Cost-effectiveness of in-home automated external defibrillators for individuals at increased risk of sudden cardiac death: there's no place like home  
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Record Status  
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology  
Initial treatment with an in-home automated external defibrillator (AED) followed by emergency medical services (EMS) was compared with treatment by the EMS equipped with AEDs (EMS-D) for individuals suffering an in-home cardiac arrest.

Type of intervention  
Treatment.

Economic study type  
Cost-effectiveness analysis.

Study population  
The study population comprised four hypothetical cohorts of individuals aged over 60 years at progressively increasing risk of sudden cardiac death (SCD). Cohort 1 comprised adults with an annual SCD probability of 0.4%. Cohort 2 comprised adults with multiple SCD risk factors (SCD probability of 2%). Cohort 3 comprised adults with a prior myocardial infarction (MI) (SCD probability of 4%). Cohort 4 comprised adults with ischaemic cardiomyopathy who were unable to receive an implantable defibrillator (SCD probability of 6%).

Setting  
The setting was the community. The economic study was carried out in the USA.

Dates to which data relate  
The effectiveness data were derived from studies published between 1984 and 2003. The resource use data were derived from studies published in 1998 and 2004 and from personal communications. The price year was 2004.

Source of effectiveness data  
The effectiveness data were derived from a review of published studies, augmented by the authors' assumptions.

Modelling  
A Markov decision model was constructed in DATA 4 and Excel 2000 software to evaluate the lifetime clinical and economic impact of the two alternative strategies. A graphical representation of the model was provided.

Outcomes assessed in the review  
The model input parameters derived from the review were:
the probability that arrest will occur at home;

the probability that an AED will be used on an in-home arrest victim;

the probabilities of initial resuscitation with EMS and with an AED;

the probabilities of surviving to hospital discharge with EMS and with AED;

the annual probability of dying in cardiac arrest survivors;

the probabilities of surviving a cardiac arrest unimpaired, moderately impaired and severely impaired; and

the quality of life when unimpaired, moderately impaired and severely impaired.

**Study designs and other criteria for inclusion in the review**

Not reported.

**Sources searched to identify primary studies**

MEDLINE (from 1966 to 2003) and the abstracts of major scientific meetings (from 2000 to 2003) were searched using three terms, "heart arrest", "emergency medical services" and "public access defibrillation". The bibliographies of the selected articles were checked for additional articles.

**Criteria used to ensure the validity of primary studies**

Not reported.

**Methods used to judge relevance and validity, and for extracting data**

Not reported.

**Number of primary studies included**

Twenty-three studies were reviewed to derive the clinical input parameters.

**Methods of combining primary studies**

In the situation where more than one estimate was available, the authors selected the most methodologically sound single study and used the effectiveness estimate obtained. When no single study was deemed to be superior, the mean estimate of all relevant studies was used and the broad range was used in a sensitivity analysis.

**Investigation of differences between primary studies**

Not reported.

**Results of the review**

The parameters used as model inputs were as follows:

the probability that arrest occurred at home was 0.50;

the probability that an AED was used on an in-home arrest victim was 0.40;

the probability of initial resuscitation was 0.30 with EMS and 0.50 with an AED;
the probability of surviving to hospital discharge was 0.15 with EMS and 0.30 with an AED;
the annual probability of dying in cardiac arrest survivors was 0.15;
the probability of surviving a cardiac arrest unimpaired was 0.75;
the probability of surviving a cardiac arrest moderately impaired was 0.15;
the probability of surviving a cardiac arrest severely impaired was 0.10; and
quality of life was 0.85 when unimpaired, 0.20 when moderately impaired, and 0.1 when severely impaired.

**Methods used to derive estimates of effectiveness**
Assumptions were made about several model input parameters.

**Estimates of effectiveness and key assumptions**
The authors assumed that 50% of all arrests occurred at home, and that 40% of these arrests were witnessed and treated with the available in-home AED.

**Measure of benefits used in the economic analysis**
The measure of health benefit was the quality-adjusted life-years (QALYs) gained. The utility values for the unimpaired were derived from two published studies of cardiac arrest survivors, while values for the moderately and severely impaired were based on published estimates for stroke survivors.

**Direct costs**
The quantity/cost boundary adopted in the economic evaluation was that of society. As such, it appears the all the relevant direct cost categories were included. These incorporated medical costs for individuals in each of the four cohorts, the costs of AED purchases, maintenance, training and supplies, the costs for post arrest hospitalisation and medical costs for arrest survivors. The unit costs and the resource quantities were reported separately. Resource use was derived from the model. With the exception of AED training, the costs of which were obtained from personal communication with Johnson County Red Cross, the cost data were taken from published studies Historic costs were adjusted to 2004 dollars using an inflation rate of 2.5% to reflect inflation in the Consumer Price Index between 1999 and 2002. The future costs were discounted at a rate of 3%.

**Statistical analysis of costs**
The costs were treated deterministically, although they were included in the extensive sensitivity analysis.

**Indirect Costs**
Although a societal perspective was stipulated, it was unclear whether any indirect costs were included in the analysis.

**Currency**
US dollars ($).

**Sensitivity analysis**
One- and two-way sensitivity analyses were conducted to examine the impact of uncertainty on the results derived in the economic study. The ranges of sensitivity analyses were taken from published studies. In addition, a Monte Carlo simulation was used to assess the robustness of the authors' findings.
Estimated benefits used in the economic analysis
Compared with EMS-D for individuals aged 60 years, providing in-home AEDs to all adults resulted in a QALY gain of 0.024.

EMS-D for individuals aged 60 years compared with adults with multiple SCD risk factors resulted in a QALY gain of 0.037.

EMS-D for individuals aged 60 years compared with adults with a prior MI resulted in a QALY gain of 0.047.

EMS-D for individuals aged 60 years compared with adults with ischaemic cardiomyopathy resulted in a QALY gain of 0.054.

Cost results
Compared with EMS-D for individuals aged 60 years, providing in-home AEDs to all adults resulted in an incremental cost of $5,175.

EMS-D for individuals aged 60 years compared with adults with multiple SCD risk factors resulted in an incremental cost of $4,930.

EMS-D for individuals aged 60 years compared with adults with a prior MI resulted in an incremental cost of $4,925.

EMS-D for individuals aged 60 years compared with adults with ischaemic cardiomyopathy resulted in an incremental cost of $4,720.

Synthesis of costs and benefits
The incremental cost per QALY gain was $216,000 for all adults, $132,000 for adults with multiple SCD risk factors, $104,000 for adults with a prior MI, and $88,000 for adults with ischaemic cardiomyopathy.

Sensitivity analyses revealed that the incremental costs per QALY gained were sensitive to the probability that the arrest occurred at home, the probability that available AED was used, and the probability of suffering SCD. The life expectancy of cardiac arrest survivors and the absolute reduction in the time-to-defibrillation interval had impacts on the incremental costs per QALY gained.

Monte Carlo simulations were performed in which the annual risk of cardiac arrest was held constant at 2, 4 and 6%. These demonstrated mean costs per QALY gained of $176,000 (2%), $131,000 (4%) and $105,000 (6%), respectively.

Authors' conclusions
The results of the cost-effectiveness analysis suggested that an in-home automated external defibrillator (AED) might be a reasonable investment for individuals at high risk of sudden cardiac death (SCD). However, population-based deployment to all adults aged 60 years was relatively expensive.

CRD COMMENTARY - Selection of comparators
The rationale for the choice of the comparator was clear. EMS-D represented current practice in the authors' setting. You should decide whether it is a valid comparator in your own setting.

Validity of estimate of measure of effectiveness
The model parameters were mainly derived from published studies. It was unclear whether a systematic review of the literature was performed, but criteria were applied to the search for primary studies. No information on the designs of the primary studies was provided. The use of data derived from clinical trials ensured the validity of the clinical estimates. The robustness of the results was addressed by sensitivity analyses on the clinical inputs. Given the limited reporting of the methods of the review and synthesis, it was difficult to determine if the best available evidence had
been used to populate the model.

Validity of estimate of measure of benefit
Using QALYs as the summary benefit measures was appropriate since they capture the impact of the intervention on quality of life. The measure is comparable with the benefits of other health interventions. Discounting was applied in accordance with accepted guidelines.

Validity of estimate of costs
The authors explicitly stated the perspective adopted. As such, it would appear that all the relevant categories of costs have been taken into consideration. However, it was unclear if productivity losses were included, or whether they were excluded given the age of the study population. Further, if excluded, no explicit justification for their exclusion was given. A breakdown of the unit costs and some resources used were provided, which assists the generalisability of the study results. Extensive sensitivity analyses were conducted to assess the impacts of uncertainty and appropriate ranges were used. This enhances the possibility of replicating the study. The price year was reported. An appropriate inflation rate and discount rate were used, which aids reflation exercises in other settings.

Other issues
The authors did not compare their findings with those from other studies. The issue of the generalisability of the study to other settings was addressed by performing extensive sensitivity analyses, the results of which were satisfactorily reported. The authors' conclusions reflected the scope of the analysis. The authors noted several limitations of the study. First, this study deliberately chose model inputs that underestimated the benefit of in-home AEDs. Second, the anxiety for both patients and their family caused by in-home AEDs was not incorporated. Finally, potential complications resulting from in-home AED deployment were not captured.

Implications of the study
The authors suggested that decision-making around in-home AED deployment for individuals aged 60 years should consider the risk of SCD. They also implied that population-based deployment does not appear to be appropriate.

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Other publications of related interest


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