Resuscitation 80 (2009) 854–858

Contents lists available at ScienceDirect

Resuscitation

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

Clinical paper

Community public access sites: Compliance with American Heart Association recommendations☆

Sarah E. Haskell[a], Michael Post[b], Peter Cram[c], Dianne L. Atkins[a,*]

[a] University of Iowa Children's Hospital, Carver College of Medicine, University of Iowa, Iowa City, IA 52242, United States
[b] University of Iowa College of Public Health, Iowa City, IA 52242, United States
[c] Department of Internal Medicine, Carver College of Medicine, University of Iowa, Iowa City, IA 52242, United States

ARTICLE INFO

Article history:
Received 18 November 2008
Received in revised form 14 April 2009
Accepted 20 April 2009

Keywords:
Cardiac arrest
Public access defibrillation
Automated external defibrillators
Cardiopulmonary resuscitation

ABSTRACT

Background: Public access defibrillation (PAD) programs are a major goal of the American Heart Association (AHA) to ensure that automated external defibrillators and trained lay rescuers are available in public areas where sudden cardiac arrest (SCA) is likely to occur. The Johnson County Early Defibrillation Task Force (JCEDTF) is a volunteer organization which distributed AEDs throughout Johnson County, Iowa. JCEDTF was responsible for initial training but ongoing support was the responsibility of each site.
Objective: The purpose of this study was to evaluate compliance of community PAD sites to recommendations for site maintenance as proposed by the American Heart Association (AHA).
Methods: Thirty-two surveys were distributed to community PAD sites that received assistance from JCEDTF. PAD sites were categorized into business, educational, or community sites. A twenty-five point scoring system to assess PDA programs was developed based on AHA recommendations. On-site evaluations were conducted to verify survey results and assess barriers to an effective PAD site. Differences among the three categories were measured with ANOVA.
Results: No site was able to comply with all the AHA guidelines for a PAD site. The mean score among all sites was 57% of possible points with no significant differences among the three categories. Business sites were more compliant with ongoing training compared to educational and community sites ($p < 0.022$).
Conclusions: Community PAD sites in Johnson County currently do not comply with the recommendations for effective PAD sites. After initial training and establishment of community PAD sites, better methods for assuring ongoing training and maintenance are needed for sites to be effective.

1. Introduction

Sudden cardiac arrest (SCA) is a major cause of death in United States.[1] Ventricular fibrillation is a common rhythm abnormality detected in SCA which is effectively treated only if delivery of an electric shock to chest occurs quickly. For every minute delay in defibrillation, survival rates fall 7–10%.[2]

Automated external defibrillators (AEDs) are designed to distinguish between shockable and non-shockable cardiac arrest rhythms and to deliver a shock, if indicated. In 1994, the American Heart Association (AHA) began recommending lay rescuer AED programs to improve survival rates of out-of-hospital SCA in adults. Public access defibrillation (PAD) programs became a major goal of AHA.[3] The goal of PAD programs is to shorten the time from onset of ventricular fibrillation until CPR and shock delivery by ensuring that AEDs and trained lay rescuers are available in public areas where SCA is likely to occur. The AHA has published recommendations for the elements of an effective PAD site. These include: a planned and practiced response; ongoing training of anticipated rescuers in CPR and use of AEDs; links with local EMS agencies and a process of ongoing quality improvement.[4,5]

The Johnson County Early Defibrillation Task Force (JCEDTF) is a volunteer, non-profit organization incorporated in 2002 with the primary goal of reducing death and disability resulting from SCA through use of AEDs. The JCEDTF Board of Directors includes paramedics, nurses, and physicians from the local EMS agencies and hospitals, law enforcement officers, and representatives from the American Red Cross and the AHA. The goals of JCEDTF are to develop awareness in Johnson County about the importance of early public access defibrillation; serve as a resource to individuals and organizations who wish to establish public access defibrillation programs and develop a strategic plan to prioritize locations

☆ A Spanish translated version of the abstract of this article appears as Appendix in the final online version at doi:10.1016/j.resuscitation.2009.04.033.

* Corresponding author at: Division of Pediatric Cardiology, University of Iowa, 200 Hawkins Drive, Iowa City, IA 52242-1083, United States. Tel.: +1 319 356 3540; fax: +1 319 356 4693.
E-mail address: dianne-atkins@uiowa.edu (D.L. Atkins).

0300-9572/$ – see front matter © 2009 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.resuscitation.2009.04.033

in Johnson County where the need is greatest to place AEDs. The task force is supported by donations and grants. All AEDs were purchased with grant funds. JCEDTF equipped or assisted with the purchase of AEDs within first responder units and AEDs in community PAD sites.

Johnson County has a population of 120,000 persons in a geographical area of 623 square miles. One-half of the population is in Iowa City, which is 10% of the land area. Coralville is a small contiguous town, and the remaining population is rural. First responder units within separate fire and law enforcement units are dispatched to all medical calls within the county. Johnson County Ambulance Service is the sole 911 provider for the county and responds to 50–60 cardiac arrests annually. Although the average response time within Iowa City limits is 5–6 min, the average county-wide response time is 15 min. Thus, effective PAD sites may significantly improve survival.

The purpose of this study was to evaluate adherence of the community PAD sites to the AHA guidelines for PAD sites after program initiation. We hypothesized that the components of an effective PAD program were present in sites that received or purchased AEDs in Johnson County and that programs were maintained over time.

2. Methods

2.1. Participants and survey distribution

In 2002, JCEDTF established a priority list to determine appropriate PAD locations which was based on prior arrest locations. Those sites were contacted directly, and if interested, were provided funds for AEDs and initial training. Additional sites independently requested assistance with AED purchase and these requests were accommodated. Sites for this study received assistance from the JCEDTF between 2002 and 2004. JCEDTF provided or assisted with initial CPR training and AED operation at all sites. Information on AED maintenance and recommendations for repeat training every 2 years was provided at program initiation, but no additional support was available from JCEDTF.

A seven-page survey was mailed to each PAD site contact person in 2006. Surveys collected demographic information about each site and questions of the point scoring system (see below) and budgeted costs to maintain the PAD site. Surveys included specific answer choices for each question in order to standardize the answers. After return of each survey, an attempt was made to perform an on-site evaluation. All site evaluations were conducted by one author (MP). Site evaluations confirmed survey responses, viewed location of AEDs, and assessed any barriers to finding or using AEDs.

PAD sites were separated into three groups consisting of education, business, and community sites. Educational sites included public schools and one community college. Community sites included churches, shopping malls, libraries, and public recreational centers. Business sites ranged from small, locally owned businesses to major corporations. Number of employees at businesses ranged from less than 50 to more than 500.

This study was approved by the University of Iowa Institutional Review Board.

2.2. Point scoring system

A twenty-five point scoring system was developed by the investigators and derived from the AHA four major components of an effective PAD site.[5] Multiple elements with each component were defined and assigned numeric values (Table 1). The point value for each element was assigned empirically by the investigators, weighting elements related to delivery of CPR and use of the AED higher (training and program maintenance) than systems issues

Table 1
Twenty-five point scoring system for survey.

Planned and practiced response

How many employees are trained in CPR?
- 2-point: 100% of the employees are trained.
- 1-point: 50% of employees are trained.
- 0.5-point: 25% of the employees are trained.
- 0.25-point: 10% of employees are trained.
- 0-point: less than 10% of the employees are trained.

How many employees are trained in the use of AED?
- 2-point: 100% of the employees are trained.
- 1-point: 50% of employees are trained.
- 0.5-point: 25% of the employees are trained.
- 0.25-point: 10% of employees are trained.
- 0-point: less than 10% of the employees are trained.

How many employees are trained in both CPR and the use of an AED?
- 2-point: 100% of the employees are trained.
- 1-point: 50% of employees are trained.
- 0.5-point: 25% of the employees are trained.
- 0.25-point: 10% of employees are trained.
- 0-point: less than 10% of the employees are trained.

What efforts have been undertaken to confirm that employees know of the existence and location of the AED?
- 1-point: employees received an in-service on the existence and location of the AED(s) upon initial hire, or some other means of information communicating to the employee that the site has an AED and its location.
- 0-point: no efforts have been made to confirm that employees know of the existence and location of the AED.

What steps have been taken to minimize the likelihood of tampering/vandalism/theft of the AED?
- 1-point: defibrillator is placed in a controlled location, in a protective wall mounting, or some other mechanism is in place to prevent/alert when the device is being tampered with or removed from its case.
- 0-point: defibrillator is not placed in a controlled location, and is not in a protective wall mounting.

Do you have a written policy established on the use of the AED?
- 1-point: yes, there is a written policy established.
- 0-point: no written policy established.

What type of ongoing maintenance program do you have?
- 2-point: daily AED check.
- 1.75-point: weekly AED check.
- 1.5-point: monthly AED check.
- 1.25-point: quarterly AED check.
- 1.0-point: yearly AED check.
- 0-point: no maintenance check.

Do you document the maintenance?
- 1-point: yes, maintenance is documented.
- 0-point: no maintenance documentation occurs.

Is the location of an AED placed so that it can be reached with ninety seconds from all areas of the program site?
- 1-point: yes.
- 0-point: no.

Are the AEDs in locations that are accessible during all hours that your facility is in operation?
- 1-point: yes
- 0-point: no

Training of anticipated rescuers in CPR and use of the AED

Is a trained rescuer present at all times?
- 2-point: trained rescuer is present 100% of business hours of operation.
- 1.5-point: trained rescuer is present 50% of business hours of operation
- 1.0-point: trained rescuer is present 25% of business hours of operation.
- 0-point: there is never a trained rescuer present during hour of operation.

Does your facility require or provide ongoing training in the use of the AED?
- 1.0-point: facility requires and provides ongoing AED training.
- 0.5-point: facility requires ongoing AED training, but does not provide this training.
- 0-point: facility neither requires nor provides ongoing AED training.

Are certain people expected or required to attend CPR and AED training?

Table 1 (*Continued*)

1-point: managers/supervisory staff and employees are required to attend CPR and AED training.
0.5-point: only managers/supervisory staff or employees are required to attend CPR and AED training.
0-point: neither employees nor managers are expected or required to attend CPR and AED training.

How often are individual required to undergo CPR and AED training?
2.0-point: quarterly.
1.5-point: every 6 months.
1.0-point: yearly.
0.5-point: every 2 years.
0-point: not applicable.

Does your facility have an emergency response protocol in place?
1-point: yes.
0-point: no.

Link to the local EMS system

Have you informed either or all of the following services that your facility has a defibrillator and the location of the defibrillator: Johnson County Sheriffs Office, Iowa City Police Department, Coralville Police Department, and Iowa City Fire Department?
2-point: the site has informed all of the above services of the presence and location of its defibrillator.
1-point: the site has informed one or more of the services of the presence and location of the defibrillator.
0-point: the site has not informed any of the services of the presence and location of its defibrillator.

Has your facility contacted Johnson County Ambulance Service to inform them that your facility has a defibrillator and the location of the defibrillator?
1-point: yes.
0-point: no.

Continuous quality improvement

Does your facility have a mechanism in place for a post-event review to review components of system function, personnel performance, and AED performance?
1-point: yes.
0-point: no.

(links to EMS and quality improvement). Total points assigned to each component were: 14 planned and practiced response, 7 ongoing training of CPR and AED use, 3 links to local EMS, and 1 continuous quality improvement.

2.3. Statistical analyses

We calculated mean and median points assigned for each of the four components for effective PAD sites in each of the three categories with SPSS 15.0 software (SPSS, Chicago, IL). We assessed statistical differences among the four components and among the sites with ANOVA with Bonferroni's correction for multiple comparisons. A p-value of <0.05 was considered significant.

3. Results

Thirty-three surveys were mailed to Johnson County businesses, educational facilities, and community buildings. Thirty-two surveys were returned from 5 educational sites, 13 business sites, and 14 community sites (97% survey response rate). Twenty-two site visits were completed.

The overall mean score among all sites of an effective PAD site was 14.3/25 (57% of possible points) (Table 2). Among the four individual components, the mean score was 8.91/14 (64%) for planned and practiced response, 4.13/7 (59%) for ongoing training, 1.03/3 (34%) links with local EMS agencies and 0.22/1 (22%) for continuous quality improvement.

Table 2 shows the scores among educational, business, and community sites. There was no significant difference among overall mean scores of the three different site categories. The mean scores were 13.6/25 (54%) for educational sites, 15.1/25 (60%) for business sites, and 13.8/25 (55%) for community sites. However, a difference among sites was demonstrated when scores for components of a PAD site were compared. Business sites scored statistically higher for ongoing CPR and AED training than the two other categories ($p < 0.05$). No differences were detected among sites for planned and practiced response, links to local EMS, or continuous quality improvement.

The on-site interviews discovered multiple barriers which could decrease the effectiveness of PAD sites. AEDs were frequently not easily accessible or clearly labeled. AEDs were on work shelves without clear identification, stored in reception area desks, and hung on doors with other objects. Several sites had depleted batteries and expired AED pads.

Only 15 sites had budgets for maintenance of their PAD sites. Eight sites budgeted up to $100 annually, while four budgeted $101–500. Only three sites, all businesses, budgeted more than $501 for training and program maintenance. Most sites were unable to state if and how any money was actually expended.

4. Discussion

PAD sites are increasing in the United States because of the recognition of need for early defibrillation to improve survival from sudden cardiac arrest.[6,7] However, to the best of our knowledge, long-term maintenance and ongoing training of voluntary, community sites have not been evaluated previously. Our study demonstrates that many community-based PAD sites do not comply with the AHA recommendations for effective sites. Deficiencies were most evident at educational sites. Within the four components, deficiencies in establishing links to local EMS services and continuous quality improvement were greatest, although shortcomings were present within all sites across all components.

The twenty-five point scoring system was based on the four components recommended by the AHA for an effective PAD site. Although the point assignment was empiric and has not been validated, it is apparent that no site in our study was able to comply

Table 2
Survey results of PAD sites in Johnson County, Iowa.

Category (N)	Total score, 25 pts, mean ± SD (percentage)	Planned and practiced response, 14 pts, mean ± SD (percentage)	Training, 7 pts, mean ± SD (percentage)	EMS links, 3 pts, mean ± SD (percentage)	CQI, 1 pt, mean ± SD (percentage)
All sites, $N = 32$	14.3 ± 3.8 (57)	8.9 ± 2.7 (63)	4.13 ± 1.7 (59)	1.03 ± 1.0 (34)	0.22 ± 0.4 (22)
Education, $N = 5$	13.6 ± 2.7 (54)	8.0 ± 0.9 (56)	4.2 ± 0.7 (56)	1 ± 1.2 (47)	0.4 ± 0.5 (40)
Business, $N = 13$	15.1 ± 3.3 (60)	8.5 ± 2.6 (59)	5.0 ± 0.7 (63)	1.3 ± 1.1 (63)	0.3 ± 0.4 (30)
Community $N = 14$	13.3 ± 4.8 (55)	9.6 ± 2.8 (69)	3.3 ± 2.2 (41)	0.8 ± 0.9 (26)	0.1 ± 0.3 (9)
Point range	7.5–20	4.5–11.75	0–6.5	0–3	0–1
Interquartile range	6	4	2	1	<1
p-Value	NS	0.022	NS	NS	NS

with all of the AHA recommendations. Business sites were more compliant with ongoing training compared to educational and community sites. This may be due in part to more funding allocated. Only three sites allotted >$501 for PAD site maintenance and all were business sites. Despite business sites having more personnel and potentially more funding, there was no difference in overall performance among the three categories. Interestingly, the PAD site that received most points in our study was a local, public recreation center (20 points).

To demonstrate the effectiveness of PAD sites, the PAD trial was conducted between July 2000 through September 2003 within urban and suburban communities served by EMS systems that provided advanced life support.[8,9] Results of the PAD trial demonstrated more survivors in the sites where the volunteers were trained in CPR and AED use compared to sites with just CPR.[10] The trial supports current AHA guidelines for lay rescuer AED programs and the emphasis on planning, training, and practice of CPR and use of AEDs.

During the PAD trial, all sites recruited for the trial were required to have emergency plans in place prior to participation.[8,9] Volunteer responders were trained in CPR and AED use at least twice in a 20 month period. Even with these rigorous measures, AEDs were deployed during only 30% of the arrest events.[10] This demonstrates that purchase of an AED is not enough to ensure effective PAD sites and the difficulty in achieving all four components of AHA recommendations.

5. Importance of CPR and ongoing training

It is increasingly apparent that CPR is vital for resuscitation of sudden cardiac arrest.[11–14] Several studies have shown that 90–180 s of CPR prior to defibrillation improves the probability of defibrillation in the presence of prolonged ventricular fibrillation.[15,16] Additionally, the quality of CPR affects resuscitation rates.[12,13] Thus, persons who know and can effectively administer CPR are crucial to the success of a PAD program. Lay rescuers need frequent, ongoing training to maintain skills.[17,18] Ensuring that persons are trained and receive ongoing training increases complexity and expense of maintaining a PAD site but are vital for successful resuscitation. Our study demonstrates that less than half (44%) of sites received 70% of points allotted for ongoing training. Only one site was able to achieve >90% of points for ongoing training. This indicates that many community PAD sites are failing to ensure maintenance of CPR and AED use skills after initial training.

6. Need for oversight of pad sites

Coris et al.[19] surveyed NCAA Division I athletic programs about their experiences with placing AEDs in their facilities. Among athletic departments that owned AEDs, 20% reported unknown AED maintenance schedules and only 19% reported annual maintenance checks. In the same study, 45% of departments owning AEDs reported changing equipment batteries "as needed", with no specific scheduled checks. In our site interviews, AEDs were frequently inaccessible and were noted to have depleted batteries and/or expired AED pads. Given the increasing number of PAD sites, consistent maintenance protocols need to be implemented to insure that successful defibrillation is possible when an SCA occurs at a PAD site.

7. Cost effectiveness of pad sites

The cost effectiveness of PAD programs is determined by two factors: the cost of the PAD program and the effectiveness of PAD at improving SCA survival.[20–24] After acquisition of the AED, a substantial portion of the cost related to maintenance is provision of CPR training to site personnel and upkeep of AEDs. Our study suggests that many sites attempt to minimize the costs of their AED programs by failing to invest in important program maintenance. In turn, failure to maintain investment in PAD programs is likely to reduce the effectiveness of PAD when compared to results of randomized trials. More research needs to be done on cost effectiveness of PAD sites once consistent training and maintenance protocols have been implemented.

8. Limitations

The major limitation of our study is the lack of validation of the twenty-five point scoring system and inability to demonstrate predictive value. The individual point values, although developed from the AHA criteria and CPR literature, were empirically assigned by the investigators. Validation of the survey will require a larger geographic site with greater frequency of cardiac arrest. We were unable to assess effectiveness of individual PAD sites as no cardiac arrest occurred and no AEDs were used at any PAD site during this study.

9. Conclusion

Our study demonstrated the community PAD sites in Johnson County currently do not comply with recommendations for effective PAD sites and that better methods for assuring ongoing training and maintenance are needed for sites to be effective.

Conflict of interest

The authors Sarah Haskell, Michael Post and Dianne Atkins declared that they have no conflicts of interest.

Dr. Cram is supported by a K23 career development award (RR01997201) from the NCRR at the NIH and the Robert Wood Johnson Physician Faculty Scholars Program. Dr. Cram served as a consultant to Medtronic Inc. during 2008 and assisted the company in its efforts to develop a cost-effectiveness model related to PAD. His total compensation was less than $5000.

References

1. Rea TD, Pearce RM, Raghunathan TE, et al. Incidence of out-of-hospital cardiac arrest. Am J Cardiol 2004;93:1455–60.
2. Larsen MP, Eisenberg MS, Cummins RO, Hallstrom AP. Predicting survival from out-of-hospital cardiac arrest: a graphic model. Ann Emerg Med 1993;22:1652–8.
3. Weisfeldt ML, Kerber RE, McGoldrick RP, et al. American Heart Association Report on the Public Access Defibrillation Conference—December 8–10, 1994. Circulation 1995;92:2740–7.
4. American Heart Association. Guidelines 2000 for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation 2000;102(Suppl. I):I-1–384.
5. Hazinski MF, Idris AH, Kerber RE, et al. Lay rescuer automated external defibrillator ("Public Access Defibrillation") programs: lessons learned from an international multicenter trial: advisory statement from the American Heart Association Emergency Cardiovascular Committee; the Council on Cardiopulmonary, Perioperative, and Critical Care; and the Council on Clinical Cardiology. Circulation 2005;111:3336–40.
6. Rothmier JD, Drezner JA, Harmon KG. Automated external defibrillators in Washington State high schools. Br J Sports Med 2007;41:301–5.
7. Mears G, Mann N, Wright D, Schnyder M, Dean J. Validation of a predictive model for automated external defibrillator placement in rural America. Prehosp Emerg Care 2006;10:186–93.
8. Ornato JP, McBurnie MA, Nichol G, et al. The Public Access Defibrillation (PAD) Trial: study design and rationale. Resuscitation 2003;56:135–47.
9. Nichol G, Wells GA, Kuntz K. Methodological design for economic evaluation in Public Access Defibrillation (PAD) trial. Am Heart J 2005;150:202–8.
10. Hallstrom AP, Ornato JP, Weisfeldt M, et al. Public Access Defibrillation Trial I. Public-access defibrillation and survival after out-of-hospital cardiac arrest. N Engl J Med 2004;351:637–46.
11. Eisenberg MS. Improving survival from out-of-hospital cardiac arrest: back to the basics. Ann Emerg Med 2007;49:314–6.

12. Wik L, Kramer-Johansen J, Myklebust H, et al. Quality of cardiopulmonary resuscitation during out-of-hospital cardiac arrest. JAMA 2005;293:299–304.
13. Abella BS, Alvarado JP, Myklebust H, et al. Quality of cardiopulmonary resuscitation during in-hospital cardiac arrest. JAMA 2005;293:305–10.
14. Rea TD, Helbock M, Perry S, et al. Increasing use of cardiopulmonary resuscitation during out-of-hospital ventricular fibrillation arrest: survival implications of guideline changes. Circulation 2006;114:2760–5.
15. Wik L. Delaying defibrillation to give basic cardiopulmonary resuscitation to patients with out-of-hospital ventricular fibrillation. JAMA 2003;289:1389–95.
16. Cobb LA, Fahrenbruch CE, Walsh TR, et al. Influence of cardiopulmonary resuscitation prior to defibrillation in patients with out-of-hospital ventricular fibrillation. JAMA 1999;281:1182–8.
17. Woollard M, Whitfield R, Newcombe RG, Colquhoun M, Vetter N, Chamberlain D. Optimal refresher training intervals for AED and CPR skills: a randomised controlled trial. Resuscitation 2006;71:237–47.
18. Woollard M, Whitfeild R, Smith A, et al. Skill acquisition and retention in automated external defibrillator (AED) use and CPR by lay responders: a prospective study. Resuscitation 2004;60:17–28.
19. Coris E, Miller E, Sahebzamani F. Sudden cardiac death in division I dollegiate athletics: analysis of automated external defibrillator utilization in National Collegiate Athletic Association division I athletic programs. Clin J Sport Med 2005;15:87–91.
20. Cram P, Vijan S, Fendrick AM. Cost-effectiveness of automated external defibrillator deployment in selected public locations. J Gen Intern Med 2003;18:745–54.
21. Cram P, Vijan S, Wolbrink A, Fendrick AM. The impact of including passive benefits in cost-effectiveness analysis: the case of automated external defibrillators on commercial aircraft. Value Health 2003;6:466–73.
22. Jones E, Vijan S, Fendrick AM, Deshpande S, Cram P. Automated external defibrillator deployment in high schools and senior centers. Prehosp Emerg Care 2005;9:382–5.
23. Nichol G, Valenzuela T, Roe D, Clark L, Huszti E, Wells GA. Cost effectiveness of defibrillation by targeted responders in public settings. Circulation 2003;108:697–703.
24. Nichol G, Hallstrom AP, Ornato JP, et al. Potential cost-effectiveness of public access defibrillation in the United States. Circulation 1998;97:1315–20.