Impact of a neuroscience intensive care unit on neurosurgical patient outcomes and cost of care: evidence-based support for an intensivist-directed specialty ICU model of care

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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 a neuroscience intensive care unit (NSICU) in the treatment of critically ill neuroscience patients. The NSICU provided patient treatment comparable with that delivered in other ICU areas, but a team of physicians and nurses specifically trained for neuroscience critical care provided the care.

Type of intervention
Patient care management.

Economic study type
Cost-effectiveness analysis.

Study population
The study population consisted of patients with a diagnosis of non-traumatic intracranial haemorrhage (ICH), corresponding to the Adjacent-Disease Related Group (A-DRG)/ICD-9 code 431. This comprised both patients treated medically (A-DRG 014) and those undergoing surgical evacuation (A-DRG 001 or 002). The diagnosis included bleeding into the cerebellum, brainstem or cerebrum, but did not include extracerebral haemorrhage (e.g. subarachnoid haemorrhage) or haemorrhage resulting from trauma.

Setting
The setting was tertiary care. The economic study was carried out at the Queen's Medical Center (QMC) in Honolulu, USA.

Dates to which data relate
The effectiveness and resource use data were gathered in 1995 and 1997. The price year was 1997.

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

Link between effectiveness and cost data
For the intervention group, the costing was carried out retrospectively on the same sample of patients as that used in the effectiveness study. However, for the control group, the costing was conducted on a different sample of patients.

Study sample
Power calculations to determine the sample size were not reported. Patient charts were extracted from the QMC database for the fiscal years 1995 (control group) and 1997 (intervention group), as the NSICU service started in 1996.
There were 60 cases in the control group and 102 in the intervention group, regardless of admission area. However, the analysis focused on the group of ICH patients admitted to an ICU. There were 50 patients in the control group and 78 in the intervention group. In the control group, the mean age was 62.8 (+/- 9.8) years, 27 patients were men, and the Glasgow Coma Scale (GCS) score at admission was 11.9 (+/- 0.6). In the intervention group, the mean age was 65.7 (9+/- 10.3) years, 36 patients were men, and the GCS score at admission was 10.8 (+/- 0.4). There were 44 medical and 6 surgical patients in the control group, compared with 53 medical and 25 surgical patients in the intervention group.

**Study design**
This was a retrospective cohort study that was carried out in a single centre. The chart review showed a 4% error rate in the ICD-9 classification and misclassified charts were excluded from the analysis. The authors stated that, with the exception of the introduction of the NSICU, no other substantial changes were made from the standard ICU model. The patients were followed until discharge from the NSICU. The outcome assessment was not blinded.

**Analysis of effectiveness**
All of the patients included in the initial study sample were considered in the effectiveness study. The health outcomes used were:

- the mortality rate;
- the proportion of patients having a good overall outcome, defined by discharge to their home or a rehabilitation facility;
- the hospital length of stay (LOS);
- the incidence of invasive procedures; and
- the number of consultations per patient (after excluding routine consultations).

The two groups were comparable at baseline in terms of age, GCS score on admission, co-morbidity, location and size of the cerebral haemorrhage, and risk factors. In the sub-groups of medical versus surgical patients, the latter (surgical patients) were slightly younger with a lower GCS score, although the differences were not statistically significant. Most of the outcome measures were explored in other sub-groups, but these were too small to lead to significant results.

**Effectiveness results**
The mortality rate was 36% in the control group versus 19% in the intervention group, (p<0.05). The proportions of patients having a good overall outcome were 48% (control) and 69% (intervention), respectively, (p<0.05). The LOS decreased in the intervention group, (p non significant).

There was also an increase in the incidence of invasive procedures in the intervention group:

- 24% versus 35% of the patients were mechanically ventilated;
- intraventricular cerebrospinal fluid drainage catheters were placed in 12% versus 23% of the patients;
- emergent craniotomy for haematoma evacuation was undertaken in 18% versus 32% of the patients.

When medical patients were compared with surgical patients, overall mortality was 12% in the surgical group versus 22.6% in the medical group, (p non significant). The proportions of patients having a good overall outcome were 72% (surgery) and 47.2% (medical), respectively, (p non significant).

The number of consultations per patient was 0.4 (+/- 0.5) in the NSICU and between 2.8 (+/- 1.1) and 3.4 (+/- 0.7) in other ICUs.
Clinical conclusions
The effectiveness study showed that patients treated in the NSICU showed lower mortality rates and better disposition after hospitalisation than those treated in standard ICUs.

Measure of benefits used in the economic analysis
The health outcomes were left disaggregated and no summary benefit measure was used in the economic evaluation. A cost-consequences analysis was therefore carried out.

Direct costs
Discounting was not relevant since the costs per patient were incurred during a short time. The unit costs and the quantities of resources used were not analysed separately. The health services in the economic evaluation referred to ICU resources associated with the most common neurological admissions. The ICU resources included personnel, hospital stay, imaging, pharmaceuticals and laboratory services. The most common neurological admissions were craniotomy with intracranial haemorrhage or coma (A-DRG 001), craniotomy with no intracranial haemorrhage or coma (A-DRG 002), and skull fracture with or without coma lasting more than 1 hour or with intracerebral haemorrhage (A-DRG 027 and A-DRG 028).

The cost/resource boundary adopted in the study is likely to have been that of the hospital as DRGs were used to derive the costs (not charges). The HBS International database, which provides benchmarking systems and tools to more than 900 hospitals and health care delivery systems across the USA, was used to derive the costs and resource use data for patients who were treated in standard ICUs (control patients). The data referred to a sample of more than 80 institutions, which were comparable with the QMC in terms of size and level of care provided. The resource use and cost data for patients in the intervention group were obtained from a retrospective review of patient charts at the QMC. All the costs were estimated in the fiscal year 1997.

Statistical analysis of costs
Statistical tests were carried out to test the statistical significance of differences in the total costs and total LOS between the two groups.

Indirect Costs
The indirect costs were not included in the economic evaluation.

Currency
US dollars ($).

Sensitivity analysis
Sensitivity analyses were not performed.

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

Cost results
The LOS was:

4.5 (+/- 0.4) days in the intervention group and 6 (+/- 0.5) days in the control group for A-DRG 001 patients;

1.8 (+/- 0.2) days (intervention) and 2.9 (+/- 0.2) days (control), respectively, for A-DRG 002 patients;
1.2 (+/- 0.1) days (intervention) and 2.2 (+/- 0.3) days (control), respectively, for A-DRG 027 patients; and
1.3 (+/- 0.2) days (intervention) and 2 (+/- 0.3) days (control), respectively, for A-DRG 028 patients.

Most of these differences in LOS were statistically significant, and all the reductions ranged from 25 to 45% below the national benchmark. These reductions translated into a significant cost-difference of 28% for A-DRG 001 and 002 patients, and a significant cost-difference of 35% for A-DRG 027 and 028 patients.

In A-DRG 001 patients, the cost-savings exceeded $5,900 per case.

The cost differences were only represented graphically. Cost reductions were observed in most cost components (i.e. ancillary costs for imaging, pharmaceuticals and laboratory services).

**Synthesis of costs and benefits**
The costs and benefits were not combined.

**Authors’ conclusions**
A neuroscience intensive care unit (NSICU) with specialty-trained physicians and nurses led to better clinical outcomes and cost-savings in comparison with the standard ICU.

**CRD COMMENTARY - Selection of comparators**
The rationale for the choice of the comparator was clear. The NSICU was compared with the standard ICU used in the treatment of critically ill neuroscience patients. You should decide whether it represents a valid comparator in your own setting.

**Validity of estimate of measure of effectiveness**
The analysis of effectiveness used a cohort study, although a prospective randomised trial would have been more appropriate. However, the authors stated that while the analysis of a sample with a single common disease led to the use of very strict inclusion criteria, it was perhaps more appropriate than examining a random sample of a wide selection of patient populations. Clearly, the retrospective comparison of patients selected in two different timeframes with a 2-year interval has several drawbacks. First, although selection bias may have been reduced by very strict criteria for chart review and patient selection, the retrospective design implies that the outcomes may not have been assessed comparably in the two groups, thus introducing assessment bias. The authors performed several sub-group analyses to reduce the potential biases introduced in the effectiveness analysis, as well as statistical tests to identify prognostic factors. Some consistency in the results was found, thus ensuring the validity of the analysis. Second, factors other than the study intervention may have had an impact on the estimated outcome because of the 2-year interval. Again, the authors stated that no major changes were introduced at their institution during this timeframe. However, no justification was provided for the size of the sample and power calculations were not carried out. Thus, it was unclear whether the sample size was appropriate to detect statistically significant differences in the main outcome measures. These issues tend to limit the internal validity of the analysis.

**Validity of estimate of measure of benefit**
No summary benefit measure was used in the analysis and a cost-consequences analysis was therefore conducted.

**Validity of estimate of costs**
The perspective adopted in the study was not explicitly stated. It appears to have been that of the hospital (or of the reimbursement authority), as DRGs were used to estimate the true costs of the services delivered. The source of the cost data was accurately described, as an external comparison group was selected from a national database of hospitals. All the costs were presented in 1997 values, thus simplifying reflation exercises in other settings. However, a
breakdown of the cost categories was not provided and the unit costs were not reported. This may have been due to the use of DRGs, although the reason was not given explicitly. The authors considered potential differences in the two groups of patients by presenting the results for sub-groups of diagnosis. This made it possible to highlight the diagnostic areas in which most of the savings were obtained.

Other issues
The authors compared their findings with those from other studies and found similar results, which supported the conclusions of the present study. However, the issue of the generalisability of the study results to other settings was not addressed and sensitivity analyses were not carried out. Consequently, the external validity of the analysis is low. The study focused on critically ill neuroscience patients with specific diagnoses and this was reflected in the authors’ conclusions. Some limitations of the analysis were discussed.

Implications of the study
The study results suggested that specialty care for critically ill patients may provide better outcomes and a reduction in both hospital stay and costs. Further prospective studies should be carried out to corroborate the findings of the present study.

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