American Red Cross
American Red Cross Advisory Council on First Aid, Aquatics, Safety and Preparedness

ACFASP Scientific Review

Minimally Trained Witness Defibrillation Efficacy

Questions to be addressed:

The original question raised at the December 2006 ACFASP meeting in Washington, DC, was where should public-access AED's be placed? The Committee's opinion was that this begged the question, "Does public-access defibrillation work?" The Committee also expressed an interest in understanding the scientific evidence describing the cost-effectiveness of public access defibrillation. Before determining the evidence for cost-effectiveness of public access defibrillation, we must first examine the evidence of the effectiveness of public access defibrillation.

The Committee understands that there are various levels of public-access defibrillation, including use by non-traditional first responders, such as lifeguards, security personnel, and flight attendants. Public-access defibrillation also includes citizen CPR defibrillation, which applies to laypeople who have received AED training, usually to care for a particular high-risk individual. Yet another type of public-access defibrillation is minimally trained witness defibrillation, where AED location is displayed prominently and any witness to an emergency has access to these devices, including untrained individuals. (Nichol, 1998)

The CPR Council refined the question to read, "Does Public Access Defibrillation improve survival from out-of-hospital cardiac arrest?" We intend to conduct a systematic review of the literature to answer this question. The presence of a defibrillator accessible to anyone in the vicinity, at the time and location of a cardiac arrest will be the independent variable. The dependent variable will be survival. We will attempt to perform sub-group analysis for witnessed arrests, witnessed arrests due to ventricular fibrillation or ventricular tachycardia and level of training of the rescuer and patient age.

Introduction/Overview:

The primary aim of this review is to determine if public access defibrillation improves survival to hospital discharge for individuals who have an out-of-hospital cardiac arrest. Our approach will be to review scientific papers that studied cases where individuals experienced an out-of-hospital cardiac arrest and someone retrieved and brought a publically-accessible defibrillator to the patient's side. We will also evaluate evidence for cases where the defibrillator is actually turned on and connected to the patient, as well as searching for comparative studies between all cardiac arrests in systems that have PAD versus

those that do not. We will analyze these groups based on all cardiac arrests, cardiac arrests where resuscitation is attempted, cardiac arrests where resuscitation is attempted and the arrest is thought to be of cardiac etiology, and, of this group. We will successively narrow this group to witnessed arrests, then to witnessed arrests with bystander CPR. We will sub-analyze each group to determine outcome differences when the original rhythm is ventricular fibrillation or ventricular tachycardia or all other rhythms.

Review Process and Literature Search Performed

PubMed: “electric countershock” AND (“cardiopulmonary resuscitation" OR "heart arrest” as MESH major headings in a PubMed Clinical Query for therapy with a narrow, specific search scope (41 hits).

Criteria for considering studies for this review

Types of studies

We included all studies of randomized or pseudo-randomized controlled trials.

Types of interventions

We considered studies that evaluate the effectiveness of public access defibrillation. We included studies that evaluate the presence of defibrillators in the same location as the cardiac arrest or that evaluates use of PAD.

Types of outcome measures

Primary outcomes

The primary outcome measure of interest is survival to hospital discharge.

Secondary outcomes

Secondary outcome measures include return of spontaneous circulation, return of spontaneous ventilation, survival to emergency department, survival to hospital admission, 30-day and 1-year survival, and one year overall and cerebral performance or similar functional or quality of life measures.

Adverse outcomes

We reviewed the literature for reports of defibrillator failure and rescuer injury.

Search strategy for identification of additional studies

We reviewed the reference of selected articles and perform hand-searches of articles from the journals Resuscitation and Annals of Emergency Medicine. We may also use searches using Internet search engines to identify news articles or items in conference proceedings. We may correspond with any individual or organization that may have additional data, including unpublished studies.

Summary of Key Articles/Literature Found and Level of Evidence:

Author(s)	Full Citation	Summary of Article (provide a brief summary of what the article adds to this review)	Level of Evidence (Using table below)
Becker L	Becker L, Gold LS, Eisenberg M, White L, Hearne T, Rea T. Ventricular fibrillation in King County, Washington: a 30-year perspective. *Resuscitation.* 2008;79(1):22-27.	Supportive. Level 2b. Good quality. Adding a community-wide PAD program lead to a trend toward increased survival that did not reach statistical significance.	2b
Caffrey, et al	Caffrey SL, Willoughby PJ, Pepe PE, Becker LB. Public use of automated external defibrillators. *N Engl J Med.* 2002;347(16):1242-1247.	This was a two-year prospective study of arrests at three public airports in a US city. Most of the rescuers were good Samaritans. The airport did have a training program and public-service announcements on the airport's television monitors. There were 18 witnessed cardiac arrests where the patient was in VF treated with PAD; 11 (61%) survived to hospital discharge.	2a
Cappato R	Cappato R, Curnis A, Marzollo P, Mascioli G, Bordonali T, Beretti S, Scalfi F, Bontempi L, Carolei A, Bardy G, De Ambroggi L, Dei Cas L. Prospective assessment of	Supportive study. Level 2b. Poor quality. A cohort study with historical control. Deployed 49 AEDs in a community of 1,000,000. Control group: defibrillation only in hospital or from 5 medically staffed	2b

	integrating the existing emergency medical system with automated external defibrillators fully operated by volunteers and laypersons for out-of-hospital cardiac arrest: the Brescia Early Defibrillation Study (BEDS). *Eur Heart J.* 2006;27(5):553-561.	ambulances. Intervention group: 49 AED's distributed, 85% to volunteer EMS and 15% to publically accessible locations. 16% of the cases in the intervention group were treated by the publically accessible AED's. Survival showed statistical improvement, but the authors did not subdivide those treated with AED's from the general population.	
Capucci A	Capucci A, Aschieri D, Piepoli MF, Bardy GH, Iconomu E, Arvedi M. Tripling survival from sudden cardiac arrest via early defibrillation without traditional education in cardiopulmonary resuscitation. *Circulation.* 2002;106(9):1065-1070.	Supportive study. Level 3a. Fair quality. Analyzied 354 cardiac arrests after deploying 12 publically accessible defibrillators, 15 on police and fire vehicles and 12 in layperson first-responder vehicles to cover approximately 200,000 individuals at risk. Developed system that when a dispatcher determined an emergency call was a possible cardiac arrest, in addition to dispatching EMS, the dispatcher also notified the trained mobile volunteers and people at the nearest fixed defibrillator. Compared the group treated by lay responders with the group not treated by lay responders, but there is a significant risk that these two groups were not equal.	3a
Colquhoun MC	Colquhoun MC, Chamberlain DA, Newcombe RG, Harris R, Harris S, Peel K, Davies CS, Boyle R. A national scheme for public access defibrillation in England and Wales: early results. *Resuscitation.* 2008;78(3):275-280.	Supportive study. Level 3a. Fair quality. This English study reviewed 1500 cardiac arrest over nearly 6 years after implementaion of a public access defibrillation and mobile volunteer first responders equipped with AED's. There was better surival in the group treated with publically available AED's compared to those treated by the	3a

		first responders. Tehre is a significant risk that the two gropus are not otherwise equal.	
Culley LL	Culley LL, Rea TD, Murray JA, Welles B, Fahrenbruch CE, Olsufka M, Eisenberg MS, Copass MK. Public access defibrillation in out-of-hospital cardiac arrest: a community-based study. *Circulation.* 2004;109(15):1859-1863.	This was a cohort study of PAD cases during a three year period in King County. The County had implemented a PAD program involving attempts to organize and register publicly accessible defibrillators. There were 42 arrests due to presumed heart disease that were treated with publicly accessible defibrillators. Of these, 23 (55%) survived to hospital discharge.	2c
Drezner JA	Drezner JA, Rogers KJ, Zimmer RR, Sennett BJ. Use of automated external defibrillators at NCAA Division I universities. *Med Sci Sports Exerc.* 2005;37(9):1487-1492.	This was a retrospective study of 244 NCAA Division I colleges. The study reported 35 cardiac arrests with an immediate resuscitation rate in 19 (35%) persons.	3b
Fleischhackl R	Fleischhackl R, Roessler B, Domanovits H, Singer F, Fleischhackl S, Foitik G, Czech G, Mittlboeck M, Malzer R, Eisenburger P, Hoerauf K. Results from Austria's nationwide public access defibrillation (ANPAD) programme collected over 2 years. *Resuscitation.* 2008;77(2):195-200.	Supportive study. Level 3a. Fair quality. This was a 2 year study in England reporting the uses of 1865 AED's purchased by private entities. 45% of the defibrillations reported in the study occured in public places. 38% of the 14 patients treated with the AED that was used by untrained bystanders survived to hospital discharge. There was no control group. Reporting depended on the owner of the device, backed up by manufacturer's reports of users reordering disposable supplies.	3a
Hallstrom, et al	Hallstrom AP, Ornato JP, Weisfeldt M, Travers A, Christenson J, McBurnie MA, et al. Public-access defibrillation and survival after	Multi-center implementation of 496 PAD programs compared to 497 CPR only programs in the Public Access Defibrillation (PAD) Trial. In the PAD	1a

	out-of-hospital cardiac arrest. N Engl J Med. 2004 Aug 12;351(7):637-46.	group, there were 130 treated arrests of cardiac cause, 31 (24%) survived to hospital discharge. This compared to 16 of 109 (15%) in the CPR only group. This yielded a P value of 0.03.	
Peberdy, 2005	Peberdy MA, Ottingham LV, Groh WJ, Hedges J, Terndrup TE, Pirrallo RG, et al. Adverse events associated with lay emergency response programs: the public access defibrillation trial experience. Resuscitation2006 Jul;70(1):59-65.	Supportive study. LOE 2b. Poor quality. Funded by NHLBI, AHA, Medtronic, Guidant, Cardiac Science, Philips, and Laerdal. Patient-related adverse event reporting relied on reports in the medical record. For example -- rib fractures as an adverse event. There is a significant risk that a medical record may not record the presence of a rib fracture in a post-arrest patient. There was no autopsy or investigator exam of the patient. Other data points relied on volunteer reporting. The study has no sensitivity analysis (e.g. what if only half of the events were reported?). The manuscript contains no tables and does not report clear risk rates for the various adverse events that were sought as described in the methods.	2b

Level of Evidence	Definitions **(See manuscript for full details)**
Level 1a	Population based studies, randomized prospective studies or meta-analyses of multiple studies with substantial effects
Level 1b	Large non-population based epidemiological studies or randomized prospective studies with smaller or less significant effects
Level 2a	Prospective, controlled, non-randomized, cohort or case-control studies

Level 2b	Historic, non-randomized, cohort or case-control studies
Level 2c	Case series: convenience sample epidemiological studies
Level 3a	Large observational studies
Level 3b	Smaller observational studies
Level 4	Animal studies or mechanical model studies
Level 5	Peer-reviewed, state of the art articles, review articles, organizational statements or guidelines, editorials, or consensus statements
Level 6	Non-peer reviewed published opinions, such as textbook statements, official organizational publications, guidelines and policy statements which are not peer reviewed and consensus statements
Level 7	Rational conjecture (common sense); common practices accepted before evidence-based guidelines
Level 1-6E	Extrapolations from existing data collected for other purposes, theoretical analyses which is on-point with question being asked. Modifier E applied because extrapolated but ranked based on type of study.

Scientific Foundation:

Ten papers (1 of LOE 1a, 1 of LOE 2a, 3 of LOE 2b, 1 of LOE 2c, 3 of LOE 3a and 1 of LOE 3b) support

Summary:

Published reports suggest that 42% of patients treated with PAD survive to hospital discharge in carefully controlled settings. The PAD trial, a large, controlled interventional trial, demonstrated a statistically significant 11% reduction in risk of death before hospital discharge for patients suffering heart arrest of presumed cardiac cause in settings with a PAD program compared to areas trained for CPR only. This demonstrates that Minimally Trained Witness Defibrillation does improve survival to hospital discharge from witnessed out-of-hospital cardiac arrest due to ventricular fibrillation or ventricular tachycardia.

Recommendations and Strength (using table below):

Standards: Public access defibrillation (PAD) programs are effective in reducing mortality from sudden cardiac death. PAD programs should include training likely users in the use of CPR, activation of EMS system, and AED's, (Class I).

Guidelines: None.

Options: None.

Note: This study did not look at the cost effectiveness of implementation of unique PAD programs.

Class	Description	Implication	Level of Evidence
I	Convincingly justifiable on scientific evidence alone.	Usually supports Standard	One or more Level 1 studies are present (with rare exceptions). Study results consistently positive and compelling
II	Reasonably justifiable by scientific evidence and strongly supported by expert opinion.	Usually supports Guideline but if volume of evidence is great enough and support from expert opinions is clear may support standard	Most evidence is supportive of guideline. Level 1 studies are absent, or inconsistent, or lack power. Generally higher levels of evidence. Results are consistently supportive of guideline.
III	Adequate scientific evidence is lacking but widely supported by available data and expert opinion. Based on	Usually supports Option.	Generally lower or intermediate levels of evidence. Generally, but not consistently results are supportive of opinion.
IV	No convincing scientific evidence available but supported by rational conjecture, expert opinion and/or non peer-reviewed publications	Usually does not support standard, guideline, or option. Statement may still me made which presents what data and opinion exists. In some cases and in conjunction with rational conjecture may support	Minimal evidence is available. Studies may be in progress. Results inconsistent, or contradictory.

		option.	

Abstracts for Key Articles Which Are Part of This Review

Becker L, Gold LS, Eisenberg M, White L, Hearne T, Rea T. Ventricular fibrillation in King County, Washington: a 30-year perspective. Resuscitation2008 Oct;79(1):22-7.

AIM: We determined the effect of four major program changes over a 30-year period on survival from witnessed cardiac arrest (CA) with ventricular fibrillation (VF) as the rhythm causing collapse. METHODS: We conducted an investigation of emergency medical services (EMS)-treated CA occurring between 1978 and 2007. Data were obtained from a registry maintained by the King County Emergency Medical Services Division. Using Utstein style definitions, we measured changes in patient survival in light of four programs that were implemented during the span of the study: defibrillation by emergency medical technicians (EMTs), dispatcher-assisted cardiopulmonary resuscitation (CPR), public access defibrillation, and a CPR-defibrillation protocol that replaced delivery of three sequential shocks with administration of one shock followed by 2 min of CPR. RESULTS: Overall survival from witnessed VF during the study period was 34%. While demographic characteristics of patients in CA remained constant, we observed greater rates of survival in the years following the program changes, 1983-2006, compared to survival in the period before the changes, 1977-1982. The greatest increase in survival occurred following the CPR-defibrillation protocol change in 2005. CONCLUSION: Despite adverse temporal trends, the four program changes appear to have contributed to increasing survival rates from out-of-hospital cardiac arrests in King County.

Caffrey SL, Willoughby PJ, Pepe PE, Becker LB. Public use of automated external defibrillators. N Engl J Med2002 Oct 17;347(16):1242-7.

BACKGROUND: Automated external defibrillators save lives when they are used by designated personnel in certain public settings. We performed a two-year prospective study at three Chicago airports to assess whether random bystanders witnessing out-of-hospital cardiac arrests would retrieve and successfully use automated external defibrillators. METHODS: Defibrillators were installed a brisk 60-to-90-second walk apart throughout passenger terminals at O'Hare, Midway, and Meigs Field airports, which together serve more than 100 million passengers per year. The use of defibrillators was promoted by public-service videos in waiting areas, pamphlets, and reports in the media. We assessed the time from notification of the dispatchers to defibrillation, survival rate at 72 hours and at one year among persons with cardiac arrest, their neurologic status, and the characteristics of rescuers. RESULTS: Over a

two-year period, 21 persons had nontraumatic cardiac arrest, 18 of whom had ventricular fibrillation. With two exceptions, defibrillator operators were good Samaritans, acting voluntarily. In the case of four patients with ventricular fibrillation, defibrillators were neither nearby nor used within five minutes, and none of these patients survived. Three others remained in fibrillation and eventually died, despite the rapid use of a defibrillator (within five minutes). Eleven patients with ventricular fibrillation were successfully resuscitated, including eight who regained consciousness before hospital admission. No shock was delivered in four cases of suspected cardiac arrest, and the device correctly indicated that the problem was not due to ventricular fibrillation. The rescuers of 6 of the 11 successfully resuscitated patients had no training or experience in the use of automated defibrillators, although 3 had medical degrees. Ten of the 18 patients with ventricular fibrillation were alive and neurologically intact at one year. CONCLUSIONS: Automated external defibrillators deployed in readily accessible, well-marked public areas in Chicago airports were used effectively to assist patients with cardiac arrest. In the cases of survivors, most of the users had no duty to act and no prior training in the use of these devices.

Cappato R, Curnis A, Marzollo P, Mascioli G, Bordonali T, Beretti S, et al. Prospective assessment of integrating the existing emergency medical system with automated external defibrillators fully operated by volunteers and laypersons for out-of-hospital cardiac arrest: the Brescia Early Defibrillation Study (BEDS). Eur Heart J2006 Mar;27(5):553-61.

AIMS: There are few data on the outcomes of cardiac arrest (CA) victims when the defibrillation capability of broad rural and urban territories is fully operated by volunteers and laypersons. METHODS AND RESULTS: In this study, we investigated whether a programme based on diffuse deployment of automated external defibrillators (AEDs) operated by 2186 trained volunteers and laypersons across the County of Brescia, Italy (area: 4826 km(2); population: 1 112 628), would safely and effectively impact the current survival among victims of out-of-hospital CA. Forty-nine AEDs were added to the former emergency medical system that uses manual EDs in the emergency department of 10 county hospitals and in five medically equipped ambulances. The primary endpoint was survival free of neurological impairment at 1-year follow-up. Data were analysed in 692 victims before and in 702 victims after the deployment of the AEDs. Survival increased from 0.9% (95% CI 0.4-1.8%) in the historical cohort to 3.0% (95% CI 1.7-4.3%) (P=0.0015), despite similar intervals from dispatch to arrival at the site of collapse [median (quartile range): 7 (4) min vs. 6 (6) min]. Increase of survival was noted both in the urban [from 1.4% (95% CI 0.4-3.4 %) to 4.0% (95% CI 2.0-6.9 %), P=0.024] and in the rural territory [from 0.5% (95% CI 0.1-1.6%) to 2.5% (95% CI 1.3-4.2%), P=0.013]. The additional costs per quality-adjusted life year saved amounted to euro39 388 (95% CI euro16 731-49 329) during the start-up phase of the study and to euro23 661 (95% CI euro10 327-35 528) at steady state. CONCLUSION: Diffuse implementation of AEDs fully operated by trained volunteers and

laypersons within a broad and unselected environment proved safe and was associated with a significantly higher long-term survival of CA victims.

Capucci A, Aschieri D, Piepoli MF, Bardy GH, Iconomu E, Arvedi M. Tripling survival from sudden cardiac arrest via early defibrillation without traditional education in cardiopulmonary resuscitation. Circulation2002 Aug 27;106(9):1065-70.

BACKGROUND: Early defibrillation is the most important intervention affecting survival from sudden cardiac arrest (SCA). To improve public access to early defibrillation, we established Piacenza Progetto Vita (PPV), the first system of out-of-hospital early defibrillation by first-responder volunteers. METHODS AND RESULTS: The system serves a population of 173 114 residents in the Piacenza region of Italy. Equipment for the system comprises 39 semiautomatic external biphasic defibrillators (AEDs): 12 placed in high-risk locations, 12 in lay-staffed ambulances, and 15 in police cars; 1285 lay volunteers trained in use of the AED, without traditional education in cardiac pulmonary resuscitation, responded to all cases of suspected SCA, in coordination with the Emergency Medical System (EMS). During the first 22 months, 354 SCA occurred (72+/-12 years, 73% witnessed). The PPV volunteers treated 143 SCA cases (40.4%), with an EMS call-to-arrival time of 4.8+/-1.2 minutes (versus 6.2+/-2.3 minutes for EMS, P=0.05). Overall survival rate to hospital discharge was tripled from 3.3% (7 of 211) for EMS intervention to 10.5% (15 of 143) for PPV intervention (P=0.006). The survival rate for witnessed SCA was tripled by PPV: 15.5% versus 4.3% in the EMS-treated group (P=0.002). A "shockable" rhythm was present in 23.8% (34 of 143) of the PPV patients versus 15.6% (33 of 211) of the EMS patients (P=0.055). The survival rate from shockable dysrhythmias was higher for PPV versus EMS: 44.1% (15 of 34) versus 21.2% (7 of 33), P=0.046. The neurologically intact survival rate was higher in PPV-treated versus EMS-treated patients: 8.4% (12 of 143) versus 2.4% (5 of 211), P=0.009. CONCLUSIONS: Broad dissemination of AEDs for use by nonmedical volunteers enabled early defibrillation and tripled the survival rate for out-of-hospital SCA.

Colquhoun MC, Chamberlain DA, Newcombe RG, Harris R, Harris S, Peel K, et al. A national scheme for public access defibrillation in England and Wales: early results. Resuscitation2008 Sep;78(3):275-80.

BACKGROUND: Automated external defibrillators (AEDs) operated by lay persons are used in the UK in a National Defibrillator Programme promoting public access defibrillation (PAD). METHODS: Two strategies are used: (1) Static AEDs installed permanently in busy public places operated by those working nearby. (2) Mobile AEDs operated by community first responders (CFRs) who travel to the casualty. RESULTS: One thousand five hundred and thirty resuscitation attempts. With static AEDs, return of spontaneous circulation (ROSC) was

achieved in 170/437 (39%) patients, hospital discharge in 113/437 (26%). With mobile AEDs, ROSC was achieved in 110/1093 (10%), hospital discharge in 32 (2.9%) (P<0.001 for both variables). More shocks were administered with static AEDS 347/437 (79%) than mobile AEDs 388/1093 (35.5%) P<0.001. Highly significant advantages existed for witnessed arrests, administration of shocks, bystander CPR before arrival of AED and short delays to start CPR and attach AED. These factors were more common with static AEDs. For CFRs, patients at home did less well than those at other locations for ROSC (P<0.001) and survival (P=.006). Patients at home were older, more arrests were unwitnessed, fewer shocks were given, delays to start CPR and attach electrodes were longer. CONCLUSIONS: PAD is a highly effective strategy for patients with sudden cardiac arrest due to ventricular fibrillation who arrest in public places where AEDs are installed. Community responders who travel with an AED are less effective, but offer some prospect of resuscitation for many patients who would otherwise receive no treatment. Both strategies merit continuing development.

Culley LL, Rea TD, Murray JA, Welles B, Fahrenbruch CE, Olsufka M, et al. Public access defibrillation in out-of-hospital cardiac arrest: a community-based study. Circulation2004 Apr 20;109(15):1859-63.

BACKGROUND: The dissemination and use of automated external defibrillators (AEDs) beyond traditional emergency medical services (EMS) into the community has not been fully evaluated. We evaluated the frequency and outcome of non-EMS AED use in a community experience. METHODS AND RESULTS: The investigation was a cohort study of out-of-hospital cardiac arrest cases due to underlying heart disease treated by public access defibrillation (PAD) between January 1, 1999, and December 31, 2002, in Seattle and surrounding King County, Washington. Public access defibrillation was defined as out-of-hospital cardiac arrest treated with AED application by persons outside traditional emergency medical services. The EMS of Seattle and King County developed a voluntary Community Responder AED Program and registry of PAD AEDs. During the 4 years, 475 AEDs were placed in a variety of settings, and more than 4000 persons were trained in cardiopulmonary resuscitation and AED operation. A total of 50 cases of out-of-hospital cardiac arrest were treated by PAD before EMS arrival, which represented 1.33% (50/3754) of all EMS-treated cardiac arrests. The proportion treated by PAD AED increased each year, from 0.82% in 1999 to 1.12% in 2000, 1.41% in 2001, and 2.05% in 2002 (P=0.019, test for trend). Half of the 50 persons treated with PAD survived to hospital discharge, with similar survival for nonmedical settings (45% [14/31]) and out-of-hospital medical settings (58% [11/19]). CONCLUSIONS: PAD was involved in only a small but increasing proportion of out-of-hospital cardiac arrests.

Drezner JA, Rogers KJ, Zimmer RR, Sennett BJ. Use of automated external defibrillators at NCAA Division I universities. Med Sci Sports Exerc2005 Sep;37(9):1487-92.

PURPOSE: The placement of automated external defibrillators (AED) at public sporting events is a growing national trend. The purpose of the present study was to investigate the prevalence, past use, and cost of implementing AED at university sporting venues. METHODS: Questionnaires were sent to the head athletic trainer at all Division I NCAA universities (N = 326) and responses collected between August and November 2003. RESULTS: Completed surveys were returned by 244 institutions (75% response rate). Ninety-one percent (221/244) had AED for an average of 3.3 yr (range 1-13) with a median of four AED per institution (range 1-30). There were 35 cases of AED use for sudden cardiac arrest with 77% (27/35) occurring in older nonstudents, 14% (5/35) in intercollegiate athletes, and 3% (1/35) in a student nonintercollegiate athlete (information unavailable in two cases). The immediate resuscitation rate was 54% (19/35). A shock was delivered in 21 cases with a resuscitation rate of 71% (15/21). None of the intercollegiate athletes were successfully resuscitated. The average cost per AED was 2460 US dollars. In a 10-yr model (expected useful life of an AED), the cost per life immediately resuscitated was 52,400 US dollars, and the estimated cost per life-year gained ranged 10,500 US dollars to 22,500 US dollars. CONCLUSIONS: Most Division I universities have AED available at selected sporting venues. Although no benefit was demonstrated for intercollegiate athletes, AED were successfully used in older nonstudents with cardiac arrest with a favorable long-term cost analysis.

Fleischhackl R, Roessler B, Domanovits H, Singer F, Fleischhackl S, Foitik G, et al. Results from Austria's nationwide public access defibrillation (ANPAD) programme collected over 2 years. Resuscitation2008 May;77(2):195-200.

AIM OF THE STUDY: To analyse 2 years of experience after introducing automated external defibrillators (AED) all over Austria. MATERIALS AND METHODS: This observational study evaluated the number of privately purchased devices and the rate of local bystander-triggered AED deployments from November 2002 to December 2004. As outcome measurements, the hospital discharge rate and neurological condition were recorded. Arrival times of the emergency medical service (EMS) on scene and the time intervals until shock decisions were made were calculated. Shock decisions were verified according to ECG downloads. Results were compared with historical data if applicable. RESULTS: During the study period, 1865 devices were installed. Seventy-three AED deployments were recorded. Eleven cases were excluded from the study because bystanders were part of the local EMS. Seventeen out of the remaining 62 (27%) compared to a historical 27 out of 623 (4.3%) individuals were discharged alive from hospital. Fourteen out of 26 (54%) patients who were found with a shockable rhythm survived to hospital discharge. Fifteen of our patients survived in good neurological condition (CPC I and II), two suffered from severe neurological deficit (CPC III and IV) and 45 people died. The median "call-to-AED advice interval" was 3.5 min (IQR 2-6 min; N=24). In two cases, the AED made inappropriate decisions because of artefacts. CONCLUSIONS: Compared to historical data, short 'intervals to shock' delivery and the frequent start of basic life support

resulted in an increased hospital discharge rate in good neurological condition. Despite the relatively high number of installed devices, the number of patients reached remained small.

Hallstrom AP, Ornato JP, Weisfeldt M, Travers A, Christenson J, McBurnie MA, et al. Public-access defibrillation and survival after out-of-hospital cardiac arrest. N Engl J Med2004 Aug 12;351(7):637-46.

BACKGROUND: The rate of survival after out-of-hospital cardiac arrest is low. It is not known whether this rate will increase if laypersons are trained to attempt defibrillation with the use of automated external defibrillators (AEDs). METHODS: We conducted a prospective, community-based, multicenter clinical trial in which we randomly assigned community units (e.g., shopping malls and apartment complexes) to a structured and monitored emergency-response system involving lay volunteers trained in cardiopulmonary resuscitation (CPR) alone or in CPR and the use of AEDs. The primary outcome was survival to hospital discharge. RESULTS: More than 19,000 volunteer responders from 993 community units in 24 North American regions participated. The two study groups had similar unit and volunteer characteristics. Patients with treated out-of-hospital cardiac arrest in the two groups were similar in age (mean, 69.8 years), proportion of men (67 percent), rate of cardiac arrest in a public location (70 percent), and rate of witnessed cardiac arrest (72 percent). No inappropriate shocks were delivered. There were more survivors to hospital discharge in the units assigned to have volunteers trained in CPR plus the use of AEDs (30 survivors among 128 arrests) than there were in the units assigned to have volunteers trained only in CPR (15 among 107; P=0.03; relative risk, 2.0; 95 percent confidence interval, 1.07 to 3.77); there were only 2 survivors in residential complexes. Functional status at hospital discharge did not differ between the two groups. CONCLUSIONS: Training and equipping volunteers to attempt early defibrillation within a structured response system can increase the number of survivors to hospital discharge after out-of-hospital cardiac arrest in public locations. Trained laypersons can use AEDs safely and effectively.

Peberdy MA, Ottingham LV, Groh WJ, Hedges J, Terndrup TE, Pirrallo RG, et al. Adverse events associated with lay emergency response programs: the public access defibrillation trial experience. Resuscitation2006 Jul;70(1):59-65.

The adverse event (AE) profile of lay volunteer CPR and public access defibrillation (PAD) programs is unknown. We undertook to investigate the frequency, severity, and type of AE's occurring in widespread PAD implementation. DESIGN: A randomized-controlled clinical trial. SETTING: One thousand two hundred and sixty public and residential facilities in the US and Canada. PARTICIPANTS: On-site, volunteer, lay personnel trained in CPR only compared to CPR plus automated external defibrillators (AEDs). INTERVENTION: Persons experiencing possible cardiac arrest receiving lay volunteer first response with CPR+AED compared with

CPR alone. MAIN OUTCOME MEASURE: An AE is defined as an event of significance that caused, or had the potential to cause, harm to a patient or volunteer, or a criminal act. AE data were collected prospectively. RESULTS: Twenty thousand three hundred and ninety six lay volunteers were trained in either CPR or CPR+AED. One thousand seven hundred and sixteen AEDs were placed in units randomized to the AED arm. There were 26,389 exposure months. Only 36 AE's were reported. There were two patient-related AEs: both patients experienced rib fractures. There were seven volunteer-related AE's: one had a muscle pull, four experienced significant emotional distress and two reported pressure by their employee to participate. There were 27 AED-related AEs: 17 episodes of theft involving 20 devices, three involved AEDs that were placed in locations inaccessible to the volunteer, four AEDs had mechanical problems not affecting patient safety, and three devices were improperly maintained by the facility. There were no inappropriate shocks and no failures to shock when indicated (95% upper bound for probability of inappropriate shock or failure to shock = 0.0012). CONCLUSIONS: AED use following widespread training of lay-persons in CPR and AED is generally safe for the volunteer and the patient. Lay volunteers may report significant, usually transient, emotional stress following response to a potential cardiac arrest. Within the context of this prospective, randomized multi-center study, AEDs have an exceptionally high safety profile when used by trained lay responders.