Clinical Paper

Do early emergency calls before patient collapse improve survival after out-of-hospital cardiac arrests?

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ABSTRACT

Aim: Some out-of-hospital cardiac arrests (OHCAs) are witnessed after emergency calls. This study aimed to confirm the benefit of early emergency calls before patient collapse on survival after OHCAs witnessed by bystanders and/or emergency medical technicians (EMTs).

Methods: We analysed 278,310 witnessed OHCAs [EMT-witnessed cases ($n = 54,172$), bystander-witnessed cases ($n = 224,138$)] without pre-hospital physician involvement from all Japanese OHCA data prospectively collected between 2006 and 2012. The data were analysed for the correlation between neurologically favourable 1-month survival and the time interval between the emergency call and patient collapse.

Results: When emergency calls were placed earlier before patient collapse, the proportion of EMT-witnessed cases and survival rate after OHCAs witnessed by bystanders and EMTs were higher. When analysed only for bystander-witnessed cases, for earlier emergency calls placed before patient collapse, survival rate and incidences of bystander cardiopulmonary resuscitation (CPR) and dispatcher-assisted CPR decreased: 2.9%, 33.6% and 24.4%, respectively, for emergency calls placed >6 min before collapse and 5.5%, 48.8% and 48.5%, respectively, for those placed 1–2 min after collapse. Multivariable logistic regression showed that call-to-collapse interval (adjusted odds ratio; 95% confidence interval) (0.92; 0.90–0.94) and EMT response time after collapse (0.84; 0.82–0.86) were associated with survival after bystander-witnessed OHCAs with emergency calls before collapse.

Conclusion: Early emergency calls before patient collapse efficiently increases the proportion of EMT-witnessed cases and promotes survival after witnessed OHCAs. However, early emergency call before collapse may worsen the outcome when the patient's condition deteriorates to cardiac arrest before EMT arrival.

1. Introduction

Early recognition of the life-threatening emergency followed by rapid activation of emergency medical services (EMS) or emergency call is valuable for preventing out-of-hospital cardiac arrest (OHCA).[1,2] It is important to alert the emergency response system or healthcare professionals byrecognizing early warning signs of cardiac arrest, such as syncope or pre-syncope, chest pain, palpitation and dyspnoea.[3–7] This contributes to the early initiation of definitive treatment and decreases the mortality and morbidity of seriously ill patients. Even when OHCA is not prevented, an emergency call before patient collapse may increase the proportion of emergency medical technician (EMT) witnessed OHCAs (i.e., OHCA after EMT arrival), which yield a higher survival rate than bystander-witnessed OHCAs. Therefore, early emergency calls are believed to increase the chance of survival from OHCAs.[8]

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A majority of patients are conscious and responsive at the time of placing the emergency call. However, the condition of some of them may deteriorate to OHCA before EMT arrival. In these cases, dispatcher-assisted cardiopulmonary resuscitation (DA-CPR) cannot be performed when the callers hang up the phone and do not re-call the emergency number after the deterioration of patient's clinical state. Dispatchers are requested to stay on the telephone with any caller reporting life-threatening medical emergencies (for example, cases with chest pain, dyspnoea, palpitation and other acutely developing symptoms). However, it is difficult to identify these calls accurately over the phone because of the high number of emergency calls.

To date, the beneficial effects of early emergency calls before patient collapse on the outcomes of OHCAs have not been confirmed using large population-based cohort studies, particularly with reference to the time interval between placing the emergency call and patient collapse. Furthermore, it has not been clarified whether the interval between the emergency call and patient collapse may influence the rates of DA-CPR and bystander CPR in bystander-witnessed OHCAs. This large population-based study aimed to confirm the benefit of early emergency calls before patient collapse on survival after OHCAs witnessed by bystanders and EMTs and to investigate the influence of the time interval between placing the emergency call and patient collapse on the rates of DA-CPR, BCPR and survival after OHCAs witnessed by bystanders.

2. Methods

2.1. Study design and setting

We obtained the consent of the Japanese Fire and Disaster Management Agency (FDMA) to analyse the OHCA data prospectively collected between 2006 and 2012. The study group, comprising members of the Ishikawa Medical Control Council and their collaborators, conducted this study that was approved by the review board of Ishikawa Medical Control Council.

Japan has a population of 128 million. In 2012, the aged population ($\geq$65 years) was 30.79 million, constituting 24.1% of the total population. In 2012, Japan had 770 fire departments with 5004 ambulance teams.[9]

The Japanese emergency medical service is a one-tiered system that responds to all requests for ambulance dispatch at the same level. The dispatchers handle a high number of cases with varying degrees of severity, most of which are related to mild illnesses and symptoms. The FDMA has provided standard guidelines for DA-CPR.[10] Local fire departments are allowed to create a practical manual for DA-CPR under the guidance of the local medical control council.[11]

EMTs are dispatched from the nearest fire station to deliver emergency care to the OHCA patient. EMTs are not allowed to terminate resuscitation in the field unless an OHCA patient has definitive post-mortem changes. All EMTs are allowed to use automated external defibrillators (AEDs) for OHCA patients and deliver defibrillation according to shock advisory AED message. All paramedics are authorised to perform the following resuscitation procedures: use of airway adjuncts, including suprapharyngeal or laryngeal mask airways, and peripheral venous infusion with Ringer's lactate. However, only authorised and specially trained paramedics are permitted to insert tracheal tubes and administer intravenous adrenaline; these paramedics are not allowed to administer drugs other than adrenaline. All EMTs resuscitate the OHCA patients according to manuals based on Japan Resuscitation Council (JRC) guidelines.[12,13]

2.2. Selection of participants

The FDMA database includes the following Utstein-style information:[14,15] patient background, arrest witnesses, aetiology, initiation of BCPR, type of bystanders, performance of DA-CPR, initial cardiac rhythm, estimated times of collapse (only in bystander-witnessed OHCA cases) and BCPR initiation (only in BCPR-performed OHCAs), recorded times of EMT CPR initiation, EMT arrival on site of OHCAs and hospitals, 1-month (1-M) survival and neurologically favourable 1-M survival [cerebral performance category (CPC), 1 or 2].[16] The time points of patient collapse and BCPR initiation were estimated using the EMT's interview with the bystander. Cardiac or non-cardiac origin of OHCAs was clinically determined by the physicians in collaboration with EMTs. Fire departments obtained information on 1-M survival from the hospitals. The FDMA logically checked data in the registry system and, if necessary, requested the respective fire department to correct and complete the data. The FDMA database includes no data for backgrounds of callers or patient information obtained by dispatchers from callers.

As shown in Fig. 1, from 822,550 OHCAs recorded in 2006–2012, we excluded 485,209 cases of unwitnessed OHCA. In 3675 out of 337,341 cases of witnessed OHCA, it was unknown or uncertain whether OHCAs were witnessed by bystanders or EMTs. Of 333,666 witnessed OHCAs, any pre-hospital physician involvement was recorded in 47,936, and was unknown in 33. We excluded these cases according to the following reasons: (1) some of these cases received pre-hospital advanced life support performed by physicians on duty[17]; (2) most of these OHCAs were witnessed in medical offices and sanatoriums or during physicians home visit, and these physicians on duty played primary roles in the treatment and transportation of patients; (3) according to the Utstein Recommendations,[14,15] these physicians on duty should not be categorised as bystanders; (4) When physicians were involved, DA-CPR was rarely attempted. Of the remaining 285,697 OHCAs, 6913 were lacking fundamental time records, two had no data for outcome, six had unknown background data, and 466 had no data on performance of DA-CPR and/or type of CPR. We excluded these cases and determined the time interval distributions between collapse and emergency call. Finally, we divided the 278,310 cases into EMT-witnessed cases (n = 54,172) and bystander-witnessed cases (n = 224,138).

2.3. Outcome

The primary end point was neurologically favourable 1-M survival (CPC = 1 or 2).

2.4. Analysis

First, we analysed the proportion of EMT-witnessed cases and the rate of neurologically favourable 1-M survival in association with the time interval between placing the emergency call and patient collapse in all OHCAs witnessed by bystanders and EMTs. Second, we analysed the rate of neurologically favourable 1-M survival and the incidences of DA-CPR and BCPR only in bystander-witnessed OHCAs. In these analyses, differences in nominal variables among the call-to-collapse/collapse-to-call interval groups were determined by uninominal logit analysis followed by multinomial logit analysis including the factors that were well known to be associated with survival.

Lastly, we determined the factors associated with neurologically favourable 1-M survival from bystander-witnessed OHCAs in which emergency calls were placed before patient collapse. In univariable analysis, differences across groups for nominal variables were assessed using the chi-square test and Pearson's