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Evaluation of costs and effects of epidural analgesia and patient-controlled intravenous analgesia after major abdominal surgery

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Background. The outcome of different treatment strategies for postoperative pain has been an issue of controversy. Apart from efficacy and effectiveness a policy decision should also consider cost-effectiveness. Since economic analyses on postoperative pain treatment are rare we developed a decision model in a pilot cost-effectiveness analysis (CEA) comparing epidural analgesia (EDA) and patient-controlled intravenous analgesia (PCIA) after major abdominal surgery in routine care.

Methods. Using a decision-tree model, treatment with EDA (ropivacaine and morphine) was compared with PCIA (morphine). Effects and costs of treatment were established. The number of pain-free days at rest (pain intensity <30 using visual analogue scale 1–100 mm) was the primary measure of effect. An incremental cost-effectiveness ratio (ICER) was calculated as the difference in direct costs divided by the difference in effect. A database on 644 patients collected for the purpose of quality control during the period of 1997 to 1999 was the main data source. Sensitivity analysis was used to test uncertain data.

Results. EDA was more effective in terms of pain-free days but more expensive. The additional cost for each pain-free day was 5652 Euros.

Conclusion. It is a judgement of value if the additional cost is reasonable. When the cost of around 55 000 Euros per gained life-year with full health for other interventions is debated, our result indicates poor cost-effectiveness for EDA. Before any conclusion can be drawn concerning policy recommendations the difference in costs has to be related to other outcome measures as length of hospital stay, morbidity and mortality are required.

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Good postoperative pain control is a mandatory component of adequate postoperative care if accelerated recovery is aimed for.[1–3] The most common pain relief strategies after major abdominal surgery are epidural infusion of local anaesthetics and opiates (EDA) and/or patient-controlled administration of intravenous opiates (PCIA). According to the guidelines of the Swedish Society of Anaesthesiology both methods are accepted options following major surgery. In general when selecting different treatment strategies efficacy, effectiveness and costs should be taken into account. At the University Hospital in Linköping (Sweden) both EDA and PCIA have been used following major abdominal surgery. Assessment of the clinical effectiveness of EDA during the period of 1997 to 1999 revealed, in line with the findings of others,[4–7] that 10% of patients scheduled for epidural analgesia had their treatment discontinued because of technical problems, minor side-effects or insufficient pain relief. Hence costs and consequences of planned and discontinued treatment became of interest when comparing these two strategies. Moreover this decision-problem concerns a lot of patients. In the county of Östergötland in Sweden with

450 000 inhabitants, 930 postoperative patients received epidural analgesia and 800 PCIA during 2003. This would imply that in Sweden ~40 000 patients are treated with either EDA or PCIA every year.

Since there are few economic analyses of postoperative pain treatment a decision analytic model was developed[8] to estimate the cost-effectiveness of epidural analgesia compared with patient-controlled intravenous analgesia (PCIA) after major abdominal surgery under ordinary clinical circumstances.

Methods

Cost-effectiveness model

A decision tree was used to model the clinical pathways for estimating the effects (E) and costs (C) of treatment with EDA and PCIA. The measure of effect was expressed as number of pain-free days. The cost-effectiveness, the average cost for reaching a particular outcome for a given treatment, is expressed as cost-effectiveness ratio (CER) (Fig. 1).

$$\mathrm{CER}=\frac{\mathrm{Cost}}{\mathrm{Effect}}.$$

When a decision has to be made to replace a treatment with a more expensive and more effective treatment, an estimate of the additional resources that have to be used to obtain the additional benefit is needed.[9] That is the incremental cost-effectiveness ratio (ICER): the difference in direct cost (ΔC) divided by the difference in effect (ΔE) between the two alternatives (Fig. 1).

$$\mathrm{ICER}=\frac{(\mathrm{Cost_{EDA}}-\mathrm{Cost_{PCIA}})}{(\mathrm{Effect_{EDA}}-\mathrm{Effect_{PCIA}})}.$$

The result is presented both as CER and as ICER (Fig. 1). All costs are in 2005 price and are converted to Euros using the exchange rate: 1 Euro=9 Swedish crowns. Sensitivity analyses were performed to estimate the cost-effectiveness by testing data that were uncertain or debatable.

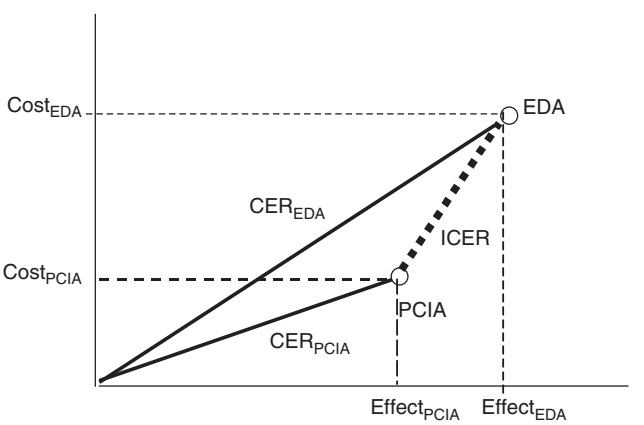

Fig 1 Illustration of the cost-effectiveness ratio (CER) and the incremental cost-effectiveness ratio (ICER).[10] The slopes of the lines from origin give the CER for the treatment with EDA and PCIA. The ICER (dotted line) is the slope of the line joining the points EDA and PCIA. CER=Cost/Effect and ICER=(Cost$_{EDA}$−Cost$_{PCIA}$)/(Effect$_{EDA}$−Effect$_{PCIA}$).

Data source

The main data source was an existing local database, started in 1997 for assessment of clinical effectiveness and by 1999 included 644 consecutive patients treated with EDA (n=602) or PCIA (n=42) following major abdominal surgery (Table 1). Patients were selected for treatment with PCIA in a non-systematic way if a shortage of resources existed on the PCU/ICU or if the patient refused epidural analgesia.

The data of the 42 patients treated with PCIA and of the 569 patients treated with EDA were used, but the data of 33 patients were incomplete. The Research Ethics Committee of the University Hospital in Linköping approved the use of the database as data source for analysis.

The treatment strategies

For the thoracic epidural analgesia a mixture of ropivacaine 2 mg ml^{-1} with morphine 0.03 mg ml^{-1} was delivered at a constant infusion rate of 5.5 ml h^{-1} (Baxter Infuser LV, Baxter Healthcare Corporation, Deerfield, IL). Rescue pain treatment was given according to an algorithm. The patients were observed on the Postoperative Care Unit/Intensive Care Unit (PCU/ICU) for at least 12 h according to actual guidelines.

For treatment with PCIA, morphine 5 mg ml^{-1} was used, and the pump (Smiths Medical, Deltec, Inc., St Paul, MN, USA) was programmed individually to meet requirements and delivery was on demand. The duration of the care on the PCU/ICU was shorter compared with the EDA group according to local instructions. The duration of the treatment was 3 days for both patient groups.

Estimation of probabilities

The structure of the decision tree was developed by the selection of the relevant events and pathways: complete treatment and change of treatment strategy; unsuccessful

Table 1 Patient characteristics of the epidural and the PCIA group. Age and weight are given in mean values (SD). The others are presented in percent

	EDA total (n=569)	**PCIA (n=42)**
Mean age, years (SD)	57 (17)	48 (16)
Weight, kg (SD)	72 (15)	77 (22)
Female, %	50	57
Male, %	50	43
ASA I, %	39	38
ASA II, %	47	52
ASA III, %	12	10
ASA IV, %	2	0
High laparotomy, %	31	31
Low laparotomy, %	60	55
Urology, %	8	14
Trauma, %	1	0