Sudden Cardiac Death and Defibrillation: The Solution Around The Corner

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According to the World Health Organization (WHO), every year many more people die from cardiovascular diseases than from any other pathologies. It has been calculated that in 2005 about 17.5 millions of people died from cardiovascular diseases, which represents more than 30% of total recorded deaths in the world. Despite the decline of heart disease mortality registered in the past 30 years, cardiovascular diseases remain the “number one killer” in the industrialised world.1

It is estimated that 40-50% of all cardiovascular deaths are out-of-hospital sudden cardiac arrest (SCA). In Europe, that equates to around 400,000 adult deaths per year. Although the average victim is 65-years-old, approximately 10% of SCA events occur among people less than 40 years of age. In 85% of SCA cases, the victims are at home, the remaining 15% are struck in public places. The most worrying statistic is that the chance of surviving an out-of-hospital cardiac arrest is between 1% to 5%—a figure that has not improved since the 1950s.2

But there is also some good news; when caused by an abnormal heart rhythm, like ventricular fibrillation (85% of initial SCA), SCA not necessary results in death if the heart can be shocked quickly with a defibrillator and a normal rhythm is restored. In fact, the implantable cardioverter defibrillators are 98% effective in protecting those at risk for SCA and when SCA occurs in a hospital intensive care unit, the survival rate is more than 95%.3

Why not in out-of-hospital cardiac arrest? Survival could be as high as 90% if treatment could be initiated within the first minute after collapse, i.e. the availability of defibrillation and the quick action by the first person on the scene. The traditional ambulance service rarely arrives within five minutes, but many studies have shown, after 20 years of experience, that early defibrillation programs including public access defibrillation (PAD) improves the rate of survival among patients with an out-of-hospital cardiac arrest.3,4,5,6,7,8 For almost two decades Rochester and Seattle reported consistently survival rates of 30 to 40 per cent for witnessed ventricular fibrillation with organised two tiered system of early defibrillation, about three times the USA and Europe average.

In the last decade this model has been adapted in different cities around the world and has shown its efficacy to save lives from premature deaths. Recently, a large study in Japan (lasting three years and including a total of 312,319 adults with out-of-hospital SCA) has shown that a national dissemination of public-access automated external defibrillators (AED) was strongly associated with shortening the time to the administration of a first shock by laypersons and increasing the number of patients who survived with minimal neurologic impairment after receiving a shock.9

According to the authors conclusions, if the number of public-access AEDs increased from one per square kilometre (i.e., a unit placed every 1000 linear metres) to more than four per square kilometre (i.e., a unit placed every 500 linear metres), the rate of survival with minimal neurologic impairment in the area could increase about four times. That means thousands of saved lives.

It’s known that an AED analyses a patient’s rhythm automatically and delivers a shock only when it detects high-rate ventricular tachycardia or ventricular fibrillation. AEDs are designed to be used by laypersons with minimal training. All PAD are based on this safe and easy use. Almost 20 years ago, the AHA published “Improving Survival From Sudden Cardiac Arrest: The “Chain of Survival Concept”10

The paper identified the idea that all communities should adopt the principle of early defibrillation. This principle applies to all personnel who are expected, as part of their professional duties, to perform basic cardiopulmonary resuscitation (CPR). They must carry an AED and be trained to operate it. Health professionals who have a duty to respond to a person in cardiac arrest should have a defibrillator available either immediately or within one to two minutes. Responsible personnel should authorise and implement more widespread use of automated external defibrillation by community responders and allied health responders.
This question was recently studied by the large, community-based, randomised PAD trial-trained volunteers 6,7 at both control and AED sites and showed a doubling number of survivors (30 vs. 15; relative risk: 2.0; 95% confidence interval [CI]: 1.07 to 3.77; p < 0.03) at sites with AEDs compared with sites without AEDs. 11 In 2004 the European Society of Cardiology (ESC) and the European Resuscitation Council (ERC) confirmed the key criteria sustained by the AHA. 12 According to these recommendations, the first priority for the implementation of AED projects should stem from emergency medical system and hospital projects and progressively move to community, onsite and home projects.

Among other considerations, ESC and ERC recommended the implementation of the 112 emergency number on a number - to access emergency medical services (EMS) across Europe. It also outlined the first requirement to ensure a success for the PADs: a European legislation to permit defibrillation by non-medical personnel. What has been done during the last six years? Unfortunately, not much. In July 2007, the European Parliament, having reviewed all the evidence on the problem of cardiovascular disease and sudden cardiac death in Europe, adopted a resolution with a list of 21 points. Among others, the European Parliament Calls on the Commission to launch a survey in order to encourage the equipment of large public spaces, such as railway and metro stations, airports and stadiums, with pre-hospital system care such as early defibrillation for victims of cardiac arrest (cardiac fibrillation).

Some countries have made some progress in the deployment of PADs, but the European Union as a whole has not advanced much more than that, making difficult a full integration of PAD with EMS and generating the basis of lower results on survival than expected. 13 Meanwhile, the scientific data provide more arguments to deploy the PADs to decrease the rate of deaths. The Resuscitation Outcomes Consortium (ROC) 14 established a population-based registry for OHCA and resuscitation called the ROC Epistry Cardiac Arrest registry 15 to test the hypothesis that despite possible delays or errors associated with AED application, cardiac arrest patients who have an AED applied before EMS arrival experience better survival than those without an AED applied.

This investigation supports a significant and important beneficial impact of PAD programs in community-based settings. On average, early AED defibrillation before EMS arrival seems to nearly double a victim’s odds of survival after OHCA. These results support strategic expansion of PAD programs particularly in public locations.

**What about home defibrillation?**

As mentioned above, 85% of total SCA strikes the victims at home. A 2008 study by the National Heart, Lung, and Blood Institute and the National Institutes of Health of USA found that AEDs in the home are safe and effective. However, the benefits of home-use AEDs are still debated. In the Home Use AED Trial (HAT), the access to home AED did not significantly improve overall survival, as compared with reliance on conventional resuscitation methods in a particular setting of post myocardial infarction patients. 16 The very low event rate, the high proportion of unattended events appear to explain these results. The overall survival of 12.0% (18.3% for witnessed events) was anyway significantly better than 2% that has previously been reported in the general population at home. Something could be changed? The odds of surviving cardiac arrest may depend on which part of town you call home and whether anyone in the neighbourhood comes to your rescue by attempting to perform CPR. A new study reveals strategy for reversing stagnant survival rates. 17

**2010, what should be changed?**

This year could be an important date in the fight against SCA. The International Liaison Committee on Resuscitation (ILCOR) is conducting systematic reviews and updates of scientific evidence supporting Emergency Cardiovascular Care (ECC) treatment recommendations. More than 250 CPR and ECC scientific topics will undergo evidence-based review. This process will form the basis of new 2010 Resuscitation Guidelines which will be published electronically at the same time, on 18 October 2010.

**What about training?**

According to the Resuscitation Council (UK) the use of AEDs should NOT be restricted to trained personnel. Furthermore, the Resuscitation Council (UK) considers that it is inappropriate to display notices to the effect that only trained personnel should use the devices, or to restrict their use in other ways. Such restrictions are against the interests of victims of cardiac arrest, and discourage the greater use of AEDs by members of the public who may be able to preserve life and assist victims of cardiac arrest. This confirms similar advice from the British Heart Foundation. 18

The Italian experience of the little town of Piacenza gained good results only by training lay responders to use AEDs without CPR in a two tailored system of early defibrillation. Survival rate from ventricular fibrillation tripled from 14% to 39.8% after two years of the project. 19 These preliminary results have been confirmed after ten years by increasing the number of AEDs and the number of lay volunteers and reaches higher results when policemen are involved in AED application (63% survival rate). 19

We think that EMS have a pivotal role in continuing advanced care support, but the first step of defibrillation may not be left to them due to their delayed arrival. Surprisingly good results have been reported by Caffrey et al. in the experience of Chicago airports where the public use of AED by non-trained passengers resulted in very high survival rate for patients who experienced a cardiac arrest in the airport where an AED is placed at 80 metre intervals and video projections demonstrate their use. 20

**Short-video auto-training.**

Numerous studies of alternative AED training courses have shown equivalent or better outcomes as compared to standardised instructor-led and directed courses. 21,22,23,24,25,26 In some studies, instructor-led courses used non-standardised teaching methods and techniques 27,28 such as computer-based training 29 and retraining 30 with good results. A study comparing the standard American Heart Association HS-AED course lasting three to four hours, with the training involving AED skills practice, versus a 30 minute “watch-while-you-practice” video based CPR course providing only a verbal discussion of the AED without a skills practice.

The investigators found that the shorter training course resulted in better performance of AED skills at the immediate post-instructional and six month testing episodes than the standard length AHA course. Most importantly, the investigators conjecture that the use of an AED is mostly a cognitive skill and that this would be amenable to video or internet training, resulting in better initial performance and a longer retention of skills as compared to the traditional instructor-led training course which emphasises the psychomotor aspects of AED use.

The implication from this is that cognitive training and device driven instructions are more important to initial and long term performance than psychomotor training when using a device such as an AED. 31 Also children may learn to use an AED after a brief watching of a video and their performance in applying it demonstrates the simplicity ad safety of AED operation. 32
An analysis of the traditionally taught, instructor-led North American PAD Trial proposed that modification of the teaching method used for the lay providers might have improved their participation and performance in sudden arrest events had the training been made more congruent with their social, employment, ethnic and personal backgrounds. The comment was made that training that is more content and skills driven rather than being formally didactic and technical would transfer the educational content into actual practice better had the training been more individualised and congruent.

In summary, for lay and healthcare basic life-support (BLS) providers requiring AED training, the simpler the better both for initial performance and skills retention. Because of the cognitive nature of AED training and the guidance provided by the device itself, the only significant effect of instructor intervention was in the placement of the pads and the encouragement given to the providers to actually use the device. This may have practical implication in involving more people in early defibrillation program, with low cost and better widespread use of AEDs.

Cost-effectiveness of early defibrillation projects.

Several cost-effectiveness analyses examining AED deployment have been published. The final results is that training and equipping policemen, fire-fighters or lay volunteers to defibrillate may have an incremental cost-effectiveness that is similar to that of other common health interventions which are considered cost-effective: < $ 50,000 per quality-adjusted life years (QALY). In particular a study conducted in Amsterdam and surrounding determined the healthcare resources used and related medical costs after OHCA in relation to time to shock. They assessed the incremental healthcare costs per life gained from reduction in time to shock of two, four and six minutes. Costs per survivor were lowest with the shortest time to shock because of shorter stay in the intensive care unit. Reducing the time to defibrillation increases the healthcare costs by an acceptable amount shorter stay in the intensive care unit. Reducing the time to defibrillation increases the healthcare costs by an acceptable amount shorter stay in the intensive care unit. Reducing the time to defibrillation increases the healthcare costs by an acceptable amount shorter stay in the intensive care unit.

CONCLUSION

In most cases, it is all but impossible to predict who will have a sudden cardiac arrest, or where and when it will happen. What we do know is that each day more than 1,000 European citizen suffer from sudden cardiac arrest—usually away from the hospital. More than 95% of them die, in many cases because life-saving equipment arrives on the scene too late, if at all. More than 20,000 or more deaths could be prevented each year if AEDs were more widely available to first line responders such as police officers and fire department personnel. Public access early defibrillation - the optimum pre-hospital treatment for cardiac arrest – provides an incremental cost for QALY similar to that of other common medical intervention (< $ 50,000).


