A decision analysis of anesthesia management for cataract surgery
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Health technology
The study investigated six different anesthesia management strategies for cataract surgery.

Strategy 1 was intravenous sedation administered by an anesthesia specialist and block anesthesia intra-operatively, with the anesthesiologist present throughout the case.

Strategy 2 was oral sedation preoperatively and block anesthesia intra-operatively, with an anesthesiologist on call if needed for additional sedation.

Strategy 3 was oral sedation preoperatively and block anesthesia intra-operatively, with no anesthesiologist on call for additional sedation.

Strategy 4 was intravenous sedation administered by an anesthesia specialist and topical anesthesia intra-operatively, with the anesthesiologist present throughout the case.

Strategy 5 was oral sedation preoperatively and topical anesthesia intra-operatively, with an anesthesiologist on call for additional sedation.

Strategy 6 was oral sedation preoperatively and topical anesthesia intra-operatively, with no anesthesiologist on call for additional sedation.

Type of intervention
Other: Anesthesia.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised a hypothetical cohort of adult patients undergoing cataract surgery.

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

Dates to which data relate
The effectiveness data were derived from a study published in 2000. The price year was 1999.

Source of effectiveness data
The effectiveness data were derived from a review of published studies, augmented by experts' opinion.
Modelling
The authors designed a decision tree (Data 3.5, TreeAge Software) to model the differences in expected cost and expected preferences for various anaesthesia management strategies for adult patients undergoing cataract surgery.

Outcomes assessed in the review
The outcomes assessed were:

the probability of admission after surgery with intravenous sedation;
the probability of admission after surgery with oral sedation;
the probability of experiencing cardiovascular instability intra-operatively or up to one week postoperatively while receiving intravenous sedation;
the probability of experiencing cardiovascular instability intra-operatively or up to one week postoperatively while receiving oral sedation;
the probability of nausea and vomiting postoperatively after having received intravenous sedation intra-operatively; and
the probability of nausea and vomiting postoperatively after having received oral sedation preoperatively.

Study designs and other criteria for inclusion in the review
The probabilities for events modelled in the decision analysis were derived using data from a large randomised clinical trial of 19,557 cataract surgeries, the Study of Medical Testing for Cataract Surgery (Schein et al., see Other Publications of Related Interest).

Sources searched to identify primary studies
Not reported.

Criteria used to ensure the validity of primary studies
Not reported.

Methods used to judge relevance and validity, and for extracting data
A plausible range of values for each probability estimate was obtained from the Study of Medical Testing for Cataract Surgery dataset using 95% confidence intervals calculated from the normal approximation to the binomial distribution.

Number of primary studies included
A systematic review of the literature on anaesthesia management for cataract surgery did not provide the specific probability estimates that were needed for this analysis. Therefore, only the Study of Medical Testing for Cataract Surgery was included in the review.

Methods of combining primary studies
Not relevant.

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

The probability of admission after surgery with intravenous sedation was 0.006 (range: 0.0047 - 0.0072).

The probability of admission after surgery with oral sedation was 0.0098 (range: 0.003 - 0.017).

The probability of experiencing cardiovascular instability intra-operatively or up to one week postoperatively while receiving intravenous sedation was 0.0277 (range: 0.0251 - 0.0304).

The probability of experiencing cardiovascular instability intra-operatively or up to one week postoperatively while receiving oral sedation was 0.0125 (range: 0.0067 - 0.0206).

The probability of nausea and vomiting postoperatively after having received intravenous sedation intra-operatively was 0.044 (range: 0.0408 - 0.0475).

The probability of nausea and vomiting postoperatively after having received oral sedation preoperatively was 0.0347 (range: 0.0213 - 0.0481).

**Methods used to derive estimates of effectiveness**

Some probability estimates (i.e. conversion to general anaesthesia and conversion from topical anaesthesia to block anaesthesia) were unavailable in the Study of Medical Testing for Cataract Surgery. These probabilities were subsequently assigned on the judgement of an 8-member panel of physicians, which included four ophthalmologists and three anaesthesiologists. This panel was asked to estimate the probability of the modelled events during cataract surgery. The median response was used as the baseline probability value to reduce the influence of any others. The highest and lowest probability scores assigned to an event (by the panel) comprised the end points for the plausible range.

**Estimates of effectiveness and key assumptions**

The probability of being converted from topical to block anaesthesia was 0.06 (range: 0.02 - 0.1).

The probability of being converted to general anaesthesia from initial intravenous sedation was 0.0036 (range: 0.0001 - 0.01).

The probability of being converted to general anaesthesia from initial oral sedation was 0.0065 (range: 0.0001 - 0.03).

The authors also assumed that conversion to general anaesthesia was assumed to be sufficiently rare as to be mutually exclusive of conversion from topical anaesthesia to ocular block. Also, complications that would require admission postoperatively were assumed to be mutually exclusive of uncomplicated intra-operative cardiovascular instability, and nausea and vomiting postoperatively.

**Measure of benefits used in the economic analysis**

The measure of benefits used was the expected net preference value of each of the anaesthesia management strategies. These were derived from the probabilities, preference values for baseline management strategies, and disutility factors for potential complications.

The preference and disutility values were elicited from a 10-member panel consisting of the eight experts who had already provided probability estimates, plus an additional ophthalmologist and a nurse anaesthetist who estimated these preference values. The experts were asked to rate several anaesthesia scenarios on a scale from 0 (worst possible experience from a patient's perspective) to 100 (representing the ideal experience). The preference values were assigned to management strategies on the basis of mean rating responses. The plausible range of a given preference value was set as the highest and lowest responses obtained. The decrease in preference value (i.e. disutility factor) attributable to a complication was determined by asking the experts to assign preference values to anaesthesia scenarios that included a complication. The disutility factor was then calculated for each complication by dividing the mean preference value assigned to the scenario with the complication by the mean preference value assigned to the scenario without the complication.
Direct costs
The direct costs included in the analysis were those of the health care service. These were for admission, the anaesthesiologist (both throughout surgery or on call), conversion from topical to block anaesthesia, general anaesthesia, the treatment of intra-operative cardiovascular instability and postoperative nausea and vomiting, oral and intravenous sedation, topical anaesthesia, peribulbar or retrobulbar block anaesthesia, anaesthesia supplies, and preoperative tests. The cost of admission was based on the Medicare per diem rate for an overnight hospital admission. The anaesthesiologist costs were based on prevailing per diem rates of an anaesthesiologist. The cost of anaesthesia supplies was based on the anaesthesia supply fee at the Johns Hopkins Hospital. The cost of the preoperative tests was based on data from the Study of Medical Testing for Cataract Surgery and Medicare cost-to-charge ratios. All other costs were based on twice the average wholesale price of the drugs. Discounting was not relevant, as all the costs were incurred during a short time, and was not performed. The resource quantities and the costs were not reported separately. The study reported the expected cost per patient. The price year was 1999.

Statistical analysis of costs
The costs were treated as point estimates (i.e. the data were deterministic).

Indirect Costs
The indirect costs were not included.

Currency
US dollars ($).

Sensitivity analysis
The stability of the results obtained from the model in terms of mean probabilities, costs and preference values was assessed through one- and two-way sensitivity analyses. A one-way sensitivity analysis was performed on each variable included in the model, by varying it over its entire plausible range while holding all other variables constant. A two-way sensitivity analysis was performed to examine the effect of varying two variables simultaneously across their plausible ranges. The variables found to be sensitive in the one-way analysis were analysed in this manner to determine the best strategy for all possible combinations of the two compared variables.

Estimated benefits used in the economic analysis
The expected net preference for each strategy was:

0.875 for strategy 1;
0.738 for strategy 2;
0.605 for strategy 3;
0.644 for strategy 4;
0.551 for strategy 5; and
0.484 for strategy 6.

Cost results
The expected cost per patient for each strategy was:

$324.42 for strategy 1;
$41.47 for strategy 2;
$16.47 for strategy 3;
$324.72 for strategy 4;
$41.77 for strategy 5; and
$16.77 for strategy 6.

Synthesis of costs and benefits
The costs and benefits were synthesised by plotting the expected average cost versus the expected net preference value for each of the six anaesthesia strategies. This showed that strategy 2 was superior to strategies 3, 5 and 6 because a substantially higher expected net preference value was obtained with strategy 2, for approximately the same expected cost as for the other strategies. Strategy 2 was dominant over strategy 4, as it had a higher expected preference value at a significantly lower expected net cost. Strategy 1 was significantly more costly, but it had a higher expected net preference value than strategy 2.

In the one-way sensitivity analysis, the results were sensitive to the values assigned to the cost estimate for topical anaesthesia and the cost of block anaesthesia. When the baseline preference value assigned to strategy 2 was close to its maximum, strategy 2 yielded a higher expected preference value than strategy 1. A similar result was observed for strategies 4, 5 and 6. In a two-way sensitivity analysis of strategy 1 against strategy 2, shifting the baseline preference value of strategy 1 toward its minimum, with concomitant shifting of the baseline preference value of strategy 2 toward its maximum, resulted in a range of preference values at which strategy 2 became preferred. A similar result was observed when comparing the preference value of strategy 1 with that of strategies 4, 5 and 6.

Authors' conclusions
The costs and preference were important considerations when choosing an anaesthesia management strategy for cataract strategy. The authors also concluded that, for some surgeries, substantial cost-savings could be available for a small change in preference.

CRD COMMENTARY - Selection of comparators
The authors compared the preferences and costs of the six cataract anaesthesia management strategies because they were all clinically relevant. You should decide if these strategies are widely used in your own setting.

Validity of estimate of measure of effectiveness
The authors only included one study in the review, as a recent systematic review of the literature on anaesthesia management for cataract surgery did not provide the specific probability estimates that were needed for the analysis. The study included was a large randomised controlled trial (RCT), which was appropriate as well-conducted RCTs are considered the 'gold' standard when comparing different health care strategies. The authors also derived 95% confidence intervals from the study using appropriate statistical techniques. These confidence intervals were then used as the range of values over which the sensitivity analysis was undertaken.

Two panels of experts were used to derive the remaining estimates of effectiveness. The majority of panel members were ophthalmologists or anaesthesiologists. In addition, six panel members had recently completed an extensive review and synthesis of the literature on the anaesthesia management of cataract surgery. The panel used the median response as the baseline probability value to reduce the influence of any outliers. The lowest and highest responses provided the range over which the sensitivity analysis was undertaken.

All estimates, whether derived from the study or from expert opinion, were appropriately investigated in the sensitivity analyses. The ranges used were appropriate.
Validity of estimate of measure of benefit
The expected net preference value for each strategy was modelled. An extended panel of experts was used to obtain the preference values. The values were assigned to management strategies on the basis of mean rating responses. All values were subject to sensitivity analyses.

Validity of estimate of costs
All the categories of cost relevant to the perspective adopted were included in the analysis, as were all relevant unit costs. The costs and the quantities were not reported separately, which limits the generalisability of the authors' results. However, the authors provided detailed unit costs. The unit costs were derived from published sources and the authors' settings. A sensitivity analysis of the prices was conducted, and both the analysis and the ranges used were appropriate. Since all the costs were incurred during a short time, discounting was unnecessary. For some prices, Medicare charges were used to proxy real prices, in this instance cost-to-charge ratios were used. The price year was reported, which will aid any possible inflation exercises.

Other issues
The authors did not compare their findings with those from other studies. This would stem from the fact that no similar studies had been published. The issue of generalisability to other settings was partially addressed through the sensitivity analysis. The authors do not appear to have presented their results selectively, and their conclusions reflected the scope of the analysis.

The authors reported a number of further limitations to their study. First, the experts, as medical professionals, might have been biased in their assessment of preference of one strategy over another, although this limitation was partially minimised through the sensitivity analysis. Second, in other locations, the cost of the anaesthetic and sedation strategies could differ from the cost estimates used in this analysis. However, the authors reported that it was unlikely that geographic variation would be associated with a significant change in the rank ordering of the strategies by cost. Third, the preference values and disutility factors used in this study did not represent the traditional utilities of decision analysis, in that perfect health and death were not the anchors. Another limitation of this study, not reported by the authors, was that no incremental analysis of the costs and benefits was undertaken to investigate which of the two strategies found to be dominant (i.e. 1 and 2) was the most cost-effective.

Implications of the study
The authors reported that if some surgeries made a small change in anaesthesia management strategy, they could reap substantial cost-savings.

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