Cost-effectiveness analysis of sedation and analgesia regimens during fracture manipulation in the pediatric emergency department

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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 study examined four procedural sedation and analgesia (PSA) regimens frequently administered and investigated in the paediatric emergency department (ED) to facilitate forearm manipulation. These were deep sedation with ketamine/midazolam (K/M) administration, propofol/fentanyl (P/F) administration, fentanyl/midazolam (F/M) administration, and brachial plexus regional block using the axillary approach.

Type of intervention
Treatment.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised a hypothetical cohort of 10-year-old children weighing 30 kg, with a forearm fracture, who were in the paediatric ED.

Setting
The setting was secondary care. The economic analysis was performed in Memphis, USA.

Dates to which data relate
The effectiveness data used to populate the model came from studies published between 1995 and 2003. The dates to which the resource use data referred were not reported. The price year was not reported.

Source of effectiveness data
The frequency of adverse events with the different treatment regimens was evaluated. Specifically, the adverse events considered were emesis, recovery agitation, respiratory depression necessitating assist ventilation or use of reversal agents, lidnocaine toxicity, and axillary block failure requiring additional intervention and/or intense monitoring. The total time of sedation and the success rate of procedural sedation/analgesia were also derived from the literature.

Modelling
A decision analytic model was developed to compare the cost-effectiveness of the regimens. The data were analysed using Data 3.5 software (TreeAge Software Inc., Williamstown). The structure of the tree and the summary probabilities used in the analysis were reported.

Sources searched to identify primary studies
The clinical effectiveness data were derived from published literature. Unpublished data from a trial from the authors’ institution were also used. The types of clinical studies identified from the literature were not described.

**Methods used to judge relevance and validity, and for extracting data**

The studies from the published literature were identified by searching MEDLINE. The search strategy used the terms "fracture", "emergency department", "sedation", and "analgesia" to identify studies of paediatric patients (younger than 18 years) reported in English between 1966 and 2004. Studies that systematically measured distress during the procedure, sedation times and success rates of PSA were selected.

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

The measure of benefit used was the time to discharge from the ED; the shorter the time, the better.

**Direct costs**

The cost of drugs for PSA, the cost of treating adverse effects, the cost of physician and nursing time, and ED overheads were evaluated. The perspective of the hospital was adopted. The cost of the drugs was calculated from the institution's contract price per vial of medication used. Doses were calculated under the assumption that the child was 10 years of age and weighed 30 kg. ED fixed costs for maintaining a full paediatric ED service were used. Personnel costs incurred during the ED stay were included in the cost calculations. These considered salary and benefits for nurses, based on the average hourly wages for ED nurses at the hospital, and costs for respiratory therapist and paediatric emergency medicine physician time, based on their wages. The unit costs were reported, but resource quantities were not. The price year was not reported. Discounting was not carried out, but it would not have been relevant as the costs were incurred during less than a year.

**Statistical analysis of costs**

When one study was used to determine the probability of adverse events, the 95% confidence interval (CI) was calculated from the available data. When more than one study was used to determine probability, a weighted mean was calculated, and the maximum and minimum values of probability in the studies represented the range of values. The costs were treated deterministically.

**Indirect Costs**

No productivity losses were considered.

**Currency**

US dollars ($).

**Sensitivity analysis**

A sensitivity analysis, in which the key variables were altered to allow for uncertainty in clinical outcomes and heterogeneity in costs, was employed. No explicit justification was provided for the range of values used in sensitivity testing. Two-way sensitivity analyses were used to determine the threshold values of complications at which the less favourable option would become more cost-effective. The costs were varied between 50% and 200% of the baseline values. Monte Carlo simulations of the decision model, in which one or more parameters of interest were varied, were used to test the robustness of the model through 1,000 iterations of the simulation.

**Estimated benefits used in the economic analysis**

The time to discharge was 0.51 hours for P/F, 1.06 hours for axillary block, 1.75 hours for K/M and 2.19 hours for F/M.
Cost results
P/F cost $84.06, axillary block cost $88.18, K/M cost $105.32 and F/M cost $159.79.

Synthesis of costs and benefits
The authors reported that P/F was the dominant strategy, being more effective and costing less.

Authors’ conclusions
Propofol/fentanyl (P/F) administration would appear to be the most cost-effective regimen for procedural sedation and analgesia (PSA) to facilitate fracture manipulation in the paediatric emergency department (ED).

CRD COMMENTARY - Selection of comparators
A justification was provided for the technologies compared. They were identified as sedation and analgesia regimens that are frequently administered and have been investigated in the paediatric ED setting, to facilitate forearm manipulation. You should decide if these represent valid comparators in your own setting.

Validity of estimate of measure of effectiveness
The authors combined data from a systematic search of the literature. However, the criteria for selecting the papers were not explicitly reported. The types of clinical study used to supply the data were not described. Data from the available papers might have been used selectively.

Validity of estimate of measure of benefit
The estimation of health benefit was derived appropriately using a decision tree analysis. Time to discharge was used as the measure of benefit. You should decide if this adequately measures the health outcomes. The authors went on to calculate the incremental cost-effectiveness ratios (ICERs), which was unnecessary as one intervention dominated all the others; these ICERs are therefore meaningless.

Validity of estimate of costs
The analysis of the costs was performed from the perspective of the hospital. It appears that all the relevant categories of cost have been included in the analysis. The authors adequately reported the sources of resource use and cost data. The authors made assumptions in order to estimate the use of professional time in treating complications and this was a major determinant of the costs.

Other issues
The authors reported that they calculated the ICER in terms of the cost for ED time saved. This was unnecessary since one intervention dominated all the others. Further, the ICERs calculated were meaningless. The authors compared their findings with those from other studies and, in general, showed the results to be in agreement. The authors addressed the issue of generalisability to other settings and suggested that clinicians could use the findings of this analysis to identify the best practice methods for PSA at their own institution.

Implications of the study
The authors made no recommendation for further research but suggested that clinicians can use the findings of their study to identify best practice methods for PSA at their own institution.

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