Original article

Prehospital predictors of neurological outcomes in out-of-hospital cardiac arrest patients aged 95 years and older: A nationwide population-based observational study

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A R T I C L E   I N F O

A B S T R A C T

Background: Population aging has rapidly progressed in Japan. However, few data exist regarding the characteristics of extremely elderly patients with out-of-hospital cardiac arrest (OHCA). We aimed to determine the prehospital predictors of one-month survival with favorable neurological outcomes (Cerebral Performance Category scale, category 1 or 2; CPC 1–2) in this population.
Methods: We investigated 23,520 OHCA patients aged ≥95 years from a prospectively recorded, nationwide, Utstein-style Japanese database between 2008 and 2012. The primary study endpoint was one-month CPC 1–2 after OHCA.
Results: The one-month CPC 1–2 rate was 0.27% (63/23,520). Only two variables were significantly associated with one-month CPC 1–2 in a multivariate logistic regression model: prehospital return of spontaneous circulation (ROSC) [adjusted odds ratio (aOR), 94.4; 95% confidential interval (CI), 50.1–191.7] and emergency medical service (EMS)-witnessed arrest (aOR, 5.1; 95% CI, 2.6–10.2). When stratified by these two predictors, the one-month CPC 1–2 rates were 20.2% (18/89) for patients who had both prehospital ROSC and EMS-witnessed arrest, 4.2% (33/783) for those who had prehospital ROSC without EMS-witnessed arrest, 0.28% (3/1065) for those who had EMS-witnessed arrest without prehospital ROSC, and 0.04% (9/21,583) for those who had neither predictor, respectively.
Conclusions: The crucial prehospital predictors for one-month CPC 1–2 in elderly OHCA patients aged ≥95 years in Japan were prehospital ROSC and EMS-witnessed arrest and the former was the predominant predictor.

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Introduction

Population aging has rapidly progressed throughout the world [1]. The number of elderly individuals accounting for out-of-hospital cardiac arrest (OHCA) has increased as well, including in Japan [2–6]. It is well known that age alone is not a dominant predictor of outcome; however, outcomes after OHCA are clearly worse as age increases [2–12]. Recently, we reported that although survival with favorable neurological outcomes after OHCA improved significantly in patients aged 75–94 years, there was no improvement in patients aged ≥95 years [5]. These findings suggest that characteristics of extremely elderly patients other than age may contribute to poor outcomes. To date, no studies on neurological outcomes after OHCA have focused on these patients.

In Japan, emergency medical service (EMS) personnel are not legally permitted to terminate resuscitation for OHCA patients in the prehospital setting, and almost all OHCA patients are transported to a hospital regardless of whether resuscitation is successful or not [2]. On the other hand, the USA and other Western countries have implemented a universal termination-of-resuscitation (TOR) rule defined by three mandatory criteria [EMS-unwitnessed arrest, no prehospital return of spontaneous

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circulation (ROSC), and no shock delivery]; however, age is not taken into consideration [13–16]. Worldwide, therefore, cardiopulmonary resuscitation (CPR) has been performed independently of age.

Given this background, it is important to determine prehospital predictors of prognosis in extremely elderly OHCA patients. However, few data exist regarding the characteristics of these patients, and medical futility has not been fully investigated in this population; it is therefore unresolved whether resuscitation efforts in extremely elderly OHCA patients should be restricted.

In this study, we investigated survival with favorable neurological outcomes in OHCA patients aged ≥95 years, and examined prehospital predictors of outcomes. Additionally, we examined whether resuscitation of this cohort is futile.

Methods

Study design and data source

In January 2005, the Fire and Disaster Management Agency (FDMA) of Japan launched a prospective, nationwide, population-based registry based on the Utstein style that covers all OHCA patients [2,17]. The detailed design of the registry has been described previously [2,5]. Using this registry, the present observational study enrolled extremely elderly patients (age ≥95 years) for whom resuscitation had been attempted after OHCA in Japan between January 2008 and December 2012. Selected data from this patient cohort have been reported as part of other analyses [5]. All EMS providers perform CPR according to the Japanese CPR guidelines [18,19]. Since EMS personnel in Japan are legally prohibited from TOR in the field, most OHCA patients who receive CPR from EMS providers are transported to hospitals, except in cases where fatality is certain. Data were prospectively collected using a form based on the Utstein-style reporting guidelines for OHCA [17]. Neurological outcome was defined using the Cerebral Performance Category (CPC) scale [17]. CPC categorization was determined by the physician in charge.

This study was approved by the ethics committee of Kanazawa University with a waiver of informed consent because of the anonymous nature of the data (2012-032).

Endpoints

The primary study endpoint was one-month survival with favorable neurological outcome, defined as a CPC score of 1 or 2 (CPC 1–2). The secondary endpoints were one-month survival and prehospital ROSC. Medical futility was defined as a probability of one-month CPC 1–2 of less than 1% [20].

Statistical analysis

Categorical variables were expressed as counts (%). Continuous variables were expressed as medians (interquartile range) or means and standard deviations. Multivariate logistic regression analysis was used to identify factors associated with each endpoint; odds ratios (ORs) and their 95% confidence intervals (CIs) were calculated. The covariates including potential confounding factors based on biological plausibility and previous studies with a p-value <0.05 in the univariate models were included in the multivariate models. Since changes in CPR guidelines could affect the outcomes, we divided the study period into two based on the guidelines in use at the time: the 2005 CPR guidelines period (from 2008 to 2010) and the 2010 CPR guidelines period (from 2011 to 2012). We also classified initially documented rhythm into two categories: shockable rhythm (pulseless ventricular tachycardia or ventricular fibrillation) and non-shockable rhythm (pulseless electrical activity or asystole). Annual improvement in outcomes during the study period was analyzed with the Cochran-Armitage test for trends.

All statistical analyses were performed using the JMP statistical package, version 11 (SAS Institute, Cary, NC, USA). All tests were two-tailed, and p-values of <0.05 were considered statistically significant.

Results

Patient and EMS characteristics

During the 5-year study period, 607,147 OHCA events were documented. Of 600,860 OHCAs with attempted resuscitation, 23,520 patients aged ≥95 years were eligible for our analysis (Fig. 1). Patient and EMS characteristics are shown in Table 1. The annual OHCA incidence increased each year. The median age of all participants was 97 years. The initially documented rhythm was predominantly non-shockable (98.1%). The proportions of male, witnessed arrest, provision of bystander CPR, and presumed cardiac origin were 26.1%, 41.1%, 53.2%, and 63.9%, respectively.

Outcomes

The overall prehospital ROSC, one-month survival, and one-month CPC 1–2 rates were 3.7% ($n = 872$), 1.4% ($n = 331$), and 0.27% ($n = 63$), respectively (Table 1). In patients with prehospital ROSC, one-month survival and one-month CPC 1–2 rates were 17.3% ($n = 151$) and 5.8% ($n = 51$), respectively. In contrast, in patients without prehospital ROSC ($n = 22,648$), these values were 0.79% ($n = 180$) and 0.05% ($n = 12$), respectively. The one-month survival and one-month CPC 1–2 rates did not improve. However, the prehospital ROSC rate significantly improved (Fig. 2).

Predictors of one-month CPC 1–2

Multivariate logistic regression analysis demonstrated that only two factors, prehospital ROSC and EMS-witnessed arrest, were independently and positively associated with one-month CPC 1–2 (Table 2). When stratified by these two predictors, the one-month CPC 1–2 rates were 20.2% (18/89) for patients who had both prehospital ROSC and EMS-witnessed arrest, 4.2% (33/783) for those who had prehospital ROSC without EMS-witnessed arrest, 0.28% (3/1065) for those who had EMS-witnessed arrest without prehospital ROSC, and 0.04% (9/21,583) for those who had neither predictor, respectively.
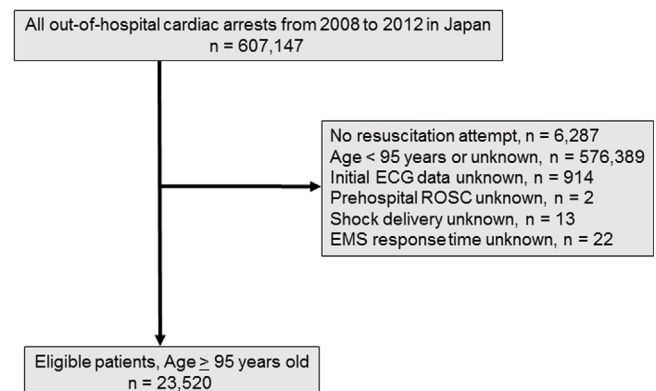

Fig. 1. Study flowchart of patient selection. ECG, electrocardiography; EMS, emergency medical services; ROSC, return of spontaneous circulation.