



Short communication

Cardiac arrest in schools: Nationwide incidence, risk, and outcome[☆]

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ABSTRACT

Aim: Schools are an important location for improving OHCA outcome. But there are few data on out of hospital cardiac arrest (OHCA) in schools. This study aimed to show incidence and outcome of OHCA in schools, specifying location and activities.

Methods: We used the Korean nationwide OHCA registry from 2008 to 2014. OHCA victims were categorized regarding level of school. The average annual incidence of OHCA was calculated based on per 1000 schools. The epidemiological characteristics are analysed and location and activity at the time of arrest is further described. The outcome of OHCA victims were analysed.

Results: 511 OHCA occurred in school while 374 cases were cardiac origin, 125 cases were non-cardiac, and 12 cases were missing in information. Annual incidence was 5.72 per 1000 school while highest incidence was shown in university (11.02 per 1000 school). The majority of victims were male (84.1%), aged 19–64 (62.2%, median 44.75), either students (35.0%) or visitors (35.2%). Most victims had none shockable rhythms, did not received EMS defibrillation and were not witnessed arrests, while most received bystander CPR. A large proportion of arrests occurred at an outdoor campus (29.7%) or sports facility (28.8%), and the most frequent activity was exercise (30.7%). 100 patients (19.6%) survived to discharge, and 66 patients (12.9%) were discharged with good neurological outcome.

Conclusion: Incidence of OHCA in school is low. Most of victims were adult visitors. About one third of OHCA occurred during sports activity or at the sports facility.

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Introduction

Sudden cardiac arrest is a tragic event for the patient's family and a significant health problem. Sudden cardiac arrest occurring at school is rare but has greater impact on the family and community because of the relatively younger age of victims.¹

In East Asian culture, the school campus is not only used for education, but also for various community activities, both on school days and holidays. Thus, there is increasing concern among students, faculty, other staff, and community members about health problems that occur in schools, including cardiac arrest.²

Use of an Automated External Defibrillator (AED) is one of the most effective ways to treat cardiac arrest. Previous studies reported relatively low use rates, but a school is considered an important candidate for an AED program.^{2,3} Some studies reported characteristics of AED use in school cardiac arrest, but the populations were relatively small and the results could not be generalised.^{3,4}

In this study, we used a large-scale, nationwide database to calculate the average annual incidence of school cardiac arrest, and analysed the epidemiological characteristics, with further categorization of activity and location in school at the time of arrest, as well as the outcome.

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Table 1
Annual incidence of OHCA in school by level and year during 2008–2014.

| | Annual average number of school | Total number of cardiac arrest | Annual incidence of cardiac arrest | | | | | | | Annual average incidence per 1000 school |
|------------|---------------------------------|--------------------------------|------------------------------------|------|------|------|------|------|------|--|
| | | | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | |
| Total | 12,765 | 511 | 6.8 | 5.5 | 4.7 | 4.2 | 6.4 | 5.9 | 5.6 | 5.7 |
| Elementary | 5874 | 127 | 2.6 | 2.2 | 2.4 | 2.7 | 4.4 | 4.4 | 2.9 | 3.1 |
| Middle | 3141 | 74 | 4.9 | 2.9 | 3.5 | 2.9 | 2.5 | 2.5 | 4.4 | 3.4 |
| High | 2272 | 125 | 11.0 | 9.0 | 6.2 | 7.9 | 7.0 | 6.9 | 7.3 | 7.9 |
| University | 1478 | 114 | 14.5 | 7.0 | 7.5 | 13.4 | 13.9 | 13.7 | 7.2 | 11.0 |
| Unknown | NS | 77 | 11 | 17 | 9 | 4 | 11 | 11 | 14 | NS |

Methods

Study setting

Emergency Medical Services (EMS) in South Korea is a single-tiered, government-based system that provides basic-to-intermediate level ambulance services.^{5,6} There are three levels of emergency departments designated by the national government according to resources and functional requirements.⁷ The public access AED program in South Korea was started in 2009, and deployment and training are in progress.

The Ministry of Education of South Korea identified 12,995 schools in 2014, including 5913 elementary schools, 3173 junior high schools, 2322 high schools, and 1549 universities and other higher educational facilities. The total number of students was 9,564,159, with 516,653 faculty or staff members.⁸

In 2014, the Ministry of Education announced the Regulation of School Health Act, which applied to elementary and middle school faculty.⁹ This regulation states that health teachers, physical education teachers, and sports educators should complete basic life support (BLS) training annually, while all the other faculties should complete BLS training every 3 years. School cardiopulmonary resuscitation (CPR) training is a 4-h program, including 2 h of lectures and 2 h of hands-on sessions in first aid, BLS, and AED use. There are currently 18,731 AEDs deployed at various public places in South Korea,¹⁰ while AED placement in schools is not required by law until 2015.

Data source

This is a retrospective, observational study using the Cardiovascular Disease Surveillance (CAVAS) database, which is a nationwide registry of Out-of-Hospital Cardiac Arrest (OHCA) patients in South Korea.⁵

Study population

All OHCA events that occurred in schools from January 2008 to December 2014 in South Korea were included. Patients with missing variables were excluded from the analysis.

Study variables

We classified the site of arrest into 4 categories: elementary, middle, and high school, and university. Basic demographic data variables and potential confounders included age, sex, occupation of the victim, season, time of day, day of week, witnesses, bystander CPR, EMS response time (time from call until ambulance arrival at the scene), EMS scene time (time from arrival at scene until departure), EMS transport time (time from departure from scene to arrival at hospital), primary rhythm, and pre-hospital defibrillation. Further information about the location and activity of the

victim at the time of arrest was obtained by reviewing individual records.

Outcomes

The outcomes of this study were the average annual incidence of OHCA in schools and victim outcomes. Victim outcome data included the incidence of survival to discharge from the hospital and the incidence of good neurologic outcomes. A good neurologic outcome was defined as Cerebral Performance Category (CPC) 1 or 2. Each outcome was calculated independently for cardiac arrest and non-cardiac arrest.

Statistical analysis

Demographic data of cardiac arrest victims were analysed, and descriptive statistics for categorical variables are presented as frequency distributions and percentages, while continuous variables are presented as median and interquartile ranges (IQR). The annual average incidence of OHCA in schools was calculated according to the annual average total number of schools in 2008–2014. The institutional review board waived consent for this retrospective study.

Results

From 2008 to 2014, there were 511 OHCA events in schools. The annual average incidence of OHCA per 1000 schools was 5.7; the highest incidence occurred in universities (11 per year) and the lowest in elementary school (3.1 per year) (Table 1).

Demographic findings

Table 2 summarises the demographic findings of school OHCA events according to school type. Among 511 arrests, the distribution was as follows: elementary school (N=120, 23.5%), middle school (N=76, 14.9%), high school (N=128, 25.0%), university and graduate school (N=116, 22.7%), and unspecified school type (N=71, 13.9%). The majority of victims were male (84.1%), aged 19–64 (62.2%, median 44.75), and were either students (35.0%) or visitors (35.2%). There was no significant seasonal variation or difference between weekdays or weekends, while most arrests occurred during working hours (6 AM–6 PM, 77.1%).

The EMS response time interval, scene time interval, and transport time interval were generally similar between school types but consistently longer in the unspecified school group. The majority of victims had no shockable rhythm, did not receive defibrillation by EMS, and were not witnessed arrests, but received more bystander CPR.

Activities and locations (Table 3)

The majority of arrests occurred at a sports facility (29.7%) or classroom (28.8%), or elsewhere on the campus (19.4%), but some

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