Step 2B: Critically assess each article/source in terms of research design and methods.
Was the study well executed? Suggested criteria appear in the table below. Assess design and methods and provide an overall rating. Ratings apply within each Level; a Level 1 study can be excellent or poor as a clinical trial, just as a Level 6 study could be excellent or poor as an animal study. Where applicable, please use a superscripted code (shown below) to categorize the primary endpoint of each study. For more detailed explanations please see attached assessment form.

Component of Study and Rating	Excellent	Good	Fair	*Poor*	*Unsatisfactory*
Design & Methods	Highly appropriate sample or model, randomized, proper controls **AND** Outstanding accuracy, precision, and data collection in its class	Highly appropriate sample or model, randomized, proper controls **OR** Outstanding accuracy, precision, and data collection in its class	Adequate, design, but possibly biased **OR** Adequate under the circumstances	*Small or clearly biased population or model* *OR* *Weakly defensible in its class, limited data or measures*	*Anecdotal, no controls, off target end-points* *OR* *Not defensible in its class, insufficient data or measures*

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

Step 2C: Determine the direction of the results and the statistics: supportive? neutral? opposed?

DIRECTION of study by results & statistics:	SUPPORT the proposal	NEUTRAL	OPPOSE the proposal
Results	Outcome of proposed guideline superior, to a clinically important degree, to current approaches	Outcome of proposed guideline no different from current approach	Outcome of proposed guideline inferior to current approach

Step 2D: Cross-tabulate assessed studies by a) *level*, b) *quality* and c) *direction* (ie, supporting or neutral/ opposing)**; combine and summarize.** Exclude the *Poor* and *Unsatisfactory* studies. Sort the *Excellent, Good,* and *Fair* quality studies by both *Level and Quality of evidence,* and *Direction of support* in the summary grids below. Use citation marker (e.g. author/ date/source). In the *Neutral* or *Opposing* grid use bold font for *Opposing* studies to distinguish them from merely neutral studies. Where applicable, please use a superscripted code (shown below) to categorize the primary endpoint of each study.

Supporting Evidence

AED programs are safe, feasible and effective

Quality of Evidence	1	2	3	4	5	6	7	8
Excellent	PAD trial Investigators 2004 C	Van Alem 2003 B,C						
Good			Myerburg 2002 C Stiell 1999 CD Weaver 1988 C	Culley 2004 C	Valenzuela 2000 C		De Maio 2003 C	
Fair			Capucci 2002 A,C,D	Mosesso 1998 C	Caffrey 2002 D Page 2000 C Smith 2002 Sedgwick 1993 D Rourke 1997D MacDonald 2002 C		Groeneveld 2001 CEA Forrer 2002 CEA	
	Level of Evidence							

A = Return of spontaneous circulation
B = Survival of event
C = Survival to hospital discharge
D = Intact neurological survival
E = Other endpoint
CEA=Cost effectiveness analysis

Neutral or Opposing Evidence

AED programs are safe, feasible and effective

Quality of Evidence									
	Excellent								
	Good		Cummins 1987 C					Kenward 2002 C Pell 2002 C Walker 2003E CEA Nichol 2003 CEA	
	Fair		Kellerman 1993 D		White 1998 D Eisenberg 1989 C	Chen 2002 E			
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
		Level of Evidence							

A = Return of spontaneous circulation
B = Survival of event
C = Survival to hospital discharge
D = Intact neurological survival
E = Other endpoint
CEA=Cost Effectiveness Analysis

REVIEWER'S PERSPECTIVE AND POTENTIAL CONFLICTS OF INTEREST: Briefly summarize your professional background, clinical specialty, research training, AHA experience, or other relevant personal background that define your perspective on the guideline proposal. List any potential conflicts of interest involving consulting, compensation, or equity positions related to drugs, devices, or entities impacted by the guideline proposal. Disclose any research funding from involved companies or interest groups. State any relevant philosophical, religious, or cultural beliefs or longstanding disagreements with an individual.

Reviewer 1: academic clinical cardiologist, coronary care, device implantation, ECC. 20 years clinical research on OOH/in hospital cardiac arrest. Member Board ERC, chair WG BLS/AED. Scientific "COI" from recent studies on AED. COI from consultancy, compensation, study support by Medtronic ERS.

Reviewer 2: Cardiac electrophysiologist and basic scientist with a 15 year history in resuscitation science. Current AHA BLS subcommittee member (year 5). Co-inventor of ACD CPR device and impedance threshold device. Published >100 papers in the field of resuscitation. Founder, Advanced Circulatory Systems, Incorporated, a device company started to develop resuscitation technology. Advanced Circulatory Systems has business relationships with Medtronic Physio-control and Zoll Medical.

REVIEWER'S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK: Summarize your final evidence integration and the rationale for the class of recommendation. Describe any mismatches between the evidence and your final Class of Recommendation. "Mismatches" refer to selection of a class of recommendation that is heavily influenced by other factors than just the evidence. For example, the evidence is strong, but implementation is difficult or expensive; evidence weak, but future definitive evidence is unlikely to be obtained. Comment on contribution of animal or mechanical model studies to your final recommendation. Are results within animal studies homogeneous? Are animal results consistent with results from human studies? What is the frequency of adverse events? What is the possibility of harm? Describe any value or utility judgments you may have made, separate from the evidence. For example, you believe evidence-supported interventions should be limited to in-hospital use because you think proper use is too difficult for pre-hospital providers. Please include relevant key figures or tables to support your assessment.

Sudden death and resuscitation occur mainly (70-80%) in or near the home of victims. The remaining 20-30% of sudden death events occur evenly during work or in public places. Most studies showing large treatment benefits and/or high survival rates from the use of AEDs are performed in these latter domains (airports, casino's, airplanes).(Valenzuela 2000, Caffrey 2002, MacDonald 2002, Page 2000) Studies attempting to employ AEDs in the residential domains where most victims are dying suddenly and use

(targeted) first responders like police bringing an AED to the victim, show a much smaller benefit and lower survival rates.(Capucci 2002, Myerberg 2002, Smith 2002, Van Alem 2003) The reason for the difference of AEDs on outcome is (by design) the very short response times characteristic of the unusual settings of the studies showing large benefit. The result is a very optimistic picture of the benefit of the application of AEDs.

The reality is that public access defibrillation (PAD) applications, such as tested in the PAD trial (PAD Trial Investigators 2004), require very large efforts and cost, (Nichol 2003, Walker 2003) demonstrate high survival rates but only reach a small proportion of the community. This is demonstrated by the Seattle/King County AED survey (Culley 2004), which showed that only a few percent (~2%) of patients are assisted with AEDs. This percentage is certainly rising, but the limitations of benefit are clear. On the other hand, the small benefit from targeted non-traditional first responders (e.g., police) is obtained with relatively small number of defibrillators and responders (Myerburg 2002, van Alem 2003) and benefits the whole population. Therefore, ultimately, the application of AEDs is much more cost-effective and saves more lives. For this reason the PAD approach should be a IIA recommendation even though a significant benefit on mortality was observed in the PAD trial, because of the low cost-effectiveness and limited benefit of this approach to the population at large. Conversely, AED use by targeted first responders should be a class I recommendation. Home use of AEDs, albeit intuitively sound, remains of unproven benefit. One controlled study (Eisenberg 1989) was underpowered for benefit and did not demonstrate a positive trend. Convincing evidence is lacking.

Preliminary draft/outline/bullet points of Guidelines revision: Include points you think are important for inclusion by the person assigned to write this section. Use extra pages if necessary.

Attachments:

- Bibliography in electronic form using the Endnote Master Library. It is recommended that the bibliography be provided in annotated format. This will include the article abstract (if available) and any notes you would like to make providing specific comments on the quality, methodology and/or conclusions of the study.

Citation List

Citation Marker	Full Citation*
Caffrey 2002	Caffrey, S. L., P. J. Willoughby, et al. (2002). Public use of automated external defibrillators. N Engl J Med 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. *Notes:* *This study demonstrates the usefulness of introduction of AEDs in a public area where a large volume of persons are both at risk and available to offer help. The response times are short, all witnessed, BLS for all and as a result, survival high. It is an example of a "niche" where remarkable results can be obtained, but with limited impact on the population as a whole. It is of interest to note that many rescuers were untrained. On the other hand, half of the untrained rescuers who assisted survivors were physicians. Because of the lack of a control group, this case-series study is level 5. The limited impact classifies this as fair evidence.*
Capucci 2002	Capucci, A., D. Aschieri, et al. (2002). Tripling survival from sudden cardiac arrest via early defibrillation without traditional education in cardiopulmonary resuscitation. Circulation 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. *Notes:* *This study demonstrates a three-fold increase in survival from introducing AEDs in the community, albeit from a very low survival rate in the control group. The control group is biased, as it was not a population control without AED resuscitation. This biases the result; it would have been better to use communities without AED as control. Now it is a competition where "winners" (AED first at scene) are compared with "losers" (AED last at scene). Time to shock for EMS is not known, nor is bystander BLS; both can be another source of bias. As a non-randomized study, the level of evidence is 3, fair quality because of quality of data.*
Culley 2004	Culley, L. L., T. D. Rea, et al. (2004). Public access defibrillation in out-of-hospital cardiac arrest: a community-based study. Circulation 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. *Notes: This is an excellent population-based follow up study. The important finding is the high survival rate in this community with AED use but the limitation of impact of AED use is clear: "only" 2 percent of patients (as of 2002) were resuscitated with assistance of an AED. On the other hand, the percentage was clearly rising and higher numbers as of 2004 are expected. The quality of data collection was excellent in the study context. Its non-controlled cohort design makes it a level 4 study of good quality*
Cummins 1987	Cummins, R. O., M. S. Eisenberg, et al. (1987). Automatic external defibrillators used by emergency medical technicians. A controlled clinical trial. JAMA 257(12): 1605-10. In a randomized controlled clinical trial, the effectiveness of emergency medical technician (EMT) use of automatic external defibrillators (AEDs) was compared with EMT use of standard defibrillators for patients in cardiac arrest. A total of 321 cardiac arrest patients were treated during the study: 116 were treated by EMTs using the AED (AUTO group), 158 were treated by EMTs using the standard defibrillators (standard group), and 47 were treated by EMTs using the standard defibrillator when they were assigned to use the AED. There was no significant differences in hospital admission or discharge rates between the AUTO group (54% admitted, 28% discharged) and the standard group (52% admitted, 23% discharged) for patients in ventricular fibrillation (VF), for patients in non-VF rhythms, or for all patients combined. The only significant difference observed was in the time from power ON to first shock: 1.1 minutes average AUTO group and 2.0 minutes average standard group. The treatment groups did not differ significantly in sensitivity for VF (78% AED, 76% standard), specificity for non-VF rhythms (100% AED, 95% standard), or rates of defibrillation to a non-VF rhythm (62% AED, 57% standard). We conclude that in clinical outcomes and device performance, AEDs are comparable with standard defibrillators and should be considered an acceptable alternative. Automatic external defibrillators appear to have advantages over standard defibrillators in training, skill retention, and faster operation. Such devices can make early defibrillation available for a much larger portion of the population. They are a major

	innovation for the prehospital care of cardiac arrest patients. *Notes: Early randomized trial with proper controls from alternation in allocation of AEDs. Neutral level 2 evidence, Good study because of quality of data collection. Probably underpowered and small differences of response times to shock.*
de Maio 2003	De Maio, V. J., I. G. Stiell, et al. (2003). Optimal defibrillation response intervals for maximum out-of-hospital cardiac arrest survival rates. Ann Emerg Med 42(2): 242-50. STUDY OBJECTIVE: Many centers optimize their emergency medical services (EMS) systems to achieve a target defibrillation response interval of "call received by dispatch" to "arrival at scene by responder with defibrillator" in 8 minutes or less for at least 90% of cardiac arrest cases. The objective of this study was to analyze survival as a function of time to test the evidence for this standard. METHODS: This prospective cohort study included all adult, cardiac etiology, out-of-hospital cardiac arrest cases from phases I and II of the Ontario Prehospital Advanced Life Support (OPALS) study. Patients in the 21 Ontario study communities received a basic life support level of care with defibrillation by ambulance and firefighters but no advanced life support. Survival was plotted as a function of the defibrillation response interval. The equation of the curve, generated by means of logistic regression, was used to estimate survival at various defibrillation response interval cutoff points. RESULTS: From January 1, 1991, to December 31, 1997, there were 392 (4.2%) survivors overall among the 9,273 patients treated. The defibrillation response interval mean was 6.2 minutes, and the 90th percentile was 9.3 minutes. There was a steep decrease in the first 5 minutes of the survival curve, beyond which the slope gradually leveled off. Controlling for known covariates, the decrement in the odds of survival with increasing response interval was 0.77 per minute (95% confidence interval 0.74 to 0.83). The survival function predicts, for successive 90th percentile cutoff points, both survival rates and additional lives saved per year in the OPALS communities compared with the 8-minute standard: 9 minutes (4.6%; -18 lives), 8 minutes (5.9%; 0 lives), 7 minutes (7.5%; 23 lives), 6 minutes (9.5%; 51 lives), and 5 minutes (12.0%; 86 lives). CONCLUSION: The 8-minute target established in many communities is not supported by our data as the optimal EMS defibrillation response interval for cardiac arrest. EMS system leaders should consider the effect of decreasing the 90th percentile defibrillation response interval to less than 8 minutes. *Notes: This analysis of the importance of time delays and the impact of AEDs is of very high quality. Its main conclusions are model derivations from their observations, which makes it a level 7 study. The quality is good, the best for non-controlled studies.*
Forrer 2002	Forrer, C. S., R. A. Swor, et al. (2002). Estimated cost effectiveness of a police automated external defibrillator program in a suburban community: 7 years experience. Resuscitation 52(1): 23-9. OBJECTIVE: To estimate the cost effectiveness of a 7-year police automatic external defibrillator (AED) program in four suburban communities. METHOD: 10-year retrospective study (7/89-7/99) of patients of four suburban communities during two study periods: (1) police first response and advanced life support (ALS) care (No-AED) and; (2) AED equipped police first response (P-AED) with subsequent ALS care. Using the perspective of the communities, we obtained costs of AED program from police agencies. We estimated cost/life saved and cost/year lives saved using decreased time to VF shock by EMS. We performed a sensitivity analysis for estimates of potential benefit using estimated improved survival as a result of decreased EMS response interval and obtained survival data. We used literature-based estimates of life expectancy after cardiac arrest survival to estimate cost/year life saved. We used student's t-test and chi(2) to estimate differences between groups. RESULTS: During the 10-year study period 208 patients met study criteria; (81 No-AED, 128 P-AED). The two groups were not different by patient age, ALS response interval, percent in VF, percent witnessed (WIT), or arrest location. Interval to first defibrillator equipped EMS vehicle arrival was less in the P-AED group (2.0 vs. 5.4 min, P<0.001) as was the interval from the emergency (911) call to first VF shock (6.6 vs. 8.4 min, P=0.02). Survival to DC was not statistically different with P-AED (11.9 vs. 9.9%, P=0.66) but this study was not powered to detect a difference. Estimated cost per life saved with P-AED varied from $23542 to $70342 and cost per year life saved ranged from $1582 to $16060. CONCLUSION: Police AED appears to be a cost-effective intervention in these suburban communities which have relatively rapid EMS response

	intervals. *Notes: Well conducted cost study of police first responders. Based on literature data cost per life-year saved was calculated. Limitations are the lack of data on medical cost, which must be added to the program cost for a full picture. Level 7 quality with fair design.*
Groeneveld 2001	Groeneveld, P. W., J. L. Kwong, et al. (2001). Cost-effectiveness of automated external defibrillators on airlines. Jama 286(12): 1482-9. CONTEXT: Installation of automated external defibrillators (AEDs) on passenger aircraft has been shown to improve survival of cardiac arrest in that setting, but the cost-effectiveness of such measures has not been proven. OBJECTIVE: To examine the costs and effectiveness of several different options for AED deployment in the US commercial air transportation system. DESIGN, SETTING, AND SUBJECTS: Decision and cost-effectiveness analysis of a strategy of full deployment on all aircraft as well as several strategies of partial deployment only on larger aircraft, compared with a baseline strategy of no AEDs on aircraft (but training flight attendants in basic life support) for a hypothetical cohort of persons experiencing cardiac arrest aboard US commercial aircraft. Estimates for costs and outcomes were obtained from the medical literature, the Federal Aviation Administration, the Air Transport Association of America, a population-based cohort of Medicare patients, AED manufacturers, and the Bureau of Labor Statistics. MAIN OUTCOME MEASURES: Quality-adjusted survival after cardiac arrest; costs of AED deployment on aircraft and of medical care for cardiac arrest survivors. RESULTS: Adding AEDs on passenger aircraft with more than 200 passengers would cost $35 300 per quality-adjusted life-year (QALY) gained. Additional AEDs on aircraft with capacities between 100 and 200 persons would cost an additional $40 800 per added QALY compared with deployment on large-capacity aircraft only, and full deployment on all passenger aircraft would cost an additional $94 700 per QALY gained compared with limited deployment on aircraft with capacity greater than 100. Sensitivity analyses indicated that the quality of life, annual mortality rate, and the effectiveness of AEDs in improving survival were the most influential factors in the model. In 85% of Monte Carlo simulations, AED placement on large-capacity aircraft produced cost-effectiveness ratios of less than $50 000 per QALY. CONCLUSION: The cost-effectiveness of placing AEDs on commercial aircraft compares favorably with the cost-effectiveness of widely accepted medical interventions and health policy regulations, but is critically dependent on the passenger capacity of the aircraft. Placing AEDs on most US commercial aircraft would meet conventional standards of cost-effectiveness. *Notes: Theoretical analysis of employment of AED in "niche" application in aircrafts. Variables of relevance are analyzed for impact on cost. Many assumptions, no direct data collection. Cost per QALY relatively high. It may be of interest to note that airline decisions on AEDs are not guided by cost per QALY but by the current commercial and legal implications of litigation. Level 7 study of fair data, because of sources limited to literature.*
PAD Trial investigators 2004	The Public Access Defibrillation Trial Investigators. Public-Access Defibrillation and Survival after Out-of-Hospital Cardiac Arrest. N Engl J Med 2004;351:637-46. 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. *Notes: The PAD trial is supposed to give the ultimate answer on the application of AEDs in the community. The study is very well executed and controlled. The benefit (among the trial patients) is a doubling of survival. However, the important draw-back is that only 15% of the AEDs in the PAD trial were placed in the locations where 80% of victims are to be expected: the residential areas. As a result, only 2 of 45 survivors originated from residential areas.* *The effectiveness of AED placement in public areas is demonstrated, the cost-effectiveness is not (yet) but the large efforts and cost to save an absolute number of patients (15) over a two-year period is obvious, especially when compared to the similar absolute number of added saved victims in a similar time period from studies on targeted first responders (Myerburg, Capucci, van Alem). The quality of the study design and execution make it an excellent, level 1 study.*
Kellerman 1993	Kellermann, A. L., B. B. Hackman, et al. (1993). Impact of first-responder defibrillation in an urban emergency medical services system. JAMA 270(14): 1708-13. OBJECTIVE--To evaluate the impact of adding first-responder defibrillation by fire-fighters to an existing advanced life-support emergency medical services system. DESIGN--Nonrandomized, controlled clinical trial with periodic crossover. SETTING--Memphis, Tenn, a city of 610,337 people, which is served by a fire department-based emergency medical services system. All city ambulances provide advanced life support. PATIENTS--Adult victims of out-of-hospital cardiac arrest due to heart disease. INTERVENTION--Twenty of 40 participating engine companies were equipped with an automated external defibrillator and ordered to apply it immediately in all cases of cardiac arrest. The other 20 companies were ordered to start cardiopulmonary resuscitation (CPR) immediately and wait for paramedics to arrive. Every 75 days, group roles were reversed. Care otherwise proceeded according to 1986 American Heart Association guidelines. MAIN OUTCOME MEASURES--Return of spontaneous circulation in the field, survival to hospital admission, survival to hospital discharge, and neurological status at discharge. RESULTS--During the 39-month study interval, 879 patients were treated by a project engine company. Four hundred thirty-one (49%) of these were found in ventricular fibrillation. Bystander CPR was started in only 12% of cases. Overall, firefighters reached the scene a mean of 2.5 minutes faster than simultaneously dispatched paramedics. Although our automated external defibrillators proved to be reliable and efficacious for terminating ventricular fibrillation and pulseless ventricular tachycardia, patients treated by an automated external defibrillator-equipped engine company were no more likely than CPR-treated controls to be resuscitated (32% vs 34%, respectively), to survive to hospital admission (31% vs 29%), or to survive to hospital discharge (14% vs 10%). Neurological outcomes were also similar in the two treatment groups. CONCLUSIONS--In a fast-response, urban emergency medical services system served by paramedics, the impact of adding first-responder defibrillation appears to be small. Early defibrillation alone cannot overcome low community rates of bystander CPR. Careful attention to every link in the "chain of survival" is needed to achieve optimal rates of survival after cardiac arrest. *Notes: Fire fighter first responder study. Controls by alternating allocation of AEDs. Analysis unfortunately not on community level, but only on level of first responders involved. This makes assessment of impact on community not possible. This limits the value of the study. Level 2 evidence of fair quality.*
Kenward 2002	Kenward, G., N. Castle, et al. (2002). Should ward nurses be using automatic external defibrillators as first responders to improve the outcome from cardiac arrest? A systematic review of the primary research. Resuscitation 52(1): 31-7. INTRODUCTION: The outcome from in-hospital cardiac arrest has improved little since the

	implementation of cardiopulmonary resuscitation 40 years ago. Early defibrillation improves survival following ventricular fibrillation and pulseless ventricular tachycardia. The emergence of automatic external defibrillators and advisory defibrillators has been heralded as the answer to defibrillation delays in-hospital. AIM: To locate and evaluate the evidence supporting automatic external defibrillator use in-hospital on general wards. METHOD: A systematic review of indexed and grey literature to identify primary research. RESULTS: Fifteen in-hospital automatic external defibrillator studies were located, five met the inclusion criteria. CONCLUSIONS: There is limited primary research evaluating automatic external defibrillators in-hospital. Manual defibrillators remain the most commonly used device for in-hospital defibrillation. Automated external defibrillators offer an alternative to manual defibrillation providing they have a screen and manual override capability, and the technology for pacing is close to hand. For in-hospital automatic external defibrillator programmes to be effective a change in nursing philosophy must occur, and defibrillation must become an expected rather than an extended nursing role. *Notes: Review paper (not a formal meta-analysis)of in-hospital AED papers. Level 7 evidence of limited benefit, well performed. In fact the only information on in-hospital AED use of sufficient value for judgment.*
MacDonald 2002	MacDonald, R. D., J. L. Mottley, et al. (2002). Impact of prompt defibrillation on cardiac arrest at a major international airport. Prehosp Emerg Care 6(1): 1-5. OBJECTIVE: To describe the impact of a rapidly deployable, automated external defibrillator (AED)-equipped first-responder service at Boston's Logan International Airport on the rate of survival to hospital discharge after cardiac arrest. METHODS: A prospective observational outcome study was undertaken for cardiac arrests taking place on the airport grounds from January 1, 1995, to December 31, 1999. Patients were included if they were unresponsive, they had no palpable pulse and no spontaneous respirations, an AED was turned on, and the cardiac arrest took place on airport grounds. Airport fire rescue and emergency medical services (EMS) personnel submitted resuscitation records and AED memory modules for each cardiac arrest. Each author independently reviewed all cardiac arrest reports and code summaries to ensure accuracy and data integrity. Relevant dispatch and response times were determined from airport fire rescue and EMS dispatch records. Patient outcome was determined from hospital patient records. Descriptive statistics were calculated. RESULTS: The airport fire rescue crew responded to 53 cardiac arrests. Of those, 38 met inclusion criteria. In 36 of 38 cases (94.7%), the airport fire rescue crew was first to apply the defibrillator, and the first to deliver a shock in 28 of 32 cases (87.5%) where a shock was delivered. The median response time for the airport fire rescue crew was 2 minutes, with a mode of 1 minute. The EMS response times were 5:29 (95% CI 4:37-6:19) for basic life support crews and 8:07 (95% CI 7:17-8:57) for advanced life support crews. All patients who survived to hospital admission (n = 15) and hospital discharge (n = 8) received their first shock by the airport fire rescue crew. Eight patients (21.1%) survived to hospital discharge. In five of the eight survivors to hospital discharge, defibrillation by the airport crew alone achieved a return of spontaneous circulation. CONCLUSIONS: A rapidly deployable first-responder service permits early defibrillation minutes before arrival of EMS personnel. This rapid response positively impacts the return of spontaneous circulation and survival to hospital discharge after cardiac arrest. *Notes: Case series of well reported study in "niche" application by first responders. Level 5, fair supportive evidence.*
Mosesso 1998	Mosesso, V. N., Jr., E. A. Davis, et al. (1998). Use of automated external defibrillators by police officers for treatment of out-of-hospital cardiac arrest. Ann Emerg Med 32(2): 200-7. OBJECTIVE: To determine the feasibility of police officers providing defibrillation with automated external defibrillators (AEDs) and to assess the effectiveness of this strategy in reducing time to defibrillation of victims of out-of-hospital sudden cardiac arrest. METHODS: This was a prospective, interventional cohort study with historical controls conducted in 7 suburban communities in which police usually arrived at the scene of medical emergencies before EMS personnel. All adult patients who suffered cardiac arrest before EMS arrival and on whom EMS personnel attempted resuscitation were enrolled. Police officers who were trained to use and equipped with AEDs during the intervention phase were dispatched simultaneously with EMS to medical emergencies. Police were instructed to use the AED immediately on determination of pulselessness. Outcome measures were the difference between control and intervention phases in interval from the time the call was received at dispatch to the time of first defibrillation and in rate

	of survival to hospital discharge for patients initially in ventricular fibrillation. RESULTS: EMS personnel attempted 183 resuscitations in the control phase and 283 during the intervention; of these, 80 (44%) and 127 (45%), respectively, involved patients with initial ventricular fibrillation rhythms. Mean time to defibrillation decreased from 11.8+/-4.7 minutes in the control phase to 8.7+/-3.7 minutes in the intervention phase (P<.0001). Survival to hospital discharge of patients in ventricular fibrillation did not differ between phases (6% control versus 14% intervention, P=.1). When police arrived before EMS personnel, shock administered by police compared with shock administered by EMS was associated with improved survival (26% [12/46] versus 3% [1/29], P=.01). Logistic regression analysis revealed AED use was an independent predictor of survival to hospital discharge. CONCLUSION: In 7 suburban communities, police use of AEDs decreased time to defibrillation and was an independent predictor of survival to hospital discharge. *Notes: Police first responder cohort study with logistic regression analysis of AED effect. Some potential bias: fair study design of level 4 evidence.*
Myerburg 2002	Myerburg, R. J., J. Fenster, et al. (2002). Impact of community-wide police car deployment of automated external defibrillators on survival from out-of-hospital cardiac arrest. Circulation 106(9): 1058-64. BACKGROUND: Disappointing survival rates from out-of-hospital cardiac arrests encourage strategies for faster defibrillation, such as use of automated external defibrillators (AEDs) by nonconventional responders. METHODS AND RESULTS: AEDs were provided to all Miami-Dade County, Florida, police. AED-equipped police (P-AED) and conventional emergency medical rescue (EMS) responders are simultaneously deployed to possible cardiac arrests. Times from 9-1-1 contact to the scene were compared for P-AED and concurrently deployed EMS, and both were compared with historical EMS experience. Survival with P-AED was compared with outcomes when EMS was the sole responder. Among 420 paired dispatches of P-AED and EMS, the mean+/-SD P-AED time from 9-1-1 call to arrival at the scene was 6.16+/-4.27 minutes, compared with 7.56+/-3.60 minutes for EMS (P<0.001). Police arrived first to 56% of the calls. The time to first responder arrival among P-AED and EMS was 4.88+/-2.88 minutes (P<0.001), compared with a historical response time of 7.64+/-3.66 minutes when EMS was the sole responder. A 17.2% survival rate was observed for victims with ventricular fibrillation or pulseless ventricular tachycardia (VT/VF), compared with 9.0% for standard EMS before P-AED implementation (P=0.047). However, VT/VF benefit was diluted by the observation that 61% of the initial rhythms were nonshockable, reducing the absolute survival benefit among the total study population to 1.6% (P-AED, 7.6%; EMS, 6.0%). CONCLUSIONS: P-AED establishes a layer of responders that generate improved response times and survival from VT/VF. There was no benefit for victims with nonshockable rhythms. *Notes: This study uses a before-after control design, but is very well documented. The secondary descriptions make the control group very convincing. The police first responder study makes this approach applicable to the whole community and probably quite cost-effective. The unusual large amount of AEDs employed is due to the fact that each police officer could take his/her AED home after duty, effectively taking it from service when off duty. The data collection is very accurate. The benefit (to the whole community) is large. The quality makes it a good study, but the historic control makes it level 3.*
Nichol 2003	Nichol, G., T. Valenzuela, et al. (2003). Cost effectiveness of defibrillation by targeted responders in public settings. Circulation 108(6): 697703. BACKGROUND: Out-of-hospital cardiac arrest is frequent and has poor outcomes. Defibrillation by trained targeted nontraditional responders improves survival versus historical controls, but it is unclear whether such defibrillation is a good value for the money. Therefore, this study estimated the incremental cost effectiveness of defibrillation by targeted nontraditional responders in public settings by using decision analysis. METHODS AND RESULTS: A Markov model evaluated the potential cost effectiveness of standard emergency medical services (EMS) versus targeted nontraditional responders. Standard EMS included first-responder defibrillation followed by advanced life support. Targeted nontraditional responders included standard EMS supplemented by defibrillation by trained lay responders. The analysis adopted a US societal perspective. Input data were derived from published or publicly available data. Future costs and effects were discounted at 3%. Monte Carlo simulation and sensitivity analyses assessed the robustness of results. Standard EMS had a median of 0.47 (interquartile range [IQR]=0.32 to 0.69) quality-adjusted life years and

	a median of 14 100 dollars (IQR=8600 dollars to 21 900 dollars) costs per arrest. Targeted nontraditional responders in casinos had an incremental cost of a median 56 700 dollars (IQR=44 100 dollars to 77 200 dollars) per additional quality-adjusted life year. The results were sensitive to changes in time to defibrillation, incidence of arrest, and number of devices required to implement rapid defibrillation. CONCLUSIONS: Where cardiac arrest is frequent and response time intervals are short, rapid defibrillation by targeted nontraditional responders may be a good value for the money compared with standard EMS. The incidence of arrest should be considered when choosing locations to implement public access defibrillation. *Notes: A high-quality model-derived study, showing the extremely poor cost-effectiveness of AED placement in many locations considered for public access defibrillation programs. Only very few locations remain good cost-effective candidates. Good study. level 7*
O'Rourke 1997	O'Rourke, M. F., E. Donaldson, et al. (1997). An airline cardiac arrest program. Circulation 96(9): 2849-53. BACKGROUND: As many as 1000 lives are lost annually from cardiac arrest in commercial aircraft. Ventricular fibrillation (VF), the most common mechanism, can be treated effectively only with prompt defibrillation, whereas the current policy of most airlines is to continue cardiopulmonary resuscitation pending aircraft diversion. The objective of this study was to assess the impact of making semiautomatic external defibrillators (AEDs) available for use on airline passengers with cardiac arrest. METHODS AND RESULTS: AEDs were installed on international Qantas aircraft and at major terminals, selected crew were trained in their use, and all crew members were trained in cardiopulmonary resuscitation. Supervision was provided by medical volunteers or (remotely) by airline physicians. During a 64-month period, AEDs were used on 109 occasions: 63 times for monitoring an acutely ill passenger and 46 times for cardiac arrest. Twenty-seven episodes of cardiac arrest occurred in aircraft, often (11 of 27 [41%]) unwitnessed, and they were usually (21 of 27 [78%]) associated with asystole or pulseless idioventricular rhythm. All 19 arrests in terminals were witnessed; VF was present in 17 (89%). Overall, defibrillation was initially successful in 21 of 23 cases (91%). Long-term survival from VF was achieved in 26% (2 of 6 in aircraft and 4 of 17 in terminals). The ability to monitor cardiac rhythm aided decisions on diversion, which was avoided in most passengers with asystole or idioventricular rhythm. CONCLUSIONS: AEDs in aircraft and terminals, with appropriate crew training, are helpful in the management of cardiac emergencies. Survival from VF is practicable and is comparable with the most effective prehospital ambulance emergency services. Costly aircraft diversions can be avoided in clearly futile situations, enhancing the cost-effectiveness of the program. *Notes: Case-series of an airline program with remarkable results: the first to be published of this kind. Similar in quality as Page study. Supportive in a "niche" application. Level 5 evidence*
Page 2000	Page, R. L., J. A. Joglar, et al. (2000). Use of automated external defibrillators by a U.S. airline. N Engl J Med 343(17): 1210-6. BACKGROUND: Passengers who have ventricular fibrillation aboard commercial aircraft rarely survive, owing to the delay in obtaining emergency care and defibrillation. METHODS: In 1997, a major U.S. airline began equipping its aircraft with automated external defibrillators. Flight attendants were trained in the use of the defibrillator and applied the device when passengers had a lack of consciousness, pulse, or respiration. The automated external defibrillator was also used as a monitor for other medical emergencies, generally at the direction of a passenger who was a physician. The electrocardiogram that was obtained during each use of the device was analyzed by two arrhythmia specialists for appropriateness of use. We analyzed data on all 200 instances in which the defibrillators were used between June 1, 1997, and July 15, 1999. RESULTS: Automated external defibrillators were used for 200 patients (191 on the aircraft and 9 in the terminal), including 99 with documented loss of consciousness. Electrocardiographic data were available for 185 patients. The administration of shock was advised in all 14 patients who had electrocardiographically documented ventricular fibrillation, and no shock was advised in the remaining patients (sensitivity and specificity of the defibrillator in identifying ventricular fibrillation, 100 percent). The first shock successfully defibrillated the heart in 13 patients (defibrillation was withheld in 1 case at the family's request). The rate of survival to discharge from the hospital after shock with the automated external defibrillator was 40 percent. A total of 36 patients either died or were resuscitated after cardiac arrest. No complications arose from use of the automated external defibrillator as a monitor in conscious passengers. CONCLUSIONS: The use of

	the automated external defibrillator aboard commercial aircraft is effective, with an excellent rate of survival to discharge from the hospital after conversion of ventricular fibrillation. There are not likely to be complications when the device is used as a monitor in the absence of ventricular fibrillation. *Notes: A well conducted case-series of airplane experiences. Although uncontrolled, the predicted zero-survival (inside an airborne airplane without AED) makes this an important "niche" study. This is a level 5 study by design, fair because of the limitation in regard to relevance for the community at large.*
Pell 2002	Pell, J. P., J. M. Sirel, et al. (2002). Potential impact of public access defibrillators on survival after out of hospital cardiopulmonary arrest: retrospective cohort study. BMJ 325(7363): 515. OBJECTIVE: To estimate the potential impact of public access defibrillators on overall survival after out of hospital cardiac arrest. DESIGN: Retrospective cohort study using data from an electronic register. A statistical model was used to estimate the effect on survival of placing public access defibrillators at suitable or possibly suitable sites. SETTING: Scottish Ambulance Service. SUBJECTS: Records of all out of hospital cardiac arrests due to heart disease in Scotland in 1991-8. MAIN OUTCOME MEASURES: Observed and predicted survival to discharge from hospital. RESULTS: Of 15 189 arrests, 12 004 (79.0%) occurred in sites not suitable for the location of public access defibrillators, 453 (3.0%) in sites where they may be suitable, and 2732 (18.0%) in suitable sites. Defibrillation was given in 67.9% of arrests that occurred in possibly suitable sites for locating defibrillators and in 72.9% of arrests that occurred in suitable sites. Compared with an actual overall survival of 744 (5.0%), the predicted survival with public access defibrillators ranged from 942 (6.3%) to 959 (6.5%), depending on the assumptions made regarding defibrillator coverage. CONCLUSIONS: The predicted increase in survival from targeted provision of public access defibrillators is less than the increase achievable through expansion of first responder defibrillation to non-ambulance personnel, such as police or firefighters, or of bystander cardiopulmonary resuscitation. Additional resources for wide scale coverage of public access defibrillators are probably not justified by the marginal improvement in survival. *Notes: A well conducted study but based on hypothetical analysis on the potential impact of AEDs. This prediction of the limitations of PAD subsequently seems to be supported by actual data from recent studies. The design of the study makes it a level 7 study, simple, but well performed.*
Sedgwick 1993	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 Aug;26(1):75-88. The Heartstart Scotland project for out-of-hospital defibrillation covers the whole of Scotland, a population of approximately 5,102,400 (14.9% > 65 years, 48.3% male). All 395 ambulances in Scotland have been equipped with an automated external defibrillator and crews are trained in basic cardiopulmonary resuscitation and defibrillator use (EMT-D). Between 1 May 1990 and 30 April 1991 a total of 1700 cardiac arrests was reported by the ambulance service. Of the 1676 arrests which we could trace, 63% were witnessed. A total of 1383 (83%) of all patients were declared dead on arrival at hospital or in the emergency department, 119 (7%) died in hospital and 174 (10%) were discharged alive. Of the 174 survivors, 87% were conscious and normal at discharge, 9% had moderate residual disability and 2% severe disability. Survival of patients discharged alive from hospital was 85% at 1 year. Defibrillation was undertaken in 71% of the reported cardiac arrests. Survival of bystander witnessed arrests was increased from 7 to 15% with bystander CPR ($P < 0.005$). If the cardiac arrest was witnessed by the ambulance crew and required defibrillation, survival to discharge was 39%. Of bystander witnessed arrests reached while still in VF (n = 643), 11% were discharged alive. Patients who were defibrillated within 4 min of arrest had a 43% survival rate to hospital discharge. *Notes: A well-conducted case-series of level 5, fair evidence. Gives a good picture of impact on the community application in targeted first responders.*
Smith 2002	Smith, K. L. and J. J. McNeil (2002). Cardiac arrests treated by ambulance paramedics and fire fighters. Med J Aust 177(6): 305-9. The Emergency Medical Response (EMR) program is a Victorian Government initiative in which

	fire fighters trained in cardiopulmonary resuscitation and equipped with automatic external defibrillators are dispatched to suspected cardiac arrests simultaneously with ambulance paramedics across metropolitan Melbourne. During the first 12 months (February 2000 to February 2001) of the expanded EMR program, 2942 events involved simultaneous dispatch of ambulance paramedics and fire fighters. In 430 events, patients had suffered a cardiac arrest of presumed cardiac cause, and resuscitation was attempted by the emergency medical services. Fire fighters provided the initial defibrillation to 41 (26.5%) patients presenting in ventricular fibrillation. Survival to hospital discharge for bystander-witnessed ventricular fibrillation cardiac arrests was 21.8%. The mean emergency services (fire and ambulance) response time to cardiac arrest patients was 6.03 (SD, 1.65) minutes. The mean time to defibrillation for ventricular fibrillation patients was 8.75 (SD, 2.07) minutes. *Notes: A real community study with complete Utstein data, demonstrating potential impact of targeted first responders. Well presented case-series. Fair, level 5 study.*
Stiell 1999	Stiell, I. G., G. A. Wells, et al. (1999). 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 281(13): 1175-81. CONTEXT: Survival rates for out-of-hospital cardiac arrest are low; published survival rates in Ontario are only 2.5%. This study represents phase II of the Ontario Prehospital Advanced Life Support (OPALS) study, which is designed to systematically evaluate the effectiveness and efficiency of various prehospital interventions for patients with cardiac arrest, trauma, and critical illnesses. OBJECTIVE: To assess the impact on out-of-hospital cardiac arrest survival of the implementation of a rapid defibrillation program in a large multicenter emergency medical services (EMS) system with existing basic life support and defibrillation (BLS-D) level of care. DESIGN: Controlled clinical trial comparing survival for 36 months before (phase I) and 12 months after (phase II) system optimization. SETTING: Nineteen urban and suburban Ontario communities (populations ranging from 16 000 to 750 000 [total, 2.7 million]). PATIENTS: All patients who had out-of-hospital cardiac arrest in the study communities for whom resuscitation was attempted by emergency responders. INTERVENTIONS: Study communities optimized their EMS systems to achieve the target response interval from when a call was received until a vehicle stopped with a defibrillator of 8 minutes or less for 90% of cardiac arrest cases. Working both locally and provincially, communities implemented multiple measures, including defibrillation by firefighters, base paging, tiered response agreements with fire departments, continuous quality improvement for response intervals, and province-wide revision and implementation of standard dispatch policies. All response times were obtained from a central dispatch system. MAIN OUTCOME MEASURE: Survival to hospital discharge. RESULTS: The 4690 cardiac arrest patients studied in phase I and the 1641 in phase II were similar for all clinical and demographic characteristics, including age, sex, witnessed status, rhythm, and receipt of bystander cardiopulmonary resuscitation. The proportion of cases meeting the 8-minute response criterion improved (76.7% vs 92.5%; P<.001) as did most median response intervals. Overall survival to hospital discharge for all rhythm groups combined improved from 3.9% to 5.2 % (P = .03). The 33% relative increase in survival represents an additional 21 lives saved each year in the study communities (approximately 1 life per 120000 residents). The charges were estimated to be US $46900 per life saved for establishing the rapid defibrillation program and US $2400 per life saved annually for maintaining the program. CONCLUSION: An inexpensive, multifaceted system optimization approach to rapid defibrillation can lead to significant improvements in survival after cardiac arrest in a large BLS-D EMS system. *Notes: Community program of AED introduction to EMT-D first responders. Controls are before-after comparisons. Effect analysis by logistic regression for potential confounders. Moderate but significant effect of AED introduction, attributed to earlier defibrillation. Level 3 evidence, support by good data collection and analysis.*
Valenzuela 2000	Valenzuela, T. D., D. J. Roe, et al. (2000). Outcomes of rapid defibrillation by security officers after cardiac arrest in casinos. N Engl J Med 343(17): 1206-9. BACKGROUND: The use of automated external defibrillators by persons other than paramedics and emergency medical technicians is advocated by the American Heart Association and other organizations. However, there are few data on the outcomes when the devices are used by nonmedical personnel for out-of-hospital cardiac arrest. METHODS: We studied a prospective series of cases of sudden cardiac arrest in casinos. Casino security officers were instructed in the

	use of automated external defibrillators. The locations where the defibrillators were stored in the casinos were chosen to make possible a target interval of three minutes or less from collapse to the first defibrillation. Our protocol called for a defibrillation first (if feasible), followed by manual cardiopulmonary resuscitation. The primary outcome was survival to discharge from the hospital. RESULTS: Automated external defibrillators were used, 105 patients whose initial cardiac rhythm was ventricular fibrillation. Fifty-six of the patients (53 percent) survived to discharge from the hospital. Among the 90 patients whose collapse was witnessed (86 percent), the clinically relevant time intervals were a mean (+/-SD) of 3.5+/-2.9 minutes from collapse to attachment of the defibrillator, 4.4+/-2.9 minutes from collapse to the delivery of the first defibrillation shock, and 9.8+/-4.3 minutes from collapse to the arrival of the paramedics. The survival rate was 74 percent for those who received their first defibrillation no later than three minutes after a witnessed collapse and 49 percent for those who received their first defibrillation after more than three minutes. CONCLUSIONS: Rapid defibrillation by nonmedical personnel using an automated external defibrillator can improve survival after out-of-hospital cardiac arrest due to ventricular fibrillation. Intervals of no more than three minutes from collapse to defibrillation are necessary to achieve the highest survival rates. *Notes: Famous study in "niche" application. The power of the study is the complete collection of data, in particular the delay from collapse to first shock and the demonstrated very high survival rate, achieved under unusual circumstances. Because of the high quality data it is classified as "good," but because of case-series character it is level 5 evidence.*
van Alem 2003	van Alem, A. P., R. H. Vrenken, et al. (2003). Use of automated external defibrillator by first responders in out of hospital cardiac arrest: prospective controlled trial. BMJ 327(7427): 1312. OBJECTIVE: To test the hypothesis that the use of an automated external defibrillator by police and fire fighters results in higher discharge rates for out of hospital cardiac arrest. DESIGN: Controlled clinical trial with initial random allocation of automated external defibrillators to first responders in four of the eight participating regions; each region switched from control to experimental, and vice versa, every four months. SETTING: Amsterdam and surroundings, the Netherlands. PARTICIPANTS: Patients with witnessed out of hospital cardiac arrests, identified by the emergency medical system between January 2000 and January 2002. MAIN OUTCOMES MEASURES: Survival to hospital discharge; return of spontaneous circulation; admission to hospital. RESULTS: 243 patients (65% in ventricular fibrillation) were included in the experimental area and 226 patients (67% in ventricular fibrillation) in the control area. The median time interval between collapse and first shock was 668 seconds in the experimental area and 769 seconds in the control area ($P < 0.001$). 44 (18%) patients in the experimental area versus 33 (15%) patients in the control area were discharged (odds ratio 1.3 (95% confidence interval 0.8 to 2.2), $P = 0.33$), 139 (57%) experimental versus 108 (48%) control patients had return of spontaneous circulation (1.5 (1.0 to 2.2), $P = 0.05$), and 103 (42%) experimental versus 74 (33%) control patients were admitted (1.5 (1.1 to 1.6), $P = 0.02$). The median delay from receipt of call to dispatch of the ambulance was 120 seconds, and the delay to dispatch of the first responder was 180 seconds. CONCLUSIONS: Use of automated external defibrillators by first responders did not significantly increase survival to discharge from hospital, although it did improve return of spontaneous circulation and admission to hospital. Improved dispatch procedures should increase the success of programmes of first responders using external defibrillators. *Notes: reviewer Koster is co-author.* *Community study with adequate randomized controls at the community level with police first responders. Slightly underpowered, but consistent significant benefit of AEDs for ROSC and admission, but non-statistical but consistent benefit for survival to hospital discharge. Data collection, description of time intervals and analysis of delays are of excellent quality. Because of limited benefit level 2 evidence.*
Walker 2003	Walker, A., J. M. Sirel, et al. (2003). Cost effectiveness and cost utility model of public place defibrillators in improving survival after prehospital cardiopulmonary arrest. BMJ 327(7427): 1316. OBJECTIVE: To determine the cost effectiveness and cost utility of locating defibrillators in all major airports, railway stations, and bus stations throughout Scotland. DESIGN: Economic modelling exercise with data from Heartstart (Scotland). Parameters used in economic model included direct costs derived for increased accident and emergency attendances, increased hospital

	bed days, purchase and maintenance of defibrillators, and training in their use; life years gained calculated from increased discharges from hospital and mean survival after discharge; utility (quality of life) obtained from published data. Sensitivity analyses tested the robustness of model. Future gains discounted at 1.5% a year and future costs at 6%. SETTING: Whole of Scotland. SUBJECTS: Records of all prehospital cardiac arrests due to presumed heart disease that occurred in a major airport, railway, or bus station between May 1991 and March 1998 and were not witnessed by ambulance or medical staff. MAIN OUTCOME MEASURES: Observed survival to hospital admission and observed survival to discharge. Predicted survival calculated by applying observed survival in patients attended by ambulance staff within three minutes to those who waited longer. RESULTS: The total discounted direct costs were 18 325 pounds sterling a year. The cost per life year gained was 29 625 pounds sterling (49 625 dollars, 43 151 Euros) and the cost per quality adjusted life year (QALY) gained was pound 41 146 (68 924 dollars, 59 932 Euros). More widespread provision of public place defibrillators would increase these figures. CONCLUSIONS: The cost per QALY calculated for public place defibrillators represents poorer value for money than some alternative strategies for improving survival after prehospital cardiopulmonary arrest, such as the use of other trained first responders. The figure exceeds the commonly discussed cut off levels for funding in the United Kingdom and United States of pound 30 000 and 50 000 dollars per QALY, respectively. *Notes: Cost-effectiveness study of hypothetical PAD application within real world data from public out-of-hospital cardiac arrest. Demonstrates high cost per QALY. Well conducted level 7 evidence not in favour of community application of AEDs.*
Weaver 1988	Weaver, W. D., D. Hill, et al. (1988). Use of the automatic external defibrillator in the management of out-of-hospital cardiac arrest. N Engl J Med 319(11): 661-6. The automatic external defibrillator is a simple device that can be used by nonprofessional rescuers to treat cardiac arrest. In 1287 consecutive patients with out-of-hospital cardiac arrest, we assessed the results of initial treatment with this device by firefighters who arrived first at the scene, as compared with the results of standard defibrillation administered by paramedics who arrived slightly after the firefighters. Of 276 patients who were initially treated by firefighters using the automatic defibrillator, 84 (30 percent) survived to hospital discharge (expected rate according to a logistic model, 17 percent; P less than 0.001), as compared with 44 (19 percent) of 228 patients when fire-fighters delivered only basic cardiopulmonary resuscitation and the first defibrillation was performed after the arrival of the paramedic team. Few patients with conditions other than ventricular fibrillation survived. In a multivariate analysis of characteristics that influenced survival after ventricular fibrillation, a better survival rate was related to a witnessed collapse (odds ratio, 3.9; 95 percent confidence interval, 2.0 to 7.6), younger age (odds ratio, 1.2; 95 percent confidence interval, 1.0 to 1.4), the presence of "coarse" (higher-amplitude) fibrillation (odds ratio, 4.2; 95 percent confidence interval, 1.6 to 11.0), a shorter response time for paramedics (odds ratio, 1.4; 95 percent confidence interval, 1.0 to 2.1), and initial treatment by firefighters using an automatic external defibrillator (odds ratio, 1.8; 95 percent confidence interval, 1.1 to 2.9). These findings support the widespread use of the automatic external defibrillator as an important part of the treatment of out-of-hospital cardiac arrest, although the overall impact of the use of this device on community survival rates is still uncertain. *Notes: Fire fighter first responder community study. Controls are not randomized but effect analyzed by logistic modeling with AED use as covariate. This makes it a level 3 study of good quality, also considering the year of publication: 1988*
White 1998	White, R. D., D. G. Hankins, et al. (1998). Seven years experience with early defibrillation by police and paramedics in an emergency medical services system. Resuscitation 39(3): 145-51. PRIMARY OBJECTIVE: To assess the outcome of patients with out-of-hospital cardiac arrest with ventricular fibrillation as the presenting rhythm in an emergency medical services system utilizing a combined police/paramedic response to provide early defibrillation. MATERIALS AND METHODS: Police and paramedics were dispatched from law enforcement and ambulance communications centers, respectively. First-arriving personnel delivered initial shocks, all using automated external defibrillators. Patients were classified according to response to initial shocks: restoration of pulses with shocks only or in need of advanced life support, including epinephrine. Discharge survival was defined as return to home without disabling neurologic injury. RESULTS: Over the 7-year period of study 131 patients presented with ventricular fibrillation: 58 were first

	treated by police and 73 by paramedics. Restoration of pulses with shocks only and discharge survival were not different in police and paramedic groups, with overall survival of 40% (53 of 131 patients). Among the survivors, 19% (18/95 patients) obtained a spontaneous circulation only after administration of epinephrine and other ALS interventions. CONCLUSION: Both restoration of a functional circulation, without need for advanced life support interventions, and discharge survival without neurologic disability are very dependent upon the rapidity with which defibrillation is accomplished, regardless of who delivers the shocks. In addition, a smaller but significant number of patients who require ALS interventions, including epinephrine, for restoration of a spontaneous circulation survive to discharge. Short time differences, on the order of 1 min, are significant determinants of both immediate response to shocks and discharge survival. *Notes: Summary of seven year experience with police first responders. Controls not randomized but biassed by delay selection. (winner vs loser). Therefore level 4 evidence with limited data collection. Fair study, no demonstration of benefit.*
Eisenberg 1989	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. Abstract: This 57-month study evaluated the use of automatic external defibrillators (AEDs) in the homes of high risk cardiac patients (survivors of out-of-hospital ventricular fibrillation [VF]). The goal was to determine the utility of these devices by trained lay persons in actual cardiac arrest episodes. Ninety-seven survivors of out-of- hospital VF were enrolled in the study; 59 patients received AEDs, and 38 patients served as a control group. During the study period, 7 deaths occurred in the hospital without preceding out-of-hospital cardiac arrest or from noncardiac causes. There were 14 out-of-hospital cardiac arrests, 10 in the AED group and 4 in the control group. There was 1 long-term survivor in the control group. In the AED group, among the 10 cardiac arrests for which the device was available, it was used in 6. Only 2 patients were in VF; 1 was resuscitated with residual neurologic deficits and survived several months. This study observed a small potential for AEDs to save high risk patients. *Note: The first ever attempt to ivestigate home-use of AEDs. Too low power for any conclusion, offers no insight in possible added benefit or risk for home AED.*
Chen 2002	Chen MA, Eisenberg MS, Meischke H. Impact of in-home defibrillators on postmyocardial infarction patients and their significant others: an interview study. Heart Lung 2002;31:173-85. Abstract: OBJECTIVE: To investigate the impact of automated external defibrillator (AED) placement in the homes of postmyocardial infarction (MI) patients and their significant others. DESIGN: This qualitative study used a semistructured interview to examine a nonrandomized convenience sample recruited from a larger study of home AEDs. SETTING AND PARTICIPANTS: Patients (and their significant others) were recruited from an ongoing study of AED use in the home. Seventeen interviews with 15 patients (14 men, 1 woman) and 16 significant others (1 man, 15 women) aged 39 to 80 years were performed in patients' homes. METHODS: Verbatim transcripts of audiotaped interviews were reviewed, and responses were categorized. Other data were obtained from hospital chart abstraction. RESULTS: The majority of subjects noted only positive effects of the presence of home AEDs (eg, giving them feelings of security and control). There was no evidence that AED presence in the home caused excessive anxiety or stress either in patients or their significant others, nor were they perceived to cause relationship stress. On average, patients and their significant others estimated a 38% and 43% (respectively) risk of cardiac arrest and a 92% and 87% likelihood of a successful resuscitation with the use of the AED. Subjects' perceived risk of cardiac arrest were subjectively related to their estimate of current health status, size of infarction, and symptoms during their MI. Subjects also related their estimates of risk to their likelihood of traveling with their AED and whether they would consider purchasing one. Significant others had high confidence in their ability to properly use the AED. CONCLUSIONS: AEDs were valued highly by subjects and enhanced their perceived control over their heart disease. This was especially true for subjects who believed that their risk of cardiac arrest was high. The possible effects of providing education regarding expert estimates of the likelihood of cardiac arrest and of a successful resuscitation at the time of AED placement are discussed. *Note: the presence of an AED in the house of a high risk patient results in reassurance and great trust in the ability to survive a possible future cardiac arrest. The perceived rate of success*

	probably is a large overestimation of reality.

*Type the citation marker in the first field and then paste the full citation into the second field. You can copy the full citation from EndNote by selecting the citation, then copying the FORMATTED citation using the short cut, Ctrl-K. After you copy the citation, go back to this document and position the cursor in the field, then paste the citation into the document (use Ctrl-V). For each new citation press Tab to move down to start a new field.

WORKSHEET for PROPOSED Evidence-Based GUIDELINE RECOMMENDATIONS

Worksheet Author:	**Taskforce/Subcommittee:** _X_BLS __ACLS __PEDS __ID __PROAD __Other:
Author's Home Resuscitation Council: _X_AHA __ANZCOR __CLAR __ERC __HSFC __HSFC __RCSA __IAHF __Other:	**Date Submitted to Subcommittee:** August 23, 2004; revised Dec 10, 2004; Dec 20, 2004 and Dec 21, 2004

STEP 1: STATE THE PROPOSAL. State if this is a proposed new guideline; revision to current guideline; or deletion of current guideline.
Existing guideline, practice or training activity, or new guideline:

No specific guidelines. General discussion of principles of QA, maintenance, medical direction, training, and deployment strategies on pg I67-71.

Step 1A: Refine the question; state the question as a positive (or negative) hypothesis. State proposed guideline recommendation as a specific, positive hypothesis. Use single sentence if possible. Include type of patients; setting (in- /out-of-hospital); specific interventions (dose, route); specific outcomes (ROSC vs. hospital discharge).

Quality improvement efforts for AED programs such as an on-going review of equipment, supplies and responder preparedness and post-event review of event response and AED function, improve AED program performance.

Step 1B: Gather the Evidence; define your search strategy. Describe search results; describe best sources for evidence.

Cochrane systematic reviews searched for each of the terms "defibrillation," "automated external defibrillator," and "defibrillator;" 6 reviews found, none of which were relevant. Medline (1966-2004) via Ovid searched for the following: electronic countershock (textword) and Quality Control (MeSH) or Quality Assurance (MeSH or textword); "automated external defibrillator (textword) and Quality Control (MeSH) or Quality Assurance (MeSH or textword), which yielded 43 titles of which 17 were considered relevant, and for "automated external defibrillator" (textword), which yielded 102 titles of which 40 were relevant. Hand search of references of relevant articles was then conducted.

List electronic databases searched (at least AHA EndNote 7 Master library [http://ecc.heart.org/], Cochrane database for systematic reviews and Central Register of Controlled Trials [http://www.cochrane.org/], MEDLINE [http://www.ncbi.nlm.nih.gov/PubMed/], and Embase), and hand searches of journals, review articles, and books.
Cochrane Database of Systematic Reviews, Medline (via Ovid). Embase was not searched.

- State major criteria you used to limit your search; state inclusion or exclusion criteria (e.g., only human studies with control group? no animal studies? N subjects > minimal number? type of methodology? peer-reviewed manuscripts only? no abstract-only studies?)

None

- Number of articles/sources meeting criteria for further review: Create a citation marker for each study (use the author initials and date or Arabic numeral, e.g., "Cummins-1"). If possible, please supply file of best references; EndNote 6+ required as reference manager using the ECC reference library.

57 articles were reviewed and 17 were included in the worksheet

STEP 2: ASSESS THE QUALITY OF EACH STUDY

Step 2A: Determine the Level of Evidence. For each article/source from step 1, assign a level of evidence—based on study design and methodology.

Level of Evidence	Definitions (See manuscript for full details)
Level 1	Randomized clinical trials or meta-analyses of multiple clinical trials with substantial treatment effects
Level 2	Randomized clinical trials with smaller or less significant treatment effects
Level 3	Prospective, controlled, non-randomized, cohort studies
Level 4	Historic, non-randomized, cohort or case-control studies
Level 5	Case series: patients compiled in serial fashion, lacking a control group
Level 6	Animal studies or mechanical model studies
Level 7	Extrapolations from existing data collected for other purposes, theoretical analyses
Level 8	Rational conjecture (common sense); common practices accepted before evidence-based guidelines

Step 2B: Critically assess each article/source in terms of research design and methods.
Was the study well executed? Suggested criteria appear in the table below. Assess design and methods and provide an overall rating. Ratings apply within each Level; a Level 1 study can be excellent or poor as a clinical trial, just as a Level 6 study could be excellent or poor as an animal study. Where applicable, please use a superscripted code (shown below) to categorize the primary endpoint of each study. For more detailed explanations please see attached assessment form.

Component of Study and Rating	Excellent	Good	Fair	*Poor*	*Unsatisfactory*
Design & Methods	Highly appropriate sample or model, randomized, proper controls **AND** Outstanding accuracy, precision, and data collection in its class	Highly appropriate sample or model, randomized, proper controls **OR** Outstanding accuracy, precision, and data collection in its class	Adequate, design, but possibly biased **OR** Adequate under the circumstances	*Small or clearly biased population or model* *OR* *Weakly defensible in its class, limited data or measures*	*Anecdotal, no controls, off target end-points* *OR* *Not defensible in its class, insufficient data or measures*

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

Step 2C: Determine the direction of the results and the statistics: supportive? neutral? opposed?

DIRECTION of study by results & statistics:	SUPPORT the proposal	NEUTRAL	OPPOSE the proposal
Results	Outcome of proposed guideline superior, to a clinically important degree, to current approaches	Outcome of proposed guideline no different from current approach	Outcome of proposed guideline inferior to current approach

Step 2D: Cross-tabulate assessed studies by a) *level*, b) *quality* and c) *direction* (ie, supporting or neutral/ opposing)**; combine and summarize.** Exclude the *Poor* and *Unsatisfactory* studies. Sort the *Excellent, Good,* and *Fair* quality studies by both *Level and Quality of evidence,* and *Direction of support* in the summary grids below. Use citation marker (e.g. author/ date/source). In the *Neutral* or *Opposing* grid use bold font for *Opposing* studies to distinguish them from merely neutral studies. Where applicable, please use a superscripted code (shown below) to categorize the primary endpoint of each study.

Supporting Evidence

Quality improvement efforts for AED programs such as an on-going review of equipment, supplies and responder preparedness and post-event review of event response and AED function, improve AED program performance.

Quality of Evidence									
	Excellent					Herlitz 1998 E Kellerman 1993 E MacDonald 2001E Sunde 1999 E		Priori 2004 E	McDowell 1993 E
	Good					Cleland 1998 E Davis 1998 E Ornato 1992 E	Cleland 1997 E	Tan 2002 E White 1993 E	Colquhoun 2004 E Kaye 1995 E White 2001 E
	Fair					Cleland 1999 E			
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**

Level of Evidence

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

Neutral or Opposing Evidence

Quality improvement efforts for AED programs such as an on-going review of equipment, supplies and responder preparedness and post-event review of event response and AED function, improve AED program performance.

Quality of Evidence									
	Excellent								
	Good					Calle 2001 E			
	Fair								
		1	2	3	4	5	6	7	8
		Level of Evidence							

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

REVIEWER'S PERSPECTIVE AND POTENTIAL CONFLICTS OF INTEREST: Briefly summarize your professional background, clinical specialty, research training, AHA experience, or other relevant personal background that define your perspective on the guideline proposal. List any potential conflicts of interest involving consulting, compensation, or equity positions related to drugs, devices, or entities impacted by the guideline proposal. Disclose any research funding from involved companies or interest groups. State any relevant philosophical, religious, or cultural beliefs or longstanding disagreements with an individual.

I am an Associate Professor of Emergency Medicine at the University of Pittsburgh. I am a Paramedic and serve as an assistant medical director for City of Pittsburgh EMS. My research has focused on out of hospital care and sudden cardiac arrest. I am a member of the national BLS subcommittee and former ACLS national faculty. I serve as medical director for the National Center for Early Defibrillation, which provides information about sudden cardiac arrest (SCA) and advocates for optimal immediate care, especially early defibrillation. The Center receives funding from a number of AED and ICD manufacturers. I have received research support from Medtronic Physio–Control and through the Public Access Defibrillation (NHLBI, AHA, AED manufacturers) and the AutoPulse Assisted International Resuscitation (Revivant Corp) trials.

REVIEWER'S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK: Summarize your final evidence integration and the rationale for the class of recommendation. Describe any mismatches between the evidence and your final Class of Recommendation. "Mismatches" refer to selection of a class of recommendation that is heavily influenced by other factors than just the evidence. For example, the evidence is strong, but implementation is difficult or expensive; evidence weak, but future definitive evidence is unlikely to be obtained. Comment on contribution of animal or mechanical model studies to your final recommendation. Are results within animal studies homogeneous? Are animal results consistent with results from human studies? What is the frequency of adverse events? What is the possibility of harm? Describe any value or utility judgments you may have made, separate from the evidence. For example, you believe evidence-supported interventions should be limited to in-hospital use because you think proper use is too difficult for pre-hospital providers. Please include relevant key figures or tables to support your assessment.

There are no controlled trials evaluating the benefit of a quality improvement program for AED programs specifically. A number of papers endorse quality improvement as important for both improving and maintaining system performance (Herlitz 1998, Kaye 1995, McDowell 1993, Priori 2004, Sunde 1999, White 2001). Some, including the FDA, have published checklists and event report forms (Colquhoun 2004, White 1993).