as pediatric cardiac arrests or obvious respiratory arrests,
traditional CPR in dispatcher-assisted CPR does not indicate
additional CPR with rescue breathing. This high prevalence of
that many bystanders assisted by dispatchers provided tra-
mend CCCPR for dispatcher-assisted CPR, our data showed
worldwide.
be the standard for lay-rescuer CPR programs in most areas
of CCCPR in the community, we believe that CCCPR should
the recent data showing the benefit of wider dissemination
CCCPR can be more useful in areas where there is a greater
chance of receiving shocks with public-access AEDs.33 In
Japan, the proportion of bystander CPR has been increasing
in the last decade but has leveled off to ≈40%.5,6,21 In advanced
areas where the proportion of bystander CPR is relatively
high, the benefit of wider dissemination of CCCPR might be
relatively small. However, the proportion of bystander CPR
is insufficient in most areas of the world.1–4,27 Considering
the recent data showing the benefit of wider dissemination of
CCCPR in the community, we believe that CCCPR should
be the standard for lay-rescuer CPR programs in most areas
worldwide.

Although the Japanese CPR guidelines started to recom-
mand CCCPR for dispatcher-assisted CPR, our data showed
that many bystanders assisted by dispatchers provided tradi-
tional CPR with rescue breathing. This high prevalence of
traditional CPR in dispatcher-assisted CPR does not indicate
a high prevalence of cardiac arrests that need rescue breathing
such as pediatric cardiac arrests or obvious respiratory arrests,
but instead it shows the difficulty of implementing new guide-
lines or new strategies in an EMS system, as reported.34,35

Most dispatch systems do not have a detailed protocol for
dispatcher-assisted CPR and simply recommend that dis-
patchers encourage bystanders to provide CCCPR if they are
not trained in CPR or if it is difficult for them to administer
rescue breathing. Systematic training and a detailed protocol
for dispatchers are needed to improve dispatcher-assisted CPR
and to increase CPR by bystanders.

This nationwide registry shows that the proportion of
bystander CPR and survival after OHCA are improving in
Japan. However, survival with favorable neurological out-
come was still 3.3%, and the proportion of those who received
shocks with public-access AEDs was only 1.0% among wit-
nessed OHCAs.5 Although public-access AEDs were deliv-
ered to >40% of bystander-witnessed OHCA victims in public
places, this is still insufficient.36 Even in an interventionnal trial,
an on-site AED was used for only one third of the victims who
had an arrest at locations with public-access AEDs.37 More
strategies and efforts to increase the number of lay-rescuers
who can at least perform CPR and use an AED are needed.

**Limitations**
The important limitations of this study are the lack of data
on the quality of bystander CPR and the potential biases
involved in providing CCCPR or conventional CPR.34 A
previous study from Japan reported that the unwillingness to
perform conventional CPR was not the result of fear or reluc-
tance to provide mouth-to-mouth ventilation but the lack of
confidence in performing CPR properly.38 Because only con-
tentional CPR with rescue breathing has been taught for a
long time, rescuers who provide CCCPR may be less trained
and thus provide less effective chest compressions,14 espe-
cially in earlier times. Temporal improvements in the OR of
CCCPR compared with no CPR might be due to this bias.
The insufficiency of detailed information on the type of CPR
training is another limitation. As with all multisite epidemi-
ological studies, data integrity, validity, and ascertainment
bias are potential limitations.

**Conclusion**
Nationwide dissemination of CCCPR for lay-rescuers was
associated with the increase in the incidence of survival with
favorable neurological outcome after OHCA in Japan.
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## Disclosures

None.

## References


**CLINICAL PERSPECTIVE**

Cardiopulmonary resuscitation (CPR) by bystanders plays a key role in increasing survival after out-of-hospital cardiac arrests (OHCA). However, despite the proven effectiveness of CPR and communities’ efforts to increase CPR, the proportion of CPR by bystanders is still low around the world. Recently, many studies have shown the effectiveness of chest compression-only CPR (CCCP), and the best CPR technique has been intensively discussed. The latest CPR guidelines recommend CCCP for untrained lay-rescuers and dispatcher-assisted CPR; however, conventional CPR with rescue breathing is still a standard of CPR. Importantly, most analyses focused on comparison between CCCP and conventional CPR at the individual level. How well the dissemination of CCCP increases survival after out-of-hospital cardiac arrests at the population level remains unclear. Because CCCP is easier to learn and perform, CCCP would lead to an increase in the number of individuals trained and in CPR by bystanders. In this study, we evaluated the impact of nationwide dissemination of CCCP on the incidence of survival after out-of-hospital cardiac arrest using a nationwide population-based registry covering the whole population of Japan, where the CPR guideline recommended communities to train citizens in CCCP to further disseminate CPR. As the proportion of CCCP by bystanders increased, the incidence of survival with favorable neurological outcome attributed to any CPR (either CCCP or conventional CPR) significantly increased. This study demonstrated that nationwide dissemination of CCCP for lay-rescuers served to increase the incidence of survival after out-of-hospital cardiac arrest in Japan would reinforce this strategy and help other communities promote these programs.
Dissemination of Chest Compression–Only Cardiopulmonary Resuscitation and Survival After Out-of-Hospital Cardiac Arrest
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SUPPLEMENTAL MATERIAL

Appendix Figure 1: Age ≥18, Cardiac cause

Any CPR (Trend P<0.001)
- Chest compression-only CPR (Trend P<0.001)
- Conventional CPR (Trend P=0.020)

Incidence of Survival with Favorable Neurologic Outcome

Year
2005 2006 2007 2008 2009 2010 2011 2012

Any CPR
- 8.6
- 14.2
- 18.6
- 30.8
- 29.1
- 38.0
- 36.4
- 38.3

Chest compression-only CPR
- 1.6
- 4.6
- 7.7
- 16.4
- 17.4
- 23.3
- 20.8
- 25.7

Conventional CPR
- 7.1
- 9.6
- 11.0
- 14.3
- 11.8
- 14.8
- 15.6
- 12.6

Trend P values are given for each group.
Appendix Figure 2: Age ≥18, Non-cardiac cause

- Any CPR (Trend P=0.077)
- Chest compression-only CPR (Trend P=0.331)
- Conventional CPR (Trend P=0.162)

Incidence of Survival with Favorable Neurologic Outcome

Year

2005 2006 2007 2008 2009 2010 2011 2012

Any CPR
Chest compression-only CPR
Conventional CPR
Appendix Figure 3: Age 0-17, Cardiac cause

- Any CPR (Trend P=0.220)
- Chest compression-only CPR (Trend P=0.312)
- Conventional CPR (Trend P=0.261)
Appendix Figure 4: Age 0-17, Non-cardiac cause

- Any CPR (Trend P=0.583)
- Chest compression-only CPR (Trend P=0.377)
- Conventional CPR (Trend P=0.607)