



Clinical paper

Effects of Dispatcher-assisted Cardiopulmonary Resuscitation on Survival Outcomes in Infants, Children, and Adolescents with Out-of-hospital Cardiac Arrests[☆]



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ABSTRACT

Objective: We studied the effect of a dispatcher-assisted cardiopulmonary resuscitation (CPR) program on paediatric out-of-hospital cardiac arrest (OHCA) outcomes by age groups.

Methods: All emergency medical services (EMS)-treated paediatric OHCA cases in Korea were enrolled between 2012 and 2014, excluding cases witnessed by EMS providers and those with unknown outcomes. The cases were divided into three groups: bystander CPR with dispatcher assistance, bystander CPR without dispatcher assistance, and no-bystander CPR. The endpoint was survival until discharge from hospital. Multivariable logistic regression analysis was performed. The final model with an interaction term was evaluated to compare the effects across age groups.

Results: A total of 1529 patients (32.8% bystander CPR with dispatcher assistance, 17.3% without dispatcher assistance, and 54.6% no-bystander CPR) were included. Both bystander CPR groups were more likely to have higher rate of survival to discharge (8.8% and 12.1%) compared to no-bystander CPR (3.9%). The adjusted OR (95% CI) for survival to discharge were 1.77 (1.04–3.00) in bystander CPR with dispatcher assistance and 2.86 (1.61–5.08) in without dispatcher assistance compared with no-bystander CPR. By age groups, the adjusted OR (95% CI) in bystander CPR with and without dispatcher assistance were 2.18 (1.07–4.42) and 2.27 (1.01–5.14) for the group aged 9–18 years; 2.32 (0.64–8.44) and 6.21 (1.83–21.01) for the group aged 1–8 years; 1.06 (0.41–2.77) and 2.00 (0.64–6.18) for the group aged 0–12 months, respectively.

Conclusions: Bystander CPR, regardless of dispatcher assistance, was associated with improved survival outcomes after OHCA in the paediatric population. However, the associations between dispatcher-assisted bystander CPR and survival outcomes varied by age.

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BACKGROUND

Out-of-hospital cardiac arrest (OHCA) in the paediatric population is one of the most important public health problems; there

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is a high burden of disease due to the low survival rate, and many patients suffer from serious permanent brain injury after the cardiac arrest.^{1,2} Survival outcomes after OHCA in the paediatric population are still relatively lower than those in adults despite much effort to improve the chain of survival including enhancement in community awareness and prevention of cardiac arrests.³ Early cardiopulmonary resuscitation (CPR) by bystanders, one of the key components in the chain of survival, may result in a higher rate of neurologically intact survival in paediatric OHCA. However, laypersons tend to have more difficulty in providing CPR to paediatric OHCA cases as it requires sophisticated hand positions, compression force, and proper rescue ventilation according to the age of the OHCA patients.¹

In comparison with adults and adolescents, younger children and infants have less likelihood of survival after OHCA presumably because most of their arrests are caused by respiratory failure or circulatory hypo-perfusion following chronic conditions, whereas arrests in the adult population are largely attributable to acute coronary events.^{1,4–6} Therefore, survival of children and infants after OHCA depends largely on rescue mouth-to-mouth ventilation, while adults can benefit from simplified chest-compression-only CPR technique. To increase bystander CPR rates, the means of promoting simplified chest-compression-only CPR are being widely distributed, but the effect of chest-compression-only CPR in children is known to be insignificant.⁷

A dispatcher-assisted CPR program is designed to promote bystander CPR by laypersons by removing barriers to starting CPR; assisting trained bystanders in recalling CPR procedure; and promoting proper chest compression.^{7–11} However, CPR guidelines for paediatric OHCA vary for patients of different ages, and therefore, levels of compliance to dispatchers' instructions and the effect of the dispatcher-assisted CPR program would vary according to patient age. To date, studies that compare the effects of dispatcher-assisted CPR on survival outcomes of paediatric OHCA by patients' age have not been reported.

We hypothesize that bystander CPR with and without dispatcher assistance is associated with improved survival outcomes in infants, children, and adolescents with OHCA, and that the size of the effect would be larger in magnitude in patients of older age groups.

METHODS

Study Setting

In Korea, the emergency medical services (EMS) system is single-tiered and fire-based. Service level is basic-to-intermediate, and the highest qualified emergency medical technicians (EMTs) are capable of providing CPR with an automated external defibrillator (AED), evaluating cardiac rhythms on site, managing advanced airway including endotracheal intubation and supraglottic airway, and injecting intravenous or intraosseous fluids. EMTs cannot declare death in the field unless there are signs of irreversible death (rigor mortis, dependent lividity, decapitation, transection and decomposition) and this is confirmed by direct medical control from a physician. EMS providers are not allowed to stop CPR unless the patient's pulse is regained in the field or during transport to an emergency department (ED). All EMS-assessed patients are transported to a hospital.^{12,13}

Since October 2011, the National Emergency Management Agency (the national fire department) initiated a dispatcher-assisted CPR program at all provincial fire departments.^{14,15} The dispatcher-assisted CPR program was designed in accordance with the 2010 American Heart Association (AHA) guidelines¹⁶ and included two simplified questions for detecting OHCA (unresponsiveness [Is the patient awake? Is he/she unconscious and not reacting to pain?]) and abnormal breathing [Is he/she breathing normally?]) and structured dialogue for bystanders to provide CPR.¹⁷ For paediatric OHCA, there are currently three types of dispatcher-assisted CPR protocols: 1) two-finger chest compression technique and rescue ventilation in infants (aged 1 year or younger); 2) one-hand chest compression and rescue ventilation in children (aged 1–8 years); and 3) two-hand chest-compression-only technique in adolescents (aged 9 years or older).

All dispatch centers operate a system for detecting OHCA, instructing CPR for bystanders via telephone, and reporting the process to higher authorities. At every dispatch center, there are two levels of dispatchers, and primary call dispatchers are responsible

for detecting OHCA and transferring the call to medical control dispatchers for providing CPR instructions. In general, primary call dispatchers are firefighters, and medical control dispatchers are either EMTs or nurses. At every dispatch center, a dispatch medical director, who is a part-time emergency physician certified by the Ministry of Health and Welfare, supervises the team. To improve the quality of the dispatcher-assisted CPR program, medical directors review more than 10% of all dispatcher-assisted CPR audio recordings and regularly provide feedback to the dispatchers.¹⁸ Senior medical control dispatchers review the dispatcher CPR registry and contribute to an increased detection rate of OHCA, a minimized violation of protocols, and quality maintenance of the dispatcher-assisted CPR processes.

Study Design and Data Source

This is a cross-sectional study using a nationwide, prospective registry of OHCA in Korea. Data was collected from the following sources: EMS run sheets for ambulance operation information, EMS cardiac arrest and dispatcher CPR registries for the Utstein factors,^{19,20} and the National OHCA registry for hospital care and outcomes, these data are extracted by medical record reviewers of the Korea Centers for Disease Control and Prevention (CDC).¹⁴

Provincial EMS headquarters, which are operated by the national fire department, store electronic EMS run sheets.¹³ EMS providers recorded the EMS cardiac arrest registry for all EMS-transported OHCA, and medical control dispatchers recorded the dispatcher CPR registry for all potential OHCA cases identified by the primary call dispatchers. For every eligible patient, the EMS registry is linked to the national fire department's electronic database using the ambulance dispatch number and is integrated as a single episode.

Using the abovementioned registries, the Korea CDC reviewed medical records of all OHCA patients transported to hospitals by EMS personnel and extracted clinical information using structured forms based on the Utstein template. A quality management committee composed of emergency physicians, epidemiologists, statistical experts, representatives from the fire department, and medical record review experts, ensured quality of the medical record review processes. The quality management committee educated all medical record reviewers prior to joining the project, provided a standard manual for data abstraction, provided feedback to the reviewers on a monthly basis, and gave consultations in equivocal cases as needed.^{12,13}

Study Population

The study population was OHCA patients identified between January 2012 and December 2014 who were 18 years of age or younger. Patients were excluded from analysis if they did not receive resuscitative efforts or were witnessed by EMS providers. Cases were also excluded if they had missing information on bystander CPR or neurological outcomes at discharge.

Main Outcomes

The primary and secondary outcomes were survival and good neurological recovery at discharge from the hospital, as identified by medical record review. Good neurological recovery was recorded if the patient had a cerebral performance category score of 1 (good cerebral performance) or 2 (moderate cerebral disability; able to perform daily activities independently).

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