Available online at www.sciencedirect.com

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Clinical paper

Public access of automated external defibrillators in a metropolitan city of China

Lin Zhang[a], *Boyu Li*[b], *Xufeng Zhao*[b], *Yiqin Zhang*[b], *Yiting Deng*[b], *Anqi Zhao*[b], *Wenjie Li*[b], *Xuejie Dong*[a], *Zhi-Jie Zheng*[c,*]

[a] *Shanghai Jiao Tong University School of Public Health, Shanghai, China*
[b] *Shanghai Jiao Tong University School of Medicine, Shanghai, China*
[c] *Peking University School of Public Health, Beijing, China*

Abstract

Background: Public access of automated external defibrillator (AED) is an important public health strategy for improving survival of cardiac arrest. Major metropolitan cities in China are increasingly investing and implementing public access defibrillator programs, but the effectiveness of these programs remains unclear. This study aims to evaluate the public accessibility of AED in Shanghai, a major metropolitan city in China.

Methods: From July 1 to September 30, 2018, all AED locations indicated by AED Access Map Apps were visited and investigated in three most densely distributing areas of AED (Huangpu District, Xuhui District, and Central Area of the Pudong New District) in Shanghai. Two AED Access Map APPs were used to identify the location of AEDs. Characteristics of and the barriers to access, the AED sites were recorded. Awareness and skills of first aid and AED among on-site staff of the AED installation sites were evaluated.

Results: A total of 283 sites were marked on two AED Apps. One hundred and seventy (60%) locations were accessible, and 142 (50%) were actually with AEDs installed. Among those AED installed sites, 112 (79%) were completely identifiable to the information on the maps, 20 (14%) were inconsistent and 10 (7%) were inaccurate on the maps. Ninety-four (66%) AEDs had visible signs and information around the location, 7 (5%) AEDs had signs outside of the location, and 107 (75%) sites had educational instructions. In addition, 230 individuals who were around the AED site were interviewed. Among them, 79 (34%) had good knowledge of AED. After shown the picture of AED, 112 (49%) knew whether there was AED in the site, and 108 (47%) knew the AED's location. Eighty-seven (38%) staff have received first aid training, and among them 26 (30%) reported that they had skills in operating the AED.

Conclusions: Public placement and accessibility of AEDs, related public signs and information on AED, and staff's awareness about AED were not optimal in Shanghai. Continuing efforts should be made to improve public accessibility and public awareness, knowledge, and user skills of AED.

Keywords: Automated external defibrillator, Cardiac arrest, AED map, Awareness, China

Introduction

Out-of-hospital cardiac arrest (OHCA) is a major public health challenge in China and worldwide. 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.[1,2] Research has suggested that each minute of delay in resuscitation equals to a 10% decrease in survival rate.[3] Early access to emergency medical system, bystander CPR, early defibrillation are the key elements to a better survival rate. For example, bystander cardiopulmonary resuscitation (CPR) doubles the survival rate and early defibrillation could lead to 75% increase in survival rates for witnessed OHCA.[4,5] The quality of CPR can be essentially improved by dispatcher-assisted CPR and regular basic lifesaving trainings on laypeople.[6–8] Moreover, public access to automated external defibrillator (AED) is an effective approach for rapid and early defibrillation.[5,9]

* Corresponding author at: Department of Global Health, Peking University School of Public Health, 38 Xue Yuan Road, Beijing 100191, China.
E-mail address: zhengzj@bjmu.edu.cn (Z.-J. Zheng).

https://doi.org/10.1016/j.resuscitation.2019.05.015
Received 14 February 2019; Received in revised form 27 April 2019; Accepted 16 May 2019

As part of efforts to implementing international and national guidelines such as those of the American Heart Association (AHA) and the European Resuscitation Council,[10,11] public access defibrillation (PAD) programs have been widely promoted in majority western and several Asian countries.[12–14] Whereas AEDs are cost-effective in settings with high cardiac arrest incidence, with most studies reporting a threshold of $100,000 in quality-adjusted life years,[15] barriers of bystander defibrillation achievable and public knowledge gap of the AEDs also highlight in several studies.[16–19] Shanghai, one of the pioneering cities in China, has experienced increasing development and utilization of AED in conjunction with AED maps and mobile apps to facilitate individual AED location for public in the past few years. Despite the establishment of PAD program in Shanghai, the accessibility and effectiveness of these AEDs are unclear. We therefore conducted an observational study to evaluate the accessibility of the AEDs, actuality of the AED placement, and assess the management and public awareness of AED to identify major barriers. Ultimately, we hope the findings of this study could help establish evidence-based strategies for promoting and implementing PAD in China.

Methods

Study design and setting

From July 1 to September 30, 2018, we conducted an observational, survey-based study to identify AED accessibility through field visits guided by AED map mobile Apps and interviewing staff or employees working around the AED sites in Shanghai, China.

The geographical data on AED location were searched by AED map mobile Apps. Two most used AED map apps, one developed by Shanghai Medical Emergency Center/Red Cross, and the other, First-Responder Life-Saving Map, were used. These Apps are regularly updated by the developers and vendors, with the most recent updates occurred in May and June 2018. Three downtown districts (Huangpu, Xuhui, and the Pudong New District) out of 11 districts in Shanghai were selected for this study. These three districts are typical areas with high density in residence and business, encompassing over 1200 km^2 with a total of 7.2 million population. As of July 6, 2018, there were 182 and 185 AEDs register on these two maps, respectively. Eighty-four overlapping AED addresses were excluded after matching the AED labeled addresses. Thus, a total of 283 AED locations that were registered on those two AED maps were included in the final analyses. Detail information on these locations can be found in the Table 1.

Six research staff (Boyu L, Xufeng Z, Yiqin Z, Yiting D, Anqi Z, Wenjie L) were assigned to look for AEDs individually and interviewed the relevant staff. The research staff were divided into three teams and each responsible for one district. Staff were trained prior to the field survey and standardized questionnaires and data collection tools were used for data collection.

The surveys were conducted on working days and working hours from Monday to Friday between 10 am and 5 pm. The research team first independently located the exact placement (such as floor) of the AED within the building at the address identified by the AED map Apps. If the AED could not be found, they would ask the first available employee beginning with introducing themselves, their affiliation, the research purposes, and whether the building had accessible AED. In addition, they asked about the employee's awareness and training experience in AED and/or CPR. If the employee did not know or were not sure what an AED was, the research staff would show the pictures of AEDs and explain the purpose of an AED. If the first individual queried was unsure about this survey and interview, they would be asked to report the case to their manager or obtain another staff who may know the information about AED. Every attempt was made to ensure that the AED location could be confirmed and that the individuals most likely to cooperate for the accuracy of the information.

This study was approved by the Joint Research Ethics Board of the Shanghai Jiao Tong University Schools of Public Health and Nursing, and no informed consent for participants was required (SJUPN-201714).

Data collection on AED location and accessibility

For identified AEDs, detailed AED location, building accessibility, AED installation, and relevant posting signs were recorded during the field survey. AED visibility, AED box and lock, the presence of a hammer, the condition of the AED, the battery, the quantity of electric charges, the presence of relevant signs, the operational instruction and maintenance record, and the visibility of signs and instructions were obtained through the visual inspections by research team. The AEDs and their surrounding environment were also photographed for records.

Survey of on-location employees and personnel

The first available on-location employee such as front desk or security personnel, and the manager of the business in the building or the nearest construction were interviewed randomly. The information was collected on the nature of the job, knowledge about the AED, knowledge about the presence and location of AED in the building, whether the AED could be brought out, whether he or she had CPR training and their level of AED skills. If the interviewee had training, information about the type and the training date were asked. Any obstacles encountered from the staff during the survey were also recorded.

Table 1 – Number of AEDs identified from the two AED map Apps in Shanghai, China, 2018.

District name	Number of AEDs	The Shanghai Medical Emergency Center/Red Cross AED Map	The First-Responder Life-Saving Map	Overlapping AEDs on both Maps
HuangPu	47	37	19	9
XuHui	48	42	11	5
PuDong New Area	188	103	155	70
Total	283	182	185	84

AED information collect date till July 6, 2018.

Statistical analysis

Summary statistics characterized buildings accessibility, AED characteristics, and employee awareness of AED. The categorical variables were reported as number with proportions. To test if there were any significant differences in proportions between groups we used a Pearson's Chi^2-test or Kruskal–Wallis test. The p value <0.05 was considered statistically significant. All statistical analyses were performed using IBM SPSS statistical software (Version 22).

Results

AED locations and availability

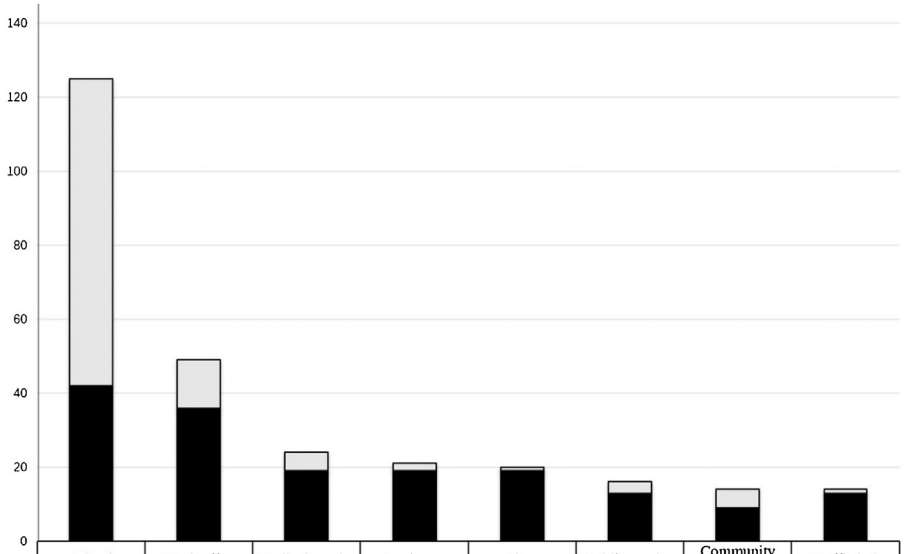
Of the total of 283 registered AED locations, 170 (60%) locations were publicly accessible and remaining 113 (40%) were inaccessible to public (Fig. 1). AEDs in schools (125) accounted for the largest proportion (44%) of all labeled AED locations on the AED maps but with the lowest accessible rate (34%). Among the 170 accessible locations, 142 AEDs were identified. Of these identified AEDs, 29 (20%) were in schools, another 29 (20%) were in business offices, 19 (13%) in medical service facilities, 18 (12.7%) in shopping centers, 15 (11%) in scenic spots, 13 (9%) in public service buildings, 12 (8.5%) in traffic hubs, and 7 (5%) in residential community service centers. Among these 142 identified AEDs, 112 (79%) were in the locations completely consistent to the labeled address on the map apps, while 20 (14%) were inconsistent and 10 (7%) inaccurate on these maps.

Onsite AED installation

All of the 142 identified and visualized ones, AEDs were installed in the specialized cabinet and sited inside the buildings with their availability only during the working hours. One hundred thirteen (113, 80%) AED cabinets were locked with keys. Of these, 29 (25.7%) were with keys obtainable from staff, 13 (11.5%) with keys nearby the cabinets, and 71 (62.8%) with no information about how to get the keys. All 113 locked AEDs were equipped with a hammer to break the box in case of an emergency. One hundred twenty-two (86%) AEDs were visible from all angles, 16 (11%) were in locations that were partially obstructed and only 4 (3%) not in easily visible locations. In 94 (66%) AEDs, visible signs of the AEDs were found nearby. Most of the signs (97%) were unobstructed and easily recognizable. However, few AED signs were beyond the proximity of the AED location: just 7 (5%) buildings marked outside with a sign that there is an AED inside of the building or a sign that can guide the way to find these AEDs. Of the 78 visualized electric charges, 76 (97.4%) were 2/3 to full quantity of electricity (Table 2).

Employee personnel interviews

Of a total of 230 personnel interviews, 79 (34%) answered that they knew AED. Of the remaining 151 who did not know about AED, 37 (24%) recognized the AED after seeing the pictures and 114 (76%) still did not know about AED after seeing the pictures. Of these interviewed, 108 (47%) knew the exact location of the AED in the building, 4 (2%) knew there was an AED in the building but could not point to the exact location, 118 (51%) did not know there was an AED in the building. Eighty-seven (38%) individuals interviewed have taken first-aid training courses, with front desk/security staff less likely be trained compared with the managers or other employees (30% vs 65% vs 58%, P = 0.002). Among the trained employees, 54 (62%) and 26 (30%) reported that they had the simulation training or had on-hand CPR and AED practice during the training, respectively (Table 3).



	School	Work office	Medical service	Scenic spot	Shop	Public service	Community service	Traffic hub
□Inaccessible	83 (66.4%)	13 (26.5%)	5 (20.8%)	2 (9.5%)	1 (5%)	3 (18.7%)	5 (35.7%)	1 (7.1%)
■Accessible	42 (33.6%)	36 (73.5%)	19 (79.2%)	19 (90.5%)	19 (95%)	13 (81.2%)	9 (64.3%)	13 (92.9%)

Fig. 1 – AED Placements by location type: Shanghai, China, 2018. Medical service centers include 10 hospitals, 6 community health centers, and 8 nursing homes; public services centers include 3 hotels, 3 museums, 3 churches, 3 gyms, 1 bank, 1 library, 1 theater, and 1 exhibition; community service centers included 8 residential community offices and 6 residential buildings; traffic hub included 13 metro stations and 1 railway station.

Table 2 – AED onsite installation and posting survey: Shanghai, China, 2018.

	Total	Schools	Business offices	Medical service facilities	Shopping centers	Scenic spots	Public service buildings	Traffic hubs	Community services	P value
Number of AEDs, N, (%)	142 (100)	29 (20.4)	29 (20.4)	19 (13.4)	18 (12.7)	15 (10.6)	13 (9.2)	12 (8.5)	7 (4.9)	
AED installation										
AED cabinet locked	113 (79.6)	28 (96.6)	21 (72.4)	8 (42.1)	16 (88.9)	14 (93.3)	11 (84.6)	12 (100)	6 (85.7)	<0.001
Method to get the key (n = 113)										0.004
Ask for working staff	29 (25.7)	4 (14.3)	10 (47.6)	1 (12.5)	7 (43.7)	1 (7.14)	5 (45.4)	12 (100)	1 (16.7)	
Key available nearby AED	13 (11.5)	3 (10.7)	1 (4.8)	2 (25)	1 (6.3)	5 (35.7)	1 (9.1)	0	0	
Do not know	71 (62.8)	21 (75)	10 (47.6)	16 (62.5)	8 (50.0)	8 (57.1)	5 (45.4)	0	5 (83.3)	
AED attached with a hammer	113 (79.6)	21 (72.4)	25 (86.2)	10 (52.6)	16 (88.9)	14 (93.3)	9 (69.2)	12 (100)	6 (85.8)	0.01
AED visibility										0.38
Unobstructed	122 (85.9)	24 (82.8)	26 (89.7)	16 (84.2)	13 (72.2)	13 (86.7)	13 (100)	12 (100)	5 (71.4)	
Partially obstructed	16 (11.3)	4 (13.8)	2 (6.9)	3 (15.8)	4 (22.2)	2 (13.3)	0	0	1 (14.3)	
Severely obstructed or hidden	4 (2.8)	1 (3.4)	1 (3.4)	0	1 (5.6)	0	0	0	1 (14.4)	
AED relevant signs										
AED signs nearby the AEDs	94 (66)	13 (44.8)	19 (65.5)	14 (73.7)	12 (66.7)	12 (80.0)	8 (61.5)	10 (83.3)	6 (85.7)	0.15
Unobstructed visibility of signs	91 (97)	13 (100)	19 (100)	12 (85.7)	12 (100)	11 (91.7)	8 (100)	10 (100)	7 (100)	0.31
Relevant signs outside the field of vision	7 (5)	1 (3.4)	2 (6.9)	0	0	4 (26.7)	0	0	0	0.03
Education instruction for CPR & AED	107 (75)	13 (44.8)	25 (86.2)	15 (78.9)	13 (72.2)	13 (86.7)	10 (76.9)	12 (100)	6 (85.7)	0.002
Maintenance records	77 (54)	8 (27.6)	20 (69.0)	5 (26.3)	12 (66.7)	11 (73.3)	7 (53.8)	12 (100)	2 (28.6)	<0.001
Permission to bring out (n = 99)										0.01
Yes	74 (52.1)	18 (62.1)	15 (51.7)	9 (47.4)	13 (72.2)	12 (80.0)	4 (30.8)	1 (8.3)	2 (28.6)	
Yes with supervisor permission/presented certificates	12 (7.7)	2 (6.9)	2 (6.10)	1 (5.3)	1 (5.6)	1 (6.7)	4 (30.8)	0	0	
No	6 (4.2)	1 (3.4)	1 (3.5)	1 (5.3)	1 (5.6)	0	1 (7.7)	0	1 (14.3)	
Do not know	7 (4.9)	8 (27.6)	11 (37.9)	8 (42.1)	3 (16.7)	2 (13.3)	4 (30.8)	11 (91.7)	4 (57.1)	

Table 3 – Awareness and training experience of selected employees in the AED-located buildings: Shanghai, China, 2018.

	Total	Front desk/security	Manager	Other employees	P value
Number of respondents	230 (100)	174 (75.6)	20 (8.7)	36 (15.6)	
AED awareness					<0.001
Knew what is AED	79 (34.3)	44 (25.3)	15 (75.0)	20 (55.6)	
Knew what is AED after shown the picture	37 (16.1)	31 (17.8)	3 (15.0)	3 (8.3)	
Did not know AED	114 (49.6)	99 (56.9)	2 (10.0)	13 (36.1)	
AED location					
Knew exact AED location	108 (46.9)	67 (38.5)	17 (85.0)	24 (66.7)	<0.001
Knew AED somewhere here, but not the exact location	4 (1.7)	3 (1.7)	1 (5.0)	0	
Did not know there is an AED in this place	118 (51.3)	104 (59.7)	2 (10.0)	12 (33.3)	<0.001
Have taken the first aid training	87 (37.8)	53 (30.4)	13 (65.0)	21 (58.3)	0.002
Have practiced CPR (n = 87)	54 (62.1)	31 (58.5)	11 (84.6)	12 (57.1)	0.05
Have practiced AEDs (n = 87)	26 (29.9)	9 (17.0)	9 (69.2)	8 (38.1)	<0.001
Time since trained (n = 87)					0.23
<0.5 year	20 (23.0)	12 (22.6)	2 (15.4)	6 (28.6)	
0.5–1 year	12 (13.8)	5 (9.4)	4 (30.8)	3 (14.3)	
1–2 years	27 (31.0)	18 (34.0)	5 (38.5)	4 (19.0)	
>2 years	17 (19.5)	13 (24.5)	0	4 (19.0)	

Discussions

As early defibrillation is an essential component of the chain of survival, AEDs significantly improve the survival rate of OHCA patients by automatically evaluate heart rhythm and defibrillate when VT/VF is present.[5,20–23] In this study, we found that the PAD program in Shanghai, China is less optimal, compared with the well-developed programs in western countries. In addition, the awareness and knowledge of the potential first contacts or responders in the AED-located buildings are low. Considering the complexity of AED installation and setup as well as the lack of the awareness and knowledge of employees, the expectation for applying early defibrillation to cardiac arrest patients by laypersons in the field as a potential solution for improving patient survival may not be easily met in China.

With the advancement of information and communication technology, AED map Apps could ideally help EMS professionals and lay-persons conveniently identify and find the nearest available AEDs in case of an emergency. Our survey indicates an extremely low dissemination and coverage of AEDs in Shanghai, China. In an area covered over 1200 km^2 with a total of 7.2 million residential population, there were only 283 AEDs labeled on two AEDs maps with only 142 on-site confirmed available AEDs. The population coverage of 0.02 AEDs per 1000 residents approximates only 0.5% of those in well-established countries such as Netherlands (4.7 AEDs/1000 residents), Sweden (4.2), Japan (3.2), or United States (3.1).[17,19,22,24,25] AHA recommends that an "on-site" AED needs to provide within 1–1.5 min brisk walk from a cardiac arrest.[26,27] Even abundant coverage of 7500 AEDs (1.3 AEDs/1000 inhabitants) in Denmark AED network, the probability of bystander defibrillation decreased rapidly related to the distance from cardiac arrest to nearest accessible AED (0 m 35.7% [95% confidence interval 28.0%–43.5%], 100 m 21.3% [17.4%–25.2%], and 200 m 13.7% [10.1%–16.8%]).[27] Although there is lack of OHCA registry calculated survivor data in China, our findings indicate that the coverage of onsite AEDs might be far less than anticipated, and the rate of survival could be much lower than reported in the literature.

Despite substantial studies of, and major improvement in PAD programs in developed countries, the rate of public bystander defibrillation of OHCA is low worldwide, around 2%–4%.[21,25,28] Lack of available "on-site" AEDs is associated with lower rates of early initiated CPR and worse outcomes.[17,18,29,30] Strategic placement of AED is essential to increase the likelihood of public access to the devices, particularly in public places where cardiac arrests frequently occur,[10,31] or home where two-third of OHCAs cases occur.[19] In this study we found that 40% of AEDs marked on the maps were actually not publicly accessible, mainly due to the locations like schools or governmental buildings that have restricted access for security reasons. We also found that only 7 (5%) accessible AEDs were in residential settings and none of those AEDs are accessible at night or on weekend suggests inappropriate distribution and deployment and less optimal management. Thus, better population and public health strategies are required on AED placement in order to fully benefit from the PAD program in case of an emergency when patients having an acute cardiac event.

Development of a multi-dimensional guide to the AED locations is one of the challenges to the current mobile technology. Majority of the AED location labeled on mobile apps is accurate only for the address or a landmark, but not precise on exact floor in city high-rises or compounds, thus onsite visual guides or signs are extremely important.[16] In our study, very few buildings provide guides and AED signs beyond the proximity of AED location, similar to those for emergency exits, fire extinguishers or restrooms. Thus, we believe more detailed and standardized guides or policies on the AED installation may be required such as the PAD signages we proposed in Fig. 2a–c.

Public awareness and knowledge of CPR and AED are another major key element to cardiac arrest survival and public knowledge and

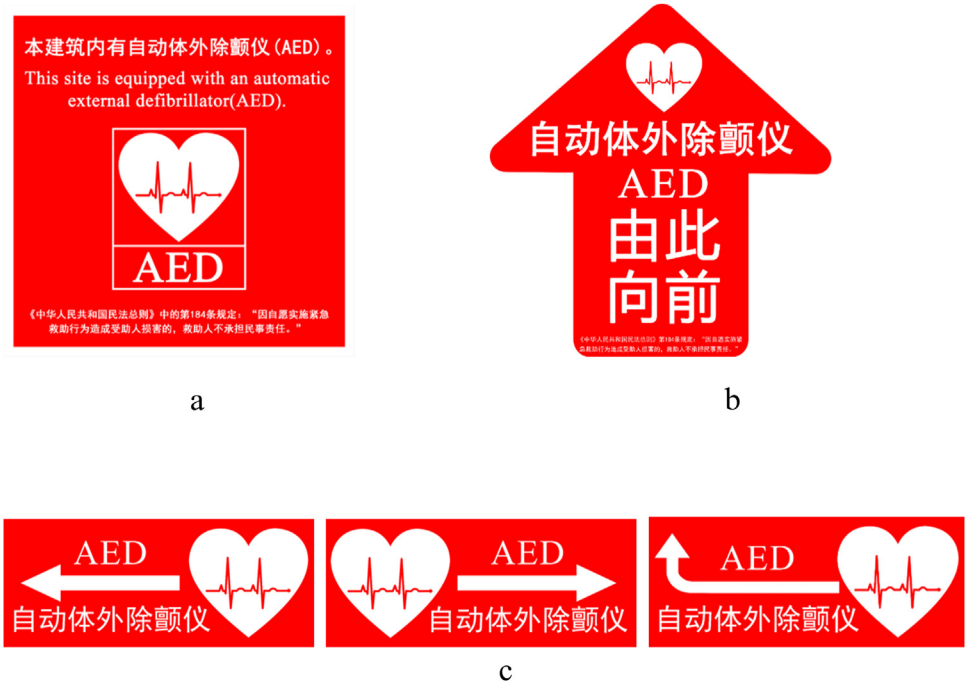


Fig. 2 – The recommended AED signages. (a) Outdoor signage to indicate an AED inside the building. (b) On-ground signage to show the way to the AED location straight forward. (c) Signages to show ways to AED location left, right or in the corner.

confidence in using AED remains problematic.[32–37] In China, less than 1% of public have received CPR training and only 4.5% bystander CPR were performed in case of cardiac arrest.[32] Front desk security personnel and other relevant staff are the designated or potential first contacts or first responders in case of an emergency. Unfortunately, our study indicated that the awareness and knowledge of these first contacts or responders are poor, and they are less likely to receive CPR/AED training compared to other staff.

There are several limitations of this study: (1) the study covers only three downtown districts and may not be representative of entire Shanghai, where socioeconomic and population characteristics are vast different among districts, thus the findings from this study may not be generalizable to entire Shanghai, even less so for entire China. (2) While there were 6 competing AED maps in Shanghai, we chose to use 2 most popular AED map Apps for our investigation due to the reasons that the chosen AED maps were designated by authoritative agencies and they were conveniently searchable by smartphone devices. (3) There may have been AEDs that were not registered and not visualized in the maps with inaccurate address. Nevertheless, this study provides a first glance at the PAD program in China.

National efforts are needed to increase the proportion of the general public who recognize signs and symptoms of a heart attack or cardiac arrest and who are willing to participate in the "chain of survival," which includes dialing 1-2-0, attempting cardiac resuscitation, and using automated external defibrillators until emergency personnel arrive. A national guideline on AED placement, installation and setup that could make AEDs easier to find and more accessible. A national AED registry that include precise address, as well as better public education could help eliminate potential barriers identified in this study.

Conclusions

The placement and public accessibility of AEDs, public signs and information and staff's awareness about AED were not optimal in Shanghai. National efforts are needed to raise the public awareness and knowledge of cardiac arrest and CPR and improve the public access of AED.

Financial supports

N (Grant No. 81703303), S (Grant No. 17PJC070) and the Heart Rescue China Program. This study was supported by the National Natural Science Foundation of China (Grant No. 81703303), Shanghai Municipal Government Pujiang Research Development Program (Grant No. 17PJC070) and Innovative Research Team of High-level Local Universities in Shanghai.

Conflict of interest

None.

Acknowledgements

We wish to acknowledge pioneering works from the Shanghai Medical Emergency Center, Shanghai Red Cross, and first responder for establishing the AED maps and related Apps for public use. In addition, we thank all the organizations who allocate the resources for AEDs and make AEDs accessible to the public for saving the lives.

REFERENCES

1. Shao F, Li CS, Liang LR, Li D, Ma SK. Outcome of out-of-hospital cardiac arrests in Beijing, China. Resuscitation 2014;85:1411–7.
2. Zhang S. Sudden cardiac death in China: current status and future perspectives. Europace 2015;17:ii14–8.
3. Cummins RO, Ornato JP, Thies WH, Pepe PE. Improving survival from sudden cardiac arrest: the "chain of survival" concept. A statement for health professionals from the Advanced Cardiac Life Support Subcommittee and the Emergency Cardiac Care Committee, American Heart Association. Circulation 1991;83: 1832–47.
4. Pollack RA, Brown SP, Rea T, et al. Impact of bystander automated external defibrillator use on survival and functional outcomes in shockable observed public cardiac arrests. Circulation 2018;137:2104–13.
5. Hallstrom AP, Ornato JP, Weisfeldt M, et al. Public-access defibrillation and survival after out-of-hospital cardiac arrest. N Engl J Med 2004;351:637–46.
6. Lu C-H, Fang P-H, Lin C-H. Dispatcher-assisted cardiopulmonary resuscitation for patients with traumatic out-of-hospital cardiac arrest. Resuscitation 2016;106:e40–1.
7. Møller TP, Andréll C, Viereck S, Todorova L, Friberg H, Lippert FK. Recognition of out-of-hospital cardiac arrest by medical dispatchers in emergency medical dispatch centres in two countries. Resuscitation 2016;109:1–8.
8. Cartledge S, Bray JE, Leary M, Stub D, Finn J. A systematic review of basic life support training targeted to family members of high-risk cardiac patients. Resuscitation 2016;105:70–8.
9. Bækgaard Josefine S, Viereck S, Møller Thea P, Ersbøll Annette K, Lippert F, Folke F. The effects of public access defibrillation on survival after out-of-hospital cardiac arrest. Circulation 2017;136:954–65.
10. Perkins GD, Handley AJ, Koster RW, et al. European Resuscitation Council Guidelines for Resuscitation 2015: section 2. Adult basic life support and automated external defibrillation. Resuscitation 2015;95:81–99.
11. Kleinman Monica E, Brennan Erin E, Goldberger Zachary D, et al. Part 5: adult basic life support and cardiopulmonary resuscitation quality. Circulation 2015;132:S414–35.
12. Kitamura T, Iwami T, Kawamura T, Nagao K, Tanaka H, Hiraide A. Nationwide public-access defibrillation in Japan. N Engl J Med 2010;362:994–1004.
13. Colquhoun MC, Chamberlain DA, Newcombe RG, et al. A national scheme for public access defibrillation in England and Wales: early results. Resuscitation 2008;78:275–80.
14. Fleischhackl R, Roessler B, Domanovits H, et al. Results from Austria's nationwide public access defibrillation (ANPAD) programme collected over 2 years. Resuscitation 2008;77:195–200.
15. Holmberg MJ, Vognsen M, Andersen MS, Donnino MW, Andersen LW. Bystander automated external defibrillator use and clinical outcomes after out-of-hospital cardiac arrest: a systematic review and meta-analysis. Resuscitation 2017;120:77–87.
16. Sidebottom DB, Potter R, Newitt LK, Hodgetts GA, Deakin CD. Saving lives with public access defibrillation: a deadly game of hide and seek. Resuscitation 2018;128:93–6.
17. Merchant RM, Asch DA. Can you find an automated external defibrillator if a life depends on it? Circ Cardiovasc Qual Outcomes 2012;5:241–3.
18. Deakin CD, Shewry E, Gray HH. Public access defibrillation remains out of reach for most victims of out-of-hospital sudden cardiac arrest. Heart 2014;100:619–23.
19. Ringh M, Hollenberg J, Palsgaard-Moeller T, et al. The challenges and possibilities of public access defibrillation. J Intern Med 2018;283:238–56.

20. Weisfeldt ML, Everson-Stewart S, Sitlani C, et al. Ventricular tachyarrhythmias after cardiac arrest in public versus at home. N Engl J Med 2011;364:313–21.
21. Kitamura T, Kiyohara K, Sakai T, et al. Public-access defibrillation and out-of-hospital cardiac arrest in Japan. N Engl J Med 2016;375:1649–59.
22. Weisfeldt ML, Sitlani CM, Ornato JP, et al. Survival after application of automatic external defibrillators before arrival of the emergency medical system: evaluation in the resuscitation outcomes consortium population of 21 million. J Am Coll Cardiol 2010;55:1713–20.
23. Ringh M, Jonsson M, Nordberg P, et al. Survival after public access defibrillation in Stockholm, Sweden — a striking success. Resuscitation 2015;91:1–7.
24. Cobb LA, Eliastam M, Kerber RE, et al. Report of the American Heart Association Task Force on the future of cardiopulmonary resuscitation. Circulation 1992;85:2346–55.
25. Wissenberg M, Lippert FK, Folke F, et al. Association of national initiatives to improve cardiac arrest management with rates of bystander intervention and patient survival after out-of-hospital cardiac arrest. JAMA 2013;310:1377–84.
26. Aufderheide T, Hazinski MF, Nichol G, et al. Community lay rescuer automated external defibrillation programs: key state legislative components and implementation strategies: a summary of a decade of experience for healthcare providers, policymakers, legislators, employers, and community leaders from the American Heart Association Emergency Cardiovascular Care Committee, Council on Clinical Cardiology, and Office of State Advocacy. Circulation 2006;113:1260–70.
27. Sondergaard KB, Hansen SM, Pallisgaard JL, et al. Out-of-hospital cardiac arrest: Probability of bystander defibrillation relative to distance to nearest automated external defibrillator. Resuscitation 2018;124:138–44.
28. Moon S, Vadeboncoeur TF, Kortuem W, et al. Analysis of out-of-hospital cardiac arrest location and public access defibrillator placement in metropolitan Phoenix, Arizona. Resuscitation 2015;89:43–9.
29. Schnaubelt S, Krammel M, van Tulder R, et al. Public access defibrillation is insufficiently available in rural regions — when layperson efforts meet a lack of device distribution. Resuscitation 2018;126:e4–5.
30. Hansen CM, Wissenberg M, Weeke P, et al. Automated external defibrillators inaccessible to more than half of nearby cardiac arrests in public locations during evening, nighttime, and weekends. Circulation 2013;128:2224–31.
31. Aufderheide T, Hazinski Mary F, Nichol G, et al. Community lay rescuer automated external defibrillation programs. Circulation 2006;113:1260–70.
32. Xu F, Zhang Y, Chen Y. Cardiopulmonary resuscitation training in China: current situation and future development. JAMA Cardiol 2017;2:469–70.
33. Brooks B, Chan S, Lander P, Adamson R, Hodgetts GA, Deakin CD. Public knowledge and confidence in the use of public access defibrillation. Heart 2015;101:967.
34. Kozlowski D, Klosiewicz T, Kowalczyk A, et al. The knowledge of public access to defibrillation in selected cities in Poland. Arch Med Sci 2013;9:27–33.
35. Deakin CD, Shewry E, Gray HH. Public access defibrillation remains out of reach for most victims of out-of-hospital sudden cardiac arrest. Heart 2014;100:619.
36. Kragholm K, Wissenberg M, Mortensen RN, et al. Bystander efforts and 1-year outcomes in out-of-hospital cardiac arrest. N Engl J Med 2017;376:1737–47.
37. Fredman D, Ringh M, Svensson L, et al. Experiences and outcome from the implementation of a national Swedish automated external defibrillator registry. Resuscitation 2018;130:73–80.