Hospital volume is related to clinical and economic outcomes of esophageal resection in Maryland

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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 oesophageal resection (OER), including total and partial oesophagectomy, was examined.

Type of intervention
Treatment.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised patients undergoing OER.

Setting
The setting was secondary care. The economic study was conducted in Maryland, USA.

Dates to which data relate
The effectiveness and resource use data were gathered from 1984 to 1999. The price year was 1999.

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

Link between effectiveness and cost data
The costing was conducted on the same sample of patients as that used in the effectiveness study. It appears to have been carried out retrospectively.

Study sample
Power calculations were not conducted. Eligible patients were identified from a database comprising 52 centres that were classified into three groups based on their annual procedural volume. The volume groupings were:

- less 3 or less procedures per year (low volume);
- between 4 and 15 procedures per year (medium volume); and
- more than 15 procedures per year (high volume).
There were 3 hospitals in the high-volume group, 20 hospitals in the medium-volume group, and 39 hospitals in the low-volume group. Several hospitals changed from low to medium volume due to varying numbers of oesophageal procedures performed over time. The whole study sample comprised 1,136 patients. There were 445 patients in the low-volume group, 291 in the medium-volume group, and 400 in the high-volume group. The patients in the low-volume group had a mean age of 62 (+/- 12) years, and 74% were men and 72% were white. The patients in the medium-volume group had a mean age of 61 (+/- 13) years, and 72% were men and 70% were white. The patients in the high-volume group had a mean age of 59 9+/− 14) years, and 76% were men and 84% were white.

Study design
This was a retrospective cohort study that was conducted at 52 non-federal, acute-care hospitals in the state of Maryland. Data were derived from the Uniform Health Discharge Data Set maintained by the Maryland Health Services Cost Review Commission. The length of follow-up was unclear, but the patients were likely to have been followed until discharged from the hospital. The loss to follow-up was not reported. However, it appears that patient charts were completed.

Analysis of effectiveness
All the patients included in the initial study sample were considered the effectiveness analysis. The primary outcome measures were in-hospital mortality and the length of stay (LOS). The study groups differed at baseline in terms of their age, race, presence of malignancy, chronic obstructive pulmonary disease, history of myocardial infarction, proportion of out-of-state patients, miles to hospital, and Medicare status. Due to baseline differences, the outcomes were adjusted for demographics (age, gender and race), co-morbid disease and severity of illness. The analysis was conducted for three timeframes (1984 to 1989, 1990 to 1994, and 1995 to 1999).

Several statistical tests were conducted to assess the statistical significance of differences in the outcomes between the groups. A multivariate regression was then used to test the association of hospital volume with in-hospital mortality while adjusting for important independent variables (univariate predictors). A multiple linear regression of log-transformed LOS was used to assess the association of hospital volume after adjusting for other independent predictors. The effect of hospital volume on in-hospital mortality was investigated in patients aged older or younger than 65 years.

Effectiveness results
The unadjusted in-hospital mortality over the whole study period was 10.5%. This equated to 16% in low-volume hospitals, 12.7% in medium-volume hospitals, and 2.7% in high-volume hospitals, (p<0.001).

The corresponding values by time period were:
for 1984 to 1989, low-volume 15.9%, medium-volume 13.7%, and high-volume 3.7%, (p=0.02);
for 1990 to 1994, low-volume 19.6%, medium-volume 10.8%, and high-volume 5%, (p<0.001);
for 1995 to 1999, low-volume 12.1%, medium-volume 13.5%, and high-volume 0.6%, (p<0.001).

Similar results were obtained in the sub-group analysis when patients were grouped according to age older or younger than 65 years.

Other univariate predictors of death were:
non-white race, (p=0.004),
extent of resection, (p=0.02),
age, (p<0.001),
urgent and emergent admission, (p<0.001), and
chronic renal disease, (p=0.01).

The multivariate analysis showed that high volume was associated with a five-fold reduction in the risk of in-hospital mortality (odds ratio 0.21, 95% confidence interval, CI: 0.10 - 0.42; p<0.001).

The unadjusted median LOS over the whole study period was 16 days (interquartile range, IQR: 10 - 27).

The unadjusted median LOS by type of hospital was 19 days (IQR: 12 - 33) in low-volume hospitals, 20 days (IQR: 13 - 31) in medium-volume hospitals, and 11 days (IQR: 9 - 16) in high-volume hospitals, (p<0.001).

The corresponding values by time period were:

for 1984 to 1989, low-volume 22 days (IQR: 15 - 34), medium-volume 24 days (IQR: 15 - 38), and high-volume 17 days (IQR: 12 - 29), (p=0.004);

for 1990 to 1994, low-volume 22 days (IQR: 14 - 36), medium-volume 18 days (IQR: 13 - 29), and high-volume 11 days (IQR: 10 - 18), (p<0.001);

for 1995 to 1999, low-volume 13 days (IQR: 10 - 22), medium-volume 15 days (IQR: 11 - 26), and high-volume 9 days (IQR: 8 - 11), (p<0.001).

Other predictors of increased LOS in the univariate analysis were:

older age, (p=0.02),

male gender, (p=0.002),

diabetes mellitus, (p=0.02),

malignant disease, (p=0.03),

metastatic disease, (p=0.004),

history of myocardial infarction, (p=0.0004),

renal disease, (p=0.05),

peripheral vascular disease, (p=0.06), and

three or more co-morbidities, (p=0.04).

The multivariate analysis showed that high-volume hospitals had a significant reduction in LOS compared with low-volume hospitals. This reduction corresponded to a decrease of 6 days (95% CI: 5 - 7 days) in LOS at high-volume hospitals.

A significant reduction in LOS was also seen for patients who underwent operations during time period 3.

Clinical conclusions
The effectiveness analysis showed that reductions in mortality rates were observed in high-volume hospitals in comparison with low- and medium-volume hospitals. Similarly, significant results in LOS were also observed.

Measure of benefits used in the economic analysis
No summary benefit measure was used in the economic study. In effect, a cost-consequences analysis was carried out.
Direct costs
Discounting was not relevant since the costs per patient were incurred during a short time. The unit costs were not presented separately from the quantities of resources used. A breakdown of the cost items was not provided, but all costs relevant to the perspective of the hospital were considered. The costs and the quantities of resources used were estimated using actual data derived from the same database as that used in the effectiveness analysis. Thus, the costs were related to individual patient data. Charges rather than costs were used and the authors did not apply a cost-to-charge ratio. The authors noted that hospital charges were tightly regulated by the Health Service Cost Review Commission in Maryland, therefore they were a good approximation of the true costs. All the costs were presented in 1999 values using the appropriate consumer price index for health care.

Statistical analysis of costs
A multiple linear regression of log-transformed charges was used to assess the association of hospital volume after adjusting for other independent predictors. The costs were presented as median values and IQRs.

Indirect Costs
The indirect costs were not included.

Currency
US dollars ($).

Sensitivity analysis
Sensitivity analyses were not conducted.

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

Cost results
The unadjusted median charges over the whole study period were $33,483 days (IQR: 23,000 - 55,000).

The unadjusted median charges were $42,318 (IQR: 29,000 - 60,000) in low-volume hospitals, $39,979 (IQR: 27,000 - 71,000) in medium-volume hospitals, and $23,072 (IQR: 19,000 - 34,000) in high-volume hospitals, (p<0.001).

The corresponding values by time period were:

for 1984 to 1989, low-volume $42,012 (IQR: 29,000 - 74,000), medium-volume $45,314 (IQR: 30,000 - 63,000), and high-volume $35,774 (IQR: 27,000 - 61,000), (p<0.001);

for 1990 to 1994, low-volume $46,721 (IQR: 29,000 - 84,000), medium-volume $37,297 (IQR: 27,000 - 63,000), and high-volume $25,801 (IQR: 21,000 - 36,000), (p<0.001);

for 1995 to 1999, low-volume $31,934 (IQR: 24,000 - 59,000), medium-volume $37,884 (IQR: 27,000 - 55,000), and high-volume $19,378 (IQR: 17,000 - 24,000), (p<0.001).

Other independent variables in the univariate analysis were: male gender, (p=0.007), increasing age, (p=0.02), non-white race, (p<0.001), urgent admission, (p=0.001).
emergent admission, (p<0.001),
extent of procedure, (p=0.005),
malignancy disease, (p=0.0004),
metastatic disease, (p=0.009), and
a history of myocardial infarction, (p=0.01).

The multivariate analysis showed that high?volume hospitals were independently associated with a 35% (95% CI: 28 - 41; p<0.001) reduction in hospital charges. This reduction corresponded to $11,673 (95% CI: 9,504 - 12,841).

A significant reduction in charges (17%, 95% CI: 7 - 26; p=0.001) was also seen for patients who underwent operation during time period 3.

**Synthesis of costs and benefits**
Not relevant due to the cost?consequences approach taken.

**Authors' conclusions**
Lower mortality, shorter hospital stay and lower costs were observed in high?volume hospitals, compared with low? and medium?volume hospitals, for patients undergoing oesophageal resection (OER). Clinical and economic improvements over time were observed within the sample of high?volume hospitals, but no significant changes were seen at low? and medium?volume hospitals.

**CRD COMMENTARY - Selection of comparators**
The comparators considered in the study where three different levels of hospital volumes for the intervention under evaluation. Since the objective of the study was to assess the impact of hospital volume on several clinical and economic outcomes, the choice of high-, medium and low-volume hospitals appears to have been appropriate. You should decide whether these are valid comparators in your own setting.

**Validity of estimate of measure of effectiveness**
The effectiveness evidence came from a cohort study, which was based on a retrospective review of patients' charts extracted from a national database. The allocation of patients to the study groups on the basis of hospital volume led to unbalanced study groups. Therefore, several statistical tests were carried out to adjust for baseline differences. Other factors, such as case-mix, which were comparable at baseline, were also varied in the adjusted analysis. The authors stressed that the large number of patients involved in each group and the long time horizon of the study were the main strengths of the analysis. Therefore, all eligible patients appear to have been included in the analysis, thus reducing selection bias. However, the retrospective design is usually a weak source of data, owing to the possibility that it may lead to the introduction of some bias and administrative errors. The estimation of at least long-term mortality, rather than the in-hospital death rate, would have been more interesting. Further, the authors noted that not all differences in prognostic factors were captured in the baseline analysis. Therefore, the impact of hospital volume could have been either underestimated or overestimated. Finally, the direction of causality between outcomes and volume was confused by the different referral patterns observed in the sample.

**Validity of estimate of measure of benefit**
No summary benefit measure was used in the analysis because a cost?consequences analysis was conducted.

**Validity of estimate of costs**
The cost analysis appears to have been conducted from the perspective of the hospital. It was unclear whether all the
relevant categories of costs were considered in the analysis since a detailed breakdown of the cost items was not provided. Likewise, the unit costs and quantities of resources used were not reported. The source of the data was reported and the price year was provided, which will facilitate reflation exercises in other settings. Hospital charges were considered as a reliable proxy of costs, although the use of a cost-to-charge ratio would have been helpful.

**Other issues**

The authors made some comparisons of their findings with those from other studies and found similar results. However, they also stated that it was unclear whether their results could be generalised to other settings. Sensitivity analyses were not conducted, which reduces the external validity of the analysis. The study involved patients eligible for OER and this was reflected in the authors’ conclusions.

**Implications of the study**

The study results suggested that patients requiring OER should be referred to high-volume hospitals to ensure lower mortality or costs.

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**Other publications of related interest**


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