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Clinical paper

Cardiopulmonary resuscitation by trained responders versus lay persons and outcomes of out-of-hospital cardiac arrest: A community observational study☆

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ABSTRACT

Objectives: The study aims to compare bystander processes of care (cardiopulmonary resuscitation (CPR) and defibrillation) and outcomes for witnessed presumed cardiac etiology in OHCA patients in whom initial resuscitation was provided by dedicated trained responder (TR) versus lay person (LP) bystanders.
Methods: Data on witnessed and presumed cardiac OHCA in adults (15 years or older) from 2011 to 2015 in a metropolitan city with 10 million persons were collected, excluding cases in which the information on TRs, bystander CPR, defibrillation, and clinical outcomes was unknown. Exposure variables were TRs who were legally designated with CPR education and response and LPs who were bystanders who witnessed the OHCA by chance. The primary/secondary/tertiary outcomes were a good cerebral performance category (CPC) of 1 or 2, survival to discharge, and bystander defibrillation. A multivariable logistic regression analysis was used to calculate the adjusted odds ratio (AOR) with 95% confidence intervals (CIs), adjusting for potential confounders.
Results: Of 20,984 OHCA events, 6475 cases were ultimately analyzed. The TR group constituted 6.4% of the cases, and the patients showed significantly better survival and a good CPC. From the multivariable logistic regression analysis of the outcomes, by comparing the TR group with the LP group, the AOR (95% CIs) was 1.49 (1.04–2.15) for a good CPC, 1.59 (1.20–2.11) for survival to discharge, and 10.02 (7.04–14.26) for bystander defibrillation.
Conclusion: The TR group witnessed a relatively low proportion of OHCA but was associated with better survival outcomes and good neurological recovery through higher CPR rates and defibrillation of adults older than 15 years with witnessed OHCA in a metropolitan city.

Background

Out-of-hospital cardiac arrest (OHCA) is the one of the largest public health burdens due to its high incidence and low survival rates in the United States, Europe, Australia, and Asia [1–3]. To improve the outcomes of OHCA, evidence-based guidelines for cardiopulmonary resuscitation have been proposed through a scientific review process by the International Liaison Committee on Resuscitation [4,5]. However, a substantial gap between scientific knowledge and clinical practice has been apparent over the last several decades, and the implementation of current recommendations in cardiopulmonary resuscitation (CPR) at the community and population levels is one of the most difficult steps in delivering these scientific findings to the community [6,7].

Early good quality CPR and appropriate training of trained responders (TRs) with a duty to respond to an OHCA event were recommended under the concept of "formula of survival" and by

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the 2015 Guidelines for CPR of the European Resuscitation Council and the American Heart Association [4,8]. The public access defibrillator (PAD) program using automatic external defibrillators (AEDs) for those TRs is one of the key strategies for improving outcomes by early defibrillation [9,10]. The PAD program has been argued for its cost-effectiveness and low utilization issues, regardless of scientific evidence on its clear benefit in OHCA patients [11–13]. An AED deployment strategy targeting TRs, who are willing or likely to run to OHCA patients, has been regarded as a more cost-effective approach than that targeting general lay person (LP) bystanders.

TRs are a specific population group that is likely to witness a patient collapsing or to be called when an event occurs in daily life. However, TRs include various population groups depending on the EMS systems and communities involved, including firefighters, policemen, public transportation vehicle drivers, school teachers, sports instructors, and lifeguards who may or may not be designated by the Emergency Medical Services (EMS) Act and regulations [9,10]. The proportions of OHCAs witnessed by TRs among all patients, the CPR rates performed by TRs, and outcomes after TR CPR and TR defibrillation are uncertain and not fully understood. The lack of a standard definition and standard criteria for TRs and the extensive variations in the public health regulations for TRs are causing the gap between scientific recommendations and real implementations in the communities.

This study aimed to compare bystander activities (CPR and defibrillation) between TRs and LPs and their subgroups and to test the association between bystander groups (TRs and LPs) and outcomes.

Methods

This was a citywide cross-sectional observational study. All data were collected and owned by the Korea Centers for Disease Control and Prevention (CDC) according to national statistics law and were approved for this study. The institutional review board of the study hospital reviewed and approved the study. Informed consent was waived because the data variables did not include personal information, and the study process posed a minimal risk for patients.

Study setting

The study was conducted in a metropolitan city that spans 605 km^2 with a population of approximately 10 million residents. There are 25 districts, each with one health center that provides CPR training to TRs and LPs. The CPR training standards and materials were developed and distributed by the Korea CDC and were based on international and domestic recommendation guidelines. The 2010 national CPR training standards and program were developed and approved in 2011 and then disseminated to entire provinces and metropolises.

The national EMS Act was revised to designate potential TRs (school teachers, sports instructors, public transportation vehicle drivers, safety guards of national parks, and policemen) in 2004 to encourage bystander CPR. A revision was made in 2008 for bystander defibrillation and then in 2011 to designate more TRs (apartment safety guards in towns with more than 500 houses), and mandatory training for TR CPR and defibrillation was added to the act. Most places where TRs work or live are mandatory sites for PAD programs designated by the EMS Act. Since 2005, trained responders have been required to complete regular CPR and AED training every year with at least one two-hour course according to the EMS Act. (See Appendix R1 in Supplementary material for the Korean TRs designated by the national EMS Act and the mandatory sites for the PAD program.)

The metropolitan city of Seoul developed a 2nd five-year EMS agenda in 2010 and has implemented programs based on the agenda since 2011. The agenda includes the expansion of CPR training and implementation of the public AED program. Every year, 500–1000 AEDs are distributed in public spaces supported by the city health department. The total number of AEDs for bystander use was approximately 8000 in 2015 (80 per 100,000 persons and 1250 persons per AED).

An intermediate level of EMS care is provided by the city fire department (170 ambulances and 3 crews per ambulance) and includes CPR, AED, advanced airway, and intravenous fluid resuscitation. However, the use of medications is not permitted during CPR, and emergency medical technicians are mandated to transport all cardiac arrest patients to emergency departments while continuing CPR in the ambulance if the patients are not resuscitated on the ground [14].

There are three levels of emergency departments (EDs): one level 1 ED, where 24 h/7 day emergency care for critically ill emergency patients is served by specialized emergency physicians; 27 level 2 EDs, where emergency physicians provide emergency care for emergency patients with high acuity; and 23 level 3 EDs, where general physicians provide emergency care for patients with low acuity. The designation, evaluation, and accreditation of level of EDs are provided annually by the national government's health department.

Data source

The national OHCA registry was used for the study, which included all EMS-assessed OHCAs since 2006 [15–17]. The registry was constructed from four electronic databases: 1) a dispatch CPR registry recorded by dispatchers for information and pre-arrival instructions, 2) EMS run sheets on general and time-related information regarding ambulance operations, 3) an EMS CPR registry for OHCA event information recorded by EMS providers after transporting OHCA patients, and 4) hospital medical records collected by the Korea CDC on hospital care and outcomes. OHCA cases were obtained from EMS run sheets from the national fire department's server and merged with the dispatch CPR registry and EMS CPR registry. The OHCA cases were collected and sent to the Korea CDC to obtain hospital medical records, which are created by trained medical record reviewers who go to hospitals and review all hospital records considering the care in the ED, intensive care unit, and wards, as well as the outcomes at discharge. The data quality management team consisting of EMS physicians, epidemiologists, biostatistics experts, and cardiologists maintains the data quality through regular monthly education and providing feedback to medical record reviewers about undetermined variables during medical record reviews. The OHCA statistics from this registry were approved by the National Statistical Office as one set of national health statistics.

Study population

Adults aged 15 years or older who suffered from OHCA and had a presumed cardiac etiology from January 1, 2011, to December 31, 2015, were enrolled. A cardiac etiology was presumed in the absence of any other obvious cause such as trauma, drowning, hanging, overdose, or asphyxiation, as well as by using clinical information gathered in some cases from the medical record of physicians. Patients who were not treated, who were witnessed by EMS providers, who were unwitnessed in general, who had collapsed in an unknown place, who had unknown outcomes, and who had unknown information regarding bystander CPR and AED use were excluded.