WORKSHEET for Evidence-Based Review of Science for Emergency Cardiac Care

Worksheet author(s)

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Clinical question. In AED programs (P), does the inclusion of any specific factors (eg. linkage to 911 registries, location of program [including home]) (I) compared with not including those factors (C) improve the outcome of the program (O)?

Is this question addressing an intervention/therapy, prognosis or diagnosis? Intervention/therapy
State if this is a proposed new topic or revision of existing worksheet: Revision

Conflict of interest specific to this question

Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet? No

Search strategy (including electronic databases searched).

Here's the search strategy used in PubMed for the original search: Parish
(AED[tw] OR PAD[tw] OR SAED[tw] OR FAED[tw] OR "automated external defibrillator"[tw] OR "public access defibrillator"[tw] OR defibrillators[mh] OR cardiopulmonary resuscitation[mh] OR heart arrest[mh] OR ventricular fibrillation[mh] OR electric countershock[mh] OR ventricular tachycardia[mh]) AND (program evaluation [mh] OR survival rate [mh] OR survival analysis [mh] OR treatment outcome [mh] OR outcome assessment (health care) [mh] OR time factors [mh]).

I restricted my search results to RCTs and other clinical trials, meta-analyses, and practice guidelines.
Secondary references were derived from review of citations in reviewed articles. Most are case studies, prospective studies, descriptive studies, letters, and the like, which would not necessarily have been included in the list of articles derived from the search.

The search terms above were used as keywords in various combinations in searching Cochrane and DTIC, which picked up no new references.

We did not have access to EMBASE (the European database); CINAHL, the nursing and allied health database, was searched later.

The search was updated on September 1, 2009. The search was conducted by Roxanne Nelson, RN, MLS, Assistant Professor, Library Sciences, MUSM.

Last search time: May, 2009 Scapigliati

Searches were limited to:
- *"Public Access Defibrillation" programs,* according to expert feedback. No other limit applied.
This limit provided a more restricted but better defined field of research in order to reach reasonable conclusions.
This aspect was discussed with Task Force expert and mentioned during WS presentation at 2008 ILCOR meeting in New Orleans.

Databases search strategy:

- Cochrane Library (Databases: Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effects)
Query: "Public access defibrillation [All TXT]" – 16 hits
6 hits selected

- PubMed
Database search strategy according to expert feedback:
Query: "Public access defibrillation [Mesh]" – 176 hits
21 hits selected

- Embase (1988-2008)
Database search strategy according to expert feedback:
Query: "Public access defibrillation" – 652 hits
41 hits selected

- ECC Endnote Master library
Query: "Public access defibrillation" – 50 hits

- Manual search of references

3 hits selected

• **State** inclusion and exclusion criteria

Inclusion: AED used in human trial and survival to discharge reported. Parish

Exclusion: Non human study, simulation study, editorial or policy paper, AED group not identifiable, survival not reported. Parish

Exclusion. According to the decision of limiting search strategy to PAD programs, AED programs involving only professional healthcare providers or implemented in healthcare environments (even if non-patient areas) were excluded. Scapigliati
Non English language, review articles, guidelines and/or scientific institutions position statements, editorials and letters, manikin models. Scapigliati

Inclusion. AED programs involving non-healthcare professionals even if integrated in a Emergency Medical System (EMS) were included. Adult populations, human studies, meta-analyses. Scapigliati

• **Number** of articles/sources meeting criteria for further review: 62 Parish

After abstract analysis, 26 articles have been selected. Scapigliati
During ongoing manuscript analysis, one article has been excluded due to a possible COI and poor design, one as meeting exclusion criteria, one as using a statistical extrapolation without clinical intervention and one meta-analysis as not adding value compared to original studies . On the other hand, other articles have been retrieved by hand search in the references and will be included in the final review.

One experimental study compared two AED programs with different strategies without true randomization (LOE2).
The other studies compared an AED program with one of the following interventions:
- other standard interventions like CPR alone or traditional EMS (LOE2),
- historical data from literature (LOE3)
- no control (LOE4).

At the moment of this submission, 21 full articles were obtained. The main aspects of all the articles and comments will be summarized in an attached table.

Summary of evidence

Evidence Supporting Clinical Question

Good		**Capucci 2002, Colquhoun 2008**	**Cappato 2006 Myerburg 2002 Kajino 2009 Stiell 1999**	**Valenzuela 2000 Davies 2005 Bertrand 2004 Mols 1994 Sedgwick 1993**	**Smith 2000**
Fair	**Hallstrom 2004 Vukov 1988**		**Fleischhackl 2008**	**Caffrey 2002 O'Rourke 1997 Page 2000 Heber 1983 Weaver 1986**	**Sanna 2008**
Poor		**Weaver 1988**	**Culley 2004 Hollenberg 2009**	**Haynes 1991 Whitfield 2005 Cobbe 1991 Drezner 2009 England 2005 Hanefeld 2005**	
	1	**2**	**3**	**4**	**5**
Level of evidence					

A = Return of spontaneous circulation
B = Survival of event
C = Survival to hospital discharge
D = Intact neurological survival
E = Other endpoint
Italics = Animal studies

Evidence Neutral to Clinical Question

Good	**van Alem 2003 Bardy 2008 Schneider 2000 Kudenchuk 2006**	**Kellerman 1993 Sweeney 1998**	**Mosesso 1998 Moore 2008 Cobb 1999**	**Callaham 1993 MacDonald 2002 Lim 2005**	**Folke 2009**
Fair		**White 1998 Eisenberg 1989 Cummins 1985 Cummins 1987 Stults 1986**	**Shuster 1993 Stotz 2003 Groh 2001 Richless 1993 Weaver 1984 Walters 1990**		
Poor		**Kuisma 2003**	**Herlitz 1998**	**Ho 1997 Holmberg 1998 Jakobsson 1989 Stapczynski 1997 Gray 1987**	
	1	**2**	**3**	**4**	**5**
Level of evidence					

A = Return of spontaneous circulation
B = Survival of event
C = Survival to hospital discharge
D = Intact neurological survival
E = Other endpoint
Italics = Animal studies

Evidence Opposing Clinical Question (none)

Good					
Fair					
Poor					
	1	**2**	**3**	**4**	**5**
Level of evidence					

A = Return of spontaneous circulation
B = Survival of event
C = Survival to hospital discharge
D = Intact neurological survival
E = Other endpoint
Italics = Animal studies

REVIEWER'S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK:

The worksheet question relates to whether there are factors that must be incorporated into AED programs to enhance likelihood of patient survival. This is a complicated question; AEDs have been used for more than 30 years in a variety of programmatic settings. The original programs deployed AEDs in EMT services in the 1980s. AED use saved training time and extended the range of EMT defibrillation programs (Weaver 1986; Vukov 1988). AED use by basic EMTs was found to be successful in some settings but not beneficial with less rapid response or lower rates of witnessed ventricular fibrillation (Stultz 1986). AED usage was extended to trained first responders, usually police and/or firemen. Use of EMTs or first responders with automatic defibrillators as a second tier proved beneficial in venues where the difference in response time for the AED and the ALS deployed groups was sufficiently long that AEDs were used in patients early in ventricular fibrillation (Weaver 1988: Myerburg 2002). There was no benefit in locations where ALS providers arrived at the same time or where the difference in time response was extensive (Callaham 1993; Kellerman 1993; Groh 2001). The effect is difficult to assess because many cities trained firemen as basic EMTs and some fire departments ran the ambulance services.

The next wave of deployment of AEDs came in airports, airplanes and gaming casinos. AEDs deployed in areas of high traffic and stress with trained personnel who have a duty to respond can result in high rates of survival of victims of witnessed ventricular fibrillation (Bertrand 2004; Page 2000; Valenzuela 2000). More recently programs have deployed AEDs in what is being called public access defibrillation. Programs that have deployed devices in locations known to be high in traffic and likelihood of sudden cardiac death, incorporated monitoring to assure that the machines function when needed, and identify individuals who perceive a duty to respond have achieved good outcomes (Hallstrom 2004; Colquhoun 2008; Culley 2004; Fleischhackl 2008). The individuals with perceived duty to respond have been by far the most likely to apply and utilize the defibrillator. Lay bystander AED use for resuscitation has been rare, although role distinctions are often poorly documented.

Placement of AEDs in the homes of patients with high likelihood of an event has shown little benefit (Bardy 2008; Eisenberg 1989). Public access programs that have attempted to bring devices to the homes of individuals who collapse have low rates of survival. Ventricular fibrillation is less common, identification of collapse is delayed and time to get the AED to the victim is prolonged (Colquhoun 2008; Moore 2008).

Programs that work in one setting frequently are not replicable. Good outcomes in the Great Britain and Wales project (Colquhoun 2008) and low rates of survival in Northern Ireland (Moore 2008) occur despite all being in the same country and using the same design. The differences result from low rates of witnessed arrest in the community in Belfast and higher rates in London. The Great Britain program had elegant results when devices were initially deployed to public sites including airports, transit stations and other very high traffic sites. The good results were not replicable as the devices were deployed to arrests at home. AEDs clearly contribute to saving individual lives and can be incorporated into a wide range of projects. Limiting factors in assessing this field include frequent usage of devices which are capable of being used as either AEDs or in full monitoring and defibrillation mode. Several in hospital studies deployed devices that are dually functional; it is impossible to distinguish which patients were resuscitated using which function. Similarly high benefit sites such as sporting events are frequently staffed by services which have a full defibrillator capability. The literature on deployment of AEDs in school is methodologically weak, primarily in survey format (Drezner 2009). There are problems with deployment of the AEDs to sites that are easily accessible when needed (Folke 2009). Where there is no clear responsibility for monitoring or personnel with perceived duty to respond, programs are not successful. Characteristics of good outcome programs include prompt response by individuals with a duty to respond, a system to maintain the positioning and function of AEDs and a population that has a high rate of witnessed ventricular fibrillation.

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Roxanne Nelson, MLS, Assistant Director for Public Services, Mercer University School of Medicine

Citation List

Bardy GH, Lee KL, Mark DB, Poole JE, Toff WD, Tonkin AM, Smith W, Dorian P, Packer DL, White RD, Longstreth WT,Jr, Anderson J, Johnson G, Bischoff E, Yallop JJ, McNulty S, Ray LD, Clapp-Channing NE, Rosenberg Y, Schron EB, HAT Investigators. Home use of automated external defibrillators for sudden cardiac arrest. *N Engl J Med.* 2008; 358: 1793-1804.

Level 1, Good, Neutral

This randomized trial of home AED use enrolled 7001 patients with prior anterior wall MI that were not candidates for AICD placement. 3506 people were in the control group and 3495 were in the AED group. The study was conducted from January 2003 to October 2005.Multi-center, international trial was designed to have a power of 90% to detect a 20% reduction in the relative risk of death from any cause. 450 patients died-228 (6.5%) in the control and 222 (6.4%) in the AED group. Spouses or companions were trained for home use of AED, but less than half of the patients with a sudden cardiac arrest at home had a witnessed event and the AED was not always applied.

Bertrand C, Rodriguez Redington P, Lecarpentier E, Bellaiche G, Michel D, Teiger E, Morris W, Le Bourgeois JP, Barthout M. Preliminary report on AED deployment on the entire Air France commercial fleet: a joint venture with Paris XII University Training Programme. *Resuscitation.* 2004; 63: 175-181.

Level 4, Good, Supporting

This study reports the implementation of an AED program in Air France. AEDs were placed in 246 airplanes and 14,000 flight attendants were trained. There were 4194 emergency care episodes from11/02 to 11/03, of which 12 were arrests. Five victims received shocks and two survived. Airplane resuscitation is infrequently needed and can result in survivors.

Caffrey SL, Willoughby PJ, Pepe PE, Becker LB. Public use of automated external defibrillators. *N Engl J Med.* 2002; 347: 1242-1247.

Level 4, Fair, Supporting

This is a study based in the airports in Chicago and it was conducted in the years 1999 through 2001. The subjects were individuals with arrests within the confines of the three airports in Chicago. Following deployment of AEDs, 21 individuals had arrests that were treated, 19 of them were travelers, 20 of the cases were witnessed, 18 were ventricular fibrillation. There were 11 survivors in good neurologic status. The importance of this study is that in a setting that otherwise would be unable to manage patients who arrest, AEDs add capacity to resuscitate individuals with sudden death.

Callaham M, Braun O, Valentine W, Clark DM, Zegans C. Prehospital cardiac arrest treated by urban first-responders: profile of patient response and prediction of outcome by ventricular fibrillation waveform. *Ann Emerg Med.* 1993; 22: 1664-1677.

Level 4, Good, Neutral

This study reports the outcomes of victims of VF treated by fire department first responders equipped with AEDs in a two tiered EMS service in San Francisco. The study was conducted from 1989 to 1991. Of 1121 arrests, 835 resuscitations were conducted. 274 were in VF and 24 of these survived to hospital discharge (9%). Refibrillation was common. AED services can achieve meaningful survival in a rapid response system.

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 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: 553-561.

Level 3, Good, Supporting

This is a study from Italy in the Brescia region. This project added AEDs deployed and delivered by volunteers and public servants to a pre-existing ambulance based defibrillation service. The study was conducted between 1997 and 1999. There were 702 events

in the study period, 211 of these were ventricular fibrillation. The v-fib patients had a 10% survival and neurologically intact status. This increased survival in the overall study group from historical controls from 1% to 3%. This study is overall positive for deployment of AEDs despite the consistently low survival rates.

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: 1065-1070.

Level 2, Good, Supporting

This study reports the initial 22 months of a project that began June, 1999 in Piacenza, a mid-size town in Italy, and the surrounding region.1285 volunteers designated as non-medical personnel, including **police officers, financial guards, town guards, firemen, railway station employees, ambulance employees, post office workers, pharmacy employees, lifeguards and other motivated volunteers** were trained in AED use. Code calls resulted in dispatch of EMS and telephone calls to PPV volunteers. Resuscitation, survival and neurologically intact survivals rate for persons treated by the volunteers were greater. Training volunteers to use AED resulted in faster defibrillation and increased survival.

Cobb LA, Fahrenbruch CE, Walsh TR, Copass MK, Olsufka M, Breskin M, Hallstrom AP. Influence of cardiopulmonary resuscitation prior to defibrillation in patients with out-of-hospital ventricular fibrillation. *JAMA.* 1999; 281: 1182-1188.

Level 3, Good, Neutral

This study addressed delivery of 90 seconds of CPR prior to defibrillation in a two tier EMS service in Seattle. The pre-intervention period was from July 1990 to December 1993 and post-intervention was January 1994 to December 1996. There were 639 patients in pre-intervention and 478 post-intervention. Survival and neurological status were examined. Greater survival to discharge occurred in the intervention period. The neurological status was improved but not significantly.

Cobbe SM, Redmond MJ, Watson JM, Hollingworth J, Carrington DJ. "Heartstart Scotland"--initial experience of a national scheme for out of hospital defibrillation. *BMJ.* 1991; 302: 1517-1520.

Level 4, Poor, Supporting

This paper reports the initial experience of the Heartland Scotland project. Further years are reported in Sedgewick, 1993. AEDs were placed in 268 ambulances and 2000 ambulance crew members were trained. From 10/88-9/89 there were 1111 arrests; 602 were defibrillated and 75 survived. AED based services can achieve good survival of VF.

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: 275-280.

Level 2, Good, Supporting

This is a follow up report from the England and Wales national defibrillation program. Earlier reports of the project are in Davies. The plan for the study was to deploy AEDs to areas known to be likely to have cardiac arrests. Addition to the fixed system of AED placement was mobile devices that were to be deployed by trained individuals to individuals having events either not near the stationary devices or at home. 1,530 resuscitations were attempted. 735 individuals were shocked, of these 132 survived which is an 18% survival rate. Of the 795 patients not shocked, 13 survived. There were marked differences in survival between witnessed and unwitnessed arrests The study continues to show excellent results in survival among patients resuscitated in public but demonstrated very poor survival in patients resuscitated at home.

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: 1859-1863.

Level 3, Poor, Supporting

This project added public access defibrillation to a two tiered EMS system in Seattle. 4004 persons were trained in CPR and AED use. From January 1999 to December 2002, 50 victims received PAD prior to EMS arrival, 50% of whom survived to hospital discharge. Public Access Defibrillation treated victims had a high rate of survival.

Cummins RO, Eisenberg MS, Hallstrom AP, Hearne TR, Graves JR, Litwin PE. What is a "save"?: outcome measures in clinical evaluations of automatic external defibrillators. *Am Heart J.* 1985; 110: 1133-1138.

Level 2, Fair, Neutral

This early 1980s study of AED use in suburban Kings County compared patients treated initially by EMTs then paramedics with a group treated by paramedics. None of the results were statistically significant. The EMT-treated group had better outcomes regarding hospital admission and D/C. There was an 8.5-minute reduction in response times for EMTs which may contribute to the better outcomes in the EMT group. The AED intrinsically does not improve survival.

Cummins RO, Eisenberg MS, Litwin PE, Graves JR, Hearne TR, Hallstrom AP. Automatic external defibrillators used by emergency medical technicians. A controlled clinical trial. *JAMA.* 1987; 257: 1605-1610.

Level 2, Fair, Neutral

This 1980s study compared AED to full defibrillator capacity in a two tiered EMS program in Kings County, Washington. 18 fire departments switched between AEDs and standard defibrillators every 75 days. More patients treated with the AED were admitted and discharged alive; however, the difference was not (statistically) significant. There were substantial, systematic protocol violations with services using full defibrillators when assigned to AED in one third of cases.

Davies CS, Colquhoun MC, Boyle R, Chamberlain DA. A national programme for on-site defibrillation by lay people in selected high risk areas: initial results. *Heart.* 2005; 91: 1299-1302.

Level 4, Good, Supporting

This is the initial report of a program established in England and Wales. The project identified 110 places with high risk of cardiac arrest and placed 681 automatic external defibrillators. There were 172 public cardiac arrests during the time period of the study between April 2000 and March 2004. A shockable rhythm was present in 78% of cases and 38 patients (28% of witnessed ventricular fibrillation) survived to hospital discharge. Placement of these devices was in locations including Heathrow Airport, subway stations and other high volume public traffic sites.

Drezner JA, Rao AL, Heistand J, Bloomingdale MK, Harmon KG. Effectiveness of emergency response planning for sudden cardiac arrest in United States high schools with automated external defibrillators. *Circulation.* 2009; 120: 518-525.

Level 4, Poor, Supporting

This is a survey of high schools with AEDs and utilizes a web based registry of the AED sites. The response from 18,000 schools was 2,000; of these 1,710 reported at least one AED location. 36 events were reported, 14 in students and 22 in older individuals. The survival of the 36 events was 23 persons. The second component of this study was few schools reported organized plans for deployment and maintenance of the AEDs. The very low response to the survey limits its significance. Survival of events that occur and generate response is good.

Eisenberg MS, Moore J, Cummins RO, Andresen E, Litwin PE, Hallstrom AP, Hearne T. Use of the automatic external defibrillator in homes of survivors of out-of-hospital ventricular fibrillation. *Am J Cardiol.* 1989; 63: 443-446.

Level 2, Fair, Neutral

This study assessed home AED placement in survivors of VF. Between 1983 and 1987, 76 individuals were assigned to AED at home or no AED. The study was conducted in King's County Washington. The groups were not randomly assigned. 14 OHCA occurred; 10 in the AED group and 4 in the control group. The AED was used 6 times and 1 person survived. One person survived in the control group. Use of AEDs at home by family did not confer a survival advantage.

England H, Hoffman C, Hodgman T, Singh S, Homoud M, Weinstock J, Link M, Estes,NAM,III. Effectiveness of automated external defibrillators in high schools in Greater Boston. *Am J Cardiol.* 2005; 95: 1484-1486.

Level 4, Poor, Supporting

This is an early study of placement of AEDs in high schools in the city of Boston. AEDs were placed in 35 schools; primary mode of follow up was survey. Of the 29 schools which had AEDs placed and responded to the survey, 2 had arrests occur, one in a referee at a sporting game, one in a teacher, and both resulted in survival. While a small study it does verify the potential for survival in school based AED placement.

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: 195-200.

Level 3, Fair, Supporting

This observational study from November 2002 thru December 2004 reports the results of national AED deployment in Austria. Seventy-three cases of AED deployment occurred, but 11 were excluded because bystanders were part of the EMS system. Sixty-two cases remained; 17 were discharged alive, 15 with CPC score 1-2, two with CPC 3-4. OHCA treated with AEDs had high survival and good neurological outcomes.

Folke F, Lippert FK, Nielsen SL, Gislason GH, Hansen ML, Schramm TK, Sorensen R, Fosbol EL, Andersen SS, Rasmussen S, Kober L, Torp-Pedersen C. Location of cardiac arrest in a city center: strategic placement of automated external defibrillators in public locations. *Circulation.* 2009; 120: 510-517.

Level 5, Good, Neutral

This study describes historical arrests in one city and maps the locations of the arrests. The report describes a program of deployment of AEDs across the city and describes the matching of the device placement to prior arrests and the limited use of the devices after they had been placed. While it does not have a report of survival to hospital discharge it is important to this presentation because of 104 AEDs placed across the city none were used in the first year of their deployment. Mapping demonstrated that the AEDs had been placed in low risk locations or in municipal buildings that were close to high risk locations but were not easily accessible when needed. In the absence of a well organized program, deployment of AEDs is unlikely to be of benefit.

Gray AJ, Redmond AD, Martin MA. Use of the automatic external defibrillator-pacemaker by ambulance personnel: The Stockport experience. *Br Med J (Clin Res Ed).* 1987; 294: 1133-1135.

Level 4, Poor, Neutral

This cohort study reports an 18-month experience in Stockport with use of AEDs for resuscitation. There were 113 patients involved in the study; 65 of whom were in ventricular fibrillation. There were no survivors. The overall quality of data maintenance in this study is poor. The reasons for such poor outcomes are not clear.

Groh WJ, Newman MM, Beal PE, Fineberg NS, Zipes DP. Limited response to cardiac arrest by police equipped with automated external defibrillators: lack of survival benefit in suburban and rural Indiana--the police as responder automated defibrillation evaluation (PARADE). *Acad Emerg Med.* 2001; 8: 324-330.

Level 3, Fair, Neutral

Indiana counties trained police officers in AED use and devices were deployed to police vehicles. No significant differences in outcome were found. The study demonstrated few cases of police-AED use. Police having AEDs alone does not improve survival. The interval from 911 call to arrival at scene and shock were significantly improved.

Hallstrom AP, Ornato JP, Weisfeldt M, Travers A, Christenson J, McBurnie MA, Zalenski R, Becker LB, Schron EB, Proschan M, Public Access Defibrillation Trial Investigators. Public-access defibrillation and survival after out-of-hospital cardiac arrest. *N Engl J Med.* 2004; 351: 637-646.

Level 1, Fair, Supporting

This randomized, multi center, controlled trial of public access defibrillation was funded by NIH. The study was conducted between July 2000 and September 2003. Public settings such as malls and community centers were randomized to AED or standard CPR initial treatment of arrests. A large number of sites were enrolled and thousands of individuals were trained in each group. Locations with appropriate size had more than one AED placed. Retraining and device checks were scheduled as part of the protocol. The study had substantial problems in management; less than half of the predicted arrests occurred in each group. Many facilities were non compliant and there were difficulties achieving retraining and retaining long term volunteers. Resuscitation was attempted in only half of the observed arrests. Attempts were made in residential units on only 29% of events but were attempted in 90% of public location events. There was a substantial and not fully explained drop from 1800 events to 128 arrests of cardiac cause with resuscitation in the AED group. Volunteer response was activated in 54% of the CPR group and 70% of the AED group. VF was the first identified rhythm in 58% of the cases in the AED group. There were 30 survivors in the AED group and 15 in the CPR group. Overall the study is positive for placement of the AEDs but demonstrates the difficulties in developing and sustaining a large scale public access defibrillation program.

Hanefeld C, Lichte C, Mentges-Schroter I, Sirtl C, Mugge A. Hospital-wide first-responder automated external defibrillator programme: 1 year experience. *Resuscitation.* 2005; 66: 167-170.

Level 4, Poor, Supporting

This is an in-hospital study from Germany in a university hospital, conducted in 2003 and 2004. The hospital placed AEDs in strategic locations, in areas that did not have code carts or defibrillators prior to the project. There was an organized system to identify locations likely to need resuscitation and sufficiently far from the central code teams to justify placement of AEDs. There were 138 calls during the study period, 38 of these were for arrests, 18 were in ventricular fibrillation; of the patients in ventricular fibrillation, 10 were discharged alive. While difficulty identifying reasons for the drop from 138 calls to 38 arrests limits the quality of the data, survivors that have been treated directly with AEDs are real and substantial.

Haynes BE, Mendoza A, McNeil M, Schroeder J, Smiley DR. A statewide early defibrillation initiative including laypersons and outcome reporting. *JAMA.* 1991; 266: 545-547.

Level 4, Poor, Supporting

This study from California is the report of a statewide registry which assessed treatment of cardiac arrest by EMS, fire safety and the public with AED placement. There is no control group. 1,487 individuals were shocked, 1,009 were in witnessed ventricular fibrillation and there were 191 survivors. While this study has no control group and relatively poor data collection and reviewing standards, the number of survivors suggests benefit from deployment of AEDs.

Heber M. Out-of-hospital resuscitation using the "Heart-Aid", an automated external defibrillator-pacemaker. *Int J Cardiol.* 1983; 3: 456-458.

Level 4, Fair, Supporting

This is one of the earliest trials of automatic external defibrillator placement. It had a small study group with no comparison. Automatic external defibrillators were placed by paramedics in Brighton in 1981 and 1982. A total of 48 patients were treated; 14 achieved return of spontaneous circulation and 5 survived. The importance of this study is it's one of the very first trials using automatic external defibrillators to reverse ventricular fibrillation in the field.

Herlitz J, Bang A, Axelsson A, Graves JR, Lindqvist J. Experience with the use of automated external defibrillators in out of hospital cardiac arrest. *Resuscitation.* 1998; 37: 3-7.

Level 3, Poor, Neutral

This is a study from the Emergency Medicine system in Gotenberg, Sweden. It addresses the time period from 1987 through 1992. It compares patients resuscitated using AEDs with those treated without AEDs. The study covers a period in which AEDs were being placed on services in Sweden. There were 317 in the AED group and 1,398 in the CPR group. Bystander CPR was infrequent in both groups,with 17% and 14%; most were witnessed. There was 12% hospital discharge in the AED and 8% in the CPR group among patients in witnessed ventricular fibrillation.

Ho J, Held T, Heegaard W, Crimmins T. Automatic external defibrillation and its effects on neurologic outcome in cardiac arrest patients in an urban, two-tiered EMS system. *Prehosp Disaster Med.* 1997; 12: 284-287.

Level 4, Poor, Neutral

This is a study from the Minnesota EMS from the time period of 1993 through 1995. The study was conducted in the city of Minneapolis. The project placed AEDs in the fire department as part of a two tier response. The study mentions a control group but it was never characterized. The study reports 356 arrests and 271 resuscitation attempts. AEDs delivered shocks in 109 victims and 22 of these survived.

Hollenberg J, Riva G, Bohm K, Nordberg P, Larsen R, Herlitz J, Pettersson H, Rosenqvist M, Svensson L. Dual dispatch early defibrillation in out-of-hospital cardiac arrest: the SALSA-pilot. *Eur Heart J.* 2009; 30: 1781-1789.

Level 3, Poor, Supporting

This is a one year study from December 2005 to December 2006 in comparison with historical controls. The setting is Stockholm and reports results of placement of AEDs in fire stations and public venues including malls, transport sites, stadiums and airports. The guards in these sites were trained in use of the AEDs. The retrospective data was obtained from the Swedish Cardiac Arrest registry. In the study year there were 863 arrests; 70% were witnessed; 57 individuals or 9.7% of the witnessed arrests survived to one month. Historically there were 657 events in 2004; 439 were witnessed and 25 or 5.7% survived. EMS dispatch only occurred in 35% of cases and the fire brigade arrived first in 155 cases. The study is overall positive for use of AEDs including public venues; however the use of a different data set for the control group limits the significance of the study.

Holmberg M, Holmberg S, Herlitz J, Gardelov B. Survival after cardiac arrest outside hospital in Sweden. Swedish Cardiac Arrest Registry. *Resuscitation.* 1998; 36: 29-36.

Level 4, Poor, Neutral

This is a study of country wide use of AEDs in Sweden. It was done from 1990 to 1995. It reports a voluntary registry supplied to a central depository. The registry reports approximately 11,000 cases, 70% witnessed and 43% ventricular fibrillation. There is a major drop off of data for a variety of variables as is common in large registry studies. The registry reports an overall survival of 5% and a survival of ventricular fibrillation of 9.5%. Only 11% of the events occurred in a public setting. The relevance of this study is difficult to assess as it is a voluntary registry and includes only selected portions of the country.

Jakobsson J, Rehnqvist N, Nyquist O. One year's experience of early defibrillation in Stockholm. *J Intern Med.* 1989; 225: 297-301.

Level 4, Poor, Neutral

This cohort study was conducted in Stockholm in the 1980s for one year. The project placed AEDs with ambulances which had previously used only CPR. In one year there were 546 arrests; 165 of these were in VF; 28 patients were admitted to the hospital and 3 survived to hospital discharge. 70% of the events occurred at home and 28% occurred in public settings. This one year cohort study shows very poor outcomes for individuals treated with AEDs or resuscitated in the Stockholm area. The quality of the data is poor and much of the data was incomplete.

Kajino K, Iwami T, Berg RA, Hiraide A, Hayashi Y, Yukioka H, Tanaka H, Shimazu T, Sugimoto H. Comparison of neurological outcomes following witnessed out-of-hospital ventricular fibrillation defibrillated with either biphasic or monophasic automated external defibrillators. *Emerg Med J*. 2009; 26: 492-496.

Level 3, Good, Supporting

This is a study which compares monophasic and biphasic shock in patients with ventricular fibrillation. This study is from Japan. Only 20% of patients with witnessed out of hospital cardiac arrest of presumed cardiac etiology had ventricular fibrillation. Biphasic shocks converted a higher but not significantly different percentage of patients. A return of spontaneous circulation occurred more frequently and neurologically favorable one month survival was more common in the biphasic group (23% vs. 3%). There was a substantial decrease in time from first shock to second shock in the biphasic group but it is unclear whether this contributed to the difference in survival. This study was conducted in early 2004. There was no evidence of industry participation in funding the study.

Kellermann AL, Hackman BB, Somes G, Kreth TK, Nail L, Dobyns P. Impact of first-responder defibrillation in an urban emergency medical services system. *JAMA*. 1993; 270: 1708-1713.

Level 2, Good, Neutral

This is a study based in Memphis, TN which has an Emergency Medicine service with advanced life support capacity. This study assessed the effect of adding fire service based AEDs as a second tier of responders. The time was from 1989 through 1992. The service had 20 advanced life support ambulances and 48 fire stations across the city of Memphis. There were 447 cases in the AED treatment and 432 in the basic CPR treatment. There was an increase in survival among the AED treated patients but it did not achieve statistical significance. There was an average of 2.5 minutes saved in first responders arriving at the patient's side. The study is neutral but is used in the metaanalyses that suggest benefit from AED services.

Kudenchuk PJ, Cobb LA, Copass MK, Olsufka M, Maynard C, Nichol G. Transthoracic incremental monophasic versus biphasic defibrillation by emergency responders (TIMBER): a randomized comparison of monophasic with biphasic waveform ascending energy defibrillation for the resuscitation of out-of-hospital cardiac arrest due to ventricular fibrillation. *Circulation*. 2006; 114: 2010-2018.

Level 1, Good, Neutral

This randomized, controlled trial was conducted from November 2002 to September 2004 in a 2-tiered EMS system in Seattle, Washington. All adults in the response area with out-of-hospital arrest due to VF before EMS arrival were treated by EMS units randomized to monophasic or biphasic AEDs. Responders were blinded to the waveform. No statistical differences in outcome were found. Defibrillation with monophasic or biphasic waveforms demonstrated equal survival from out-of-hospital cardiac arrest.

Kuisma M, Castren M, Nurminen K. Public access defibrillation in Helsinki--costs and potential benefits from a community-based pilot study. *Resuscitation*. 2003; 56: 149-152.

Level 2, Poor, Neutral

This study reports a cohort from Helsinki, Finland and was conducted from 1999 through 2002. This study presents placement of AEDs in high likelihood areas such as railway stations, harbor terminals and malls. The study compared areas that had AEDs placed with portions of the town that did not have AEDs. There were 7 events in the AED areas and 13 in the non-AED areas. There were no survivors in the locations that had AEDs and there were 4 survivors in the control group. This small study demonstrated no benefit to the placement of AEDs in high likelihood of cardiac arrest locations.

Lim SH, Anantharaman V, Teo WS, Chan YH, Chee TS, Chua T. Results of the first five years of the prehospital automatic external defibrillation project in Singapore in the "Utstein style". *Resuscitation*. 2005; 64: 49-57.

Level 4, Good, Neutral

This is a report of the first five years of an AED based EMT service in Singapore. There were 968 resuscitation efforts in the five year period. Only 22% of events occurred in public sites. EMS witnessed 136 events. Less than half of the events were ventricular fibrillation and 40 individuals survived. The study has a good quality of reporting of data and demonstrates that AED based services can contribute survivors but outcomes are poor in non-public, non witnessed VF cases.

MacDonald RD, Mottley JL, Weinstein C. Impact of prompt defibrillation on cardiac arrest at a major international airport. *Prehosp Emerg Care.* 2002; 6: 1-5.

Level 4, Good, Neutral

This study reports the initial experience of placement of AEDs in the major airport in Boston. The study was conducted between 1995 and 1999. The analyses are descriptive. There were 53 arrests during the time period; 38 are included in this report. In 36 of these the fire rescue for the airport arrived first. 28 subjects were shocked and 8 subjects survived to hospital discharge. The study demonstrates that placement of AEDs in locations which would otherwise be difficult for emergency services to access can result in meaningful survival.

Mols P, Beaucarne E, Bruyninx J, Labruyere JP, De Myttenaere L, Naeije N, Watteeuw G, Verset D, Flamand JP. Early defibrillation by EMTs: the Brussels experience. *Resuscitation.* 1994; 27: 129-136.

Level 4, Good, Supporting

This study is from Brussels in the years 1989 to 1992. It is a study of addition of AEDs to a basic EMS service. There were 25 associated ambulance services. The city also had 6 MD ambulances but is unclear whether these were deployed with AEDs or full defibrillation. There were 316 arrests of which 105 were in VF; 45 achieved return of spontaneous circulation and 14 survived. The VF arrests were witnessed in 68% of cases and 23% had bystander CPR. The study verifies survival of individuals. Whether they could have been resuscitated without the AED is not assessable as there is no control comparison group.

Moore MJ, Hamilton AJ, Cairns KJ, Marshall A, Glover BM, McCann CJ, Jordan J, Kee F, Adgey AA. The Northern Ireland Public Access Defibrillation (NIPAD) study: effectiveness in urban and rural populations. *Heart.* 2008; 94: 1614-1619.

Level 3, Good, Neutral

This is a report from the study of placement of AEDs throughout Northern Ireland in a public access model similar to the England and Wales study. The time for this report is 2004 through 2006. AEDs were placed in 29 urban and 53 rural locations. Lay and police volunteers were trained in both venues with 335 urban and 493 trainees. First responders in urban areas were paged to 128 events, attended 88 of them and arrived before EMS in 18 cases. In the rural areas, they were paged to 49 events, attended 42 and arrived at 23 before EMS. Survival in urban areas was 5.1% in 2004 and 1.6 % in 2005 and 2006. Over 75% of arrests occurred at home and asystole was the identified rhythm in 75% or more of the attended events throughout the study. Overall there were low rates of AED application in a public access defibrillation modality and low rates of overall survival.

Mosesso VN,Jr, Davis EA, Auble TE, Paris PM, Yealy DM. Use of automated external defibrillators by police officers for treatment of out-of-hospital cardiac arrest. *Ann Emerg Med.* 1998; 32: 200-207.

Level 3, Good, Neutral

This study of police deployment with AEDs in counties surrounding Pittsburg, PA was conducted from 1990 to 1995 and compared results to an historical control group. There were 203 patients treated in the control period and 317 in the intervention period. In the control period, 83 patients had police arrive first and in the intervention period 172 had police present first. Police were the first to see patients in VF in 75 cases in the intervention group and delivered shocks to 46 patients. There was a statistically significant increase in the return of spontaneous circulation in the intervention group but not in survival. The placement of AEDs in police vehicles substantially decreased the time to initial defibrillation in patients in VF. The study suggested improvement in survival to discharge but was underpowered to achieve statistical significance.

Myerburg RJ, Fenster J, Velez M, Rosenberg D, Lai S, Kurlansky P, Newton S, Knox M, Castellanos A. Impact of community-wide police car deployment of automated external defibrillators on survival from out-of-hospital cardiac arrest. *Circulation.* 2002; 106: 1058-1064.

Level 3, Good, Supporting

This clinical trial of police first responders was conducted in Miami, Florida from February to July 1999 and reports 420 cardiac arrest victims for which police with AEDs and EMS responded. AED training was provided and units deployed to all police officers. The 911-notification system was modified for dual-dispatch. If EMS arrived first police were diverted. The initial rhythm was VF/VT in 163 of the police responses and 122 of the EMS responses (comparison). This police AED program conferred a survival advantage when the arrest was witnessed and the rhythm was shockable. Police equipped with AEDs improved the response time. AEDs alone do not enhance outcome.

O'Rourke M, Donaldson E. Management of ventricular fibrillation in commercial airliners. *Lancet.* 1995; 345: 515-516.
No abstract available.

Level 4, Fair, Neutral

This is a study of airline AED deployment including planes and terminals. The study was conducted in Australia and covers the time between September 1991 and December 1994. AEDs were used 50 times; 29 of these were for arrests; 16 occurred in aircraft and 13 in the terminal. Of the 29 arrests; 15 were in ventricular fibrillation and 3 survived. This study demonstrates that airlines can use AEDs and achieve survival in both airplanes and airline terminals.

Page RL, Joglar JA, Kowal RC, Zagrodzky JD, Nelson LL, Ramaswamy K, Barbera SJ, Hamdan MH, McKenas DK. Use of automated external defibrillators by a U.S. airline. *N Engl J Med.* 2000; 343: 1210-1216.

Level 4, Fair, Supporting

This study reports events occurring on a particular airline company or in the airport terminals served by this company. This is a study that was conducted between 1997 and 1999. AEDs were placed on all of the airplanes of one large commercial airline company. 24,000 flight attendants were trained. The attendants placed AEDs on 200 patients, 99 of whom had loss consciousness. 36 events were considered to be an arrest, 14 were in ventricular fibrillation, 13 were defibrillated and treatment was withheld on one for a do not resuscitate order status. Of 36 total resuscitation attempts, 6 patients survived, all of whom were in the treated ventricular fibrillation group. This study demonstrates the ability of AEDs to be used in airplanes and airports and contribute to patient survival.

Richless LK, Schrading WA, Polana J, Hess DR, Ogden CS. Early defibrillation program: problems encountered in a rural/suburban EMS system. *J Emerg Med.* 1993; 11: 127-134.

Level 3, Fair, Neutral

This was an early trial of deployment of AEDs with voluntary ambulances in rural Pennsylvania in 1985 and 1986. The AEDs were taken home by EMTs and driven in personal cars to the event. There were 134 events of which 96 were entered into the study. 33 were in ventricular fibrillation or ventricular tachycardia and 3 survived, 2 from VF and one from VT. Response times were long, with an average of 13 minutes. The survival of resuscitation in rural venues is low and AEDs may add slightly to survival.

Sanna T, La Torre G, de Waure C, Scapigliati A, Ricciardi W, Dello Russo A, Pelargonio G, Casella M, Bellocci F. Cardiopulmonary resuscitation alone vs. cardiopulmonary resuscitation plus automated external defibrillator use by non-healthcare professionals: a meta-analysis on 1583 cases of out-of-hospital cardiac arrest. *Resuscitation.* 2008; 76: 226-232.

Level 5, Fair, Supporting

This systematic review and meta-analysis of reports of out of hospital cardiac arrests assessed 1583 cases of OHCA from 3 papers. Initial literature search yielded 186 papers. One hundred sixty two papers were excluded because they were non-randomized clinical trials and twenty-one papers were excluded because the treatment or control aims were not relevant to the aims of the meta-analyses. Two meta-analyses cases were done; both demonstrated benefit. Only studies with of level of evidence 1 or 2 were used. The studies included in the meta-analysis had better outcomes for AED but the benefits were not statistically significant.

Schneider T, Martens PR, Paschen H, Kuisma M, Wolcke B, Gliner BE, Russell JK, Weaver WD, Bossaert L, Chamberlain D. Multicenter, randomized, controlled trial of 150-J biphasic shocks compared with 200- to 360-J monophasic shocks in the resuscitation of out-of-hospital cardiac arrest victims. Optimized Response to Cardiac Arrest (ORCA) Investigators. *Circulation.* 2000; 102: 1780-1787.

Level 1, Good, Neutral

This randomized, controlled trial was conducted in four European cities between 1996 and 1998. Subjects were OHCA treated by EMS personnel using an AED. Mainz, Germany enrolled 197 patients, Brugge, Belgium 69 patients, Hamburg, Germany 37 patients and Helsinki, Finland 35 patients. The 115 patients with an initial rhythm of ventricular fibrillation were analyzed. ECG and shock data were obtained from the recording systems within the AEDs and reviewed by investigators at each site. 53/54 patients (98%) were defibrillated with 150-J biphasic shocks compared to 42/61 (69%) with escalating monophasic shocks of 200 and 300-J, $p < 0.0001$. Biphasic AEDs demonstrated greater efficacy at defibrillating patients following OHCA in this study.

Sedgwick ML, Dalziel K, Watson J, Carrington DJ, Cobbe SM. Performance of an established system of first responder out-of-hospital defibrillation. The results of the second year of the Heartstart Scotland Project in the 'Utstein Style'. *Resuscitation.* 1993; 26: 75-88.

Level 4, Good, Supporting

This is a report of the Heartland Scotland project in which AEDs were placed on ambulances across the country. This is a single tier service where AEDs add to basic EMS services. An earlier report from this project is Cobbe, 1991. There were 1,700 arrests; of these 174 were discharged alive, most conscious and in normal condition. 85% of those who survived were known to be alive at one year. Bystander CPR was demonstrated to double survival and VF witnessed by the team had a 39% survival rate. This is

considered positive because it demonstrated improved survival from historical controls although the level of data maintenance for the two groups is not strictly comparable.

Shuster M, Keller JL. Effect of fire department first-responder automated defibrillation. *Ann Emerg Med.* 1993; 22: 721-727.

Level 3, Fair, Neutral

This historical control cohort study was conducted in Hamilton Ontario in 1990 and 1991. The study placed AEDs with ambulance services and compared the outcomes to pre-AED controls. There were 151 patients in the control group and 146 in the AED treated group. Survival improved from 3% to 6% which was from 4 to 8 individuals. The survival improvement was not statistically significant. This underpowered study shows improvement in overall outcome with use of AED as opposed to CPR only.

Smith KL, Cameron PA, Peeters A, Meyer AD, McNeil JJ. Automatic external defibrillators: changing the way we manage ventricular fibrillation. *Med J Aust.* 2000; 172: 384-388.

Level 5, Good, Supporting

This is a metaanalysis. It addresses 6 studies all of which are in this review. The individual studies in the review were negative and underpowered. The combining effect of the metaanalysis suggests that AED programs improve patient survival.

Stapczynski JS, Svenson JE, Stone CK. Population density, automated external defibrillator use, and survival in rural cardiac arrest. *Acad Emerg Med.* 1997; 4: 552-558.

Level 4, Poor, Neutral

This is a three year study from 1992 through 1994 conducted in the Emergency Medicine Services in Kentucky. The intervention consisted of placement of AEDs in ambulances which previously had been CPR only services. The comparison in this study is between areas that are more urban or less urban. There were 311 arrests; 110 of these were defibrillated and 19 survived to hospital discharge. Witnessed VF survival was 14 of 89 subjects. Analyses demonstrated lower survival in less densely populated areas which was also associated with a significant increase in response time and a significant increase in asystole as the first rhythm identified. The study is weakened by a substantial amount of lost data.

Stiell IG, Wells GA, Field BJ, Spaite DW, De Maio VJ, Ward R, Munkley DP, Lyver MB, Luinstra LG, Campeau T, Maloney J, Dagnone E. Improved out-of-hospital cardiac arrest survival through the inexpensive optimization of an existing defibrillation program: OPALS study phase II. Ontario Prehospital Advanced Life Support. *JAMA.* 1999; 281: 1175-1181.

Level 3, Good, Supporting

This report of phase 2 of the Ontario Province Advanced Life Support (OPALS) trial added AEDs to a basic EMS service previously providing only CPR. The project ran from 1991 through 1997 with a historical control and excellent data collection. The project also focused on decreasing response time. Survival of out of hospital cardiac arrests increased from 3.9% to 5.2% and this was statistically significant. The time to first response was diminished significantly. Variables associated with improvement in survival included bystander witness, bystander CPR, fire/police CPR, and response less than 8 minutes. With the enhanced response time the contribution of the AED to the improved survival is difficult to separate; the overall survival rate remains low.

Stotz M, Albrecht R, Zwicker G, Drewe J, Ummenhofer W. EMS defibrillation-first policy may not improve outcome in out-of-hospital cardiac arrest. *Resuscitation.* 2003; 58: 277-282.

Level 3, Fair, Neutral

This cohort study, from 1993 to 2001, conducted in Basel, Switzerland, reports on 168 patients with cardiac arrest that was not witnessed by EMS. EMTs were trained to use an AED and instructed to use shock and CPR until a physician arrived. Telephone interview to assess neurological status and one-year survival was done. Before AED introduction 18 patients survived to hospital D/C, 13 were alive at one year and 11 had a favorable neurological outcome. After AED introduction 13 patients left the hospital alive, nine lived to one year and eight had no major neurological deficits.

Stults KR, Brown DD, Kerber RE. Efficacy of an automated external defibrillator in the management of out-of-hospital cardiac arrest: validation of the diagnostic algorithm and initial clinical experience in a rural environment. *Circulation.* 1986; 73: 701-709.

Level 2, Fair, Neutral

Clinical trial from May 1984 – June 1985 in rural communities in Iowa compared out-of-hospital cardiac arrest treated by AED equipped ambulance technicians with arrests treated by EMTs using manual defibrillators. There were no statistical differences in outcome except faster time to delivery of shock in the AED group. AED analysis and delivery of shock was comparable to the defibrillator equipped group. AED may facilitate a faster delivery of shock compared to manual defibrillators.

Sweeney TA, Runge JW, Gibbs MA, Raymond JM, Schafermeyer RW, Norton HJ, Boyle-Whitesel MJ. EMT defibrillation does not increase survival from sudden cardiac death in a two-tiered urban-suburban EMS system. *Ann Emerg Med.* 1998; 31: 234-240.

Level 2, Good, Neutral

This paper reports a study in the Charlotte, NC two-tiered EMS system with 41 Fire Department companies and 7 paramedic ambulances. The study was conducted from 1992-1995. In this prospective, crossover study 243 patients experienced witnessed arrest; 110 were treated with AED+CPR and 133 with CPR-only. Survival to discharge was not affected by the use of AEDs. Witnessed arrest and **bystander CPR** improved survival.

Valenzuela TD, Roe DJ, Nichol G, Clark LL, Spaite DW, Hardman RG. Outcomes of rapid defibrillation by security officers after cardiac arrest in casinos. *N Engl J Med.* 2000; 343: 1206-1209.

Level 4, Good, Supporting

This study placed AEDs in casinos across the United States. The time period is 1997 through 1999. Security personnel in the casinos charged with monitoring the overall flow of individuals in the area to assure safety were trained and AEDs were placed to allow response within three minutes of collapse. There were 148 arrests, 90 of which were witnessed ventricular fibrillation. Overall ventricular fibrillation occurred in 71% of arrests; 56 patients in VF survived (38% of total VF). 59% of the witnessed VF subjects survived. This is a cohort study with no comparison group but the survival rate is high and demonstrates capacity to achieve good survival using AED based programs.

van Alem AP, Vrenken RH, de Vos R, Tijssen JG, Koster RW. Use of automated external defibrillator by first responders in out of hospital cardiac arrest: prospective controlled trial. *BMJ.* 2003; 327: 1312. Erratum in: BMJ. 2004 Feb 14; 328: 396.

Level 1, Good, Neutral

This study reports a two year trial of placement of AEDs in the fire brigade and police services in Amsterdam. There was a 4 month crossover and the services were randomized to the treatment device options. There were 243 subjects in the experimental group and 226 in the control group. 157 had shockable rhythms in the experimental group and 151 in the control group. Of these 40 from the experimental group survived to hospital discharge and 32 of the control group. The study demonstrated significant improvement in admission to hospital and return of spontaneous circulation but not survival to hospital discharge.

Vukov LF, White RD, Bachman JW, O'Brien PC. New perspectives on rural EMT defibrillation. *Ann Emerg Med.* 1988; 17: 318-321.

Level 1, Fair, Supporting

This is an early study of AED deployment with the cross over in rural MN. This study was conducted between 1984 and 1986. The services were randomized and the crossover was planned, determined and achieved. The non AED group had 40 cases and the AED treated group had 70 cases. There was one survivor in the control group and 6 survivors in the treatment group. The study has generally positive outcomes but is underpowered for definitive results.

Walters G, D'Auria D, Glucksman EE. Controlled trial of automated external defibrillators in the London ambulance service. *J R Soc Med.* 1990; 83: 563-565.

Level 3, Fair, Neutral

London ambulance service from February 1987 to May 1988 placed AED on ambulances. This study compares CPR-alone vs. CPR+AED. 572 cases were treated but only 398 patients for whom postmorten examination confirmed cardiac etiology were analyzed. Five people from the CPR group survived and seven from the CPR+AED group survived.

Weaver WD, Copass MK, Bufi D, Ray R, Hallstrom AP, Cobb LA. Improved neurologic recovery and survival after early defibrillation. *Circulation.* 1984; 69: 943-948.

Level 3, Fair, Neutral

This is a human cohort study from Seattle conducted 1980 through 1982. The study group had AEDs placed with minimally trained personnel; in the control group similarly trained personnel without AEDs provided CPR. The study utilized historical controls which had tapes in monitoring devices to assess events and rhythms. Time to defibrillation was decreased by five minutes in the AED group. Time to CPR and response times were not changed. There were 87 cases in the AED group and 370 in the non-AED group. Survival was 30% vs. 28% and there was no significant difference in outcome. In this study AEDs did not improve outcomes despite substantial decreases in the time to first defibrillation.

Weaver WD, Copass MK, Hill DL, Fahrenbruch C, Hallstrom AP, Cobb LA. Cardiac arrest treated with a new automatic external defibrillator by out-of-hospital first responders. *Am J Cardiol.* 1986; 57: 1017-1021.

Level 4, Fair, Supporting

This is an early study of automatic external defibrillators in a setting where EMTs were deployed with AEDs. There is no second tier of ALS in this study. 282 patients were evaluated; 118 were found to be in VF and 91 were shocked. 30 patients survived to hospital discharge. This is a cohort study with no comparison group. There is a fair amount of missing data in the study but high rates of survival of ventricular fibrillation treated with AEDs is documented.

Weaver WD, Hill D, Fahrenbruch CE, Copass MK, Martin JS, Cobb LA, Hallstrom AP. Use of the automatic external defibrillator in the management of out-of-hospital cardiac arrest. *N Engl J Med.* 1988; 319: 661-666.

Level 2, Poor, Supporting

This study was done in Seattle in 1984 through 1986. The protocol placed AEDs in units that were known to have long paramedic response times. Standard CPR was done in the control group. This is a two tier system with a BLS first responder and an ALS advanced response. As expected, the response times were 3.7 minutes longer in the control group. There were 683 subjects in the AED group and 600 in the CPR group. 276 were in VF in the AED group and 228 in the CPR group. The AED group had a 30% survival rate; the CPR group had a 17% survival rate. The groups are difficult to compare because they were designed to have different response times which is known to be a major factor in survival.

White RD, Asplin BR, Bugliosi TF, Hankins DG. High discharge survival rate after out-of-hospital ventricular fibrillation with rapid defibrillation by police and paramedics. *Ann Emerg Med.* 1996; 28: 480-485.

Level 2, Good, Neutral

This was a trial of adding police first responders to an established advanced life support network in Rochester, MN. The study was conducted over a 57-month period. 84 witnessed VF out of hospital cardiac arrests were included in the study. Of the 84, 31 were first responded to by police and 53 by paramedics. The survival rate was 58% in those who had first response by police and 43% in the group first reached by paramedics. The differences were not significant. Patients in both groups had a very high survival rate from VF associated with very rapid response times by whichever unit arrived first. There were 74 non VF patients who were evaluated during the time period and none survived.

Whitfield, R., M. Colquhoun, et al. (2005). "The Department of Health National Defibrillator Programme: Analysis of downloads from 250 deployments of public access defibrillators." Resuscitation 64(3): 269-277.

LOE 4, Poor, Supporting on-site AEDs (public places).

Prospective, interventional case series. LOE4. Poor.
Specific factors. AEDs: on-site (public places), at risk identified sites. Responders: FR (CPR+AED). Response: direct.