

Public use of external defibrillator in Hangzhou of China



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ABSTRACT

Background: Ventricular fibrillation (VF) is one of the causes of out-of-hospital cardiac arrest (OHCA). The increase in survival after out-of-hospital cardiac arrest is closely related to early detection and shortening the first defibrillation time. The implementation of AEDs deployment plan in public places in Hangzhou City provides an opportunity to improve the survival rate after out-of-hospital cardiac arrest, and the benefits and potentials are enormous. **Aims and Objective:** Placing AEDs in public areas can effectively treat patients with pre-hospital cardiac arrest, by evaluating the configuration and usage of public AEDs in Hangzhou during the past five years, to provide the basis for improving the public areas' configuration AEDs network layout and related training management. **Materials and Methods:** The number of AEDs in public areas, the use of AEDs and the treatment effect in Hangzhou city from 2015 to 2020 were collected. **Results:** The number of AEDs in public areas, the use of AEDs and the treatment effect in Hangzhou city from 2015 to 2020 were collected. In 5 years, a total of 1201 AEDs were configured, Placed in densely populated areas such as transportation hubs, schools, and scenic spots as the main locations. 32 patients suffered prehospital cardiac arrest and used AEDs, the average age of the patients was 40.56 ± 17.20 , and the ratio of male to female was 3.57:1, In 26 cases, the initial heart rhythm was ventricular fibrillation and defibrillation, Before the first aid personnel arrived, the first witnesses Implement rescue, 22 patients with ventricular fibrillation were resuscitated successfully, 10 cases failed to ROSC. In 6 patients with suspected cardiac arrest, there was no electric shock defibrillation, and the device correctly indicates that the problem is not caused by ventricular fibrillation, In 4 cases, there was no defibrillating rhythm. **Conclusion:** AEDs in public areas are effectively used to assist in the treatment of patients with cardiac arrest; It can increase the rate of main circulation recovery. We will further increase the number of AEDs in public places, promote first aid training programs for non-professionals, Improving the public health emergency network system is essential to improve the prognosis of patients with cardiac arrest.

Key words: Out-of-hospital cardiac arrest; AEDs; Public Areas defibrillation; Defibrillators

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INTRODUCTION

Out of hospital cardiac arrest (OHCA) is a major health problem associated with cardiovascular disease.^{1,2} In China, it is estimated that 544,000 individuals suffer from OHCA each year, but less than 1% of them survive on-site or at discharge. Research has suggested that each minute of delay in resuscitation equals to a 10% decrease in survival.³ Early

defibrillation is essential to improve survival rates. The use of automatic external defibrillators (AEDs) has been shown to increase survival rates up to 75%.^{4,5} Although the rapid use of defibrillators is highly reversible, but even with immediate CPR, Ventricular fibrillation is still fatal within a few minutes. According to reports, less than 3% of OHCA patients are defibrillated before emergency medical services (EMS) arrive.^{6,7} Public access to the automated external

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defibrillator (AEDs) is an effective approach for rapid and early defibrillation.^{8,9,10} After the corresponding training, non-medical personnel (for example, flight attendants or security personnel) can use AEDs in the workplace. To save the lives of patients. Starting in May 2015, Hangzhou city started to promote the public areas' defibrillator program. Now we have made the following evaluation on the use of AEDs in the past five years.

MATERIALS AND METHODS

Setting

Hangzhou is located in the Yangtze River Delta region, which is one of the most developed, most dynamic and most potential areas in Chinese economy and is rapidly rising as the world's sixth largest city agglomeration. Since 2015, AEDs are placed in places with heavy traffic (airports, stations, subways), shopping malls with dense crowds, schools, and hotels. For example, Hangzhou Railway Station covers an area of 400,000 square meters. The average annual passenger flow is 80 million. Approximately 3,250 staff members have received cardiopulmonary resuscitation and AEDs skills training. Every year, Hangzhou City provides 150,000 people with basic training in cardiopulmonary resuscitation and the use of automatic external defibrillators.

Number and location of AEDs

May 2015 to December 2020, A total of 1201 AEDs are deployed in Hangzhou city (Figure 1: AEDs map), Among them, 10 AEDs are placed on the railway station. Defibrillation equipment is installed in waiting room and arrival exit. The AEDs is placed in a cabinet with a glass surface. The distance is about 3 minutes (Figure 2). There are obvious signs next to the defibrillator, Warning signs indicate that AEDs cannot be moved or improperly used. The cabinet is equipped with audible alarms and strobe lights. These devices are activated when the cabinet door is opened.

It uses the defibrillator (Bernhardt D1 Pro) produced by Mindray, working principle adopts biphasic wave defibrillation technology. Each electric shock produces about 150 joules of energy. Defibrillation mode selection is divided into adults and children. After defibrillation, there will be a voice prompt function of pressing rhythm during CPR. At the same time, the electrocardiogram is displayed on the LCD screen of the AEDs. The AED's LCD screen displays the electrocardiogram.

AEDs data

The digital data card in the defibrillator will record the ECG data. Machine prompts, the energy of the electric

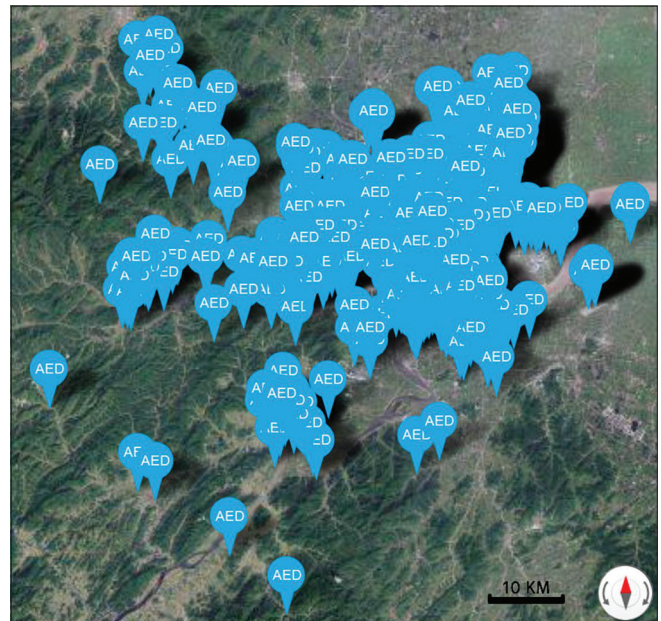


Figure 1: AEDs map of part of Hangzhou city

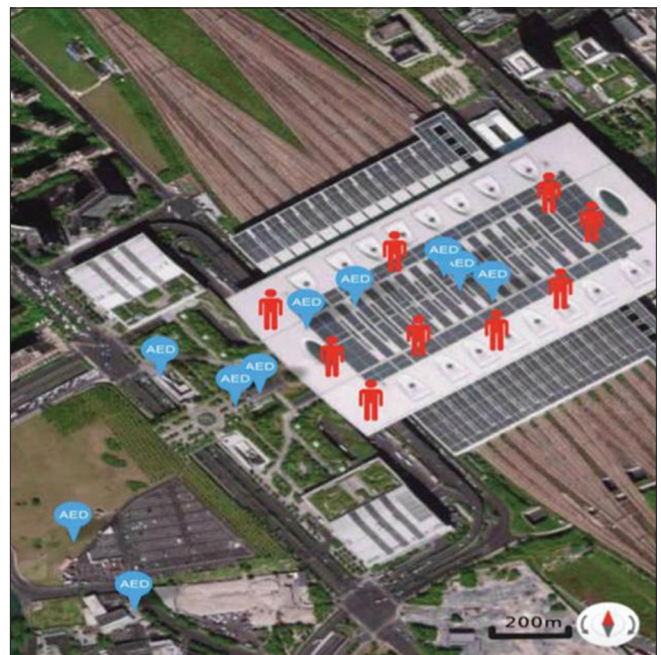


Figure 2: The location of the train station AED and the location of 9 patients with cardiac arrest

shock, and the time of all events the actual time of cardiac arrest cannot be determined. However, when the AEDs is used, it will record the time from the bystander (for example, by opening the door of the defibrillator cabinet) to the first shock, the initial heart rhythm, the number of shocks, and the recovery of spontaneous circulation. Information about whether bystanders have performed cardiopulmonary resuscitation, the patient's

condition data is obtained from the records of emergency personnel.

Statistical methods

Spss20.0 software was used for analysis, All data were tested for normality. Normally distributed data is represented by the mean, Non-normal data is represented by the median.

RESULTS

AEDs configuration and use

As the AEDs configuration increases, it has become easier for patients with cardiac arrest to obtain AEDs, and the number of uses has increased. The number of AEDs in public areas has increased from 15 in 2015 to 1201 in 2020. The proportion of patients who received public AEDs electric shock defibrillation due to cardiogenic ventricular fibrillation arrest witnessed by bystanders increased, Increase from 0.14% in (2 out of 1402 patients) to 0.46% in 2020 (7 out of 1520 patients) (Figure 3).

Clinical features

In 5 years, a total of 1201 AEDs were deployed in the public areas of Hangzhou city, provided 32 rescue behaviors for pre-hospital cardiac arrest patients. The average age of the patients was 40.56±17.20, and the male to female ratio was 3.57:1. Among them, the initial rhythm of 26 cases was ventricular fibrillation, 3 cases were PEA, 1 case was ventricular arrest, 1 case was supraventricular arrhythmia, and 1 case was normal sinus rhythm. All 26 patients with ventricular fibrillation received AED electric shock defibrillation. The remaining 6 cases were not given electric shocks when the defibrillators were operating normally. The median time of initial defibrillation provided by the AEDs for defibrillating heart rhythms is 62.5 (40.25)'S (Table 1).

Effect of defibrillation

Automated external defibrillators can work normally in all 32 patients with ventricular fibrillation. Immediately determine whether an electric shock is required and perform electric shock defibrillation. In all patients, the AEDs was operated by witnesses or airport staff before the arrival of emergency medical services. Among the 32 patients with cardiac arrest, 26 had ventricular fibrillation whose initial heart rhythm was ventricular fibrillation, and Return of spontaneous circulation (ROSC) at the scene after defibrillation by electric shock in 6 patients indicated failure to defibrillate, and 4 patients never had a defibrillating rhythm. On-site cardiopulmonary resuscitation Non-Return of spontaneous circulation. Thirteen patients were defibrillated within 60 seconds after the AEDs was switched on. Despite the rapid use

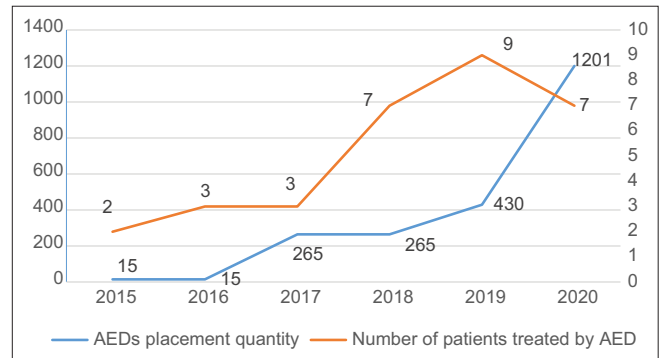


Figure 3: Configuration and treatment of AED in public areas

Table 1: Characteristics of 32 patients receiving AEDs defibrillation

	Return of spontaneous circulation (ROSC)(n)	Non-Return of spontaneous circulation (N-ROSC)(n)	Total (n)
Gender			
Male	18	7	25
Female	4	3	7
Age			
<50 years old	13	8	21
≥50 years old	9	2	11
Location			
Transportation hub	13	3	16
Other	9	7	16
Initial rhythm			
Defibrillatory rhythm	17	9	26
Non defibrillator rhythm	5	1	6
Startup defibrillation time*			
≤60 seconds	9	4	13
>60 seconds	11	4	15
Defibrillation times			
0	2	2	4
1	6	4	10
2	5	1	6
≥3	9	3	12

*4 of them never had a defibrillating rhythm, and AEDs was not defibrillated

of defibrillators, four patients were still in persistent ventricular fibrillation and eventually died were 15 patients whose defibrillation time was more than 60 seconds, 11 patients Return of spontaneous circulation (ROSC) at the scene, One patient received initial defibrillation for 27 minutes;12 patients received AED defibrillation more than 3 times. Before the arrival of pre-hospital first responders, four patients received 5 times of electric defibrillation (Table 1).

DISCUSSION

In the past five years, the number of AEDs in public areas in Hangzhou city was 1201, The configuration standard is about 10 sets per 100000 people. There are 16.3 sets per 100000 people in the main urban area, there is still a considerable gap with Lu Chuanzhu *et al.*,¹¹ suggesting to follow the standard of “100 to 200 AEDs per 100,000 people”. We found that the number of people using AEDs in public places increased. Most patients with ventricular fibrillation are resuscitated by witnesses within minutes, Witnesses immediately used the automatic defibrillator, On-site Return of spontaneous circulation (ROSC) to 67.7%. We confirmed the previous evidence; Defibrillation in public places is associated with an increased probability of survival after out-of-hospital ventricular fibrillation cardiac arrest.¹²⁻¹⁴ In contrast, the estimated survival rate of traditional pre-hospital emergency medical service is still less than 1%. Therefore, the start time of early electric shock defibrillation is an important factor affecting the success of cardiopulmonary resuscitation.^{15,16}

All patients for this study received cardiopulmonary resuscitation and AEDs defibrillation; The shortest time of initial defibrillation in patients with cardiac arrest was 48 seconds; One patient received initial defibrillation 27 minutes after CPR, It shows that even trained witnesses, It also takes a while to deliver defibrillation, Witnesses who also did not receive basic training of cardiopulmonary resuscitation and AEDs, It may take a longer time to provide initial defibrillation. Sixteen cases of cardiac arrest occurred in the transportation hub, 50% of the total cases. Due to the timely and effective emergency response of witnesses at the scene, 13 patients successfully defibrillated and Return of spontaneous circulation (ROSC) on-site, Implementation of the AEDs promotion program in public places. It has an obvious effect to train the staff of railway station, subway and other transportation hubs with normal cardiopulmonary resuscitation and AEDs skills.

We also found that increasing the number of public AEDs and shortening the time of the first shock was positively correlated with the number of patients who survived; This is consistent with reported study of Kitamura T *et al.*^{17,18} For example, there are more AEDs in Hangzhou Railway Station, and the number of people treated and the success rate are significantly higher than those in other areas. According to the American Heart Association, guidelines¹³and-related AEDs placement strategy.

Recommendations^{19,20}

AEDs can be obtained and used from any location in a public place within a 1.0 minute to 1.5-minute walk. Although the number of AEDs in public places has

increased in the past five years, but in most places the configuration of AEDs is still insufficient. Moreover, the relationship between the location of AEDs in public places and their effectiveness needs to be investigated, Many AEDs are located in buildings or other places that cannot be used at night or on weekends.²¹ This reduces the availability of a common automated external defibrillator. AEDs public planning process should be strengthened, training non-professionals. Establish a connection with the pre-hospital emergency system and a system for maintaining equipment and monitoring quality improvement.²²

This study shows that the initial heart rhythm of 81.25% of patients with cardiac arrest is ventricular fibrillation. For all other initial rhythms, the AEDs was invalid and not programmed, and no defibrillation command was issued. For patients with the out-of-hospital cardiac arrest that cannot be defibrillated, AEDs defibrillation is not applicable or ineffective.

CONCLUSION

Public area AEDs is a comprehensive program; It requires careful planning and supervision of government departments, relevant public training, and quality management. To maximize the effectiveness of these projects, the reasonable public health strategy is to formulate the standard of AEDs allocation in public areas and corresponding regulations. Encourage the development of more intelligent automatic external defibrillators. They should be installed in a suitable public area.²³ There should be a training program to promote everyone's ability to take immediate action in an emergency.²⁴ Increasing the incidence of ROSC and the survival rate after discharge from the hospital is essential to improve the prognosis of patients with cardiac arrest.²⁴

LIMITATIONS OF THIS STUDY

First, we only obtained data on cases where AEDs were used in public places and caused electric shocks. Second, there is a lack of information about bystanders who use AEDs, including those who witnessed out-of-hospital cardiac arrest and electrical shocks. Third, as with all epidemiological studies, data integrity and validity are potential limitations of our study.

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Author's Contribution:

JXS-Concept and design of the study; Interpreted the results; prepared first draft of manuscript; **YK**-Statistically analyzed and interpreted, revision of the manuscript; **ZG**-Concept, coordination, review of literature; **ZH**-Reviewed the literature and manuscript preparation.

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