Title: Patient Controlled Analgesia for Pain Management

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Context and policy issues:
Pain following surgery is often treated inadequately, with about 75% of patients experiencing moderate to severe pain. Recovery, health care costs and patient satisfaction are affected by inadequate treatment of post-operative pain. Patient controlled analgesia (PCA) is often used following surgery to relieve pain. A programmable device delivers medication to the patients when requested by pushing a button. The device is programmed by the healthcare provider and delivers a specific amount each time it is requested and a lockout interval prevents over-medication. PCA devices can administer drugs intravenously, intrathecally, subcutaneously, by epidural or transdermally. Opioids are the commonly administered drugs, although non-opioids can be administered as well.

The administration of PCA can be costly and can require a great deal of time and resources. The clinical and cost-effectiveness of PCA should be taken into account when deciding whether to implement a PCA program.

Research questions:
What is the clinical and cost-effectiveness of PCA to manage pain in a hospital setting?

Methods:
A limited literature search was conducted on key health technology assessment resources, including PubMed, The Cochrane Library (Issue 1, 2007), University of York Centre for Reviews and Dissemination (CRD) databases, ECRI, EuroScan, international HTA agencies, and a focused Internet search. Results include articles published between 2002 and the present, and are limited to English language publications only.
Summary of findings:

Clinical effectiveness of PCA

Ten systematic reviews and meta-analyses were identified that discussed the effectiveness of patient controlled analgesia compared to other types of analgesia for post-operative pain, labor pain and oral mucositis.

Post-operative analgesia

A recent Cochrane review (2006) compared PCA to conventional opioid analgesia by injection for pain following various types of surgery, including abdominal and cardiac surgery. Randomized controlled trials comparing PCA to conventional analgesia that measured pain intensity were included in this systematic review. Fifty-five studies were included. Pain intensity was measured using a visual analog scale (VAS) and was less in the PCA group compared to the control (conventional analgesia) group from 1h to 24h following surgery, with a weighted mean difference (WMD) 8 points lower. Pain scores were lower in the PCA group (WMD -9) 25h to 48h following surgery, and scores were 13 points lower in the PCA group 49h to 72 h following surgery. At 0h to 48h following surgery, pain scores were 9 points less. From 0h to 72h, there was no difference in pain intensity. Opioid consumption was also analyzed, and from 0h to 24h, consumption was significantly lower in the PCA group, however there was no difference from 25h to 48h and from 0h to 48h. In contrast, from 0h to 72h there was higher consumption in the PCA group compared to the conventional analgesia group. Eighty-four percent of patients in the PCA group were satisfied with their treatment, compared to 65% in the control group. There were no significant differences in sedation, nausea and vomiting or urinary retention, but there was a significant increase in pruritus in the PCA group compared to the control group (26% versus 18%). Studies included in this review were not blinded, and therefore this may have led to bias in patient satisfaction. In addition, pre-operative pain was not assessed and there was heterogeneity due to the type of surgery and the different PCA regimens. Overall, this review found that PCA was more effective for providing pain relief following surgery compared to conventional opioid analgesia.²

A 2007 systematic review investigated the effect of analgesia on postoperative complications. This review included 18 meta-analyses, 10 systematic reviews, 8 RCTs and 2 observational studies. Various methods of analgesia were discussed in this systematic review, and only a small section discussed PCA. This review found a lack of evidence to draw conclusions regarding the effect of PCA to improve peri-operative mortality and morbidity.⁴

A 2006 meta-analysis used a systematic methodology to compare PCA to nurse-controlled analgesia (NCA) following cardiac surgery. Only RCTs were included in this meta-analysis, and sensitivity analyses were conducted. Ten trials were included in the analysis, and it found no difference in VAS between PCA and NCA patients at 24h following surgery. At 48h following surgery, there was a significant decrease in VAS in the PCA group (WMD -0.73). More morphine was administered in the PCA group at both time points. Length of stay was not different between the groups, and there was no difference in the incidence of adverse events such as nausea and vomiting, severe sedation or respiratory depression. Patient satisfaction was not different between the groups. Limitations of this meta-analysis include the generalizability of the findings, the higher numbers of females in the NCA group, heterogeneity due to the anesthetic and surgical practice and the VAS intervals.⁵
In 2005, another meta-analysis on the efficacy of IV PCA, continuous infusion epidural and patient controlled epidural for analgesia following surgery (various; included abdominal, thoracic and lower extremity surgery) was conducted. Studies included were RCTs that compared postoperative epidural to IV PCA measuring VAS in the adult population. Combining all 48 studies that were identified in the systematic review found that both patient controlled and continuous infusion epidural were more effective for postoperative analgesia than IV PCA (p < 0.001).  

A Cochrane review was published in 2005 comparing PCA to continuous epidural analgesia (CEA) for pain following intra-abdominal surgery. Randomized controlled trials comparing IV PCA to CEA in patients over 14 years of age were included. Nine randomized controlled trials were included, and it was found that VAS was higher in the PCA group compared to the CEA group indicating that PCA was not as effective at relieving pain as CEA. There was no significant difference in adverse events, with the exception of a lower incidence of pruritis in the PCA group. Sensitivity analysis was not done in this study due to insufficient data and variability. The methodological quality of the studies included in this systematic review was low, due to a lack of allocation concealment and blinding. In addition, not all studies reported the outcomes in values that could be used in the meta-analysis and there was heterogeneity due to different surgical models and different medications.

A systematic review published in 2002 compared the effectiveness of intramuscular (IM) analgesia, PCA and epidural analgesia for post-operative pain following abdominal, gynecological, orthopedic and thoracic surgery. RCTs, clinical trials, cohort studies and case controlled studies were included. This report found that moderate to severe pain was experienced by 67.2% of patients using IM analgesia, 35.8% for PCA and 20.9% for epidural analgesia. The incidence of severe pain was 29.1% in the IM analgesia group, 10.4% in the PCA group and 7.8% in the epidural group. This systematic review did not limit the type of literature included to randomized controlled trials, and quality of the studies was not assessed. Overall, this study found that PCA was not as effective as epidural analgesia for pain relief, but was more effective than IM analgesia. 

Analgesia in pediatrics

A health technology assessment on the rational use of analgesics in paediatrics was published in 2006 by the Ministry of Health Malaysia. Pharmacological and non-pharmacological modalities were assessed. PCA was found to be safe for use in paediatric patients, although one study included in this assessment reported lower respiratory rates and oxygen saturation. The effectiveness of PCA in paediatrics was also reported, and one study found that in children from 4.75 years to 14 years PCA was effective at relieving pain due to severe burns. In addition, PCA was effective for patients following appendectomy, and the amount of analgesic consumed was less with PCA. PCA was found to be effective for pain following surgery, and it can be used in children over 5 years of age.

Analgesia for labor

Analgesia for labor was assessed in a 2002 meta-analysis comparing patient controlled epidural analgesia (PCEA) and continuous infusion epidural (CIE). All randomized controlled trials comparing PCEA to CIE were included in this review. Nine studies were included in this meta-analysis, which found that rescue medication was needed in fewer PCEA patients than CIE patients. The dose of drug was significantly higher in the CIE patients compared to the PCEA patients (p < 0.0001). VAS and patient satisfaction was similar in both groups. In addition,
there was no difference in the incidence of caesarean section or in the duration of labor between the groups.¹⁰

**Analgesia for oral mucositis**

A 2007 Cochrane review assessed the effectiveness of treatment for oral mucositis for cancer patients receiving chemotherapy or radiotherapy. All randomized controlled trials comparing treatments for oral mucositis for chemotherapy or radiotherapy patients were included, and only three studies were included that investigated the use of PCA. This review found that PCA and continuous infusion did not have differences in pain control. Morphine administered by pharmacokinetically based analgesia (PCA based on individual patient’s pharmacokinetics) was found in one trial to lower pain scores more than PCA administered morphine. Continuous infusion of morphine resulted in more morphine required compared to the PCA group. This study concluded that PCA is superior for controlling pain due to oral mucositis.¹¹

**Transdermal PCA**

A systematic review on the use of transdermal PCA for post-operative pain was conducted in 2006. A low intensity current is used to transfer the drug on demand across the skin to the circulation. A randomized controlled trial included in this review compared patients receiving the transdermal PCA to placebo following orthopedic, abdominal or thoracic surgery. VAS scores were 30.9 ± 2.4 for the PCA group and 40.8 ± 4.6 for the placebo group (p = 0.47). In the placebo group, 40.4% of patients withdrew from the study due to inadequate pain management, whereas only 25% of patients in the PCA group withdrew (p < 0.05). Another similar study found that 28.7% of PCA patients and 60% of placebo patients withdrew (p < 0.001). An RCT that compared patients receiving transdermal fentanyl PCA to patients receiving morphine PCA found no differences in pain control at the good or excellent level in the transdermal fentanyl group (73.7%) compared to the morphine PCA group (76.6%) (p = 0.36). Patient discontinuation and VAS scores were also similar in the two groups. This study indicates that transdermal fentanyl PCA and morphine PCA are similar in ability to provide pain control. In addition, transdermal fentanyl was found to be safe, and the most common adverse event was nausea in 26.6% - 40.8% of patients.³

**Guidelines for PCA use**

ECRI developed recommendations based on a review of the evidence on errors with PCA use.¹² Misprogramming of PCA infusion pumps can cause an excessive amount of drug to be delivered, which can result in serious patient injury and death. ECRI recommends that a protocol for verification and sign-off for settings by an independent colleague be implemented, that concentrations of the drug are standardized and stocking of the same drug in concentrations that differ by a factor of 10 should be avoided.¹² The Pennsylvania Patient Safety Authority recommends the same items as ECRI, in addition to increased patient monitoring and educating patients, family and staff about proper use of PCA.¹³ National Guideline Clearinghouse has recommendations for use of analgesics in critically ill adults. PCA devices may be used if the patient can understand and operate the device. This is a Grade B level recommendation, which indicates the methods are strong, results are inconsistent, and heterogeneity is present.¹⁴
Costs of PCA

A systematic review on the cost of PCA was published in 2005.\textsuperscript{15} The societal perspective was used in this study, which took direct medical costs, nonmedical costs, indirect morbidity and mortality costs and intangible costs into account, and all costs were converted to 2004 US dollars. Only costs for IV PCA were reported in the review, and it was found that costs for IV PCA ranged from $10 (for elective orthopedic surgery) to $586 (for abdominal hysterectomy). The $586 cost included the cost of a disposable PCA device, which accounted for 72\% of the cost. Most RCTs included in this systematic review compared PCA to intramuscular analgesia, with the exception of one study that compared to epidural analgesia. No information was provided in this systematic review regarding the cost-effectiveness of PCA.\textsuperscript{15}

A decision-tree model was used to compare epidural analgesia to PCA with morphine in a 2005 Swedish study.\textsuperscript{16} The cost per patient for epidural analgesia was €1701, and the cost for PCA was €627. The cost per pain free day per patient was €721 for epidural analgesia and €289 for PCA and the incremental cost effectiveness ratio was €5653. This study found that although epidural analgesia was more expensive than PCA, it was also more effective at providing pain relief than PCA. The authors conclude that PCA is more cost-effective.\textsuperscript{16}

The cost of PCA compared to IM morphine following gynecological surgery was published in 2004.\textsuperscript{17} Nursing time, equipment costs and drug costs were used to determine the total costs. The total cost in the IM group was found to be (in Hong Kong dollars) HK$858.34 (converted by the study authors to US$109.48) compared to HK$939.44 (US$119.83) in the PCA group. Although PCA was found to be more expensive, it was also found to be more effective. The level of pain was lower in the PCA group (p < 0.001) and patient satisfaction was higher in the PCA group (p < 0.001). Side effects were the same in both groups, with the exception of nausea which was more frequent in the PCA group (p = 0.03) and more drug was used in the PCA group (p < 0.001).\textsuperscript{17}

Total costs of PCEA were assessed in another study published in 2004.\textsuperscript{18} This study included cost of insertion of the catheter, material costs and staff costs. Treatment with PCEA resulted in an average cost of €447±218. Gynecological surgery had the highest costs (€471±244) and orthopedic surgery had the lowest costs (€419±221). Staff costs accounted for over half of the total costs.\textsuperscript{18} A randomized controlled trial that analyzed costs of patient controlled epidural analgesia was published in 2002.\textsuperscript{19} PCEA was compared to intrathecal morphine for cesarean section. Manpower costs, medication cost, equipment costs and cost of hospital stay were included in the analysis. There was a significant difference in total costs between the treatments, with morphine costing €43.5±29 and PCEA costing €76.55±17.5 (p < 0.001). Manpower costs and medication costs were not different between the group, whereas costs of equipment was significantly less in the morphine group (€2.2±0.6 versus €29±1.1; p< 0.001). This study demonstrated that more effective pain relief occurred with PCEA, however, it was significantly more expensive than intrathecal morphine.\textsuperscript{19}

Limitations

Only health technology assessments, systematic reviews and economic information were included in this report. Therefore, information contained in randomized controlled trials and observational studies was not included and some relevant data may have been omitted. In addition, literature from only the past five years was included. Furthermore, there were no Canadian cost studies, and it may be difficult to generalize the findings of the included cost studies to a Canadian setting. In addition, within the systematic reviews there was

\textit{Patient controlled analgesia}
heterogeneity due to the patient population and the type of surgery and different comparators and outcome measures were reported.

**Conclusions and implications for decision or policy making:**

Most studies discussed in this report found that PCA was more effective than other methods of analgesia for pain relief. PCA was shown to be more effective than conventional analgesia following surgery.\(^2\,^5\) One study comparing PCA and CIE for labour pain found that both methods were effective, but less drug was required for PCA.\(^10\) Epidural analgesia was found to be more effective than PCA in two studies,\(^6,\,^7\) and PCEA and continuous epidural was found to be better than IV PCA in another study.\(^8\) This study also found that IV PCA was better than IM analgesia.\(^8\) PCA was shown to be effective for paediatric patients over 5 years of age.\(^9\)

No Canadian cost effectiveness studies were found on PCA. One European study found that PCA was more cost-effective compared to epidural analgesia.\(^16\) Other studies showed that PCA was more expensive than IM or intrathecal morphine, but both these studies also state that PCA resulted in more effective pain relief than the other treatment.\(^17,\,^19\)

Overall, patient satisfaction appears to be greater with PCA compared to other analgesic methods and PCA has been shown to be an effective analgesic option. Greater costs may be associated with PCA, but the increased costs may be out-weighed by enhanced pain management and the increased patient satisfaction associated with PCA.

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References:


