EEG bispectral index monitoring in sevoflurane or propofol anaesthesia: analysis of direct costs and immediate recovery
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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
The use of electroencephalogram (EEG) bispectral index (BIS) monitoring, with the aim of optimising the use of hypnotics, analgesics, neuromuscular blocking agents, and antihypertensive drugs during anaesthesia.

Type of intervention
Other: anaesthesia monitoring.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised patients undergoing gynaecological surgery. The patients were aged between 18 and 75 years. The exclusion criteria were a history of neurologic disease, medication affecting the central nervous system, and alcohol or drug abuse.

Setting
The setting was a hospital. The economic study was carried out at the Department of Obstetrics and Gynaecology, Helsinki University Central Hospital, Helsinki, Finland.

Dates to which data relate
The dates during which the effectiveness and resource use data were gathered were not reported. The price year was 1998.

Source of effectiveness data
The effectiveness evidence 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 analysis.

Study sample
Power calculations were not carried out to determine the sample size. The study comprised 80 patients who were scheduled for gynaecological surgery that was expected to last more than 30 minutes. The patients were first divided into two groups of 40. In the first group, the patients were monitored with EEG BIS, whilst in the second group they were not. Each group was then subdivided into a further two groups of 20 patients, defined by the anaesthetic drug used (propofol or sevoflurane).
Study design
This was a case-control study (monitoring versus no monitoring) with a before-and-after design. The two different anaesthetics (propofol or sevoflurane) were compared in each group of patients. The data relating to the control group (no monitoring) were collected before the introduction of EEG BIS. The study was carried out in a single centre. The patients were followed only during the recovery time, which was measured using several parameters (spontaneous breathing, eye opening, extubation, and orientation). The same research coordinator, who was not involved in treating the patients, evaluated the recovery parameters.

Analysis of effectiveness
It was not reported whether the effectiveness analysis was conducted on an intention to treat basis or on treatment completers only. It appears that all the patients included in the study were accounted for in the analysis. The primary health outcome used in the analysis was recovery time. This was measured through four parameters and was presented as the average time elapsed after discontinuing the anaesthetics. The authors stated that the groups did not differ in terms of their demographic data or duration of anaesthesia.

Effectiveness results
In terms of spontaneous breathing, the median recovery time was:

for patients with propofol, 1.5 minutes (range: 0.33 - 5.5) with EEG and 3.0 minutes (range: 0 - 10.25) without EEG;
for patients with sevoflurane, 2.0 minutes (range: 0 - 8.5) with EEG and 3.5 minutes (range: 0 - 10.0) without EEG.

With respect to extubation, the median recovery time was:

for patients with propofol, 2.75 minutes (range: 1.0 - 8.0) with EEG and 7.0 minutes (range: 2.0 - 14.75) without EEG;
for patients with sevoflurane, 3.0 minutes (range: 1.33 - 13.0) with EEG and 4.0 minutes (range: 1.0 - 13.0) without EEG.

In terms of eye opening, the median recovery time was:

for patients with propofol, 3.0 minutes (range: 1.0 - 8.0) with EEG and 9.125 minutes (range: 2.0 - 22.0) without EEG;
for patients with sevoflurane, 3.42 minutes (range: 1.0 - 13.0) with EEG and 6.63 minutes (range: 1.0 - 13.0) without EEG.

In terms of orientation, the median recovery time was:

for patients with propofol, 6.0 minutes (range: 2.0 - 15.0) with EEG and 14.0 minutes (range: 5.0 - 52.0) without EEG;
for patients with sevoflurane, 6.5 minutes (range: 3.0 - 63.0) with EEG and 9.5 minutes (range: 2.0 - 19.0) without EEG.

Monitoring significantly reduced the recovery time in the group of patients anaesthetised with propofol. In the case of sevoflurane, the recovery time was lower for patients that were monitored than those that were not monitored, but the difference did not reach statistical significance.

Clinical conclusions
The effectiveness analysis has shown that EEG BIS monitoring significantly reduced recovery time, but only in the propofol group.
Measure of benefits used in the economic analysis
No summary benefit measure was adopted. A cost-consequence analysis was therefore carried out.

Direct costs
Discounting was irrelevant due to the short time horizon of the study. The resource/cost boundary was that of the hospital. The analysis included the costs of the drugs (propofol, sevoflurane, fentanyl, and rocuronium), EEG electrodes, and monitor amortisation per patient. The cost of propofol used for anaesthetic induction was not included in the analysis. The costs and the quantities were estimated from actual data that was obtained from the hospital. The dates during which the resources were measured were not reported. The price year was 1998.

Statistical analysis of costs
No statistical analysis of the costs was carried out.

Indirect Costs
The indirect costs were not included.

Currency
Finnish ECU.

Sensitivity analysis
No sensitivity analysis was carried out.

Estimated benefits used in the economic analysis
See the 'Effectiveness Results' section.

Cost results
All the drug costs were presented as ECUs/minute.

The total drug costs/minute were:
ECU 0.22935 in the propofol group without EEG (ECU 0.11619 for propofol, ECU 0.02373 for fentanyl, and ECU 0.08934 for rocuronium);
ECU 0.20661 in the propofol group with EEG (ECU 0.08746 for propofol, ECU 0.03382 for fentanyl, and ECU 0.08532 for rocuronium);
ECU 0.25424 in the sevoflurane group without EEG (ECU 0.12418 for sevoflurane, ECU 0.03902 for fentanyl, and ECU 0.09104 for rocuronium); and
ECU 0.19744 in the sevoflurane group with EEG (ECU 0.07749 for sevoflurane, ECU 0.03511 for fentanyl, and ECU 0.08483 for rocuronium).

The cost of the EEG electrodes was ECU 13.10023 per patient.

The price of the monitor was ECU 17,500. The monitor amortisation (6,000 registrations over a monitor's life time) was equal to ECU 2.91375 per patient.

The theoretical break-even time was 704 minutes for propofol and 282 for sevoflurane, but neither of these was reached in the study.
Synthesis of costs and benefits
Not applicable.

Authors’ conclusions
Electroencephalogram (EEG) bispectral index (BIS) monitoring was effective in reducing immediate recovery in patients anaesthetised with propofol. It also reduced resource consumption in patients treated with propofol or sevoflurane. However, the direct costs increased, mainly due to the high acquisition prices of the special EEG electrodes.

CRD COMMENTARY - Selection of comparators
The reason for the selection of the comparators was clear. Monitoring was compared to no monitoring because it represented the routine procedure before the introduction of the EEG instrumentation. Two anaesthetic drugs were also compared as they were commonly used for surgery. You should decide whether the interventions represent widely used technologies in your own setting.

Validity of estimate of measure of effectiveness
The effectiveness evidence was derived from a case-control study. This appears to have been appropriate to the study question, although the before-and-after approach is associated with potential bias and confounding variables. To avoid "learning contamination bias", the data for the control group (no monitoring) were collected before the introduction of EEG BIS. In addition, the subgroup analyses for propofol and sevoflurane allowed a deeper investigation of the possible effect of specific anaesthetics on the results. Although no randomisation was used in the study design, the comparability of the groups in terms of their demographics was assessed at baseline.

Validity of estimate of measure of benefit
No summary benefit measure was used in the economic analysis. A cost-consequences analysis was therefore conducted.

Validity of estimate of costs
The perspective from which the study was conducted was not explicitly reported, but it appears to have been that of the hospital. Therefore, all the actual costs relevant to the authors’ institution were included in the analysis. It was unclear whether the estimated cost represented the true costs or the charges paid by the hospital considered in the study. The cost estimations appear to have been quite specific to the study setting. The authors admitted that the costs may differ between hospitals and countries. Further, the use of other anaesthetics could have dramatically changed the cost analysis. Statistical analyses of the costs and the quantities were not conducted. The dates during which the resources were measured were not reported. These features tended to limit the generalisability of the cost results.

Other issues
The authors made few comparisons of their results with those from other studies. In addition, they did not address the issue of generalisability of the study's findings to other settings. Sensitivity analyses were not conducted.

Implications of the study
The findings suggested that EEG BIS monitoring was beneficial during anaesthetic administration. It should be used to ensure adequate anaesthetic depth.

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