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Results of the first five years of the prehospital automatic external defibrillation project in Singapore in the "Utstein style"☆

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Abstract

In 1994, all emergency medical services (EMS) ambulance officers in Singapore were trained to perform pre-hospital defibrillation with semi-automated external defibrillators (AED). All non-traumatic cardiac arrest patients over 10 years old were included, excluding those who were obviously dead and children below 36 kg. The data were collected by the ambulance officers according to the Utstein guidelines. From 1 February 1994 to 31 January 1999; resuscitation was attempted in 968 non-trauma cardiac arrests. Fifteen percent of the cases were of non-cardiac origin. The overall survival rate was 40/968 (4.1%, 95% CI 2.9–5.6%). Of 968 patients, 22/136 (16.2%, 95% CI 10.4–23.5%), 18/622 (2.9%, 95% CI 1.7–4.5%) and 0/210 (0%, 95% CI 0–1.7%) survived in the EMS witnessed, bystander witnessed and un-witnessed groups, respectively ($P < 0.001$). Within the EMS witnessed group, those with an initial rhythm of VF/VT had a higher survival rate (30.6%) than those without VF/VT (4.1%). $P < 0.001$, OR = 10.3, 95% CI 2.9–36.9. Similarly, the VF/VT survival rate in the bystander witnessed group (4.5%) was higher than the non-VF/VT (1.0%) ($P = 0.011$, OR = 4.4, 95% CI 1.3–15.4). The survival rate of patients with bystander witnessed VF/VT arrest who received bystander CPR was 9.4% compared to 1.0% in those who did not ($P = 0.037$, OR = 4.4, 95% CI 1.01–20.1). Our survival rate of bystander witnessed VF/VT arrest is comparable to large metropolitan cities in the USA. The determinants of survival include EMS witnessed arrest and VF/VT arrest. Increased quantity and quality of bystander CPR rate may improve the outcome in bystander witnessed cardiac arrest.

Keywords: Automated external defibrillation (AED); Emergency medical services; Sudden cardiac death; Out-of-hospital CPR; Outcome; Bystander CPR

1. Introduction

Singapore is an island with an area of 648 km^2, and is one of the smallest countries in the world. With a population of 3.67 million (residential population: 3.07 million), it is also one of the most densely populated [1]. The emergency medical services (EMS) is provided solely by the emergency ambulance service (EAS) of Singapore Civil Defence Force (SCDF) which is also in-charge of the fire service. During the period covered by this report, the EAS ran a fleet of 15 ambulances situated at nine fire stations. Each ambulance is staffed with one ambulance officer who is a staff nurse (with midwifery experience and additional training in standard first aid, bag valve mask, Basic Trauma Life Support, cardio pulmonary resuscitation (CPR) and intravenous access but not trained to intubate or administer intravenous medications), an ambulance attendant (a former fireman also trained in standard first aid and CPR) and an ambulance driver. Prehospital defibrillation with automated external defibrillation (AED) by non-advanced life support ambulance crews had been shown to improve survival over CPR alone in many

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studies [2,3]. In 1989, 24 of the 80 ambulance officers were trained in semi-automatic cardiac defibrillation and a pilot programme was introduced to provide pre-hospital cardiac defibrillation, which began with two EAS ambulances. This programme was initiated by the Departments of Emergency Medicine and Cardiology at the Singapore General Hospital. Although a number of lives were saved, it was not until early 1994 when this service was extended to the remaining 13 ambulances. All 80 ambulance officers were trained to perform prehospital defibrillation with the Heartstart 3000 defibrillator. This project was code-named the Heartsave project.

It was decided to review the impact of this procedure on outcomes in the Singapore environment.

2. Materials and method

All non-traumatic cardiac arrest (trauma is defined as all those conditions described in the International Classification of Diseases with codes between 800 and 999 except poisonings, drownings and electrical lightning injuries) in patients above 10 years old were included. Absolute exclusions included: (i) those patients who were obviously dead as indicated by rigor mortis or dependent lividity; (ii) children under 10 years of age or 36 kg or 80 lb. Relative contraindications were terminal illness and debilitated patients. The data of the Heartsave project was collected prospectively by ambulance officers in a standard report format according to the Utstein guidelines [4]. Prehospital Utstein core and supplementary time events were recorded automatically by the computerised SCDF central dispatch system and AEDs. The watches of all ambulance officers and the AEDs were synchronised with the central dispatch clock at the beginning of each shift. Ambulance officers were asked to report if bystander cardiopulmonary resuscitation (CPR) was being performed on arrival at scene. They would ask the bystander the estimated time of collapse, when CPR was started, and also assess if both chest compressions and ventilation, only chest compressions or only ventilation were given. At the hospital, data collection was made by the attending emergency physicians. Subsequently, the authors and project research coordinators followed up patients admitted to intensive care or in hospital beds in the emergency department, reviewing case-notes and interviewing survivors. The cause of death was obtained from the review of case-notes, death certificates, post-mortem results and coroner's reports. Patients who did not fit the more readily defined cardiac arrest of non-cardiac aetiology (e.g. drug overdose, suicide, drowning, hypoxic exsanguination, cerebrovascular accident, subarachnoid haemorrhage) were included in cardiac aetiology.

All data analyses were performed using SPSS version 11.0. Continuous variables were presented using mean (S.D.), median (with 5% and 95% quartile and range); and frequencies with percentages for qualitative variables. Associations between categorial variables were assessed using the Chi-square or Fisher's exact tests. A logistic regression analysis was performed to determine the significant predictors that will affect survival outcomes. Statistical significance was set at $P < 0.05$ unless otherwise adjusted for multiple comparisons.

3. Results

Singapore is a multi-racial society. In 1996, the population consisted of Chinese (77.3%), Malay (14.0%), Indian (7.4%) and others (1.3%). The sex ratio was 1008 males per 1000 females, with 6.65% of population aged over 65 years. The distribution of population by age group in 1996 is shown in Table 1. The total number of deaths of residents in Singapore in 1996 was 14,429 (470 per 100,000 residential population). The life expectancy at birth is 74.6 years for males and 79.0 years for females. The top five leading causes of death in residents in 1996 were cancer (26.1%), ischaemic heart disease ICD code 410–414 (20.2%), cerebrovascular disease (12.0%), pneumonia (11.1%) and accidents, poisonings and violence (5.2%). The number of deaths in for ICD code 410–414 for men aged 55–64 and women aged 55–64 were 328 per 100,000 males resident population aged 55–64 years and 139 per 100,000 females resident population aged 55–64 years.

The emergency number for our emergency medical and fire services is 995. The emergency medical and fire dispatch use a computerised system that automatically displays the location and telephone number of the caller. The police emergency number is 999. The police operator will transfer the call to the emergency medical dispatch when an ambulance is needed, e.g. assault or unconsciousness etc. The EMS is a single tier response system. The emergency dispatcher will dispatch the nearest ambulance to attend to the call. No further information regarding the patients' symptoms and no pre-arrival instruction is given.

From 1 February 1994 to 31 January 1999; there were a total of 968 arrests of non-trauma origin in whom resuscitation was attempted. Fifteen percentage of these arrest cases were found to be of non-cardiac origin.

Table 1
The age of the Singapore resident population

Age group	%
0–4	7.85
5–14	14.72
15–24	14.16
25–34	18.69
35–44	19.15
45–54	11.57
55–64	7.21
65–74	4.32
75–84	1.84
85 and over	0.49
Total	100.00

Source: Department of Statistics (Singapore), 1996.