Impact of American College of Surgeons verification on trauma outcomes
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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
Level II American College of Surgeons (ACS) verification of trauma outcomes in trauma centres were studied. This was compared to no ACS verification of the outcomes.

Type of intervention
Secondary prevention.

Economic study type
Cost-effectiveness analysis.

Study population
Three different populations were used in this study. The first population comprised 8,674 patients admitted to the hospital from March 1993 to November 2001, with the International Classification of Diseases 9th Revision (ICD-9) codes for trauma. This study population was used to assess the impact of ACS verification on trauma outcomes. The second population comprised patients admitted to the same facility during the same time with a high-volume surgical diagnosis of coronary artery bypass graft (CABG). This study population was used to provide the internal control, to assess secular trends in health care for 1993 to 2001 time period. The third population comprised trauma patients admitted to a geographically different, non-ACS verified hospital providing similar overall hospital services and severity as the ACS verified hospital. This study population was used to provide the external control, to assess unrecognised changes in trauma patients.

Setting
The setting was secondary care. The economic study was carried out in the USA.

Dates to which data relate
The data were obtained retrospectively for all patients admitted to hospital from March 1993 to November 2001. The price year was not reported.

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

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

Study sample
No sample size was determined in the planning phase of the study to assure a certain power and no results of power
calculations were reported. The authors did state (at the end) that the study sample had sufficient statistical power. To assess the impact of ACS verification on trauma outcomes, data from all patients admitted to hospital with ICD 9 codes 800xx through to 959.9x were used. In total, retrospective data on 7,811 consecutive admitted patients was used. Of these patients, 7,488 were admitted for blunt injuries, 307 for penetrating injuries and 15 for burns. Approximately, half (n=3,973) were admitted before the introduction of ACS verification (28 July 1998), while 3,835 patients were admitted after that date.

Patients who had undergone CABG formed the internal control. CABG patients were selected because evidence had suggested that they were sensitive to the administrative risk measurement used in this study. Also, because 54.8% of all trauma patients had an operation and 67% of trauma cases had an associated surgical or diagnostic feature. CABG patients were also selected to form an internal control because an external evaluative group, which can act as a measure for changes occurring internally within the facility, selected the ACS-certified facility, under the timeframes of the study, as a top 100 cardiac hospital. There were 683 patients in this control, of whom 503 were admitted to hospital from March 1993 to 28 July 1998, and 180 were admitted thereafter.

The external control comprised trauma patients at a different hospital. There were 4,287 in this control, of whom 2,489 were admitted to hospital from March 1993 to 28 July 1998, and 1,438 were admitted thereafter.

**Study design**

The study was a retrospective comparative study with historical controls, which was carried out in two centres (the ACS verified hospital and the non-ACS-verified hospital from where the external control patients originated). The patient data were obtained from an administrative data decision support system.

**Analysis of effectiveness**

Three trauma patients in the ACS-verified hospital group were unaccounted for in the analysis. The outcome measures were changes in hospitalisation such as mortality, length of stay, ventilator use, prevalence of complications, and readmissions to the hospital within 31 days of discharge. These outcomes were evaluated using hospital discharge data for the timeframes before and after 28 July 1998 (the date when ACS verification was introduced at the trauma centre). No comparisons were made at analysis to show whether the before and after groups (for ACS-verification, internal and external control groups) were comparable in terms of their age or gender. However, pre- and post-verification groups were severity adjusted (i.e. the ratio of observed to expected values) to make the groups comparable at analysis in terms of the severity of their condition. Since this was a before-and-after study, factors such as improving health care technologies and medical trends and better case management as time progresses had the potential to confound the authors' results.

**Effectiveness results**

For patients admitted with trauma diagnoses in the ACS-verified hospital, the results (presented as mean +/- SD) were as follows.

Raw length of stay was 4.80 (+/- 0.10) days post-verification versus 5.28 (+/- 0.10) days pre-verification, (p<0.001). There were no statistically significant differences between the pre- and post-verification groups for raw mortality rates, raw readmission rates and raw complication rates.

Ventilator use for less than 96 hours was higher post-verification (from 9.5 to 7.3%, p<0.000), while ventilator use for more than 96 hours dropped significantly post-verification (from 4.9 to 3.8%, p=0.007).

Adjusting for severity, the ratio of observed to expected length of stay was 10% less post-verification, (p<0.001).

In the same way, severity-adjusted mortality differences exhibited a post-verification expected mortality rate of 4.72%, whereas the pre-verification rate was 3.56%, (p<0.001). This resulted in different standardised mortality ratios, 0.814 before versus 0.593 after verification, an improvement of 22%, (p<=0.000).
Comparing the pre-verification and the timeframe post-ACS verification in trauma patients, the CABG internal control revealed no severity-adjusted changes for mortality or length of stay. Thus, it would appear that any case management or use improvement trends in CABG had minimal effects.

When evaluating the non-ACS control hospital, trauma external control over the same timeframe, the evaluation revealed no severity-adjusted changes in mortality. However, severity-adjusted length of stay increased by 19%, (p<0.000) after 28 July 1998. The readmission rates also increased by 4.2% over expected, (p<=0.000) after the post-verification timeframe. If there were any material advances or medical trends improving overall trauma care, they were also not exhibited in this external control.

**Clinical conclusions**
Successful outcomes were identified post-ACS verification in comparison with the pre-ACS verification timeframe, notably in reduced mortality and length of stay. The outcomes in the two controls did not suggest that confounding elements invalidated the improvements found.

**Measure of benefits used in the economic analysis**
No summary benefit measure was used in the economic analysis. A cost-consequences approach was therefore adopted.

**Direct costs**
The resource quantities and the costs were not reported separately. The direct costs included in the analysis were those of the hospital. These were for labour and the intensive care unit. The direct cost data were obtained from hospital discharge records. The authors did not state where they obtained the price or unit costs/charges. Discounting was irrelevant, as the costs were incurred in less than 2 years, and was not conducted. The study reported the mean costs. The pre-verification costs do not seem to have been adjusted for inflation, even though those costs were incurred several years before the post-verification costs.

**Statistical analysis of costs**
The costs were treated in a stochastic way. The costs were examined using Student's t-test with a 99% confidence interval. Differences in the costs were evaluated using the non-parametric Mann-Whitney U-test. Statistical significance was accepted at p<0.005 when using SPSS software (version 11.0). The study was sufficiently powered to detect any differences in the costs.

**Indirect Costs**
The indirect costs were not included in the analysis.

**Currency**
US dollars ($).

**Sensitivity analysis**
No sensitivity analyses were performed.

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

**Cost results**
The average actual costs were $9,588 before ACS-verification for trauma patients versus $12,049 after. The average expected costs were $10,046 for the pre-verification period and $12,522 post-ACS verification. Thus, the overall severity-adjusted ratio of the costs was 5% lower in the post-verification era (1.097 +/- 0.005) than in the pre-verification era (1.147 +/- 0.005), (p<0.000).

Comparing the pre- and post-ACS verification timeframes, the internal control revealed significantly higher overall severity-adjusted cost ratios post-verification (0.937 +/- 0.037) than pre-verification (0.755 +/- 0.009), (p<0.000).

In the external control, the severity-adjusted costs increased by 19% after 28 July 1998, 1.167 (+/- 0.044) in the post-ACS verification timeframe versus 0.968 (+/- 0.015) in the pre-verification timeframe, (p<0.000).

**Synthesis of costs and benefits**
The costs and benefits were not combined as a cost-consequences analysis was undertaken.

**Authors' conclusions**
American College of Surgeons (ACS) verification in a trauma hospital resulted in improvements in the quality of care, as reflected in reduced mortality, costs and length of stay. The results from the controls suggested that confounding elements did not affect the authors' results.

**CRD COMMENTARY - Selection of comparators**
The comparator used was justified on the grounds that it would represent current practice in the authors' setting. You should decide if this is a widely used health intervention in your own setting.

**Validity of estimate of measure of effectiveness**
The analysis used a comparative study with historical controls. This was appropriate for the study question, as the authors wished to assess the impact of ACS verification by comparing the before and after outcomes in a particular hospital. The study sample was representative of the study population. The patient groups were not shown to be comparable at analysis in terms of their age or gender. However, severity-adjusted data were reported (i.e. the groups were standardised for severity status). The analysis was handled credibly.

In using a comparative study with historical controls, there is the potential for confounding factors other than the intervention to affect the results, for example, improved medical technologies, learning effects, and new management styles. However, the use of internal and external controls did not suggest that such confounding factors had invalidated the improvements found. Further, appropriate statistical analyses were used to determine statistical significance, and the study was sufficiently powered to detect any significant differences. Three patients in the ACS-verified trauma group were unaccounted for in the analysis, but with such a large sample size these omissions are unlikely to play any significant role.

**Validity of estimate of measure of benefit**
The authors did not derive a summary measure of health benefit. The analysis was therefore categorised as a cost-consequences analysis.

**Validity of estimate of costs**
All the categories of cost relevant to the perspective adopted were included in the analysis. However, it was unclear whether, for each category of cost, all the relevant costs were included in the analysis. The costs and the quantities were not reported separately, and the dates relating to the costs and prices were not reported. These two limitations weaken the generalisability of the results and hinder reflation exercises to other settings. There was no mention of the quantities of resources used (apart from ventilator use), although it can be supposed that resource use was derived directly from the study. Appropriate statistical analyses of the costs were undertaken to detect statistically significant
differences between the groups. However, the authors did not seem to have adjusted pre-verification group costs for inflation, even though this was methodologically necessary as these costs were incurred several years before the post-verification costs. This limitation may affect the conclusions reached by the authors.

Other issues
The authors made appropriate comparisons of their findings with those from other studies, which had yielded mixed messages on the implementation of statewide trauma systems. The authors addressed the issue of generalisability to other settings. The authors do not seem to have presented their effectiveness results selectively, but the validity of the cost results is dubious. The authors' conclusions reflect the scope of the analysis. The authors reported a further limitation in that advances in trauma care and CABG over the timeframe of the analysis might have had different impacts on their respective diseases, thus limiting the utility of the internal control.

Implications of the study
The authors suggested that administrative data on level I, II and III centres and non-ACS hospitals can be incorporated into future comprehensive evaluations on trauma outcomes, and can be used to examine justification for the implementation of statewide or even regional multistate trauma centres.

Source of funding
None stated.

Bibliographic details

PubMedID
12813321

DOI
10.1097/01.TA.0000061107.55798.31

Other publications of related interest


Indexing Status
Subject indexing assigned by NLM

MeSH
Accreditation /economics; Coronary Artery Bypass /utilization; Hospital Costs /statistics & numerical data; Hospital Mortality; Hospitals, Community /economics /standards /utilization; Hospitals, Voluntary /economics /standards /utilization; Humans; International Classification of Diseases; Length of Stay /economics /statistics & numerical data;
Outcome Assessment (Health Care); Retrospective Studies; Societies, Medical; Survival Analysis; Trauma Centers
/economics /standards /utilization; United States /epidemiology; Wounds and Injuries /classification /economics
/mortality /surgery

AccessionNumber
22003000955

Date bibliographic record published
30/04/2004

Date abstract record published
30/04/2004