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## Public Access Defibrillation

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**LIST OF ABBREVIATIONS**

AED= automated external defibrillator  
BLS= basic life support  
CPR= cardiopulmonary resuscitation  
EMS= emergency medical system  
OOHCA= out of hospital cardiac arrest  
PAD= public access defibrillation  
SCD= sudden cardiac death

The single most important cause of death in the adult population of the industrialized world is sudden cardiac death (SCD) due to coronary artery disease (CAD). In a population based study the overall yearly incidence of SCD was 1 per 1000 persons aged 20 to 75 years of age. Overall 21% of deaths in men and 15% in women were sudden and unexpected. The vast majority of out of hospital deaths occur at home and about 15% in a public place or on the street. Forty percent of SCDs were unwitnessed. The majority of patients have ventricular tachycardia or fibrillation as the first recorded rhythm after patients collapse.

Although prevention strategies are now feasible in high risk patients with heart disease it is practically not feasible to establish population-based preventive measures because both the incidence of sudden death is low and the SCD is unexpected most of the time. Therefore in the majority of cases we have to act after the SCD has occurred having only a few minutes to react effectively.

Survival after out of hospital cardiac arrest is variable and is associated to the characteristics of the cardiac arrest event. Two kinds of factors influence the outcome of resuscitation efforts. Factors associated with patient characteristics which lead to SCD ('fate factors') such as age and underlying cardiac disease which cannot be modified after the cardiac arrest has been manifested. And the so called 'programme' factors which are related to the quality of resuscitation efforts such as time interval to basic life support and defibrillation.

Patient survival in out of hospital cardiac arrest is feasible only if the so called 'chain of survival' is successfully activated. Cardiac arrest should be recognized immediately and the emergency medical system should be activated thereafter. Good quality bystander CPR should be performed while ambulance is en route, and defibrillation of VF/ pulseless VT should be attempted as soon as possible. Finally advanced life support measures (e.g. endotracheal intubation, administration of intravenous medication) should be undertaken by highly trained personnel to complement basic life support (BLS) measures for successful resuscitation. Although all links of the chain of survival are important for successful resuscitation, it is now recognized that time to electrical defibrillation is the single most important determinant of survival after cardiac arrest. The possibility of survival after out of hospital arrest due to a shockable rhythm is eliminated by approximately 10% for each minute after patient collapse.

Traditional EMS in most countries was composed of a 2 tiered systems. The first tier consisted of ambulance crews that were able to recognize cardiac arrest and perform CPR while the defibrillation was performed by highly trained personnel of the second tier. Time from event to defibrillation was long and therefore survival from out of hospital cardiac arrest was less than 5% in most cases.

The implementation of automated external defibrillators have been a major advance because it gives the opportunity for successful defibrillation to be performed by non medical EMS personnel and lay rescuers and therefore time to defibrillation can be shortened. Early reports from the era before the implementation of AED have

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shown that the presence of defibrillators and trained personnel in the first EMS tier is accompanied by increased survival. The results were reproduced with the use of AED. So in an ESC-ERC policy statement in 2004 it is recommended that an AED and properly trained personnel should be placed in every vehicle that may transport patients at risk for cardiac arrest and this should be the first priority for an early access defibrillation program. [1]

The time, however, needed for most EMS vehicles to approach out of hospital cardiac arrest victims is in many occasions much longer than that needed for a successful resuscitation. Involvement of community responders outside the traditional EMS such as policemen, firefighters and trained volunteers could possibly shorten time to defibrillation further and enhance survival possibilities significantly.

Defibrillation programs outside the EMS have been implemented using three main strategies: First responder programs, onsite programs and home programs.

FIRST RESPONDER PROGRAMS

In these programs the possible first responders were increased initially using policemen and firefighters. The results of using first responders outside the traditional EMS have been encouraging in many cases. Increased survival rates have been shown to increase even if time to shock was reduced by only 1 or 2 min. The success of such programs, however, has not been evident in all studies. If time to defibrillation remained long despite the implementation of these programs (i.e.>10 min) the chances for a successful resuscitations remained unacceptably low. The most effective programs have been the ones where the first defibrillation attempt was performed <6 min from the first call. Despite conflicting results by this kind of programs it was recognized beyond doubt that the use of AEDs by trained non-medical personnel is safe and can also be effective under certain circumstances.

It also became clear that public access defibrillation programs should be more carefully designed and be scheduled in a manner that they could provide defibrillation in a timely manner. Properly trained lay rescuers were the next to be involved in resuscitative efforts in order to achieve effective defibrillation and maximize survival.

In order to test the effectiveness of such programs the Public Access Defibrillation (PAD) study was conducted. This was a prospective, community based multicenter clinical trial. In this study more than 19000 volunteer responders from 993 community units in the USA and Canada were recruited and were organized to a monitored and structured EMS. Community volunteers were randomized to provide only CPR or CPR and defibrillation with the use of AEDs. There were significantly more survivors to hospital discharge in community units where volunteers provided CPR plus defibrillation

(30/128 arrests) than in the units assigned to volunteers who provided only CPR (15 among 107). [2]

Similar attempts have been undertaken in Europe. In Brescia-Italy the 1 year survival free of neurological impairment increased and this effect was obvious in both urban and rural territories (figure 1).[3] In Piacenza-Italy survival to hospital discharge was tripled after the implementation of first responder programs (table 1). A recent meta-analysis of 1583 cases of OOHCA demonstrated that programs based on CPR plus early defibrillation with AEDs by trained non-healthcare professionals offer a survival advantage over CPR-only in OOHCA. The advantage is obvious in survival to hospital, RR: 1.22 (95% CI: 1.04-1.43) and survival to hospital discharge, RR: 1.39 (95% CI: 1.06-1.83). [4] Very encouraging results were also yielded by the implementation of community public access defibrillation programs in Austria which has increased neurologically intact survival from 4.5% (in the era of the traditional EMS system) to 27%. [5]

ON SITE PROGRAMS

In seeking a reduction of the time of onset of VF to de-

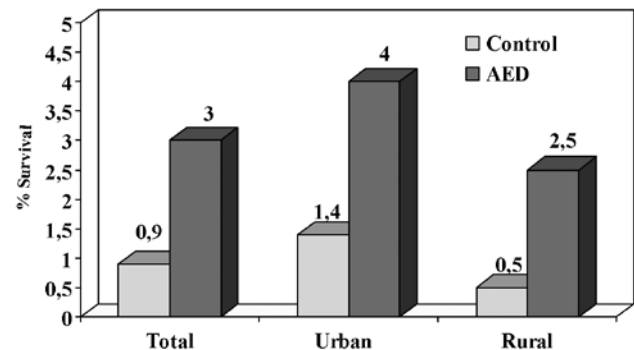


FIGURE. Percent survival of cardiac arrest victims in Brescia early defibrillation study (BEDS). All differences are statistically significant.

TABLE 1. Comparison of Resuscitation and Survival Rate From Sudden Cardiac Arrest in Piacenza Progetto Vita vs Emergency Medical System-Treated Patients

	Overall	PPV	EMS	P (PPV vs EMS)
SCA, n (%)	354	143 (40.4)	211 (59.6)	<0.001
Resuscitation rate	34/354 (9.6)	19/143 (13.3)	15/211 (7.1)	0.053
Survival rate	22/354 (6.2)	15/143 (10.5)	7/211 (3.3)	0.006
Neurologically intact	17/354 (4.8)	12/143 (8.4)	5/211 (2.4)	0.009
Witnessed, n (%)	261/354 (73.7)	97/143 (67.8)	164/211 (77.7)	0.038
Resuscitation rate	34/261 (13.0)	19/97 (19.6)	15/164 (9.1)	0.015
Survival rate	22/261 (8.4)	15/97 (15.4)	7/164 (4.3)	0.002
Neurologically intact	17/261 (6.5)	12/97 (12.3)	5/164 (3.0)	0.003
Shockable rhythm, n (%)	67/354 (18.9)	34/143 (23.8)	33/211 (15.6)	0.055
Resuscitation rate	34/67 (50.7)	19/34 (55.9)	15/33 (45.4)	NS
Survival rate	22/67 (32.8)	15/34 (44.1)	7/33 (21.2)	0.046
Neurologically intact	17/67 (25.3)	12/34 (35.3)	5/33 (15.1)	0.058

fibrillation, AEDs have been deployed in public places. The effectiveness of this approach has been tested in observational studies involving airports and casinos. All studies reported remarkable results for treatment of VF with survival >55%. Survival rates were higher for witnessed arrests and when the first shock was delivered within 3 min from patient collapse. [6]

#### HOME PROGRAMS

As already mentioned, the great majority of out-of-hospital cardiac arrests occur at home. Whether AED deployment at home of high risk individuals is of help is a matter of continuing research as preliminary studies yielded conflicting evidence. Families with genetic predisposition to SCD and families with high risk individuals that cannot receive an implantable cardioverter-defibrillator represent the primary targets for pilot projects for home defibrillation.

#### CURRENT EUROPEAN GUIDELINES

Guidelines from the European resuscitation council in November 2005 encourage the implementation of PAD programs especially in public locations when witnessed cardiac arrest is likely to occur. [7] Suitable sites might include those where the probability of cardiac arrest is least once in every 2 years. In the PAD trial, AEDs were also deployed in places that 1 out-of-hospital cardiac arrest was predicted during the study period (i.e. sites having >250 adults over 50 years of age present for >16 h/d. These programs may increase the number of victims who receive bystander CPR and early defibrillation, thus improving survival from out of hospital SCD. The aim of the rescuers should be to arrive to the cardiac arrest victim within 5-6 min from the initial call in order to achieve the highest survival benefit.

Recommended elements for PAD programs include:

- A planned and practiced approach
- Training of anticipated rescuers in CPR and use of the AED
- Link with the local EMS system
- Program with continuous quality improvement

In these guidelines no recommendations are made regarding home defibrillation programs.

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#### CONCLUSION

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AED programs should first be implemented within the EMS systems and then gradually move to the community, on-site and home defibrillation programs. To be effective AED programs should be integrated into an EMS strategy for treating patients with cardiac arrest. CPR and AED use by public safety responders (traditional and nontraditional) should be deployed. Every effort should be made for the first shock to be given to the cardiac arrest victim in a timely manner (i.e. within 5-6 min from the first call). PAD programs are more possible to be effective in public places where cardiac arrest is most possible to be witnessed. They should be closely monitored so that the program quality can be improved. Further research is needed for effective PAD programs for patients with OHCA at home.

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