Resuscitation xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Clinical paper

Impact of cardiopulmonary resuscitation duration on neurologically favourable outcome after out-of-hospital cardiac arrest: A population-based study in Japan☆

Tasuku Matsuyama[a], Tetsuhisa Kitamura[b,*], Kosuke Kiyohara[c], Chika Nishiyama[d], Tatsuya Nishiuchi[e], Yasuyuki Hayashi[f], Takashi Kawamura[g], Bon Ohta[a], Taku Iwami[g]

[a] Department of Emergency Medicine, Kyoto Prefectural University of Medicine, Kyoto, Japan
[b] Division of Environmental Medicine and Population Sciences, Department of Social and Environmental Medicine, Graduate School of Medicine, Osaka University, Osaka, Japan
[c] Department of Public Health, Tokyo Women's Medical University, Tokyo, Japan
[d] Department of Critical Care Nursing, Kyoto University Graduate School of Human Health Science, Kyoto, Japan
[e] Department of Acute Medicine, Kindai University Faculty of Medicine, Osaka, Japan
[f] Senri Critical Care Medical Center, Osaka Saiseikai Senri Hospital, Osaka, Japan
[g] Kyoto University Health Services, Kyoto, Japan

ARTICLE INFO

Article history:
Received 21 November 2016
Received in revised form
13 December 2016
Accepted 2 January 2017

Keywords:
Out-of-hospital cardiac arrest
Cardiopulmonary resuscitation duration
Termination of resuscitation
Population-based study

ABSTRACT

Background: The optimal cardiopulmonary resuscitation (CPR) duration for patients with out-of-hospital cardiac arrest (OHCA) remains unclear. We aimed to assess the association between CPR duration and outcome after OHCA.

Methods: This prospective, population-based observational study conducted in Osaka, Japan enrolled 6981 adult patients with non-traumatic witnessed OHCA who achieved return of spontaneous circulation (ROSC) from January 2005 through December 2012. CPR duration was defined as the time of CPR initiation by emergency medical service personnel to the ROSC in pre-hospital settings or after hospital admission. The primary outcome was one-month survival with neurologically favourable outcome (cerebral performance category scale 1 or 2).

Results: Overall, median CPR duration was 25 min (interquartile range: 15–34) and the proportion of neurologically favourable outcome was 12.5% (875/6,981). The proportion of neurologically favourable outcome among the CPR duration ≥31 min group was significantly lower compared with that among the 0–5 min group (55.1% [320/581] versus 2.2% [54/2424], adjusted odds ratio [AOR] 0.04; 95% confidence interval [CI] 0.03–.05 in all patients, 78.4% [240/306] versus 11.4% [30/264], AOR 0.04; 95% CI 0.02–0.06 in the shockable group, 29.1% [80/275] versus 1.1% [24/2160], and AOR 0.03; 95% CI 0.02–0.05 in the non-shockable group). The cumulative proportion for neurologically favourable outcome reached 99% after 44, 41, and 43 min of CPR in all patients, the shockable group, and the non-shockable group, respectively.

Conclusion: The proportion of patients with neurologically favourable outcome declined with increasing CPR duration, but some OHCA patients could benefit from prolonged CPR duration >30 min.

Introduction

Sudden cardiac arrest in the out-of hospital settings is one of the important causes of death in industrialized countries.[1–3] The "chain of survival" is the key concept for improving survival of patients experiencing OHCA with "early recognition of cardiac arrest and activation of the emergency response system," "early cardiopulmonary resuscitation (CPR)", and "rapid defibrillation" as its important components contributing to the early successful return of spontaneous circulation (ROSC).[4,5]

☆ A Spanish translated version of the abstract of this article appears as Appendix in the final online version at http://dx.doi.org/10.1016/j.resuscitation.2017.01.005.

* Corresponding author at: Division of Environmental Medicine and Population Sciences, Department of Social and Environmental Medicine, Graduate School of Medicine, Osaka University, 2-5 Yamada-oka, Suita, Osaka 565-0871, Japan. Fax: +81 6 6879 2929.
E-mail address: lucky_unatan@yahoo.co.jp (T. Kitamura).

http://dx.doi.org/10.1016/j.resuscitation.2017.01.005
0300-9572/

Despite the importance of the "chain of survival", one of the biggest challenges is deciding when to terminate resuscitation efforts in patients with OHCA who do not achieve ROSC shortly after starting CPR. Recently, several studies demonstrated that longer CPR duration was associated with worse outcome after OHCA,[6–11] whereas, regarding in-hospital cardiac arrests (IHCA), longer CPR duration might lead to increased survival to discharge.[12,13] Most previous studies on the relationship of CPR duration and outcome after OHCA focused on pre-hospital or the emergency department (ED) settings; few studies investigated the effect of total CPR duration from pre-hospital settings through ED settings on OHCA outcome.[6] Therefore, current CPR guidelines do not illustrate the optimal resuscitation effort time for patients with OHCA.[14,15]

The Utstein Osaka Project is a prospective large-scale population-based OHCA cohort in Osaka, Japan, and covers about 8.8 million residents. Using this large-scale database, we aimed to assess the relationships between total CPR duration and achieving neurologically favourable outcome after OHCA. In addition, we investigated the time to achieve a cumulative proportion of ≥99% survival with neurologically favourable outcome.

Methods

Study design, population, and setting

The present study enrolled adult patients aged ≥18 years who had experienced OHCA from non-traumatic cause before emergency-medical-service (EMS) arrival witnessed by bystanders, who were resuscitated by EMS personnel or bystanders, and who achieved ROSC in the Osaka Prefecture from January 1st, 2005 through December 31st, 2012. The Ethics Committee of Osaka University Graduate School of Medicine approved this study. EMS personnel already removed personal identifiers from the database. The Personal Information Protection Law and the National Medical Research Ethics Guidelines of Japan waived the requirement for informed consent from patients.

Cardiac arrest was defined as the cessation of cardiac mechanical activity as confirmed by the absence of a detectable pulse, unresponsiveness, and apnea (or agonal, gasping respirations) based on the Utstein guideline.[16] The arrest was presumed to be of cardiac origin unless it was caused by cerebrovascular diseases, respiratory diseases, malignant tumours, external causes such as trauma, drowning, drug overdose, asphyxia, or any other non-cardiac causes. Diagnoses were made by the overseeing physician in collaboration with the EMS rescuers.

The EMS system in Osaka

The details of the EMS system in Osaka were described previously.[17] Osaka is the third largest prefecture with 8.8 million residents in an 1892 km^2 area, and has 34 fire stations with respective emergency dispatch centres. The local fire stations operate the EMS system. An ambulance is dispatched from the nearest fire station when needed in an emergency. Emergency services are available 24 h a day, and are single-tiered in 32 stations and two-tiered in two stations. The two-tiered stations dispatch medics followed by the physician. Most highly trained pre-hospital emergency care providers are termed emergency life-saving technicians (ELSTs). They are trained in intravenous line and adjunct airway insertion in patients with OHCA. Specially trained ELSTs have been permitted to perform tracheal intubation and administer intravenous adrenaline. Typically, each ambulance includes a crew of three emergency providers including at least one ELST.

Do-not-resuscitate orders or living wills are not generally accepted in Japan. EMS providers are not permitted to terminate resuscitation in the field, except for in patients with OHCA showing definite signs of death such as rigour mortis, dependent cyanosis, or decomposition or in cases of decapitation and incineration on EMS arrival. Therefore, almost all patients with OHCA who were treated by EMS personnel were transported to a hospital and enrolled in the Utstein Osaka Project.

Data collection and quality control

Data were prospectively collected using a form that included data recommended by the Utstein-style reporting guidelines for cardiac arrests.[16] These data included sex, age, first documented cardiac rhythm, witness status, location of arrests, activity of daily living (ADL) before arrests, time course of resuscitation, type of bystander-initiated CPR, public-access AED use, dispatcher instruction, intravascular fluid, tracheal intubation and administration of intravascular adrenaline, destination hospital, pre-hospital ROSC, ROSC after hospital arrival (post-hospital ROSC), and survival and neurological status one month after the event. The first documented rhythm was recorded and diagnosed by EMS personnel with automated defibrillators on the scene, and it was regarded as shockable rhythm (ventricular fibrillation [VF]/pulseless ventricular tachycardia [VT]) in OHCA cases defibrillated using public-access AEDs. A series of resuscitation times of call receipt, vehicle arrival at the scene, contact with patients, initiation of CPR, EMS defibrillation, and achieving pre-hospital and post-hospital ROSC were recorded at the dispatch centre. The data form was completed by the EMS personnel in cooperation with the physicians in charge of the patients; the data were integrated into the registry system on the Information Centre for Emergency Medical Services of Osaka, and then checked by the investigators. If the data sheet was incomplete, the relevant EMS personnel were contacted and questioned for data completion. All survivors experiencing OHCA were followed up for up to one month after the event by a member of the EMS team who responded to the cardiac arrest case. The one-month neurological outcome was determined by the physician responsible for treating the patient, using the cerebral performance category (CPC) scale, which is outline as follows: 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.[17]

Outcome measures

The primary outcome of this study was one-month survival with neurologically favourable outcome, defined as a CPC of 1 or 2.[17] Secondary outcomes were hospital admission and one-month survival.

Statistical analysis

CPR duration was defined as the time of CPR initiation by EMS personnel to the time of ROSC, based on previous studies.[6,8,11] Participants were divided into 4 groups according to the first documented rhythm (shockable or non-shockable) and the timing of ROSC (pre-hospital or post-hospital). Patient and EMS characteristics and outcomes were evaluated among the 4 groups with analysis of variance (ANOVA) for continuous variables and chi-square test or Fisher's exact test for categorical variables.

We graphed the cumulative proportion of those with neurologically favourable outcome over CPR duration stratified by the first documented rhythm (shockable or non-shockable). Next, we investigated the time to achieve a cumulative proportion of ≥90%, ≥99%, and 100% survival with neurologically favourable outcome according to the first documented rhythm.

Please cite this article in press as: Matsuyama T, et al. Impact of cardiopulmonary resuscitation duration on neurologically favourable outcome after out-of-hospital cardiac arrest: A population-based study in Japan. Resuscitation (2017), http://dx.doi.org/10.1016/j.resuscitation.2017.01.005