Automated external defibrillation: Is survival only a shock away?

Brian Schwartz, P. Richard Verbeek

Technology: Automated external defibrillation for cardiac arrest.

Use: The chain of survival from sudden cardiac arrest (Fig. 1) comprises 4 key elements: early notification of emergency medical services (EMS), usually by 911 access; early car-

diopulmonary resuscitation (CPR); early defibrillation; and early advanced cardiac life support (ACLS). Research has shown that early CPR by bystanders or first responders (e.g., firefighters, police) improves survival. Several studies have focused on the effectiveness of early defibrillation in the treatment of sudden ventricular fibrillation or pulseless ventricular

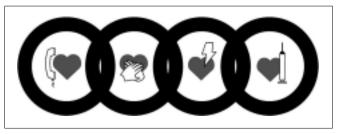


Fig. 1: Chain of survival: early access, early cardiopulmonary resuscitation, early defibrillation, early advanced life support. [Source: American Heart Association.]

tachycardia.^{2,3} Results from animal and human studies suggest that ventricular fibrillation is often a precursor to ventricular standstill, or asystole, in sudden death from a cardiac event and that it is amenable to therapy. It is intuitive, therefore, that early defibrillation will "catch" more patients in a treatable stage. The rate of death from out-of-hospital cardiac arrest is estimated to increase up to 10% with every minute of delay to first shock.^{4,5} Therefore, defibrillation after more than 8 minutes virtually guarantees death.

Many EMS systems cannot achieve response times consistent with maximizing survival.^{4,6} Recently, there has been a movement to enable first responders to provide this medical

act.^{3,7,8} The technology is now available to put a defibrillator in a lay person's hands, therefore minimizing the time to first shock and maximizing survival. Can the lay public be taught to provide this skill?

History: Manufacturers of public access defibrillation equipment have been hurrying to provide a "fire extinguisher" type of defibrillator that is quick and easy to apply. This would accurately determine cardiac rhythm and deliver appropriate energy safely and effectively. The automated external de-

fibrillator (AED) (Fig. 2) is such a machine. Over the last 10 years it has been used effectively by trained first responders and is now poised to enter the marketplace for public use in cardiac resuscitation. This device uses a computerized algorithm to accurately identify ventricular fibrillation and rapid

ventricular tachycardia. AEDs are portable and weigh as little as 1.8 kg. They have visual and verbal prompts to guide the user through the resuscitation process, from attaching the defibrillation pads to the victim's chest, to pressing the button for defibrillation after "standing clear." The available products have slight variations on the same algo-

rithm, based on ACLS guidelines, which consist of a prompt to "shock" (3 stacked defibrillations) versus "no shock" (a prompt to continue CPR for 1 minute before re-analysis).

Promise: Initial experience with this technology has been in the airline industry and most recently in casinos, 2 venues that always (in the first example) and often (in the second) have obstacles to paramedic access. Experience suggests that AEDs can be operated safely and effectively by trained lay responders. As early as 1987, Moore and colleagues demonstrated that lay people can learn to operate an AED safely. Areas of relatively poor access by EMS include golf courses, high-rise office buildings and large gatherings (e.g., sports

events and concerts). A proposed multicentre trial will compare sites with and without an on-site AED over a period of several years.

Problems: First, with the annual incidence of sudden cardiac arrest at 4 to 8 per 10 000 population, many sites will have to be involved in the proposed multicentre trial, at great cost of equipment and training. In addition, the groundswell of support for this new technology may indeed prevent its objective study. Second, as a controlled medical act (in Ontario), defibrillation



Fig. 2: Example of an automated external defibrillator.

requires medical delegation and overall supervision by a physician. Will the Colleges of Physicians and Surgeons demand that such physicians have their own qualifications to perform these acts and to delegate them? Third, who will ensure that these devices are used appropriately? Although apparently safe (the AED will only shock a shockable rhythm), can a lay responder be certain that the patient is pulseless? How can one be certain that there will be an efficient transfer of care to EMS personnel? Fourth, will such machines in widespread use be maintained properly? Is quality control possible when the AEDs are used in a "fire extinguisher" mode? Finally, what is the cost-effectiveness of training and maintaining skills of lay responders in the act of defibrillation when the frequency of use will be minimal?

Prospects: We believe that automated external defibrillation will eventually find a niche in places that do not have easy access for EMS providers. In such areas lay people could be trained to provide CPR and defibrillation if response times for EMS personnel are more than 15 minutes. In addition, selected high-risk patients for whom an implantable device is contraindicated or not available may benefit from having an AED at home, with their significant other or caregiver certified in its use. However, technology should not determine need. Controlled trials, if feasible, should serve to identify areas of potentially improved outcome and cost benefit for the use of automated defibrillators by the public.

Conclusion: Defibrillation by lay responders is on the horizon. It has the potential to increase survival from sudden cardiac arrest. We believe that to maximize effectiveness, it must be managed with appropriate medical control, be fully integrated with the community's EMS system and be subject to objective and rigorous evaluation.

Competing interests: None declared.

References

- Stiell IG, Wells GA, De Maio VJ, Spaite DW, Field BJ III, Munkley DP, et al. Modifiable factors associated with improved cardiac arrest survival in a multicenter basic life support/defibrillation system: OPALS Study phase I results. Ontario Prehospital Advanced Life Support. Ann Emerg Med 1999;33:44-50.
- Shuster M, Keller JL. Effect of fire department first-responder automated defibrillation. *Ann Emerg Med* 1993;22:721-7.
 Stiell IG, Wells GA, Field BJ, Spaite DW, De Maio VJ, Ward R, et al. Im-
- Stiell IG, Wells GA, Field BJ, Spaite DW, De Maio VJ, Ward R, et al. Improved out-of-hospital cardiac arrest survival through the inexpensive optimization of an existing defibrillation program: OPALS Study phase II. Ontario Prehospital Advanced Life Support. JAMA 1999;281:1175-81.
- Eisenberg MS, Horwood BT, Cummins RO, Reynolds-Haertle R, Hearne TR. Cardiac arrest and resuscitation: A tale of 29 cities. *Ann Emerg Med* 1990;19: 179-86.
- Larsen MP, Eisenberg MS, Cummins RO, Hallstrom AP. Predicting survival from out-of-hospital cardiac arrest: a graphic model. Ann Emerg Med 1993;22:1652-8.
- Sedgwick ML, Dalziel K, Watson J, Carrington DJ, Cobbe SM. Performance of an established system of first responder out-of-hospital defibrillation. The results of the second year of the Heartstart Scotland Project in the "Utstein Style." Resuscitation 1993;26:75-88.
- Kellermann AL, Hackman BB, Somes G, Kreth TK, Nail L, Dobyns P. Impact of first-responder defibrillation in an urban emergency medical services

- system. JAMA 1993;270:1708-13.
- Mosesso VN Jr, Davis EA, Auble TE, Paris PM, Yealy DM. Use of automated external defibrillators by police officers for treatment of out-of-hospital cardiac arrest. *Ann Emerg Med* 1998;32:200-7.
- Weisfeldt ML, Kerber RE, McGoldrick RP, Moss AJ, Nichol G, Ornato JP, et al. American Heart Association Report on the Public Access Defibrillation Conference December 8–10, 1994. Automatic External Defibrillation Task Force. Circulation 1995;92:2740-7.
- Moore JE, Eisenberg MS, Cummins RO, Hallstrom A, Litwin P, Carter W. Lay person use of automatic external defibrillation. *Ann Emerg Med* 1987;16: 669-72.
- Brison RJ, Davidson JR, Dreyer JF, Jones G, Maloney J, Munkley DP, et al. Cardiac arrest in Ontario: circumstances, community response, role of prehospital defibrillation and predictors of survival. CMA7 1992;147(2):191-9.

Related Web sites

- Public Access Defibrillation League: www.padl.org
- Toronto Ambulance: www.city.toronto.on.ca/ems
- University of Toronto Emergency Medicine Divisions: www.utoronto.ca /emergmed

Dr. Schwartz is Director, Division of Prehospital Care, Sunnybrook & Women's College Health Sciences Centre, Toronto, Ont. Dr. Verbeek is Medical Director, Level 1 and Firefighter Defibrillation Programs, Division of Prehospital Care, Sunnybrook & Women's College Health Sciences Centre, Toronto, Ont.