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ARTYKUŁ ORYGINALNY / *ORIGINAL ARTICLE*

Automated external defibrillator use in public places: a study of acquisition time

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Abstract

Background: Sudden cardiac arrest (SCA) is a frequent cause of death in the developed world. Early defibrillation, preferably within the first minutes of the incident, significantly increases survival rates. Accessible automated external defibrillators (AED) in public areas have been promoted for many years, and several locations are equipped with these devices.

Aim: The aim of the study was to assess the real-life availability of AEDs and assess possible sources of delay.

Methods: The study took place in the academic towns of Poznan, Lodz, and Warsaw, Poland. The researchers who were not aware of the exact location of the AED in the selected public locations had to deliver AED therapy in simulated SCA scenarios. For the purpose of the trial, we assumed that the SCA takes place at the main entrance to the public areas equipped with an AED.

Results: From approximately 200 locations that have AEDs, 78 sites were analysed. In most places, the AED was located on the ground floor and the median distance from the site of SCA to the nearest AED point was 15 m (interquartile range [IQR] 7–24; range: 2–163 m). The total time required to deliver the device was 96 s (IQR 52–144 s). The average time for discussion with the person responsible for the AED (security officer, staff, etc.) was 16 s (IQR 0–49). The AED was located in open access cabinets for unrestricted collection in 29 locations; in 10 cases an AED was delivered by the personnel, and in 29 cases AED utilisation required continuous personnel assistance. The mode of accessing the AED device was related to the longer discussion time ($p < 0.001$); however, this did not cause any significant delay in therapy ($p = 0.132$). The AED was clearly visible in 34 (43.6%) sites. The visibility of AED did not influence the total time of simulated AED implementation.

Conclusions: We conclude that the access to AED is relatively fast in public places. In the majority of assessed locations, it meets the recommended time to early defibrillation of under 3 min from the onset of the cardiac arrest; however, there are several causes for possible delays. The AED signs indicating the location of the device should be larger. AEDs should also be displayed in unrestricted areas for easy access rather than being kept under staff care or in cabinets.

Key words: public access defibrillation, automated external defibrillator, pre-hospital defibrillation, cardiac arrest

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INTRODUCTION

Sudden cardiac arrest (SCA), especially out-of-hospital cardiac arrest (OHCA), is a leading cause of death among adults over the age of 40 years in the United States and other developed countries in the world [1, 2]. The most frequent rhythm encountered amongst victims of sudden cardiac death is ventricular fibrillation (VF), which is usually secondary to pulseless ventricular tachycardia (VT) [3]. If untreated, VT will degenerate to VF and subsequently lead to asystole within 12–15 min. Electrical defibrillation is the most effective treatment for VT/VF [4]. A report published in the United States shows that approximately 326,000 people of all ages experience Emergency Medical Services (EMS)-assessed out-of-hospital non-traumatic SCA each year. 95% of people who experience SCA die as a result, mainly because treatment within minutes is not accessible [5]. SCA is a life-threatening condition; however, it can be treated successfully through early intervention with cardiopulmonary resuscitation (CPR), defibrillation, or advanced cardiac life support. When bystanders intervene by giving CPR and using automated external defibrillators (AEDs) before EMS arrive, then four out of ten victims have a chance to survive. Following out-of-hospital cardiac arrest, it is generally acknowledged that bystander CPR increases long-term survival rates by two to three times. Every minute defibrillation is delayed the probability of survival decreases by 10% to 12% [6, 7]. It is estimated that one in three patients survive when the arrest is witnessed by a trustee able to provide basic life support. Moreover, a 30-day survival rate improvement was achieved mainly among patients who had received bystander CPR [8, 9]. Survival is crucially dependent on reducing the delay of administering shock delivery. Conditions for defibrillation are optimal for only as little as 90 s after the onset of arrhythmia, so any delay beyond that can be critical. Two factors have a significant impact on adult survival from VF sudden cardiac arrest: the time from collapse to defibrillation and the time from collapse to CPR. If bystander CPR begins immediately after collapse, the fall in survival is more gradual, decreasing 3% to 4% for every minute between collapse and defibrillation [10, 11].

A public access defibrillation strategy has been introduced to deliver life-saving electrotherapy much earlier than ambulance-dependent defibrillation strategies — in locations where members of the public usually witness the arrest [12, 13]. The simplicity of operating the AED has greatly reduced training requirements and extended the range of people who are able to provide defibrillation [14]. AEDs are sophisticated, computerised devices that are reliable and relatively simple to operate, enabling lay rescuers with minimal training to administer this lifesaving intervention [15]. Bystanders' use of AED significantly improves prognosis after SCA [16]. Based on these observations, networks of public access defibrillators are introduced in populated areas to shorten the delay between SCA and defibrillation. There is no data and little is known about factors affecting the time of shock delivery in real life. The aim of the study was to assess real-life availability of AEDs and assess possible sources of delay.

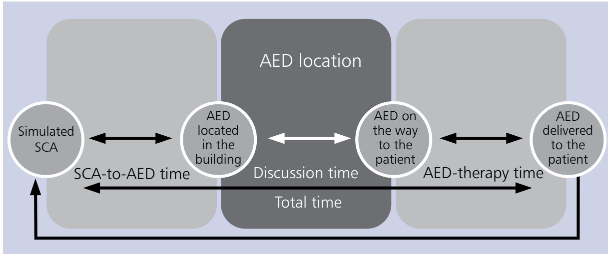

Figure 1. Methodology time parameters; EAD — automated external defibrillators; SCA — sudden cardiac arrest

METHODS

The study was performed in the academic cities of Poznan, Lodz, and Warsaw, Poland which have approximately 200 AEDs available in public areas. The researchers, who were not aware of the exact location of the AED in the selected buildings, had to deliver AED therapy in simulated SCA patients. Eighty-eight public locations equipped with AED were randomly chosen for the evaluation. A team of two researchers entered the building in an attempt to receive AED for a hypothetical SCA scenario. In each location researchers were not familiar with the exact location of the AED — only staff assistance and/or visual information (tags, posters, indicators, etc.) were used to find the device. For the purpose of the trial it was assumed that SCA takes place at the main entrance of the facility equipped with AED. The duration of several steps before the therapy delivery was measured, namely: time from SCA to AED delivery (total time), time from SCA to locating the AED (SCA–AED time), time between locating the AED and obtaining the device (getting AED time), and the time from obtaining AED and being able to deliver therapy (AED–therapy time). The devices were located in three sites:

- available without restriction in non-supervised areas;
- requiring permission from the staff to obtain the AED;
- requiring continuous assistance from the staff — the delay in obtaining the AED was also separately measured (named–discussion time; Fig. 1).

In reality, no AED was taken from its original location — the aim was to measure the time needed to locate the device, acquire it, and then deliver it to the hypothetical patient, without engaging the real device into therapy. One member of the research team was obliged to stay with the staff to provide an immediate explanation of the nature of the research, to assure that no real EMS system would be unnecessarily activated, to verify the staff's training level, and any other potentially important factors for the public defibrillation programme. Corresponding factors that were assessed

Table 1. Median discussion time is significantly ($p < 0.05$) longer in locations where automated external defibrillators (AED) are not displayed for unrestricted access. Staff assistance significantly affects the duration of discussion

Mode of access to AED	n	Median	25.0th percentile	75.0th percentile	Minimum	Maximum	Kruskal-Wallis test	
							H	p
AED provided without further assistance of the staff	10	60.0	30.0	60.0	20.0	78.0		
AED available with the assistance of a staff member	29	42.0	12.0	49.0	5.0	129.0	47.7	< 0.001
AED displayed for free access	36	0.0	0.0	0.0	0.0	31.0		

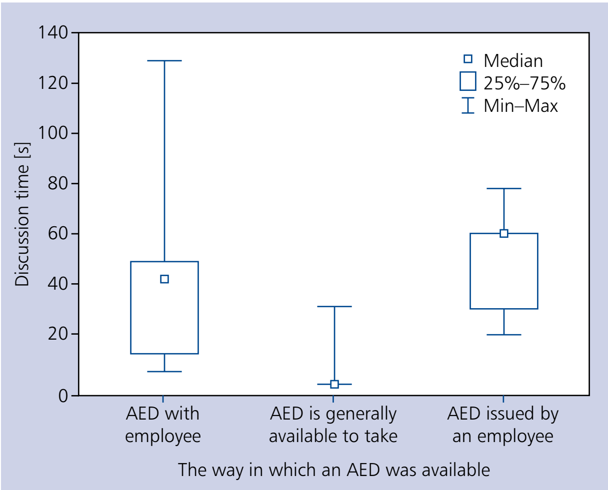

Figure 2. Box plot — comparison of three observed ways of accessing automated external defibrillators (AED) to discussion time (Mann-Whitney test, $p = 0.001$)

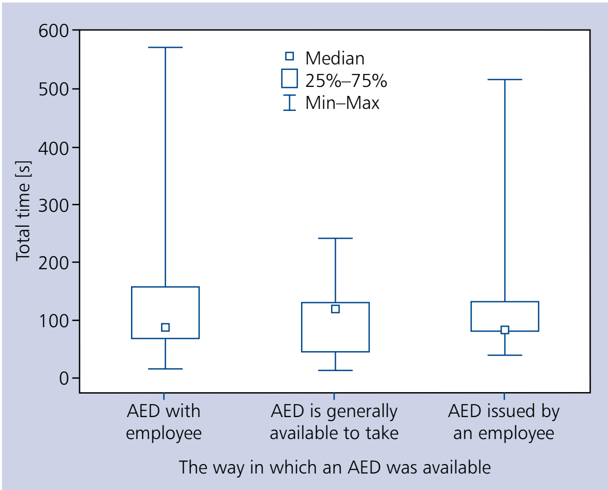

Figure 3. Box plot — comparison of three observed ways of accessing automated external defibrillators (AED) to total time needed to deliver the therapy (Mann-Whitney test, $p = 0.8$)

included: device visibility, location in the building, use of graphic signs and tags for information, and staff's training level.

RESULTS

From the 88 tested locations, the simulation of AED usage was successful in 84 sites (at nine sites, the AED was unavailable due to technical reasons). Only four sites clearly indicated the location of an AED in the building using an international ILCOR sign for AED. The median distance from SCA site (main entrance) and AED was 17 m (interquartile range [IQR] 7–24; range: 2–163 m), and in most places the AED was located on the ground floor, except in three buildings. The total time was 96 s (IQR 52–144), and the median discussion time was 16 s (IQR 0–49). The AED was located in open access cabinets for unrestricted use in 29 locations; in 10 cases an AED was delivered by the personnel and in 29 cases AED utilisation required the continuous personnel assistance. The mode of access to AED was related to the longer discussion time ($p < 0.001$; Table 1, Fig. 2); however, this did not cause any delay to therapy ($p = 0.132$; Fig. 3).

The AED was clearly visible in 34 (43.6%) sites. The visibility of AED did not influence the total time of simulated AED implementation ($p = 0.116$). Previous staff training had no impact on the delay — workers that had no previous training did not cause a longer delay than fully trained certified staff ($p = 0.798$; Fig. 4).

One location equipped with the AED did not provide the device at all despite multiple attempts and explanations lasting up to 10 min, after which the simulation was ceased. The staff there was not trained and not aware of the public access defibrillation strategy on site, hence there was no permission to take the device away from its location.

DISCUSSION

Sudden cardiac arrest is one of the leading causes of death in Europe and the United States. Depending on how we define SCA, about 350,000–700,000 individuals a year are affected in Europe [1, 17], and 326,000 inhabitants in the United Sates [18], and over 20% of those incidents occurring in public settings [19]. Most of the cardiac arrests occur in the elderly population with a mean age of 69 years [20]. Based on

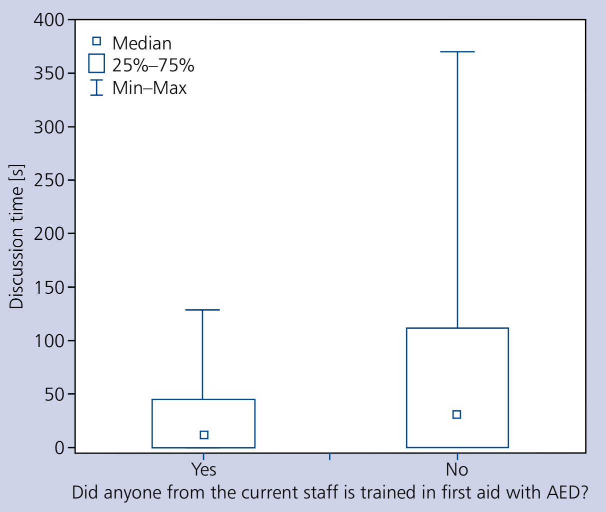

Figure 4. Box plot — comparison of non-trained vs. trained staff discussion time (Mann-Whitney test; $p > 0.05$); AED — automated external defibrillators

various trials and recommendations, in the adult population common cardiac arrest rhythm is VF or pulseless ventricular tachycardia. In this case, the European Resuscitation Council and the American Heart Association have recommended defibrillation treatment as fast as possible [7, 21, 22]. Defibrillation within 3–5 min of collapse can produce survival rates as high as 50–70% [1, 23, 24]. Moreover, for each minute delay in defibrillation from the onset of SCA, the probability of survival decreased by 10–12% [10, 11]. A study conducted by Weisfeldt et al. [25] indicated a significant and important impact of Public Access Defibrillation (PAD) programmes in community-based settings. Moreover, they showed that early AED defibrillation before EMS arrival seems to nearly double the victim's chance of survival after out-of-hospital cardiac arrest.

In our study, the simulations directly measured the amount of time needed to utilise the AED with factors that potentially affect it in public locations. It is reasonable to assume, that the results obtained in our field of research are similar to those that would be achieved in a real-life scenario. Much attention was paid to simulate the need for the device as realistically as possible. The periods of time needed to acquire AEDs are not unacceptably long, but still there is much space for improvement. The delay observed is correlated with the mode of access to the AED, and most of the delay is due to discussion with the staff aimed at granting permission to get the AED. Surprisingly, locations with the trained employees provided the device in a similar time manner to places with untrained staff. There was no statistical difference in delay according to visibility of the device in the buildings, but it is necessary to understand that the nature of our simulation assumed that the lay rescuers had no prior knowledge of the presence of the device in the building. It is possible that limited visibility of the AED can be a significant factor in delaying the time it takes to obtain the device and administer the first shock. This can lead to people providing patients with life support, to not be able to locate the AED at all, which poses a threat to the overall survival of the patient. Currently, there are no data available regarding similar research, so it is not possible to directly compare the results of our study to other public areas providing AED.

Our study is the first attempt to report on the availability of AED devices in Poznan. Despite growing access to public automated defibrillators, there are significant obstacles for the rescuers to acquire the device without delay. It is presumed that public access to AEDs in the abovementioned locations could result in drastic improvement in saving human lives [26]. We observed that a large number of facilities do not visibly display the device for free-range access and do not train the staff. This leads to unnecessary delay in potentially life-saving therapy. Early defibrillation is a key link in the chain of survival, and minimising the time-to-shock interval is a pivotal step in improving the probability of survival. Simple measures could be taken to potentially improve the outcome of SCA patients. In general, the results of our study show that sites acquiring the devices should pay attention to displaying the AED for easy collection, provide clear information for visitors about PAD programme implementation, and train the staff to underline the need for fast defibrillation. Even brief training increases the willingness to use an AED [23], hence the authors organised training sessions, events, and courses covering topics in basic life support/AED training.

CONCLUSIONS

We conclude that the access to AED is relatively fast in public places. In the majority of assessed locations, it meets the recommended time to early defibrillation of under 3 min from the onset of the cardiac arrest; however, there are several causes for possible delays. The AED signs indicating the location of the device should be larger. AEDs should also be displayed in unrestricted areas for easy access rather than being kept under staff care or in cabinets.

Conflict of interest: *none declared*

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