Costs and cost-effectiveness of routine transesophageal echocardiography in congenital heart surgery

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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
Use of transesophageal echocardiography (TEE) as a diagnostic modality during congenital heart surgery.

Type of intervention
Diagnosis.

Economic study type
Cost-effectiveness analysis.

Study population
Pediatric patients undergoing complex elective open heart surgery.

Setting
The setting was secondary care. The economic study was carried out at the University Hospitals of Cleveland, USA.

Dates to which data relate
Effectiveness data related to the years 1993 to 1995. Costs data related to the years 1993 to 1995. The price year was 1996.

Source of effectiveness data
The evidence for final outcomes was derived from a single study.

Link between effectiveness and cost data
The costing was undertaken prospectively on the same patient sample as that used in the effectiveness study.

Study sample
63 pediatric patients undergoing complex elective open-heart surgery during 1995 to 1996 with routine use of TEE were retrospectively identified. The control group consisted of 63 matched control subjects from the group of patients undergoing elective surgery in the period immediately before routine TEE use (during the years 1993 to 1995). Patients were matched with a control subject with an identical intensive care unit length of stay. Whenever possible patients were also matched for surgical procedure, and 60% of patients were exactly matched in the analysis. Patients were excluded if no matched control subject with an appropriate length of stay was available.

A separate analysis was conducted on 16 patients who underwent simple bypass procedures with the use of intraoperative TEE. Matching patients were chosen in the same way as for the main analysis. These patients were
excluded from the main analysis because TEE was not routinely used on these patients unless a specific presurgical indication existed, or a managing surgeon requested it.

The mean age of patients was 3.5 years (range: 3 months to 16 years) and mean weight was 13.2 kg (range: 3.5 - 48 kg). A separate analysis was performed for patients undergoing simple bypass procedures (mean age 4.8 years).

**Study design**

The study design was a retrospective case-control study, in which cases were those who had undergone TEE and controls had undergone the usual procedure before the introduction of routine TEE. The study was a carried out in a single centre. The duration of follow-up was the operative period and the intensive care unit (ICU) length of stay.

**Analysis of effectiveness**

The primary health outcomes used in the analysis were the total number of echocardiographic studies per patient during operative period and ICU stay. Groups undergoing complex surgery were shown to be comparable in age and size. Patients were comparable on ICU length of stay since the groups were matched on this variable. The ICU length of stay was used as the period of study in order to avoid the effects of confounding clinical events unrelated to operative results. In addition, all initial transthoracic echocardiographic reports for control patients who had undergone complex repair without TEE were reviewed to determine the percentage that were deemed to be of limited quality. Cases that had undergone TEE were also reviewed to determine whether new information provided by TEE during the operation had any impact on altering surgical management, and to determine whether any complications arose from use of TEE. Differences between the two modalities in terms of recorded time (duration of recording of information during the study) and elapsed time (total duration of the study) were also documented.

**Effectiveness results**

For complex patients, the average total number of echocardiographic studies was 1.44 per TEE patient and 1.64 per control group patient. The difference was not statistically significant, (p=0.09). For patients undergoing a simple bypass procedure, the average total number of echocardiographic studies was 1.43 per TEE patient and 1.06 per control group patient. The difference was not statistically significant, (p=0.25). Review of initial postoperative transthoracic studies (TTE) indicated that 40% were suboptimal because of poor imaging or inability to access areas of surgical importance. The analysis also found that an alteration in surgical approach occurred in roughly 3% of patients on the basis of new TEE findings. There were two complications in cases using TEE, and, in both cases, surgery was completed with removal of the probe. The average ratio of recorded time to elapsed time was 0.76 for TEE studies and 0.52 for TTE studies. This suggests that information deemed adequate for recording was more readily obtainable in the TEE group.

**Clinical conclusions**

The study suggested that the use of TEE could result in improved surgical outcomes due to new information available during the operation with the use of TEE, although this occurred in only 3% of patients in the study. For patients undergoing simple bypass surgery there was a higher average total number of echocardiographic studies in the TEE group.

**Measure of benefits used in the economic analysis**

The outcome measure used in the economic analysis was the average total number of echocardiographic studies per patient during the operation and the ICU stay.

**Direct costs**

Direct costs were not discounted as they were incurred over a short period of time (less than one year). Resource use was reported in terms of the number of echocardiographic studies per patient and the average length of study by type. Direct costs were reported for echocardiographic studies. Direct costs were counted for the aggregated operative and ICU periods. The quantity/cost boundary adopted was that of the hospital, although only the costs of performing the
Echocardiographic study were included. Other hospitals costs, such as cost of operation and cost of ICU stay, were omitted.

Echocardiographic costs included all labour, materials, overheads and equipment including depreciation, as determined by the cost accounting centre at University Hospitals of Cleveland. Physician and technician costs were pro-rated according to the average study length for TEE or control groups. To determine differences in physician and technician costs, the average length of the last 20 TEE studies was compared with 20 initial postoperative transthoracic echocardiographic studies carried out in the period before TEE use. Quantities and costs were measured from 1993 to 1996. The price date was 1996.

Statistical analysis of costs
No statistical analysis of costs was performed.

Indirect Costs
Indirect costs were not included in the analysis.

Currency
US dollars ($).

Sensitivity analysis
No sensitivity analysis was performed.

Estimated benefits used in the economic analysis
For complex patients, the average total number of echocardiographic studies was 1.44 per TEE patient and 1.64 per control group patient. The difference was not statistically significant, \( p=0.09 \). For patients undergoing a simple bypass procedure, the average total number of echocardiographic studies was 1.43 per TEE patient and 1.06 per control group patient. The difference was not statistically significant, \( p=0.25 \). Two complications were reported when the TEE method was used but they were deemed to be rare and self-limited. No complications were reported in the TTE group.

Cost results
The average total costs of echocardiographic studies per patient undergoing complex repair were $376 in the TEE group and $343 in the control group. In the simple bypass procedure analysis, the average total costs of echocardiographic studies per patient were $377 in the TEE group and $219 in the control group. It was reported that, overall, the differences in costs between TEE and TTE were not significant.

Synthesis of costs and benefits
A synthesis of costs and benefits was not performed, as TEE was the weakly dominant strategy.

Authors' conclusions
Routine TEE, in the setting of complex repair, resulted in no significant increase in echocardiographic costs. This suggests that the superior information provided may reduce the need for additional postoperative studies in the intensive care setting. The analysis for patients undergoing simple bypass procedures suggested higher echocardiographic costs.

CRD COMMENTARY - Selection of comparators
The selection of the comparator was justified as it represented usual practice before the routine use of TEE in the operative setting. One issue that could be problematic is that, to determine differences in professional and technician
costs, the average length of 20 initial postoperative TEE studies carried out in the period before 1995 was used. This may not have taken into account improvements in the TTE technique in the following years, thereby making this technique appear less effective. Care should therefore be taken in applying the study results to different settings.

Validity of estimate of measure of benefit
Retrospective case-controlled studies are prone to bias and confounding. The TEE group and the control group consisted of patients who were treated at different time periods with the potential for confounding factors to be present. In addition, the authors were not blinded to the outcomes, which is another source of potential bias. However, the authors did take care to match patients for ICU stay and for the type of intervention, as well as only considering patients who were undergoing elective surgery in order to take into account some potential confounding factors.

Validity of estimate of costs
The costs included in the study were limited, only taking into account the cost of echocardiographic studies and no other costs incurred by the hospital. This was justified in that the economic analysis was a cost-minimisation analysis. However, a cost-effectiveness analysis, including an assessment of health outcomes, would have had to include other costs such as operative costs and ICU stay. No sensitivity analysis was conducted on the resource and cost estimates. This would have been useful for settings with different technician and physician involvement in the procedures.

Other issues
This was a cost-minimisation study. The sample size was relatively small for complex repair patients and small for simple bypass procedure patients. This suggests the need for care when generalising the results. The authors reported that, to their knowledge, no other study had been conducted on the use of routine operative TEE in the pediatric setting, although their method for searching the literature was not documented in the article.

Implications of the study
The authors suggested that further research was required to determine the cost-effectiveness of TEE for patients undergoing simple bypass procedures. A cost-effectiveness study of the use of routine TEE in complex repair in pediatric patients would build on the results of this study.

Source of funding
None stated.

Bibliographic details

PubMedID
10502226

Other publications of related interest

Indexing Status
Subject indexing assigned by NLM

MeSH
Case-Control Studies; Child, Preschool; Cost-Benefit Analysis; Costs and Cost Analysis; Echocardiography, Transesophageal /economics /utilization; Heart Defects, Congenital /economics /surgery /ultrasonography; Humans;
Intraoperative Care /economics; Retrospective Studies; Time Factors

AccessionNumber
21999001919

Date bibliographic record published
31/03/2001

Date abstract record published
31/03/2001