Health technology
Four different strategies for elective colectomy (EC) performed in patients with an initial episode of diverticulitis were examined. The strategies were EC after the first episode, EC after the second episode, EC after the third episode, and EC after the fourth episode.

Type of intervention
Treatment.

Economic study type
Cost-utility analysis.

Study population
The study population comprised a hypothetical cohort of patients with a history of a single non-surgically treated episode of diverticulitis.

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

Dates to which data relate
The effectiveness data were derived from studies published between 1969 and 2004. The costs and resource use data were mainly derived from a study published in 2004. The price year was not explicitly stated but it might have been 2004.

Source of effectiveness data
The effectiveness evidence was derived from a synthesis of completed studies.

Modelling
A Markov model was constructed to examine the clinical and economic impact of the EC strategies under evaluation in two hypothetical cohorts of patients, 35-year-olds and 50-year-olds, who were followed until 90% of the cohort had died. Only ECs after the first, second, third and fourth episode of diverticulitis were considered, as the literature suggested that only 0.3% of patients have more than a fourth episode. The cycle length was 6 months. A simplified structure of the model was reported graphically.

Seventeen health states were involved in the model. After recovery from the initial episode, patients could recover and remain in a "well" state, die from unrelated causes, or have a recurrent episode. A recurrent diverticulitis episode was treated medically or necessitated emergency operation. Patients treated medically could either improve and return to the "well" state, or die from the diverticulitis episode. Patients who entered any type of "operative" state (elective or
emergency) entered one of three possible health states: uneventful recovery, recovery with stoma formation, and surgical mortality. After surgery, patients could remain well, die from age-related causes, or have a recurrent diverticulitis episode. Only acute septic complications of diverticulitis were considered. The model did not consider other complications of diverticulitis and diverticulosis, such as stricture, fistula, chronic abdominal pain, or bleeding. The probabilities of mortality in colectomy (both elective and emergency), colostomy reversal and nonoperative treatment of diverticulitis were age-dependent.

**Outcomes assessed in the review**
The outcomes estimated from the literature were:

- the age-related mortality rate due to medical treatment, emergent operation, EC and stoma reversal;
- the rates of recurrent diverticulitis after medical treatment and after colectomy;
- stoma formation in emergent operation or EC;
- the rate of stoma reversal attempt;
- the need for emergency operation in diverticulitis; and
- the utility values associated with the health states.

**Study designs and other criteria for inclusion in the review**
The clinical evidence used in the model came from a review of the literature. However, it was not stated whether the review was systematic. Most of the data came from a population-based cohort of 25,000 patients with diverticulitis, derived from a statewide hospital discharge database. Estimates of dying of age-related causes were derived from the Centers for Disease Control. The utility values were obtained from different sources, where quality of life was based on either healthy patients or patients undergoing curative surgical resection for colon cancer. The designs of the other primary studies were not described.

**Sources searched to identify primary studies**
Not stated.

**Criteria used to ensure the validity of primary studies**
The authors stated that the best evidence available was used.

**Methods used to judge relevance and validity, and for extracting data**
Not stated.

**Number of primary studies included**
Twenty-nine primary studies provided evidence.

**Methods of combining primary studies**
The primary studies appear to have been combined using a narrative method.

**Investigation of differences between primary studies**
Not stated.
Results of the review

The mortality rate due to medical treatment was 0.2% (range: 0 - 4.8) for age <50 years and 1.5% (increases by 6%/year) for age =/> 50 years.

The mortality rate due to emergent operation was 0.36% (range: 1 - 29.5) for age <50 years and 6.8% (increases by 6%/year) for age =/> 50 years.

The mortality rate due to EC was 0.14% (range: 0 - 2.3) for age <50 years and 1.6% (increases by 6%/year) for age =/> 50 years.

The mortality rate due to stoma reversal was 0.24% (range: 0 - 8.3) for age <50 years and 0.45% (increases by 6%/year) for age =/> 50 years.

The rate of recurrent diverticulitis after medical treatment was 27% in 5 years (range: 27.5 - 30 in 5 years) for age <50 years, 17% in 5 years for age =/> 50 years, and 8.5% in 5 years (range: 2.6 - 10.4) after colectomy.

The rate of stoma formation was 50% (range: 19.3 - 73.5) in emergent operation and 5% (range: 0 - 11.4) in EC.

The rate of stoma reversal attempt was 56% (range: 20 - 100).

The need for emergency operation in diverticulitis was 20% (range: 20 - 28).

The risk of a recurrent episode was the same after elective and emergent operations. Ninety per cent of recurrent events of diverticulitis occurred within the first 5 years after the initial episode.

The utility values were:

- for emergency operation, without stoma 0.7 (range: 0 - 1) and with stoma 0.6 (range: 0 - 1);
- for diverticulitis recurrence-medical therapy, without stoma 0.98 (range: 0 - 1) and with stoma, 0.83 (range: 0 - 1);
- for "well", without stoma 1 and with stoma 0.85 (range: 0 - 1);
- for EC, without stoma 0.7 (range: 0 - 1) and with stoma 0.6 (range: 0 - 1); and
- for stoma reversal, 0.7 (range: 0 - 1).

Measure of benefits used in the economic analysis

The summary benefit measure used was the quality-adjusted life-years (QALYs). These were calculated by combining utility values and survival derived from the literature. The utilities were obtained from published studies where questionnaire were completed either by healthy patients or by patients undergoing curative surgical resection for colon cancer. An annual discount rate of 3% was applied. The proportion of colostomies performed and the rate of death were also reported as model outputs.

Direct costs

Owing to the long timeframe of the analysis, the costs were discounted at an annual rate of 3%. The unit costs were not presented separately from the quantities of resources used. The economic evaluation comprised only the costs of nonoperative hospitalisations and the costs of maintaining a colostomy. The cost/resource boundary of the service payer was adopted. The resource use data and charges for the different health states were derived from a statewide hospital discharge database and were converted into costs using a standard, statewide cost-to-charge ratio in Washington state. The charge of colostomy appliances was obtained from a commercial home health care service. The price year was not reported but it might have been 2004.
Statistical analysis of costs
The costs were treated deterministically.

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

Currency
US dollars ($).

Sensitivity analysis
Univariate sensitivity analyses were performed on all model inputs to examine the robustness of the base-case results to variations in baseline values. Also, to identify which factors had the greatest influence on adverse outcomes. Two-way sensitivity analyses were carried out on selected key model inputs. Published ranges of values were used for clinical inputs, while the costs were varied by +/- 25% of their baseline values and the utilities were varied from 0 to 1.

Estimated benefits used in the economic analysis
In the cohort of 50-year-old patients, the QALYs per patient (rate of colostomies and rate of death) were:

18.3 (5.7% and 2.93%) with EC after first episode,
18.7 (3.1% and 2.07%) with EC after second episode,
18.8 (2.4% and 1.65%) with EC after third episode, and
18.8 (2.4% and 1.57%) with EC after fourth episode.

In the cohort of 35-year-old patients, the QALYs per patient (rate of colostomies and rate of death) were:

23.1 (5.9% and 0.71%) with EC after first episode,
23.4 (4.8% and 0.83%) with EC after second episode,
23.5 (4% and 0.74%) with EC after third episode, and
23.5 (3.9% and 0.70%) with EC after fourth episode.

Cost results
In the cohort of 50-year-old patients, the estimated costs per patient were:

$10,829 with EC after first episode,
$5,230 with EC after second episode,
$4,272 with EC after third episode, and
$4,195 with EC after fourth episode.

In the cohort of 35-year-old patients, the estimated costs per patient were:

$10,124 with EC after first episode,
$6,113 with EC after second episode,
$4,866 with EC after third episode, and
$4,695 with EC after fourth episode.

**Synthesis of costs and benefits**

Average cost-utility ratios were calculated to combine the costs and benefits of the alternative strategies under evaluation.

In the cohort of 50-year-old patients, the average cost per QALY was:

- $591.9 with EC after first episode,
- $279.6 with EC after second episode,
- $227.4 with EC after third episode, and
- $223.3 with EC after fourth episode.

In the cohort of 35-year-old patients, the average cost per QALY was:

- $437.8 with EC after first episode,
- $260.7 with EC after second episode,
- $207 with EC after third episode, and
- $199.6 with EC after fourth episode.

The incremental analysis showed that operating after additional diverticulitis episodes (expectant management strategy) was dominant as it was both more effective and less costly than operating earlier.

The univariate sensitivity analysis confirmed the results of the base-case analysis in both patient cohorts. It showed that the risks of colostomy in elective and emergency operations were important determinants for assessing the overall colostomy risk of different strategies. Similarly, the risks of mortality in elective and emergency operation were important determinants for death from recurrent diverticulitis or operation.

The two-way sensitivity analysis showed that operating earlier became a favourable strategy as the rate of colostomy and mortality in elective operation decreased and the rate of colostomy in emergency operation increased, although this conclusion was reached when implausible values were used.

**Authors' conclusions**

In both younger and in older patients, deferring elective colectomy (EC) until after the fourth diverticulitis episode was less costly and more effective than operating after fewer episodes. Further, operating after the fourth episode was the strategy that yielded the lowest rates of colostomy and deaths related to recurrent diverticulitis and operation.

**CRD COMMENTARY - Selection of comparators**

The authors justified the choice of the comparators, which were appropriately selected to cover all possible treatment strategies for EC. You should decide whether they are valid comparators in your own setting.

**Validity of estimate of measure of effectiveness**
The effectiveness evidence was derived from a review of the literature, although it was not explicitly stated whether the review was systematic. Details on the methods and conduct of the review were not reported. Further, information on the design of the primary studies was reported only for some inputs. Differences between the primary studies were not investigated and the issue of the validity of the primary sources was not addressed. The approach used to combine the primary estimates was not described. Owing to the uncertainty around some estimates, an extensive sensitivity analysis was performed on all model inputs.

**Validity of estimate of measure of benefit**
The use of QALYs as the summary benefit measure was appropriate as they incorporate the two most relevant dimensions of health (quality of life and survival). The utility values were derived from the literature and some information on the source of these data was provided. Given the lack of published studies, the authors made some assumptions in order to calculate the health utilities. Discounting was performed, as recommended in US guidelines. QALYs are comparable with the benefits of other health care interventions. Disease-specific benefit measures were also reported.

**Validity of estimate of costs**
The perspective of the study was explicitly stated. Only direct medical costs associated with the intervention were considered in the analysis. The costs were presented as macro-categories and a detailed breakdown of the cost items was not provided. This reduces the possibility of replicating the results of the analysis in other settings. The source of the data was given. The costs were treated deterministically but all economic estimates were varied in the sensitivity analysis. The price year was not reported, thus making it difficult to perform reflation exercises in other settings.

**Other issues**
The authors stated that their findings corroborated those from a published analysis, although some flaws of the previous study were noted. The issue of the transferability of the results to other settings was not explicitly addressed, although an extensive sensitivity analysis was conducted. The authors noted some advantages of their analysis, such as the use of data from a population-based cohort and the analysis of two different age cohorts. Some limitations of the analysis were also highlighted. For example, the decision model required a simplification of clinical care paths, which led to the exclusion of some clinical scenarios. The authors admitted that some utility values were derived from other disease processes serving as a reference.

**Implications of the study**
The study results supported the role of expectant management of patients with diverticulitis. The authors stated that their data should help those considering management options after a diverticulitis episode to develop treatment recommendations incorporating outcomes, cost and quality of life.

**Source of funding**
None stated.

**Bibliographic details**

**Other publications of related interest**


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Subject indexing assigned by NLM

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