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High-rise buildings and neurologically favorable outcome after out-of-hospital cardiac arrest

Daisuke Kobayashi [a], Tetsuhisa Kitamura [b,*], Kosuke Kiyohara [c], Chika Nishiyama [d], Sumito Hayashida [e], Tomoko Fujii [a], Junichi Izawa [a], Tomonari Shimamoto [a], Tasuku Matsuyama [f], Toshihiro Hatakeyama [a], Yusuke Katayama [g], Takeyuki Kiguchi [h], Takashi Kawamura [a], Taku Iwami [a]

[a] Kyoto University Health Service, Yoshida-Honmachi, Sakyo-ku, Kyoto 606-8501, Japan
[b] Division of Environmental Medicine and Population Sciences, Department of Social and Environmental Medicine, Graduate School of Medicine, Osaka University, 2-2 Yamada-oka, Suita, Osaka 565-0871, Japan
[c] Department of Public Health, Tokyo Women's Medical University, 8-1 Kawada-cho, Shinjuku-ku, Tokyo 162-8666, Japan
[d] Department of Critical Care Nursing, Graduate School of Medicine and School of Health Sciences, Kyoto University, 53 Shogoin Kawahara-cho, Sakyo-ku, Kyoto 606-8507, Japan
[e] Osaka Municipal Fire Department, 1-12-54 Kujo minami, Nishi-ku, Osaka 550-8566, Japan
[f] Department of Emergency Medicine, Kyoto Prefectural University of Medicine, Kamigyo-ku, Kyoto 602-0841, Japan
[g] Department of Traumatology and Acute Critical Medicine, Osaka University Graduate School of Medicine, 2-15 Yamada-oka, Suita, Osaka 565-0871, Japan
[h] Critical Care and Trauma Center, Osaka General Medical Center, 3-1-56, Bandai-higashi, Sumiyoshi, Osaka 558-8558, Japan

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ABSTRACT

Background: The number of people living in high-rise buildings has recently been increasing in Japan, and delayed transport time by emergency-medical-service (EMS) personnel from higher floors could lead to lower survival after out-of-hospital cardiac arrest (OHCA). However, there are no clinical studies assessing the association between the floor where patients reside and neurologically favorable outcome after OHCA.

Methods: This was a prospective, population-based study conducted in Osaka City, Japan that enrolled adults aged >=18 years suffering an OHCA of cardiac origin before EMS arrival between 2013 and 2014. The primary outcome measure was one-month survival with neurologically favorable outcome. We divided OHCA patients into the following groups: those residing on >=3 floors (the high floor group) and <3 floors (the low floor group). Multiple logistic regression analysis was used to assess factors associated with neurologically favorable outcome.

Results: A total of 2979 patients were eligible for analysis. Of them, 1885 (62.3%) occurred below the third floor and 1094 (37.4%) occurred at or above the third floor. The proportion of neurologically favorable outcome after OHCA was significantly lower in the high floor group than in the low floor group (2.7% [30/1094] versus 4.8% [91/1885], P = 0.005). In a multivariate analysis, neurologically favorable outcome after OHCA was significantly lower in the high floor group than in the low floor group (adjusted odds ratio, 0.59 [95% confidence interval, 0.37–0.96]).

Conclusions: In this population, one-month survival with neurologically favorable outcome from OHCA was lower in the high floor group than in the low floor group.

1. Introduction

Out-of-hospital cardiac arrest (OHCA) of cardiac origin is an important public health problem in the industrialized world [1,2], and approximately 70,000 events occur every year in Japan [3]. Owing to improvements in the "chain of survival," the survival after OHCA has been improving since 2000 worldwide, but it remains still low [4–6]. Therefore, identifying factors associated with survival after OHCA is essential.

In Japan owing to space constraints, there has been an increase in the number of people living in high-rise buildings [7]. Building access including elevator use would lead to delays in the emergency-medical-service (EMS) response time as well as the initiation of cardiopulmonary resuscitation (CPR) by bystanders or EMS personnel [8], and it might be also difficult for them to perform continuous chest compressions when going down stairs in high-rise buildings. Surprisingly, a recent study in Canada demonstrated that the proportion of survival to hospital discharge after OHCA was significantly lower among patients residing on >=3 floors compared with that among those residing on <3 floors [9]. However, no clinical study has assessed the association between building floors and neurologically favorable outcome after OHCA.

In Osaka City, Japan, we are conducting a prospective population-based OHCA registry, covering about 2.6 million residents [10]. During the 2 years between 2013 and 2014, there were approximately 3000 EMS-resuscitated OHCA of presumed cardiac origin before EMS arrival.

* Corresponding author.
E-mail address: lucky_unatan@yahoo.co.jp (T. Kitamura).

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Our hypothesis is that the proportion of neurologically favorable outcome after OHCA would be significantly lower among patients residing on high floors than among those residing on low floors.

2. Methods

2.1. Study design, setting, and population

The Utstein registry in Osaka City is a prospective, population-based OHCA database based on the international Utstein style [11,12]. The details of this registry were previously described [10]. We enrolled adult patients aged =>18 years suffering an OHCA of presumed cardiac origin before EMS arrival who were resuscitated by EMS personnel or bystanders and were then transported to emergency hospitals from January 1, 2013 to December 31, 2014. Osaka is the third largest city in Japan with a population of 2.69 million residents (2015) in an area of 222 km^2 (its population density about 12,000 residents/km^2). The research protocol was approved by the institutional review board of Osaka University and Kyoto University. The requirement of obtaining individual informed consent for the review of patient outcomes was waived by the Personal Information Protection Law and the national research ethics guidelines of Japan.

Cardiac arrest was defined as the cessation of cardiac mechanical activity as confirmed by the absence of signs of circulation [11,12]. The arrest was presumed to be of cardiac origin unless it was caused by trauma, drowning, drug overdose, asphyxia, exsanguination, or any other non-cardiac cause. These diagnoses were made clinically by the physician in charge in collaboration with the EMS rescuers.

2.2. Emergency medical service systems in Osaka City

Details of the EMS system in Japan were also described previously [5]. The EMS system is operated by the local fire stations, and the free telephone emergency number 119 is used to call for ambulance from anywhere in Japan. There are 25 fire stations and a single emergency dispatch center in Osaka City and life support is provided 24 h a day. When called, an ambulance is dispatched from the nearest fire station. Each fire ambulance has three EMS personnel with at least one emergency life-saving technician (ELST) who has been highly trained for providing pre-hospital emergency care. They were allowed to insert an intravenous line and an adjunct airway, and to use an automated external defibrillator (AED) for OHCA patients. Specially trained ELSTs were permitted to insert tracheal tubes and administer intravenous adrenaline. The use of AED by citizens was legally approved in July 2004. All EMS providers perform CPR according to the Japanese CPR guidelines [13].

2.3. Data collection and quality control

Data were prospectively collected using a form that included all core data recommended in the Utstein-style reporting guidelines for cardiac arrests [11,12]. These data included sex, age, do-not-resuscitate (DNR) order, witness status, floor where patients resided, first documented cardiac rhythm, location of arrest, activity of daily living (ADL) before arrest, time course of resuscitation, dispatcher instruction, bystander-initiated CPR, public-access AED pad application and shocks, prehospital return of spontaneous circulation (ROSC), hospital admission, one-month survival, and neurological status one month after the event. Other EMS-related data such as call receipt, contact with patients, dispatch at the scene, and hospital arrival were recorded at the dispatch center. The first documented rhythm was diagnosed by EMS personnel with AEDs at the scene, and it was regarded as ventricular fibrillation (VF) when bystanders provided shocks using public-access AEDs [6].

The data form was filled out by the EMS personnel in cooperation with the physicians in charge of the patient. They were then transferred to the Information Center for Osaka municipal fire department, and then checked by the investigators. If the data sheet was incomplete, the relevant EMS personnel were contacted and questioned, and the data sheet was completed [6].

All survivors were followed up for up to one month after the event by the EMS personnel in charge. Neurological outcome was determined by the physician responsible for the care of the patient using the cerebral performance category (CPC) scale: category 1, good cerebral performance; category 2, moderate cerebral disability; category 3, severe cerebral disability; category 4, coma or vegetative state; and category 5, death [11,12].

2.4. Outcome measures

The primary outcome measure was one-month survival with neurologically favorable outcome. Neurologically favorable outcome was defined as CPC scale 1 or 2 [11,12]. Secondary outcome measures included prehospital ROSC, admission to hospital, and one-month survival.

2.5. Statistical analysis

Based on a previous report [9], we divided OHCA patients into the following two groups: those residing on >=3 floors (the high floor group) and those residing on <3 floors (the low floor group). Patient and EMS characteristics and outcomes were compared between the high floor group and the low floor group using a chi-square test for categorical variables and a Mann–Whitney's U test for continuous variables. A trend in categorical values was tested with a Mantel–Haenszel test. Multiple logistic regression analysis assessed factors associated with neurological favorable outcome, and odds ratios

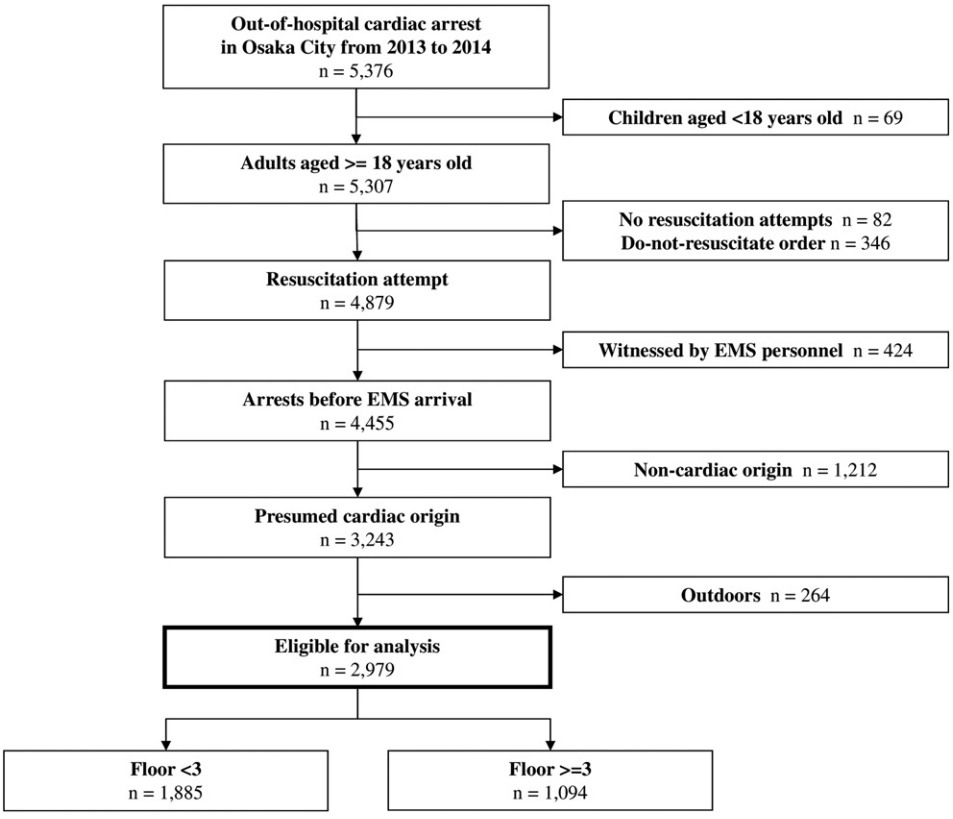

Fig. 1. Overview of EMS-treated cardiac arrests with an abridged Utstein template from January 1, 2013 to December 31, 2014. EMS indicates emergency medical service.