Survey of a Protocol to Increase Appropriate Implementation of Dispatcher-Assisted Cardiopulmonary Resuscitation for Out-of-Hospital Cardiac Arrest

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Background—Dispatch-assisted cardiopulmonary resuscitation (DA-CPR) attempts to improve the management of out-of-hospital cardiac arrest by laypersons who are unable to recognize cardiac arrest and are unfamiliar with CPR. Therefore, we investigated the sensitivity and specificity of our new DA-CPR protocol for achieving implementation of bystander CPR in out-of-hospital cardiac arrest victims not already receiving bystander CPR.

Methods and Results—Since 2007, we have applied a new DA-CPR protocol that uses supplementary key words. Fire departments prospectively collected baseline data on DA-CPR from January 2009 to December 2011. DA-CPR was attempted in 2747 patients; of these, 417 (15.2%) did not experience cardiac arrest. The sensitivity and specificity of the 2007 protocol versus estimated values of the previous standard protocol were 72.9% versus 50.3% and 99.6% versus 99.8%, respectively. We identified key words that may be useful for detecting out-of-hospital cardiac arrest. Multiple logistic regression analysis revealed that the occurrence of cardiac arrest after an emergency call (odds ratio, 16.85) and placing an emergency call away from the scene of the arrest (odds ratio, 11.04) were potentially associated with failure to provide DA-CPR. Furthermore, at-home cardiac arrest (odds ratio, 1.61) and family members as bystanders (odds ratio, 1.55) were associated with bystander noncompliance with DA-CPR. No complications were reported in the 417 patients who received DA-CPR but did not have cardiac arrest.

Conclusions—Our 2007 protocol is safe and highly specific and may be more sensitive than the standard protocol. Understanding the factors associated with failure of bystanders to provide DA-CPR and implementing public education are necessary to increase the benefit of DA-CPR. (Circulation. 2014;129:1751-1760.)

Key Words: cardiopulmonary resuscitation • out-of-hospital cardiac arrest

Dispatcher-assisted cardiopulmonary resuscitation (DA-CPR) increases bystander CPR frequency, improving out-of-hospital cardiac arrest (OHCA) outcome. To ensure a maximally effective DA-CPR, the American Heart Association and International Liaison Committee on Resuscitation made strong recommendations in the standard DA-CPR protocol that identify 2 key questions about the patient’s absence of consciousness and quality of breathing (normal/not normal) used during CPR initiation. Various factors interfere with successful implementation of DA-CPR, including the OHCA patient having agonal breathing, anoxic convulsions, or emesis; the bystander’s physical limitations or emotional stress; the relationship between a caller and the OHCA patient; and the bystander’s lack of prior CPR training. An educational approach improved the ability to accurately detect cardiac arrest by dispatchers and increased the rate of bystander CPR.

Clinical Perspective on p 1760

To improve the DA-CPR provision rate and bystander CPR in OHCA cases without a large delay in DA-CPR instruction, the Ishikawa Medical Control Council initiated a continuous quality improvement (CQI) project for DA-CPR attempts on the basis of new indication criteria defined as the 2007 protocol. A major cause for not providing DA-CPR instructions is failure of the dispatcher to recognize the cardiac arrest without definitive information about responsiveness and respiration over the telephone. Therefore, to improve the dispatchers’ detection rates of a cardiac arrest, dispatchers were encouraged to use supplementary key words suggestive of cardiac arrest in addition to the standard 2 key questions. We recently reported that this project improved the rate of bystander CPR and prognosis for OHCA patients in Ishikawa Prefecture.

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This study was conducted as a part of the CQI project. Because the quality of DA-CPR protocol should be evaluated in terms of early and proper recognition of savable cardiac arrests,1–4,10 we determined the sensitivity and specificity of our 2007 protocol and compared them with the estimated values obtained by the standard protocol. Sensitivity was defined as the number of transported emergency medical technician (EMT)–unwitnessed OHCA cases for which DA-CPR was attempted divided by the number of transported EMT-unwitnessed OHCA patients who did not receive bystander CPR on bystander’s own initiative. Specificity was defined as the number of transported non-OHCA cases for which DA-CPR was not attempted divided by the number of total transported non-OHCA cases. Furthermore, to improve the DA-CPR protocol and to design new educational approaches for dispatchers and callers, we determined the background and characteristics of OHCA patients and bystanders that were associated with the success of DA-CPR provision and bystander compliance with DA-CPR. For these analyses, we combined the emergency medical dispatch (EMD) database with our extended Utstein database and uniformly analyzed the data.11

Methods

Study Design

This was a prospective observational study. Data were collected in accordance with national ethics guidelines for epidemiological surveys.12 This study was approved by the review board of the Ishikawa Medical Control Council. As shown in Figure 1, all fire departments prospectively collected baseline data on EMD during the period from January 2009 to December 2011. We instructed the project members in each fire department to review their voice and paper dispatch records for DA-CPR that was or was not attempted for OHCAs. Two databases related to DA-CPR were ultimately generated. These databases contained information on factors that interfered with implementing DA-CPR,4,7–9,13 key words suggestive of cardiac arrest, and background information on bystanders and patients. All fire departments prospectively recorded the medical data of patients who were

Figure 1. Database information and analysis of emergency medical dispatch (EMD) records by dispatchers and medical records by emergency medical technicians (EMTs). CQI indicates continuous quality improvement; DA-CPR, dispatcher-assisted cardiopulmonary resuscitation; and OHCA, out-of-hospital cardiac arrest.
transferred to a hospital and created a database for OHCAs according to Utstein guidelines and for noncardiac arrest patients for whom DA-CPR was attempted. These databases included final information on patients and bystanders that was obtained by EMTs by interviewing callers or bystanders. In the present study, the 4 data sets were combined and analyzed for the following items: sensitivity and specificity of the DA-CPR protocol for cardiac arrest, key words specific to cardiac arrest, and factors associated with provision of DA-CPR and bystander compliance with DA-CPR.

**Study Setting**

The Japanese emergency medical service is a 1-tiered system that responds to all requests for ambulance dispatch. The dispatchers handle numerous cases with varying degrees of severity, most of which are related to mild illnesses and symptoms. Ishikawa Prefecture encompasses an area of 4185 km² and has a population of 1170000. There are 11 fire departments, 9 of which have a centralized dispatch system (dispatch center) through which full-time dispatchers manage all EMDs in their community. In the other 2 departments, emergency calls are handled by part-time staff members (usually EMTs) in each fire station. This prefecture is divided into 4 administrative regions: 1 central/urban region and 3 semirural/rural regions. Sixty-two percent of the residents live in the central region, which covers 34% of the total area (1432 km²). The percentage of residents >65 years of age is higher in the semirural/rural regions than in the urban region (28.5% versus 20.3%, respectively).

All fire departments implemented DA-CPR at the beginning of 2004. In 2007, the Ishikawa Medical Control Council initiated a CQI project for DA-CPR that used the 2007 protocol. This project included both educational and practical approaches. The educational approach included education on how to recognize OHCA in subjects with agonal breathing and vomiting and OHCA after convulsions and how to detect an impending cardiac arrest, as well as feedback from emergency physicians who belonged to the Ishikawa Medical Control Council. The practical approach included instructions on chest compression–only CPR, communication via a wireless or cellular phone placed beside the patients, recommendations for remaining on the line or reverting back to the caller for requestioning, and subsequent instructions for cases of impending cardiac arrest. The dispatchers were encouraged to initiate DA-CPR according to the new indications using the supplementary key words suggestive of cardiac arrest, in addition to the standard 2 key questions regarding the absence of consciousness and the quality of breathing (normal/not normal). With this practical protocol, EMDs were classified into 4 categories according to the indications for DA-CPR based on the initial information provided by a caller: absolutely indicative, moderately indicative, impending cardiac arrest, and rarely indicative. When an EMD was categorized as moderately indicative for DA-CPR, the dispatchers were instructed to collect key words suggestive of cardiac arrest and to initiate DA-CPR once they received ≥2 key words. In this study, all DA-CPR instructions were based on the 2007 protocol.

**Statistical Analysis**

The definitions of sensitivity and specificity are given above, and the details of these calculations are shown in Table 1. We calculated 95% confidence intervals (CIs) of the sensitivity and specificity on the basis of constant $\chi^2$ boundaries.

We analyzed the outcomes of providing DA-CPR and bystander compliance with DA-CPR for confirmed OHCAs. We calculated both unadjusted and adjusted odds ratios (ORs) for selected variables. Differences across groups for nominal variables were assessed with the $\chi^2$ test with the Pearson correction and those for continuous variables with the Kruskal-Wallis test. To build the multiple logistic regression model, we first applied multiple logistic regression analyses for those factors that were significant in univariable analyses. Next, we added other factors that were not significant in univariable analysis in a stepwise manner to obtain the lowest bayesian information criterion. Finally, we assessed the fitness of best-fit model using the $R^2$ measure of goodness-of-fit model. We analyzed all data using JMP version 10 (SAS Institute Inc, Cary, NC). For each analysis, the null hypothesis was evaluated at a 2-sided significant level of $P<0.05$, with 95% CIs calculated using profile likelihood.

**Results**

**Overview of the 2 Data Sets**

As shown at the top of Figure 2, DA-CPR was attempted in 2747 patients. Of these, 417 (15.2%) did not experience cardiac arrest on EMT arrival, and 508 (18.5%) did not receive resuscitation and were not transported to a hospital because of the presence of postmortem changes. The major causes of symptoms in the 417 patients who did not experience cardiac arrest at the time of EMT arrival were respiratory distress (n=95, 22.8%), metabolic disorder or poisoning (n=68, 16.3%), noncardiac syncope (n=64, 15.3%), cardiac symptoms

<p>| Table 1. Calculated Sensitivities and Specificities of the 2007 DA-CPR Protocol and the Standard DA-CPR Protocol |
|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|</p>
<table>
<thead>
<tr>
<th>Type of DA-CPR Protocol</th>
<th>Sensitivity (95% CI)*</th>
<th>Specificity (95% CI)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Our 2007 protocol (Number of transported EMT-unwitnessed OHCA cases for which DA-CPR was attempted according to the 2007 protocol)({\text{number of transported EMT-unwitnessed OHCA cases}−\text{number of transported EMT-unwitnessed OHCA cases that received bystander CPR on bystander's own initiative}}) (1258+563+1)/(2926−427)=72.9% (71.7–74.1)</td>
<td>({\text{number of all patients handled by dispatchers and transported by EMTs}−\text{number of transported EMT-unwitnessed OHCA cases}})−(number of transported non-OHCA cases for which DA-CPR was attempted according to the 2007 protocol)({\text{number of all patients handled by dispatchers and transported by EMTs}−\text{number of transported EMT-unwitnessed OHCA cases}}) [(108365−2926)–(186+229)]/ (108365–2926)=99.6% (99.6–99.6)</td>
<td>({\text{number of all patients handled by dispatchers and transported by EMTs}−\text{number of transported EMT-unwitnessed OHCA cases}})−(number of transported non-OHCA cases for which DA-CPR was attempted according to the standard protocol)({\text{number of all patients handled by dispatchers and transported by EMTs}−\text{number of transported EMT-unwitnessed OHCA cases}}) [(108365−2926)–188]/ (108365–2926)=99.8% (99.8–99.8)</td>
</tr>
<tr>
<td>Standard protocol (Estimated number of transported EMT-unwitnessed OHCA cases for which DA-CPR was attempted according to the standard protocol)({\text{number of transported EMT-unwitnessed OHCA cases}−\text{number of transported EMT-unwitnessed OHCA cases that received bystander CPR on bystander's own initiative}}) 1258/(2926−427) = 50.3% (49.4–51.2)</td>
<td>({\text{number of all patients handled by dispatchers and transported by EMTs}−\text{number of transported EMT-unwitnessed OHCA cases}})−(number of transported non-OHCA cases for which DA-CPR was attempted according to the standard protocol)({\text{number of all patients handled by dispatchers and transported by EMTs}−\text{number of transported EMT-unwitnessed OHCA cases}}) [(108365−2926)–188]/ (108365–2926)=99.8% (99.8–99.8)</td>
<td></td>
</tr>
</tbody>
</table>

CI indicates confidence interval; DA-CPR, dispatcher-assisted cardiopulmonary resuscitation; EMT, emergency medical technician; and OHCA, out-of-hospital cardiac arrest.

*Calculation of 95% CIs was based on constant $\chi^2$ boundaries.

†Includes 1258 absolutely indicative cases, 563 moderately indicative cases, and 1 case of impending cardiac arrest (Figure 3).

‡Includes 188 absolutely indicative cases and 229 moderately indicative cases (Figure 3).

§Standard protocol was attempted only when patient was unresponsive and respiration was abnormal or absent.
DA-CPR resulted in the successful initiation of bystander CPR in 1382 of the remaining 1822 OHCA patients (75.9%) in whom resuscitation was attempted and who were transported to a hospital.

As shown in the middle panel of Figure 2, bystander CPR on the bystander’s own initiative was performed for only 220 of 711 bystander-witnessed OHCAs (30.9%) and for only 207 of 1098 OHCAs (18.9%) that were not witnessed. The lack of bystander CPR was attributable to a failure to provide DA-CPR for 321 of 456 bystander-witnessed OHCAs (70.4%) and 356 of 661 unwitnessed OHCAs (53.9%). DA-CPR was attempted in 1822 of 2926 EMT-unwitnessed OHCAs (62.3%) that were handled by dispatchers and transported by EMTs. The rate of bystander CPR in our community was 61.8% (1809 of 2926).

As shown in Figure 2 (left), bystanders initiated chest compression–only CPR after DA-CPR in 164 of the 417 patients (39.3%) in whom DA-CPR was attempted but no cardiac arrest was experienced on EMT arrival. However, bystanders performed CPR on EMT arrival in only 93 patients. For 19 of these 417 patients (4.6%), cardiac arrest was witnessed by EMTs during transport to the hospital. These 19 patients constituted 8.8% of the 215 EMT-witnessed OHCAs.

Information Obtained After EMT Arrival
As shown in Figure 3, both unresponsiveness and abnormal respiration, including respiratory arrest (absolutely indicative category), were confirmed by dispatchers in only 1258 of the 1822 patients (69.0%) with confirmed cardiac arrest in whom resuscitation was attempted and 188 of the 417 patients (45.1%) who did not experience cardiac arrest on EMT arrival. Thus, 13.0% of patients (188 of 1446) in whom both unresponsiveness and abnormal respiration were initially indicated by dispatchers did not experience cardiac arrest on EMT arrival. For 1 patient who was responsive at the time of the first emergency call and fulfilled the criteria for impending cardiac arrest, a dispatcher initiated the instructions after reverting back to the caller and confirming loss of consciousness. In the remaining 792 patients who met the criteria for a moderate indication for DA-CPR, the status of the patient’s responsiveness or respiration was unknown on the basis of the initial information provided by the caller; however, dispatchers initiated the instructions after repeatedly questioning the caller or obtaining other information (key words) suggestive of cardiac arrest. The frequencies of key words encountered for the 563 patients with cardiac arrest and the 229 patients without cardiac arrest are shown in Figure 4. Medical history and age >70 years were common in both groups. When the frequency of each key word was compared between the 2 groups, the frequency of specific location, chest pain, and past medical history was significantly higher, whereas the frequency of onset while eating, abnormal movement or convulsions, and syncope or dizziness was significantly lower for the 563 patients with cardiac arrest.

Estimated Impact of the 2007 DA-CPR Protocol
First, the sensitivity and specificity of the 2007 protocol for managing OHCA in our EMD were determined (Table 1). Of 2926 OHCA cases with EMT-unwitnessed cardiac arrest, 1822 received DA-CPR (1258 absolutely indicative cases, 563 moderately indicative cases, and 1 case of impending cardiac arrest), and 427 received bystander CPR on bystander’s own initiative. Therefore, the sensitivity was 72.9% (95% CI, 71.7–74.1) [1822/2926–427]. Of the 108365 patients who were managed by dispatchers and transported by EMTs, 105439 (108365–2926) did not experience cardiac arrest.
on EMT arrival. Of these 105,439 patients, DA-CPR was attempted in 417 (188 absolutely indicative cases and 229 moderately indicative cases). Therefore, the specificity was 99.6% (95% CI, 99.6–99.6) [(105,439−417)/105,439]. Similarly, the sensitivity and specificity of the standard protocol were estimated. The sensitivity was reduced to 50.3% (95% CI, 49.4–51.2) [1258/(2926−427)] because DA-CPR was assumed to be provided only for the 1258 absolutely indicative cases. The specificity was slightly increased to 99.8% (95% CI, 99.8–99.8) because DA-CPR was assumed to be attempted only for the 188 absolutely indicative cases.

Factors Associated With Provision of DA-CPR in EMT-Unwitnessed OHCA Patients Who Did Not Receive Bystander CPR on Bystander’s Own Initiative
As shown in Table 2, there were significant differences in patient age (P<0.0001), male sex (OR by univariable analysis, 1.35; 95% CI, 1.12–1.62), at-home OHCA (OR, 0.44;
95% CI, 0.37–0.54), witnessed OHCA (OR, 1.72; 95% CI, 1.44–2.06), and OHCA of presumed noncardiac origin (OR, 1.49; 95% CI, 1.24–1.79) between patients in whom DA-CPR was attempted and those in whom it was not. DA-CPR was attempted less frequently in younger patients, in male patients, when cardiac arrest was witnessed or was an out-of-home arrest, and when the arrest had a noncardiac origin. The rate of DA-CPR was as low as 54.4% (136 of 250) for nonelderly (<65 years of age) patients with witnessed OHCA who were most likely to survive, whereas it was as high as 80.2% (954 of 1190) for elderly patients (≥65 years of age) with unwitnessed OHCA who were least likely to survive. When unvariable analysis was performed in a subgroup of nonelderly patients (<65 years of age) with witnessed OHCA, presumed cardiac origin (OR, 2.43; 95% CI, 1.46–4.04), occurrence of arrest after the emergency call (OR, 10.58; 95% CI, 3.59–31.15), and placing an emergency call away from the scene of arrest (OR, 7.75; 95% CI, 3.68–16.26) were significantly associated with failed provision of DA-CPR.

The rate at which emergency callers reported agonal breathing after collapse, arrest-related emesis, and abnormal movement or convulsions, all of which reportedly interfere with initiating DA-CPR, was low. Unvariable analyses did not reveal any significant differences in the frequency of these 3 factors between the 2 groups. DA-CPR was attempted less frequently when bystanders were not family members and female. Implementing a centralized dispatch system was significantly related to a failure to provide DA-CPR. The frequencies of cardiac arrest after receiving an emergency call and emergency calls made away from the scene were much higher for patients for whom DA-CPR was not attempted. As shown in Table 3, emergency calls made away from the scene were due mostly to no telephone available at the scene and third- or fourth-party calls. It should be noted, however, that approximately two thirds of third- or fourth-party calls were preventable; these calls were from other family members, friends, neighbors, family physicians, and police to whom a bystander placed the first call.

We used multiple logistic regression analyses for selected factors. The factors associated with failure to provide DA-CPR were as follows: younger patient age (OR, 1.01; 95% CI, 1.01–1.02); male sex (OR, 1.27; 95% CI, 1.03–1.58); out-of-home arrest (OR, 1.49; 95% CI, 1.04–2.13); witnessed cardiac arrest (OR, 1.61; 95% CI, 1.30–1.98); a presumed noncardiac cause of the arrest (OR, 1.34; 95% CI, 1.09–1.67); abnormal movements or convulsion (OR, 3.39; 95% CI, 1.75–6.42); placing the emergency call away from the scene of arrest (OR, 11.04; 95% CI, 8.07–15.25); occurrence of arrest after the emergency call (OR, 16.85; 95% CI, 11.27–25.77); no help from others (OR, 3.24; 95% CI, 2.44–4.34); and use of a dispatch center (OR, 1.53; 95% CI, 1.21–1.95).

Table 2. Factors Associated With the Provision of DA-CPR in 2499 OHCA Patients Who Did Not Receive Bystander CPR on Bystander’s Own Initiative

<table>
<thead>
<tr>
<th>Background and Characteristics of Patients and Emergency Callers</th>
<th>DA-CPR instruction</th>
<th></th>
<th>Adjusted Odds Ratio (95% CI) for the Failure to Provide DA-CPR Analysis‡</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Attempted (n=1822)</td>
<td>Not Attempted* (n=677)</td>
<td>Unadjusted Odds Ratio (95% CI) or P Value†</td>
<td></td>
</tr>
<tr>
<td>Patient age, median (25%–75%), y</td>
<td>80 (68–86)</td>
<td>73 (30–83)</td>
<td>&lt;0.0001</td>
<td>0.99 (0.98–0.99)</td>
</tr>
<tr>
<td>Patient sex, male, n (%)</td>
<td>1039 (43.0)</td>
<td>434 (64.1)</td>
<td>1.35 (1.12–1.62)</td>
<td>1.27 (1.03–1.58)</td>
</tr>
<tr>
<td>Location, home, n (%)</td>
<td>1396 (75.1)</td>
<td>388 (57.3)</td>
<td>0.44 (0.37–0.54)</td>
<td>0.67 (0.47–0.96)</td>
</tr>
<tr>
<td>Arrest, witnessed, n (%)</td>
<td>626 (34.4)</td>
<td>321 (47.4)</td>
<td>1.72 (1.44–2.06)</td>
<td>1.61 (1.30–1.98)</td>
</tr>
<tr>
<td>Etiology, presumed noncardiac, n (%)</td>
<td>994 (54.6)</td>
<td>434 (64.1)</td>
<td>1.49 (1.24–1.79)</td>
<td>1.34 (1.09–1.67)</td>
</tr>
<tr>
<td>Symptoms related to cardiac arrest, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agonal breathing after collapse</td>
<td>98 (5.4)</td>
<td>37 (5.4)</td>
<td>1.02 (0.69–1.50)</td>
<td>Excluded†</td>
</tr>
<tr>
<td>Emesis or vomiting</td>
<td>43 (2.4)</td>
<td>9 (1.3)</td>
<td>0.52 (0.25–1.07)</td>
<td>Excluded†</td>
</tr>
<tr>
<td>Abnormal movements or convulsions</td>
<td>27 (1.5)</td>
<td>18 (2.7)</td>
<td>1.82 (0.99–3.32)</td>
<td>3.39 (1.75–6.42)</td>
</tr>
<tr>
<td>Bystander, elderly (&gt;65 y), n (%)§</td>
<td>485/1808 (26.8)</td>
<td>199/673 (29.6)</td>
<td>1.15 (0.94–1.39)</td>
<td>Excluded†</td>
</tr>
<tr>
<td>Bystander sex, female, n (%)§</td>
<td>950/1810 (52.5)</td>
<td>389/673 (57.5)</td>
<td>1.24 (1.04–1.48)</td>
<td>1.11 (0.90–1.37)</td>
</tr>
<tr>
<td>Bystander, family member, n (%)</td>
<td>1294 (71.0)</td>
<td>361 (53.3)</td>
<td>0.47 (0.39–0.56)</td>
<td>0.79 (0.56–1.12)</td>
</tr>
<tr>
<td>Call made away from the scene, n (%)</td>
<td>173 (9.5)</td>
<td>224 (33.1)</td>
<td>4.72 (3.77–5.90)</td>
<td>11.04 (8.07–15.25)</td>
</tr>
<tr>
<td>Arrest after the emergency call, n (%)</td>
<td>39 (2.1)</td>
<td>135 (19.9)</td>
<td>11.39 (7.87–16.47)</td>
<td>16.85 (11.27–25.77)</td>
</tr>
<tr>
<td>No help from others, n (%)</td>
<td>1171 (64.3)</td>
<td>449 (66.3)</td>
<td>1.09 (0.91–1.32)</td>
<td>3.24 (2.44–4.34)</td>
</tr>
<tr>
<td>Dispatch center (centralized dispatch system), n (%)</td>
<td>1308 (71.8)</td>
<td>532 (78.6)</td>
<td>1.44 (1.17–1.78)</td>
<td>1.53 (1.21–1.95)</td>
</tr>
</tbody>
</table>

CI indicates confidence interval; DA-CPR, dispatcher-assisted cardiopulmonary resuscitation; and OHCA, out-of-hospital cardiac arrest.
*OHCA patients in whom DA-CPR was not attempted despite the lack of bystander CPR on bystander’s own initiative (Figure 2).
†Test with the Pearson correction or the Kruskal-Wallis test as appropriate.
‡Analyzed for 2481 patients for whom all characteristics were known (1808 patients in whom DA-CPR was attempted and 670 patients in whom it was not attempted). Three patients who themselves placed the emergency call were excluded. First, we used multiple logistic regression analyses for those factors that were significant in unvariable analyses. Then, we added other factors that were not significant in unvariable analysis in a stepwise manner to obtain the lowest bayesian information criterion. Generalized R² of the final model was 0.326.
§Unknown in some cases.
Not included in building of the model.
Factors Associated With Bystander Compliance With DA-CPR for OHCA Patients in Whom DA-CPR Was Attempted

As shown in Table 4, univariable analyses revealed that DA-CPR did not result in initiation of bystander CPR most frequently when the patients were male, when cardiac arrest occurred at home, when the bystanders were elderly and family members, and when the dispatch system was not centralized. The frequency of bystander strength being inadequate to move and reposition the patient was very low; however, the frequency was significantly higher for those patients who did not receive bystander CPR than for those who did. Multiple logistic regression analysis revealed the following factors that were associated with bystander noncompliance with DA-CPR: male sex (OR, 1.32; 95% CI, 1.05–1.65), at-home arrest (OR, 1.61; 95% CI, 1.01–2.57), family member as a bystander (OR, 1.55; 95% CI, 1.01–2.41), inadequate bystander strength (OR, 2.19; 95% CI, 1.20–3.89), and a noncentralized dispatch system (OR, 1.85; 95% CI, 1.47–2.38).

Complications Associated With Bystander CPR

Since the initiation of DA-CPR by all fire departments at the beginning of 2004, we have requested that the fire departments report all complications associated with bystander CPR. No complications were reported that were associated with bystander CPR administered to OHCA patients who had confirmed arrest and were transported to a hospital and patients who did not experience cardiac arrest.

Discussion

In this study, we showed that introducing our 2007 protocol in a Japanese 1-tiered emergency medical service that responds to all requests for ambulance dispatch yielded a considerably higher sensitivity for appropriately recognizing cardiac arrest than did preservation of standard protocol. In addition, we identified some key words that may be useful for the provision of DA-CPR and elucidated the characteristics of emergency calls and patients that were significantly associated with a failure to provide DA-CPR and bystander noncompliance with DA-CPR.

The criteria for a DA-CPR attempt included providing instructions on chest compression–only CPR for patients with unknown breathing or responsiveness, for whom standard protocol is rarely attempted. With our 2007 protocol, these patients were categorized as moderately indicative for DA-CPR (Figure 3). The following 4 findings suggest that this approach to DA-CPR is valid.

Table 4. Factors Associated With Bystander Compliance With DA-CPR in 1822 OHCA Patients in Whom DA-CPR Was Attempted

<table>
<thead>
<tr>
<th>Characteristics of the Patients And callers</th>
<th>Bystander CPR</th>
<th>Unachieved</th>
<th>Unadjusted Odds Ratio (95% CI) or P Value*</th>
<th>Adjusted Odds Ratio (95% CI) for Bystander Noncompliance With DA-CPR (Multiple Logistic Regression Analysis)†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient age, median (25%–75%), y</td>
<td>(n=1382)</td>
<td>(n=440)</td>
<td>P=0.995</td>
<td>Excluded</td>
</tr>
<tr>
<td>Patient sex, male, n (%)</td>
<td>766 (55.4)</td>
<td>273 (62.1)</td>
<td>1.32 (1.06–1.64)</td>
<td>1.32 (1.05–1.65)</td>
</tr>
<tr>
<td>Location, home, n (%)</td>
<td>994 (71.9)</td>
<td>375 (85.2)</td>
<td>2.25 (1.69–3.00)</td>
<td>1.61 (1.01–2.57)</td>
</tr>
<tr>
<td>Arrest, witnessed, n (%)</td>
<td>491 (35.5)</td>
<td>135 (30.7)</td>
<td>0.80 (0.64–1.01)</td>
<td>Excluded</td>
</tr>
<tr>
<td>Origin, presumed noncardiac, n (%)</td>
<td>758 (54.9)</td>
<td>236 (53.6)</td>
<td>0.95 (0.77–1.18)</td>
<td>Excluded</td>
</tr>
<tr>
<td>Bystander, elderly (&gt;65 y), n (%)‡</td>
<td>351/1371 (25.6)</td>
<td>134/437 (30.7)</td>
<td>1.29 (1.01–1.63)</td>
<td>1.24 (0.96–1.59)</td>
</tr>
<tr>
<td>Bystander’s sex, female, n (%)‡</td>
<td>722/1373 (52.6)</td>
<td>228/437 (52.2)</td>
<td>0.98 (0.79–1.22)</td>
<td>Excluded</td>
</tr>
<tr>
<td>Bystander, family member, n (%)</td>
<td>936 (67.7)</td>
<td>358 (81.4)</td>
<td>2.08 (1.60–2.71)</td>
<td>1.55 (1.01–2.41)</td>
</tr>
<tr>
<td>Call made away from the scene, n (%)</td>
<td>107 (7.7)</td>
<td>30 (6.8)</td>
<td>0.94 (0.65–1.36)</td>
<td>Excluded</td>
</tr>
<tr>
<td>No help from others, n (%)</td>
<td>766 (55.4)</td>
<td>234 (53.2)</td>
<td>0.98 (0.79–1.23)</td>
<td>Excluded</td>
</tr>
<tr>
<td>Inadequate bystander strength, n (%)§</td>
<td>33 (2.4)</td>
<td>20 (4.6)</td>
<td>1.95 (1.11–3.43)</td>
<td>2.19 (1.20–3.89)</td>
</tr>
<tr>
<td>Dispatch center (centralized dispatch system), n (%)</td>
<td>1028 (74.4)</td>
<td>280 (63.6)</td>
<td>0.60 (0.48–0.76)</td>
<td>0.54 (0.42–0.68)</td>
</tr>
</tbody>
</table>

CI indicates confidence interval; DA-CPR, dispatcher-assisted cardiopulmonary resuscitation; and OHCA, out-of-hospital cardiac arrest.

*χ² Test with the Pearson’s correction or the Kruskal-Wallis test as appropriate.
†ANOVA with the Pearson’s correction.
‡Analysis of variance for 1808 patients for whom all characteristics were known (1372 patients in whom bystander CPR was initiated and 436 patients in whom it was not initiated). First, we used multiple logistic regression analyses for those factors that were significant in univariable analyses. Then, we added other factors that were not significant in univariable analysis in a stepwise manner to obtain the lowest bayesian information criterion. However, no better model was obtained. Generalized R² of the final model was 0.061.
§Unknown in some cases.
‖Bystander (caller) could not move or reposition the patient.
|Excluded in building of the model.
First, both abnormal respiration and unresponsiveness were confirmed for only 69.0% (1258) of the 1822 patients in whom DA-CPR was attempted for confirmed cardiac arrest and who were transported to a hospital. Second, the rate of bystander compliance with DA-CPR (or acceptance rate of DA-CPR) was 75.9% (1382 of 1822) in our community and was much higher than the rates previously reported.1,2,17,18 Third, the rate of initiating bystander CPR was largely attributable to an attempt at provision of DA-CPR. Fourth, our 2007 protocol was shown to yield a higher sensitivity for cardiac arrest than the standard protocol (72.9% versus 50.3%).

We identified some key words and symptoms that were useful for detecting cardiac arrest in cases moderately indicative for DA-CPR. The key words associated with cardiac arrest at EMT arrival were specific location, chest pain, and medical history. The key words that were associated with a patient who did not experience cardiac arrest at EMT arrival were occurrence while eating, abnormal movement or convulsion, and syncope or dizziness. Because dispatchers should rapidly and correctly identify cardiac arrest with a limited number of questions,5 we requested dispatchers to detect most of the key words in the first information that was provided by callers after the following fundamental questions were asked: “Please tell me exactly what happened”; “How old is she/he?”; “Where is she/he?”; “Does she/he have any history of heart or other problems?”; “Has she/he complained of any symptom before this event?” However, the ability to obtain these key words may differ among dispatchers and may depend on the quality of communication between a dispatcher and a caller. An educational approach for detecting cardiac arrest should be made not only for dispatchers but also for citizens. In addition, further investigations are needed to elucidate definitive key words for detecting cardiac arrest.

Two major factors associated with a failure to provide DA-CPR among OHCA patients who did not receive bystander CPR on bystander’s own initiative were identified: placing an emergency call away from the scene of arrest and cardiac arrest that occurred after the emergency call (impending cardiac arrest). Major reasons for an emergency call away from the scene were no available telephone and third- or fourth-party calls. However, approximately two thirds of third- and fourth-party calls were preventable; these bystanders placed their first call to their family members and other reliable persons (Table 3).

DA-CPR for impending cardiac arrest has been a major issue in our CQI project. Our CQI project has included recommendations for remaining on the line or calling the caller back to provide requestioning and subsequent instructions. However, callers rarely responded to these requests or calls. Most of these callers tried to contact other family members after making their first emergency call, and the telephone line was frequently engaged when the dispatcher tried to call the caller back. Witnessed OHCA and young age of OHCA patients who most likely survive4 were other factors associated with a failure to provide DA-CPR. This implied practical difficulties with obtaining exact information from callers who witnessed an unanticipated cardiac arrest, particularly in young or middle-aged individuals, owing to poor communications between dispatchers and callers.

Male OHCA patients and elderly bystanders, as expected from previous reports,19–21 at-home cardiac arrest, family members as bystanders, and inadequate bystander strength were associated with bystander noncompliance with DA-CPR. In Japan, the aging population has been increasing, and the number of family members in 1 household has been decreasing.22 Most at-home OHCA were witnessed or recognized by aged bystanders, who were frequently the wives of the OHCA patients. Because both the emotional and physical conditions of bystanders have been reported to influence bystander compliance with DA-CPR,7 it may be very difficult to further improve the acceptance rate of DA-CPR.23

Because the key words used by dispatchers included specific locations (bathroom, washroom, and bedroom) and because family members were accessible for DA-CPR, at-home cardiac arrest was associated with a high incidence of providing DA-CPR but a low rate of bystander compliance with DA-CPR. These characteristics of at-home arrest suggest that the public perception of DA-CPR in our community should be improved to increase the reliability of this procedure.

It is uncommon for a realistic simulation of DA-CPR to be provided during basic life support training courses, which we recommend should be modified so that all participants are aware that a dispatcher is not merely an individual who sends ambulances.24 In Japan, basic life support training courses are most frequently conducted by fire departments. We have requested all the fire departments to include realistic simulations of DA-CPR in their training courses for family members who stay at home and that all participants should be educated of the questionings and the subsequent instructions.

A centralized dispatch system with an organized dispatch center was a factor associated with bystander compliance with DA-CPR, but it was also a factor associated with a failure to provide DA-CPR. In most small Japanese fire departments, emergency calls are handled as a concurrent duty of EMTs. On the other hand, in large fire departments, dispatchers in dispatch centers are not specially trained during an independent qualification process. Thus, the ability of these dispatchers to detect cardiac arrest may be lower. One of the advantages of a centralized dispatch system is the availability of sufficient resources that permit dispatchers to stay on the line or revert back to a caller to give instructions; this may be a reason why a centralized dispatch system was associated with an increased rate of bystander CPR.

Attempted DA-CPR may be associated with a risk of bystander CPR being administered to subjects who are not in cardiac arrest.25–27 In this survey, DA-CPR was attempted in 417 patients who did not experience cardiac arrest on EMT arrival (15.2% of 2747 attempted DA-CPR cases). This error rate was lower than that reported for King County.27 To date, no complications associated with DA-CPR have been reported to the Ishikawa Medical Control Council. However, not providing DA-CPR as a means to decrease the overestimation of cardiac arrest may be harmful to patients who actually have OHCA.

Our study had several limitations. First, information on bystanders’ levels of basic life support training was
lacking, which may influence their willingness to perform CPR. It was difficult for EMTs to obtain this information when patients with OHCA did not receive bystander CPR on bystander’s own initiative (ie, without prompting by the dispatcher). We assumed that most of the bystanders who did not perform CPR did not remember much of their training because it was in the remote past or they had no training. Second, because we have already reported that our CQI project for DA-CPR improved the outcomes of OHCA patient in our community, we did not analyze the effects of attempted DA-CPR on patient outcomes. Third, although our data were derived from a 3-year prospective cohort database in Ishikawa Prefecture, which has a population exceeding 1 million, the number of OHCA was too small for detailed analyses of specific symptoms or key words that may improve the accuracy of a diagnosis of cardiac arrest. Finally, the sensitivity and specificity of standard protocol were estimated values.

Conclusions
We demonstrated that introducing our 2007 protocol in a 1-tiered emergency medical service is safe and highly specific and may be more sensitive for OHCA patients than preserving the standard protocol, although further investigations of complications in patients without cardiac arrest who receive bystander CPR are essential. Furthermore, we identified some key words that may be useful for detecting cardiac arrest. Our 3-year survey identified factors that affected dispatchers’ attempts at DA-CPR and the subsequent initiation of bystander CPR. Some of these factors are preventable and amendable. To understand these factors associated with the success of providing DA-CPR and bystander compliance with DA-CPR, designing a better DA-CPR protocol and systematic education for both dispatchers and citizens are necessary to increase the benefit of DA-CPR.

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Disclosures
None.

References
21. Ministry of Internal Affairs and Communications Statics Bureau. Director-general for policy planning (statistical standards) and statistical
Dispatcher-assisted cardiopulmonary resuscitation (DA-CPR), called “just in time” instruction, has great potential to increase the rate of bystander CPR and to possibly improve survival rate. The American Heart Association announced a standard protocol for dispatchers’ recognition of cardiac arrest that recommended 2 key questions. One concerned the patient’s loss of consciousness, and the other concerned the patient’s quality of breathing. In 2007, we implemented the new 2007 DA-CPR protocol designed to improve dispatchers’ recognition of cardiac arrest. Because the 2007 protocol encouraged dispatchers to initiate CPR instructions using supplementary key words suggestive of cardiac arrest, in addition to the 2 key questions, dispatchers initiated DA-CPR instructions even when consciousness or respiration was unknown. This study shows that our 2007 protocol using the supplementary key word system is safe and may be more sensitive than the standard protocol using the 2 key question system. We also identified some key words that may be useful for detecting out-of-hospital cardiac arrest and elucidated the characteristics of out-of-hospital cardiac arrests and bystanders that were associated with the provision of DA-CPR and bystander compliance with DA-CPR. To further improve the rates of providing DA-CPR and survival, dispatchers should be aware of these characteristics. Moreover, the public perception that a dispatcher is merely a staff person who sends an ambulance should be altered. Systematic education of both dispatchers and citizens is essential. We believe that the application of our approach in areas with a low incidence of DA-CPR will increase the rates of bystander CPR and survival from out-of-hospital cardiac arrest.
Survey of a Protocol to Increase Appropriate Implementation of Dispatcher-Assisted Cardiopulmonary Resuscitation for Out-of-Hospital Cardiac Arrest
Yoshio Tanaka, Taiki Nishi, Keiko Takase, Yutaka Yoshita, Yuukihiro Wato, Junro Taniguchi, Yoshitaka Hamada and Hideo Inaba

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