Outcome and cost-effectiveness of cardiopulmonary resuscitation after in-hospital cardiac arrest in octogenarians

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
The study examined the use of cardiopulmonary resuscitation (CPR) in octogenarians after in-hospital cardiac arrest.

Type of intervention
Treatment.

Economic study type
Cost-utility analysis.

Study population
The study population comprised patients aged 80 years or older who experienced in-hospital cardiac arrest. Patients who experienced cardiac arrest in the emergency department, surgical recovery unit or in the operating room were excluded from the analysis.

Setting
The setting was hospital. The study was carried out at Mount Sinai Medical Centre, Miami Beach, Florida, USA.

Dates to which data relate
The effectiveness and cost data were collected between 1 January 1993 and 6 July 1996. For the surviving patients, effectiveness data were collected until 28 February 1998. Although the price year reported in the paper was 1988, it seemed that this was an erratum and that the true price year was 1998.

Source of effectiveness data
Effectiveness evidence was derived from a single study.

Link between effectiveness and cost data
The costing appears to have been undertaken retrospectively for the same sample population as that used for the effectiveness analysis.

Study sample
No power calculations were performed to determine the sample size. All patients with the International Classification of Disease version 9, code 427.5 denoting cardiac arrest at the hospital were studied. Among 91,372 consecutive hospital discharges, cardiac arrest was reported in 956 patients, of whom 474 were 80 years of age or older. These 474 octogenarian patients were considered for the effectiveness analysis. The mean age of the octogenarian population was 86 +/- 4.8 years (range: 80 - 103 years).
Study design
The study was a case series analysis, performed in a single centre. The duration of follow-up of the patients was until death or 5 years for the surviving patients. The authors did not report any loss to follow-up.

Analysis of effectiveness
Although not explicitly reported the basis for the analysis appears to have been intention to treat. The outcomes assessed in the study were: the mean length of stay; hospital survival; number of patients discharged alive from the hospital, and the percentage transferred to a chronic care hospital with ventilatory capabilities, home, skilled nursing home or admitted to rehabilitation or to a psychiatric facility; mortality rate at one week, one month and six months after discharge; percentage of patients still alive at the end of the follow up, and their survival, accounted at the end of the study.

The authors reported comparisons of survival and length of stay of the octogenarian patients with regard to those younger than 80 years who received CPR at the hospital during the period of the study. The authors also estimated the significant predictors of in-hospital death, and reported the odds ratios (OR). The number of patients needed to treat with CPR to save one life to hospital discharge, and the number of patients that had to be treated with CPR to save one long-term survival after cardiac arrest (i.e. mean survival of 21 months, within a range from 9 to 48 months) were also reported, assuming 100% mortality without CPR.

Effectiveness results
The effectiveness results were as follows:

The mean length of stay for the octogenarian group was 8.3 +/- 8.7 days, compared with that for the younger group, which was 9.09 +/- 9.56 days, (p=0.18).

The hospital survival for the octogenarians was 11%, in comparison with the younger group, which was 23.8%, (p<0.001).

The number of patients discharged alive from the hospital was 50, among whom 10 (20%) were transferred to a chronic care hospital, 19 (38%) were discharged home, 9 (18%) were placed in a skilled nursing home and 12 (24%) were admitted to a rehabilitation or psychiatric facility.

The mortality rate for those patients discharged from the hospital was 20% within one week after discharge, 34% within one month, and 46% within 6 months.

The percentage of patients still alive at the end of the follow-up, among those that were discharged from the hospital, was 36%; this figure represented 3.6% of all the octogenarian patients included in the effectiveness analysis. These patients had survived from 9 to 48 months.

The significant variables associated with in-hospital death were: absence of a cardiovascular diagnostic-related group (DRG) (Odds-Ratio (OR) = 3.13, p=0.001), respiratory DRG (OR = 3.55, p=0.03), gastrointestinal DRG (OR = 5.43, p=0.02), and age (OR = 1.02 for each year, p=0.0001).

Assuming 100% mortality without CPR, the total number of octogenarians requiring treatment in order to save one life was 12, and the number of octogenarians that had to be treated to save one long-term survivor was 29.

Clinical conclusions
The use of CPR allows the reduction in the mortality for those octogenarian patients with cardiac arrest that, otherwise, would die. The variables associated with an increase in in-hospital death were cardiovascular, respiratory and gastrointestinal DRG, and age.
Modelling
A multiple logistic regression model was used to estimate those variables that were significant predictors of in-hospital death.

Methods used to derive estimates of effectiveness
The authors made an assumption.

Estimates of effectiveness and key assumptions
Patients with cardiac arrest who did not receive CPR had 100% mortality. Therefore, it was not necessary to show whether the groups (study sample and hypothetical comparator group) were comparable at analysis.

Measure of benefits used in the economic analysis
The measures of benefit used were years of life saved (YOLS) and quality-adjusted life-years saved (QALYS).

A lifetime horizon was used to estimate the YOLS. For those patients who were still alive at the end of the follow-up, information from the United States Department of Commerce Bureau of the Census and the probability of surviving for 5 years for those older than 85 years was used to estimate the YOLS.

QALYS were calculated according to the utilities reported in the literature for hospitalised patients of 80 years or older with an expected 6-month mortality of 50% (see "Other Publications Of Related Interest" below).

Direct costs
Resource quantities and costs were reported separately. The direct costs included in the analysis were those of the health service, and were related to the CPR procedure and equipment, the CPR teaching programme, and expenses generated by surviving patients. The cost of CPR included the costs related to resident physicians, nurses, technologists, medications, crash cart check, and equipment costs, such as crash cart and defibrillator. The cost of CPR teaching programme per year comprised basic life support costs, advance cardiac life support costs and equipment costs for teaching. The costs related to the surviving patients were: hospitalisation costs during CPR, the costs of outpatient follow-up (i.e. the physician office visit and the medication costs for digoxin, aspirin, lasix and ACE inhibitors), the cost of chronic care facilities (such as nursing home, chronic hospital with ventilatory capabilities and rehabilitation), the costs of repeat hospitalisation, and the projected long-term medication costs for those patients who were still alive at the end of the follow-up. Discounting was not carried out, although it was relevant for the costs of those patients who survived for more than 2 years. The costs reported were average and total costs, and were based on actual data. The price year reported was 1988. However, as the effectiveness data were collected between 1996 and 1998, this was probably erroneously reported and the true price year is likely to have been 1998.

Statistical analysis of costs
Although the authors reported that the costs obtained for the octogenarian patient population were compared with those obtained for the younger population (less than 80 years of age) during the in-hospital period, results of these statistical analyses were not reported.

Indirect Costs
Indirect costs were not reported.

Currency
US dollars ($).
Sensitivity analysis
A sensitivity analysis of costs was performed, assigning each variable a value equivalent to two and a half times its true cost. The area of uncertainty investigated was variability in data.

Estimated benefits used in the economic analysis
In spite of the fact that the benefits were calculated as YOLS and QALYS, the authors did not report the results for the estimated benefits alone, but only the cost-effectiveness ratios.

Cost results
Total costs per person were not reported. The costs (per person per day) for nursing homes, chronic care hospitals and rehabilitation/geriatric facilities were, as follows:

- nursing homes = $130;
- chronic care hospitals = $800; and
- rehabilitation/geriatric facilities = $730.

The total cost of CPR (including the teaching costs) was $480,991 per year per hospital.

The overall cost of hospitalisation was $3,869,993.

The cost of repeat hospitalisations, physicians' office visits and medications for survivors was $665,405.

Synthesis of costs and benefits
Estimated benefits and costs were combined by means of cost-effectiveness ratios. These were calculated as the total cost of CPR and post-CPR care divided by QALYS (or YOLS). It seemed that the cost-effectiveness ratios were calculated in such a way because the comparator (no CPR) generated neither any benefit nor any cost, although this was not explicitly stated.

The cost-effectiveness ratio of CPR in octogenarians was $50,412/YOLS. The quality-adjusted cost effectiveness ratio, using a utility of 0.8, was $63,015. The authors reported that the ratio was found to be very sensitive to small changes in the health utilities, being equal to $100,825 when a utility of 0.5 was used. No other results of the sensitivity analyses were reported.

Authors' conclusions
The authors conclude that the value obtained for the cost-effectiveness ratio for CPR after in-hospital cardiac arrest in octogenarians is an acceptable value in comparison with those obtained for other life-saving medical interventions. Moreover, the number of octogenarians requiring treatment with CPR in order to save one life is also within the range of other interventions considered efficacious.

CRD COMMENTARY - Selection of comparators
In this study the choice of the ‘do-nothing’ alternative as comparator for CPR seem appropriate as it appears to represent current practice when CPR is not given to patients who suffer a cardiac arrest.

Validity of estimate of measure of effectiveness
The analysis was based on a case series study that seemed to be appropriate for the study question due to the nature of the comparator (if no CPR was given, it was assumed that no costs or benefits were generated, and therefore, there was no need to analyse a real comparator group). Some baseline characteristics were provided to show if the study sample was representative of the study population. However, as the authors reported, one of the limitations of the study was...
that it was conducted in a community hospital with university affiliation, and this may not have been representative of a
typical hospital. Furthermore, cardiac arrests occurring in the emergency department or during surgery were not
considered at analysis, although no justification was given for this choice.

**Validity of estimate of measure of benefit**
The authors derived a measure of benefit, namely YOLS and QALYS generated by CPR. The estimate of benefits
seems to have been obtained directly from the effectiveness analysis in the case of the YOLS, and the QALYS were
calculated by means of multiplying the value obtained by the utilities reported in the literature. However, the authors
did not provide the results for the health benefits alone, but, rather, reported the cost-effectiveness ratios directly.

**Validity of estimate of costs**
Although the authors reported that a societal perspective was adopted, they did not include indirect costs. The exclusion
of wages lost was justified because it was assumed that most of the patients were retired. However, the indirect costs
derived from the care given by relatives were not included, and would have been relevant to a societal perspective. The
authors did not justify this exclusion. If the researcher wishes to adopt a societal perspective, this kind of cost ought to
be included in the analysis. Some other relevant costs were related to home health service costs and hospice costs (for
those patients discharged alive from the hospital), and this exclusion was justified due to the unavailability of data. The
exclusion of these costs is likely to underestimate the total costs of CPR. Nevertheless, the authors reported that even
though the retrospective nature of the study may have failed to include all costs, relevant costs were included and, thus,
missing costs would not have had a significant effect on the cost-effectiveness ratios. The long-term costs for those
patients with a survival over 2 years were not discounted. The price year was given, but there seemed to have been an
erratum in its reported value. No statistical analysis of quantities was reported. Resource quantities and costs were
reported separately, increasing the generalisability of the results to other settings. However, total costs per patient were
not presented, thus reducing transparency.

**Other issues**
The authors made appropriate comparisons of their findings with those from other studies, in terms of the effectiveness
results and the cost-effectiveness ratios obtained. The issue of generalisability of the results to other settings was
mentioned. The authors presented the results selectively, as total benefits and total costs were not reported and no
results were given for the statistical analysis or sensitivity analysis of costs.

**Implications of the study**
The authors stated that further research is needed in order to clarify the most important predictors of successful CPR in
octogenarians to maximise the effectiveness of this intervention.

**Source of funding**
None stated.

**Bibliographic details**
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Other publications of related interest


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