Criteria of candidacy for unilateral cochlear implantation in postlingually deafened adults.
II: Cost-effectiveness analysis
UK Cochlear Implant Study Group

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 use of unilateral cochlear implantation for postlingually deafened adults was evaluated.

Type of intervention
Treatment.

Economic study type
Cost-utility analysis.

Study population
The study population comprised severely to profoundly hearing-impaired postlingually deafened adults who received multichannel cochlear implants. The inclusion and exclusion criteria were described in another paper (UK CISG 2004, see 'Other Publications of Related Interest' below for bibliographic details).

Setting
The setting was secondary care (a hospital). The economic study was carried out in 13 hospitals in the UK.

Dates to which data relate
The effectiveness data were collected from patients who received multichannel cochlear implants between 1 June 1997 and 31 May 2000. The costs were expressed at 2001/2002 financial levels.

Source of effectiveness data
The effectiveness data were derived from a single study.

Link between effectiveness and cost data
Although not stated explicitly, it appears that the cost data have been collected retrospectively from the same patient sample as that used in the effectiveness analysis.

Study sample
The effectiveness data reported in the article came from the UK CISG study (2004). A cohort of 316 severely to profoundly hearing-impaired postlingually deafened patients were included in the study. Five patients were excluded from the initial sample. The 311 individuals (mean age 50.8 years; 51% females) who remained in the study were classified as TCs if they scored zero on the BKB Sentence List when each ear was aided acoustically (n=227). The group of TCs was subdivided into "nonbenefitting TCs" (TC-I) and "benefitting TCs" (TC-II). The scores of TC-I (n=134) on the CUNY Sentence List did not improve significantly when lipreading was supplemented by acoustical
aiding, whereas the scores of TC-II (n=93) did improve significantly. Individuals were classified as MHU if they score above zero on the BKB Sentence Test when either or both ears were aided acoustically (n=84). The group of MHUs was subdivided into "nonscoring NHUs" (MHU-I; n=53) and "scoring NHUs" (MHU-IIs; n=31).

**Study design**
This was a prospective cohort study that was carried out in 13 hospitals. The patients were followed from a time before implantation until 9 months after implantation. Medical or surgical adverse events that occurred within 12 months of implantation were documented. Further information is available in the UK CISG study (2004).

**Analysis of effectiveness**
All of the patients entered in the study were included in the analysis. The outcomes were estimated for non-believers. The health outcomes assessed in the UK CISG study (2004) were:

- average hearing level, which was measured at 0.5, 1, 2 and 4 kHz before implantation;
- speech intelligibility, which was measured with an audiovisual recording of the CUNY Sentence List and with an audio recording of the BKB Sentence List; and
- self-rating of hearing, for which participants were asked to draw a graph describing their recollection of the evolution of their hearing loss in each ear.

The participants in the TC-II and MHU groups were younger than those in the TC-I group and contained proportionally more women. It was not reported whether any adjustments were made for confounding factors. Further information is available in the UK CISG study (2004).

**Effectiveness results**
Only the health utilities were reported in this article. Further details about effectiveness results are available in the UK CISG study (2004).

**Clinical conclusions**
The majority of the participants displayed an increase in utility after the cochlear implantation. The increases were higher for TCs than for MHUs.

**Modelling**
A decision tree model was used to estimate the cost of treating medical or surgical complications.

**Measure of benefits used in the economic analysis**
The summary measure of health benefit was the quality-adjusted life-years (QALYs) gained. The number of QALYs gained was calculated according to the life expectancy and the utilities displayed by each participant. The utilities were measured using the Mark Health Utilities Index 3 (HUI3). The HUI3 questionnaire was completed before implantation and at 3 and 9 months after implantation. It was assumed that utility changes linearly over the first 3 months after cochlear implantation from the preoperative value to the value measured at 3 months; utility changes linearly over the next 6 months; thereafter, utility remains constant at the value measured at 9 months. The QALYs were discounted at a rate of 6%.

**Direct costs**
Future costs were discounted at a rate of 6%. Some items of resource use were reported separately from the costs. Five domains of costs were considered at analysis. Domains 1 and 2 were related to the costs of management with acoustic
hearing aids. Domain 3 was the core costs of cochlear implantation, which were measured using data from five hospitals. It included the costs of salaries of staff, salary overheads, accommodation of the cochlear implantation programme, incidental running costs of the cochlear implantation programme, capital equipment, radiology, surgery, costs of 72 hours inpatient stay, implant hardware, replacement parts for implant hardware, and processor upgrades. Domain 4 included the costs of managing medical or surgical complications. Adverse events that required patients to be readmitted to the hospital during the first year after implantation were included. Domain 5 covered the costs of replacing electrode arrays.

The sources of the costs were appropriately reported. The cost estimation was based on actual data from five hospitals, on the literature and on some assumptions. The price year was 2001/2002. The Hospital and Community Health Service Pay and Prices Index was used to inflate the costs.

Statistical analysis of costs
The mean costs and 95% confidence intervals (CIs) were reported.

Indirect Costs
The indirect costs were not included.

Currency
UK pounds sterling (€). These were converted to Euros (Euro) at a conversion rate of 1 = Euro 1.54. On December 31, 2002, Euro 1 = 1.03 US dollars ($).

Sensitivity analysis
A univariate sensitivity analysis was performed. The parameter varied included the discount rate, the number of years of implant use, the core costs of management, the costs of providing acoustic hearing aids, the costs of replacing implanted devices that fail, and the costs of treating medical or surgical complications. The lower and higher values of the 95% CI were used in the sensitivity analysis, when available.

Estimated benefits used in the economic analysis
The mean discounted number of QALYs gained with cochlear implantation were:

- for the entire cohort, 2.46 (95% CI: 2.19 - 2.73);
- for the entire group of TCs, 2.64 (95% CI: 2.32 - 2.95);
- for TC-I, 2.75 (95% CI: 2.35 - 3.16);
- for TC-II, 2.49 (95% CI: 2.04 - 2.95);
- for the entire group of MHUs, 1.99 (95% CI: 1.47 - 2.51);
- for MHU-I, 1.73 (95% CI: 1.04 - 2.42); and
- for MHU-II, 2.44 (95% CI: 1.80 - 3.10).

Cost results
The mean incremental cost per person of providing cochlear implantation was:

- for the entire cohort, Euro 67,017 (95% CI: 66,247 - 67,829);
for the entire group of TCs, Euro 67,076 (95% CI: 66,134 - 68,037);
for TC-I, Euro 66,808 (95% CI: 65,524 - 68,300);
for TC-II, Euro 67,439 (95% CI: 66,050 - 68,950);
for the entire group of MHUs, Euro 66,854 (95% CI: 65,633 - 68,173);
for MHU-I, Euro 67,266 (95% CI: 65,688 - 69,063); and
for MHU-II, Euro 66,206 (95% CI: 64,330 - 68,071).

**Synthesis of costs and benefits**

The net monetary benefit technique was used to estimate the cost-utility ratios. A benchmark of Euro 50,000/QALY was used because this was the upper limit usually used in the UK.

The mean cost/QALY ratios were:

for the entire cohort, Euro 27,142 (95% CI: 24,532 - 30,323);
for the entire group of TCs, Euro 25,336 (95% CI: 22,720 - 28,647);
for TC-I, Euro 24,032 (95% CI: 21,052 - 28,209);
for TC-II, Euro 27,062 (95% CI: 22,772 - 32,852);
for the entire group of MHUs, Euro 33,512 (95% CI: 26,697 - 44,449);
for MHU-I, Euro 39,009 (95% CI: 27,474 - 64,471); and
for MHU-II, Euro 27,092 (95% CI: 21,519 - 37,807).

The percentage of members of groups with individual cost-utility ratios below Euro 50,000/QALY varied from 57% in the MHU-I group to 70% in the TC-I group. The percentage for the entire cohort of patients was 67%.

The sensitivity analysis showed that the results for the entire cohort were not sensitive to the choice of discount rate, the core management costs, or to the duration of implant use.

The analysis performed to test the effects of age and duration of profound deafness showed that the efficiency of cochlear implantation is questionable when patients who already benefit from acoustic hearing aids receive implants in ears that have been profoundly deaf for more than 30 years. The cost-utility of cochlear implantation declined with age. However, the cost-utility was acceptable for each age group, including the oldest group (70 to 82 years at time of implantation).

**Authors’ conclusions**

Overall, cochlear implantation was an acceptably cost-effective intervention according to UK criteria (Euro 50,000 per quality-adjusted life-year). Cost-effectiveness declined with age. However, the cost-utility was within the acceptable range, even for the oldest group (70 to 82 years at time of implantation). The relaxation of criteria for candidacy was associated with a reduction in cost-effectiveness. Nevertheless, cochlear implantation was cost-effective for the majority of candidates. Cochlear implantation was neither effective in improving health utility, nor cost-effective for the groups of patients who obtained benefit from acoustic hearing aids but who received implants in ears that have been profoundly deaf for more than 30 years. Therefore, the duration of profound deafness in the ear to be given an implant should be considered when setting criteria for candidacy for cochlear implantation.
CRD COMMENTARY - Selection of comparators
"No intervention" and treatment with acoustic hearing aids were chosen as comparators because these were the health technologies available for this type of patients. You should decide if these comparators are relevant to your own setting.

Validity of estimate of measure of effectiveness
The estimation of effectiveness was based on a prospective cohort study, which seems appropriate for the study question. Although not all of the information about the effectiveness analyses was available in the article, it would appear that the validity of health utilities estimations were high since a validated questionnaire was used. No further judgements can be made about the internal validity of the effectiveness results.

Validity of estimate of measure of benefit
The health benefit measure used in the economic evaluation was the QALYs. This is a standard measure that permits comparisons with other studies. The QALYs were discounted and were derived from data from the clinical trial. It appears that the QALYs have been estimated under the assumption that the health-utilities would remain stable during subsequent years after implantation. Note: since this abstract was written, the authors have pointed out to us that, whilst the QALYs were estimated on the assumption that the gain in health-utility associated with implantation is stable, the absolute values of health utility could change.

Validity of estimate of costs
It seems that all the costs relevant to the perspective adopted in the study have been included. The price year was reported. The sources of the costs were reported and the costs were appropriately discounted. Most of the cost variables were considered in the sensitivity analysis. All these features enhance the validity of the cost analysis. However, not all the quantities of resources were reported separately from the costs. This may limit the possibility of reproducing the calculations in other settings.

Other issues
The authors compared their findings with those of other studies and found similar results. The issue of generalisability was addressed, with the authors stating that the rank ordering of groups by cost-effectiveness was likely to be generalisable to other health systems. Comprehensive methodology issues on cost-effectiveness were reported in this article.

Implications of the study
Although the relaxation of criteria for candidacy is associated with a reduction in cost-effectiveness, overall, cochlear implantation is a cost-effective intervention according to UK criteria. The duration of profound deafness in the ear to be given an implant should be considered when setting criteria for candidacy for cochlear implantation.

Source of funding
The clinical costs of this study were met by the UK NHS, while the research costs were met by the Medical Research Council (UK).

Bibliographic details

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Other publications of related interest


**Indexing Status**
Subject indexing assigned by NLM

**MeSH**
Adolescent; Adult; Age Factors; Aged; Aged, 80 and over; Cochlear Implantation /economics /utilization; Cohort Studies; Cost-Benefit Analysis; Deafness /economics /surgery; Female; Great Britain; Health Care Costs; Hearing Aids /economics /standards; Humans; Life Expectancy; Male; Middle Aged; Patient Selection; Postoperative Complications /economics; Prospective Studies; Quality-Adjusted Life Years; Reoperation /economics; Time Factors; Treatment Outcome

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