Remote Area Usage of Automated External Defibrillators

Background

This paper was written in response to a company's enquiry as to whether AEDs should be carried on its field activities. The location of these activities varies from urban to very remote. This paper has been edited to maintain confidentiality, including omitting certain sections.

What is an Automated External Defibrillator?

An automated external defibrillator (AED) is one of the four steps in the "chain of survival": the emergency procedure that should be followed to give people suffering from Sudden Cardiac Arrest their best chance of survival. The AED is a computerized medical device that can check a person's heart rhythm and recognize a rhythm that requires a shock. It can advise the rescuer when a shock is needed using voice prompts, lights and text messages to tell the rescuer the steps to take.

Sudden Cardiac Arrest (SCA) is the sudden, abrupt loss of heart function in a person who may or may not have diagnosed heart disease. The time and mode of death are unexpected and it occurs instantly or shortly after symptoms appear. Of the SCAs treated by EMS, 20-38% are found in ventricular fibrillation (VF) or ventricular tachycardia (VT), rhythms that can be treated with AEDs.[20]

Who is at risk of SCA?

Each year, between 250,000 and 450,000 Americans have Sudden Cardiac Arrest. Ninety-five percent of these people die within minutes. SCA occurs most often in adults in their mid-thirties to mid-forties, and affects men twice as often as women. SCA rarely occurs in children.[19]

The major risk factor for SCA is having coronary artery disease (CAD). Most cases of SCA happen in people with 'silent' CAD who have no known heart disease at the time of the event.[19] The major risk factors for CAD include smoking, family history of CAD, high blood cholesterol, diabetes, increasing age, obesity, and lack of physical activities. SCA may also occur as a result of severe physical stress (for example major blood loss or severe lack of oxygen), inherited disorders or structural abnormalities of the heart.

Are there existing recommendations?

The 2000 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care recommend an automated external defibrillator (AED) be considered for a specific location if there is at least a 20% annual probability the device will be used.[1] These guidelines have subsequently been superseded by the 2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care in which no specific guidance on AED availability is given.[14] The 2005 guidelines comment that lay rescuer AED programs will have the greatest potential impact on survival from sudden cardiac arrest (SCA) if the programs are created in locations where SCA is likely to occur.

Current Adventure Travel Industry good practice does not include carrying AEDs with groups in the field: AEDs are not included on respected expedition medical equipment lists.[21]

How likely is Sudden Cardiac Arrest (SCA) in the field?

A large US-based study investigated the incidence of sudden cardiac arrest in various public places.[13] There were 10 location categories that each had a relatively high annual incidence of cardiac arrest (listed in the table below). Of these, the Seattle-Tacoma International Airport had the highest incidence, with 7 cardiac arrests per year. The ferry/ferry terminal/train terminal category had an annual incidence of .1 per year. Stated differently, each ferry, ferry terminal, or train terminal had 1 cardiac arrest every 10 years, or a total of 10 ferries would have 1 passenger per year experience a cardiac arrest.

Location	*Arrests in 5 years*	*Number of sites*	*Average annual incidence per site*
International airport	35	1	7
County jail	5	1	1
Large shopping mall	10	3	.6

Public sports venue	11	6	.4
Large industrial site	14	8	.4
Golf course	23	47	.1
Shelter	6	11	.1
Ferries/train terminal	7	13	.1
Health club	18	47	.08
Community/OAP centre	5	35	.03

In a London-based study, 110 high-risk locations were identified using Ambulance Service data. 300 AEDs were located at 23 airports, 267 at 66 main line rail stations, 12 at four major bus stations, eight at two ferry terminals, nine at a single shopping complex, and 85 at 14 major London Underground stations. 172 members of the public developed cardiac arrest at these sites between April 2000 and March 2004 and AED use equated to one use every 120 months.[3]

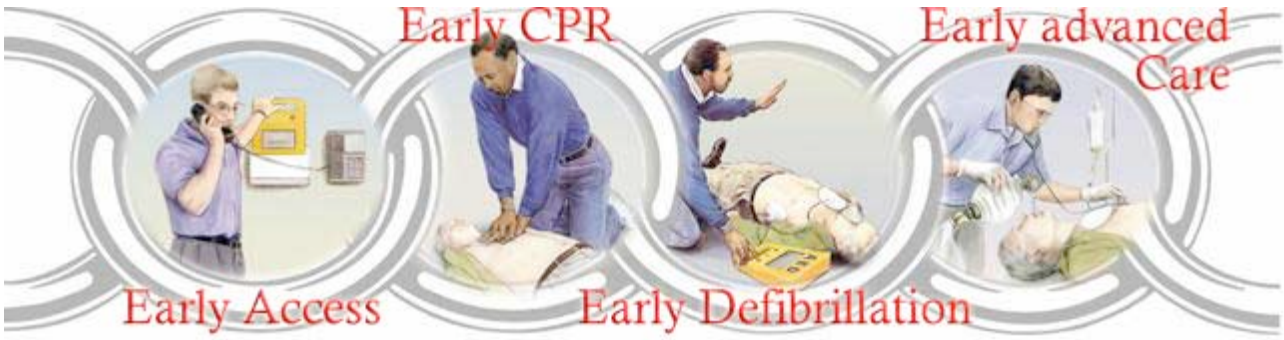
A Scottish study quantified the expected use if 31 AEDs were placed in four major airports, nine major railway stations, and four major bus stations in Scotland. Over seven years, 38 arrests occurred in these locations, equating to one AED use every 68.5 months.[12]

Extrapolating an expected rate of AED use on [company name deleted] field activities from these figures is very difficult. However the “golf course” rate in the table above may be a reasonable approximation. In 2004 two courses in the South Seattle area recorded 104 000 rounds played between them in the year.[17] This would approximately equate to 208 000 hours of golf per course, or 9 776 000 hours of golf played for the 47 sites included in the study. With 23 SCAs in a 5-year period an approximate rate in golfing activities is one SCA every 2 120 000 golfing hours.

Field Safety Statistics state [company name excluded] staff spent 56 916 hours in the field in 2006. Assuming the same rate of SCA as in golfing activities and no increase in hours spent in the field by [company name excluded] staff, this would imply an expected rate of 1 SCA every 37 years.

How likely is carrying an AED to improve patient outcome?

Factors contributing to out-of-hospital survival following Sudden Cardiac Arrest (SCA) have been described primarily in terms of the time-related “chain of survival” paradigm.[4] The four links of the chain include: (1) early recognition and call for emergency medical services; (2) initiation of basic life support CPR; (3) defibrillation; and (4) advanced cardiac life support (ACLS) drug intervention. Survival depends on the availability of the links.



Without intervention, survival following SCA decreases rapidly. Several studies have reported that for each minute of untreated cardiac arrest, the probability of successful rhythm conversion decreases by 7% to 10%, producing an equivalent per-minute-death rate.[5,6] Conversely, survival rates as high as 90% have been reported when the collapse-to-defibrillation time is within one minute.[7-9] To better define each the contribution of each link in the “chain of survival,” data were examined between 1976 and 1991 in Seattle.[10] A best fit model demonstrated a fit with the following equation:

Survival rate =	67% at collapse	– 2.3% per minute to CPR	– 1.1% per minute to defibrillation	– 2.1% per minute to ACLS

The regression constant, 67%, represents the probability of survival in the hypothetical situation in which all treatments are delivered immediately on collapse to patients with prehospital cardiac arrest. With delays in CPR, defibrillatory shock, and definitive care, the magnitude of the decline in survival rate per minute is the sum of the three coefficients (-2.2%, -1.1%, -2.1%), or –5.5%.[10]

As return of an adequate perfusing cardiac rhythm requires immediate application of the combination of CPR, defibrillation, and ACLS within a few minutes of arrest, establishing controls to permit smooth and fast support of the chain of survival enhances the probability of survival.

In practical terms, the best estimate of the upper limit or survival in the prehospital setting is that there are no survivors of normothermic arrest beyond an ACLS time interval of 30 minutes and transport time of 90 minutes.[11]

Will availability of an AED in the field cause people to change their behaviour?
A concern exists that carrying an AED on field activities may foster false sense of security and therefore make those more likely to suffer an SCA more likely to participate in risky activities. There are few studies that address this issue, however two surveys carried out at a water sports park in Europe (of 588 and 579 visitors respectively) found that 48% and 49% of respondents had participated in more sporting activities as a direct result of noticing AEDs around the park.[16]

How much does an AED cost?
AEDs cost approximately $2,000, but this cost is shared over an expected useful life of 10 years. Additional costs to consider include training, storage and maintenance. Maintenance includes checking and changing batteries and electrode cables and pads.

Do AEDs work in the rain or snow?
It is generally safe to use AEDs in all weather conditions. If the patient is lying in water, he/she should be moved to a relatively dry area before using the AED and his/her chest must be dried before affixing the pads.

Conclusion
The chance of a participant suffering an SCA on a field activity is very remote. There is a small increase in survival rate associated with early defibrillation when ACLS and hospital transfer are available within 30 minutes and 90 minutes respectively. The challenge is in balancing these factors. The financial burden of AED acquisition, training and maintenance is not great, and the danger of participants taking greater risk in undertaking field activities can be controlled by careful education plans.

Ultimately the decision whether or not to carry an AED on field activities must lie with the individual activity leader, however this review provides no compelling evidence to suggest that equipping and training field leaders for AED use will make any significant difference to mortality should a participant suffer an SCA during field activities in remote areas.

With the potential that those individuals most at risk of SCA would select urban or semi-rural field activities, it may be reasonable to suggest that field leaders include research into the likely location of the nearest AED to their activity (e.g. Hotel, sports centre etc.) and consider carrying a AED should one not be available. This recommendation would naturally need to include all field activities that involve passing through urban or semi-rural areas where the location of the nearest

AED is not known.

The question remains whether effort and resources would be better directed on other preventative or reactive measures, for example, a focus on participant education, or carrying oxygen with remote groups. If the choice is an 'either/or', then serious consideration should be made of all other steps that can be made to reduce the chance of mortality on field activities in order to investigate whether they are in reality more effective. If it is *not* a straight choice between AED provision and these other measures, it is essential that the AED issue does not divert attention away from the evaluation of other preventative and reactive steps. The provision of AEDs for field activities is a very emotive issue.

Summary: Should AEDs be carried in the field?

Arguments for:

- Survival rates *do* marginally increase provided ACLS and hospital transfer are prompt.
- Fulfils expectations of duty of care.

Arguments against:

- Survival rates *do not* increase if ACLS is more than 30 minutes away.
- Survival rates *do not* increase if transport to hospital is longer than 90 minutes.
- Training required.
- Maintenance required.
- May foster false sense of security and therefore make those more likely to suffer SCA more likely to participate in risky activities.
- Financial cost (purchase price, maintenance, peripherals, training, etc.).
- Must be carried, and rapidly accessible to all members of the party.

When making a decision whether or not to carry a defibrillator, Activity Leaders should take the following factors into account:

- the likelihood of use
- the logistics involved with carrying the device and ensuring its availability and serviceability
- the financial burden

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