Clinical utility and cost-effectiveness of interactive image-guided craniotomy: clinical comparison between conventional and image-guided meningioma surgery

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 health intervention examined in the study was image-guided craniotomy (IGC) for the treatment of meningiomas. The system included a powerful workstation, incorporating advanced software, a high-resolution colour monitor, and a keyboard, in a mobile housing. The use of IGC was characterised by accurate, small, minimally invasive openings, and subcortical lesions could be directly localised.

Type of intervention
Treatment.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised patients requiring surgical treatment for intracranial meningioma. Further inclusion/exclusion criteria were not reported.

Setting
The setting of the study was hospital. The economic study was carried out at the National Hospital for Neurology and Neurosurgery, London, UK.

Dates to which data relate
The dates during which data about effectiveness and use of resources were gathered were not reported. The price year was not specified.

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

Link between effectiveness and cost data
The costing was undertaken on the same patient sample as that used in the effectiveness analysis. It was conducted retrospectively for patients who underwent SS and prospectively for those who underwent IGS.

Study sample
Power calculations were not performed to determine the sample size. During the study period, 170 consecutive patients were treated with SS and 100 consecutive patients with IGS. Fifty IGC cases (60% female, mean age: 52.46 years, age range: 29 - 77 years) were statistically matched with 50 SS cases (60% female, mean age: 53.18 years, age range: 31 -
78 years) in terms of demographic and clinical data.

**Study design**
This was a case-control study in which patients in the SS group were selected retrospectively, whereas patients in the IGC group were selected prospectively (after the introduction of the new imaging technique at the authors’ institution). The study was carried out in a single centre, the National Hospital for Neurology and Neurosurgery. The length of follow-up was not clearly reported, but it appears that patients were followed for more than 30 days to assess the occurrence of severe complications. Loss to follow-up was not reported. No blinding assessment method was used.

**Analysis of effectiveness**
It appears that all patients included in the study were accounted for in the analysis (in effect, treatment completers only). The primary health outcomes were surgical time, operating time, blood loss, blood transfusion, number of patients in intensive therapy unit (ITU), minor (resolved within 30 days without any further surgery) and major (permanent or requiring further surgical procedures) complications (such as haematoma, swelling/edema, new neurological deficits, new seizures, infection, poor bone flap siting, deep vein thrombosis, and pulmonary embolism), and overall hospital stay. Study groups were deliberately well matched and were therefore similar in terms of age, sex, neurological and functional performance, and size and location of the tumours.

**Effectiveness results**
The effectiveness results were as follows:

- Average surgical time was 3.4 hours (range: 1.25 - 5.5 hours) in the SS group and 2.9 hours (range: 0.66 - 7.75 hours) in the IGS group, (p=0.02).

- Average operating time was 4 hours (range: 1.5 - 6 hours) in the SS group and 3.8 hours (range: 1.2 - 6 hours) in the IGS group, (p=0.12).

- Blood loss and blood unit did not differ between groups (780 ml and 1.7 versus 660 ml and 1.4), but cases of blood transfusion were significantly more numerous in the SS group (29 versus 21, p=0.02).

- The number of patients in ITU was 44 in the SS group and 43 in the IGS group, (p=0.27).

- There were 5 minor complications and 8 major complications in the SS group and 5 minor complications and 5 major complications in the IGS group.

- Overall hospital stay (in ward and ITU) was significantly longer in the SS group than in the IGS group (13.5 days versus 8.5 days, p=0.02) and this difference was due to the high rate of complications in the SS group.

**Clinical conclusions**
The IGS technique appeared to be more effective than SS in terms of some of the outcome measures used in the effectiveness analysis.

**Measure of benefits used in the economic analysis**
No summary benefit measure was used and health outcomes were left disaggregated, therefore a cost-consequence analysis was conducted.

**Direct costs**
Discounting was not relevant due to the short time frame of the analysis. Unit costs and quantities of resources used were not reported. The cost/resource boundary adopted in the study was not clearly reported, but appears to have reflected that of the hospital. The health service costs included in the analysis were costs (per 24-hour period) of in-
patient stays in the ordinary neurosurgical wards and in the ITU, costs of each operation, and costs of additional IGS equipment. Pharmacy and laboratory costs were not included in the analysis. The estimation of costs and quantities of resources was based on actual data, obtained from the hospital managers (costs) and patient database (quantities). The dates during which the resources used in the study were gathered and the price year were not reported.

Statistical analysis of costs
No statistical analyses of costs were conducted.

Indirect Costs
Indirect costs were not included in the analysis.

Currency
UK pounds sterling (£). Costs were also reported in US dollars ($).

Sensitivity analysis
Sensitivity analyses were not carried out.

Estimated benefits used in the economic analysis
See effectiveness results above.

Cost results
The mean total cost was 10,850 ($17,360) in the SS group and 9,050 ($14,480) in the IGS group. Overall, the cost in the IGS group was about 20% less than the cost in the SS group.

Synthesis of costs and benefits
Not relevant.

Authors' conclusions
The authors concluded that IGS was a safe technique for the treatment of meningiomas. It was associated with lower costs than SS and shorter hospital stay due to the lower rate of postoperative complications. Although equipment costs were particularly high for IGS, mean savings per case at the authors' institution suggested that 80 to 1,200 image-guided craniotomies would be necessary to recoup the cost of the equipment.

CRD COMMENTARY - Selection of comparators
The rationale for the choice of the comparator was clear. Standard surgery was selected because it represented the routine treatment before the introduction of interactive image guidance. You, as a user of this database, should assess whether standard surgery represents a widely used intervention in your own setting.

Validity of estimate of measure of effectiveness
The analysis of the effectiveness was based on a case-control study, which appeared appropriate to the study question. Patients in the SS group were selected retrospectively and patients in the IGS group were selected prospectively. The dates during which the effectiveness evidence was gathered were not reported. The main limits to the internal validity of the analysis were the lack of randomisation in the allocation of patients to the study groups (although groups appear to have been well matched) and the fact that power calculations were not conducted to determine the sample size.
Validity of estimate of measure of benefit
No summary benefit measure was used. It would have been helpful to have adopted a final benefit measure, reflecting the impact of the interventions on patients’ health, rather than using several health outcomes which are more likely to represent resource consumption rather than pure health benefits. However, in cost-consequences analyses, at the clinical level, the outcomes of interest are usually disaggregated and appropriate for the decision-maker.

Validity of estimate of costs
Few details of the cost items included in the study were reported, although the perspective of the study was clearly stated. Unit costs and quantities of resources used were not reported separately. The price year and the period of resource collection were not specified. Costs were treated deterministically. The estimation of costs appears to be quite specific to the study setting. These features of the cost analysis tend to limit the generalisability of the results to other settings.

Other issues
The authors made some comparisons of their findings with those from other studies. The issue of the generalisability of the study results to other settings was not addressed and sensitivity analyses were not conducted on costs and effectiveness data. As a result, the external validity of the analysis is rather low.

Implications of the study
The authors highlight the advantages of IGS in terms of greater safety and enhanced confidence of surgeons. Further research should be based on larger, randomised clinical trials to best support the cost-effectiveness of IGS techniques.

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