Automated external defibrillation in emergency medical systems: what has been achieved and where to go?

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This editorial refers to 'Prospective assessment of integrating the existing emergency medical system with automated external defibrillators fully operated by volunteers and laypersons for out-of-hospital cardiac arrest: the Brescia Early Defibrillation Study (BEDS)\(^7\) by R. Cappato et al., on page 553

Out-of-hospital cardiac arrest (OHCA) occurs with an incidence of approximately 55 per 100 000 inhabitants per year\(^1\) and a probability of survival-to-hospital discharge of only 1–3%. OHCA accounts for approximately 450 000 deaths in the United States per year.\(^2\) The advent of automated external defibrillators (AEDs) triggered high expectations to improve these figures. AEDs are safe even in the hands of untrained schoolchildren who (under experimental conditions) required only 23 s longer than trained medical professionals to apply a shock for ventricular fibrillation.\(^3\) One of the most convincing studies has been reported by Valenzuela et al.\(^4\) who deployed AEDs in casinos and trained casino officers in their use. By this intervention, the time from collapse to application of the first shock was shortened to a mean of 4.4 min and survival increased to 53%.

Similar studies also showed significant improvement in survival from OHCA at a community level, predominantly by equipping paramedics, police officers, and firefighters with AEDs,\(^5\) or by deploying AEDs in busy public locations such as airports.\(^6\) However, other investigators were not able to demonstrate a significant improvement in the survival of OHCA by these measures and concerns have been expressed that inadequate use of AEDs may delay other measures of cardiopulmonary resuscitation (CPR) such as chest compression. Therefore, it remains unknown if the use of AEDs is warranted rather in locations with trained personnel (i.e. security officers) and high catecholamine levels—casinos and airports as prominent examples—or also as part of a modern emergency medical service (EMS) system. In this context, the study by Cappato et al.\(^7\) deserves our attention.

In the Brescia Early Defibrillation Study (BEDS), survival from OHCA in the years 1997–1999 (692 victims) was compared with the years 2000–2002 (702 victims). Between these two periods, 49 AEDs had been added to the existing EMS system of Brescia County (1 100 000 inhabitants) in Italy which previously had only five EMS vehicles and 10 hospitals equipped with manual defibrillators. More than 2000 volunteers (including 152 paramedics) were trained in the use of these AEDs of which 42 were operated by ambulance services and 7 were installed in busy public locations. As a result, the survival-to-hospital admission was significantly increased from 5.5 to 8.1% (32% relative increase), and the survival-to-hospital discharge from 1.4 to 4.4% (68% relative increase). After 1 year, 3.0% of patients with OHCA survived free of neurological impairment when compared with 0.9% (70% relative increase) in the era before availability of AEDs. Although the improvement in survival-to-hospital admission is significant, the main contribution to 1-year survival seems to result from improved in-hospital survival. Although 75% of patients alive at hospital admission died before discharge in 1997–1999, this figure decreased to less than 50%, most likely due to more frequent revascularization (40 vs. 29%), implantation of ICDs (16 vs. 8%), and better pharmacological treatment. Of note, in both study periods approximately 60% of patients had OHCA in the setting of acute myocardial infarction or ischaemia.

The main criticism to the use of AEDs in BEDS relates to the fact that despite an almost 10-fold increase of mobile defibrillation facilities from 5 to 54, the time from dispatch to arrival at the site of collapse remained unchanged (7.3 vs. 7.4 min). In addition, the total response time (collapse to first defibrillation) was 17.6 ± 14.7 min, only 23% of witnessed victims received defibrillation within 8 min. Most of these patients must have been in their 'circulatory' or 'metabolic' phase where oxygen delivery, external cooling, and other measures may be more important than fast defibrillation.\(^8\) Results from the present study support this concept by the observation that defibrillation within 8 min after witnessed collapse yielded a 1-year survival without neurological deficit of 12.5% when compared with only 1.7% if defibrillation was applied later.

The difference in OHCA outcome between urban and rural areas reported in this study merits attention. Victims in an urban surrounding had a better chance to be witnessed,
shorter time to defibrillation, were almost twice as likely to arrive at the hospital alive (11.4 vs. 6.3%), and even more likely to survive until hospital discharge (7.1 vs. 2.9%) than victims in a rural environment. Therefore, particular efforts to improve survival of OHCA have to be applied to rural areas. This is supported in the BEDS study by the observed improvement of 1-year survival free of neurological deficit 1997–1999 vs. 2000–2002, which was more pronounced in rural areas (0.5 to 2.5%).

Finally, it is interesting to see how AEDs installed in busy public locations performed in this study. In fact, 5 of the 31 patients who survived-to-hospital discharge were treated with one of the 7 AEDs in public locations (0.71 survivors per dispatched AED) when compared with 26 survivors treated with one of the 42 AEDs or five manual defibrillators (0.55 survivors per ambulatory device) which confirms the usefulness of AEDs in public locations as reported by the PAD trial and the British National Defibrillator Program.

Several conclusions can be drawn from the present and other recent studies on OHCA: (1) Survival of OHCA in the community is improved by the deployment of AEDs in combination with educational programs but also by a better in-hospital survival because of a higher proportion of revascularization and other procedures. (2) The improvement achieved so far is far from satisfactory. Currently, AED deployment to apartment buildings and private homes in combination with training of family members and neighbours (‘neighbourhood-designated responders’) is thoroughly investigated as 80% of OHCA occur at home. (3) Evidence for a benefit of mobile AED deployment stems from studies with trained policemen, firefighters, security officers, and paramedics who are usually much earlier at the site of OHCA than EMS professionals. In addition, also untrained lay-persons can improve the outcome of OHCA using AEDs installed in public locations such as airports. (4) To reduce mortality from OHCA, health care resources should be utilized predominantly to decrease the delay between collapse and CPR/defibrillation, which was still far too long in the present study. Continuous maintenance of awareness of OHCA situations and training of citizens in CPR and the use of AEDs is necessary to achieve this goal. In contrast, the use of advanced-life-support interventions by trained paramedics does not seem to improve the survival of OHCA.

Conflict of interest: none declared.

References