Patient-controlled Epidural Analgesia with Bupivacaine and Fentanyl on Hospital Wards

Prospective Experience with 1,030 Surgical Patients

Spencer S. Liu, M.D.,* Hugh W. Allen, M.D.,† Gayle L. Olsson, B.N., M.N.‡

Background: The efficacy and safety of patient-controlled epidural analgesia (PCEA) for postoperative analgesia on hospital wards was studied.

Methods: Postoperative analgesia was provided for 1,030 patients with PCEA using 0.05% bupivacaine and fentanyl, 4 μg/ml, in a standardized manner. Patients were seen at least twice a day by the staff of the anesthesia pain management service. Prospectively gathered data included verbal pain scores at rest and activity (0–10); consumption of bupivacaine and fentanyl; and incidences of pruritus, nausea, sedation, hypotension, motor block, and respiratory depression. Descriptive statistics were used. Risk factors for side effects were determined using logistic regression.

Results: The study included 552 women and 477 men who underwent a median (mode) of 3 (2) days of PCEA. Their mean age was 59 ± 16 yr and their mean weight was 76 ± 19 kg. There were 454 abdominal, 165 gynecologic, 126 urologic, 108 vascular, 90 thoracic, 83 orthopedic, and 4 plastic surgical procedures. Median (mode) pain scores were 2 (0) at rest and 4 (5) with activity on postoperative day 1. Incidences of side effects were 16.7% (pruritus), 14.8% (nausea), 13.2% (sedation), 6.8% (hypotension), 2% (motor block), and 0.3% (respiratory depression). Reasons for termination of PCEA were elective (82%), displaced epidural catheter (12%), anticoagulation (3%), infection (1%), side effects (1%), inadequate analgesia (1%), and other (< 1%). Risk factors for side effects were female sex, patient weight < 75 kg, patient age < 58 yr, bupivacaine and fentanyl consumption > 9 ml/h, use of analgesic adjuncts, and lumbar placement of epidural catheters.

Conclusion: Patient-controlled epidural analgesia provides effective and safe postoperative analgesia on hospital wards. (Key words: Local anesthetics; opioids.)

HIGH-QUALITY postoperative pain relief is a goal of both national health policy§ and the specialty of anesthesiology.1 Despite this interest, postoperative pain relief is often inadequate.2,3 Previous studies have shown that epidural analgesia with local anesthetic combined with opioid provides better postoperative analgesia than epidural or systemic opioids4,5 and may improve postoperative outcome.4,6–8 Although there is limited experience concerning the efficacy and safety of patient-controlled epidural analgesia (PCEA), initial reports suggest that PCEA may improve analgesia,9 patient satisfaction,10 and safety11 compared with conventional epidural infusion or bolus techniques.

Potential benefits of PCEA must be balanced against potential risks. The unique ability of PCEA to allow self-administration of epidural local anesthetics and opioids may affect incidences of side effects in a positive or negative manner. Self-administration could prevent iatrogenic over-administration of epidural analgesics and result in a low incidence of side effects. On the other hand, excessive self-administration of epidural opioid may result in respiratory depression.12 Excessive self-administration of epidural local anesthetic could result in a high incidence of motor block or hypotension.13 Self-administration of local anesthetics and opioids could exacerbate the effects of a displaced epidural catheter into the intravascular or intrathecal space with the potential for high spinal block, systemic toxicity, or respiratory depression.14 Unfortunately, published studies that have investigated the use of PCEA with local

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* Staff Anesthesiologist, Clinical Assistant Professor of Anesthesiology.
† Director of Anesthesiology Pain Management Service, Clinical Assistant Professor of Anesthesiology.
‡ Nurse Specialist in Pain Management.

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Address correspondence to Dr. Liu, Department of Anesthesiology, Virginia Mason Medical Center, 1100 Ninth Avenue, P.O. Box 900, Seattle, Washington 98111. Address electronic mail to: anessl@vmmc.org

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anesthetic and opioid in the general surgical population have enrolled relatively few patients (<100). In comparison, previous prospective surveillance studies determining the efficacy and safety of conventional epidural analgesia techniques have enrolled 614–4,227 patients. Thus the efficacy and safety of PCEA has not been established. We prospectively studied 1,030 patients having surgery and receiving PCEA with bupivacaine and fentanyl on our hospital wards to determine the efficacy and safety of PCEA.

Materials and Methods

After we received institutional review board approval for our study, we prospectively collected data on 1,030 surgical patients consenting to epidural analgesia with PCEA between 22 May 1996 and 2 May 1997. Exclusion criteria included preoperative coagulation abnormality, severe systemic infection, history of allergy to bupivacaine or fentanyl, and patients’ inability to understand the use of patient-controlled analgesia.

Epidural catheters were placed before operation at a vertebral level corresponding to the dermatomal level of surgical incision. An 18-gauge Touhy needle and 20-gauge epidural catheter were used (obtained from various manufacturers). A loss-of-resistance technique was used to identify the epidural space, and the epidural catheter was placed 3–7 cm into the epidural space. The catheter was affixed using skin adhesive (Mastisol; Ferndale Labs, Ferndale, MI), followed by a clear dressing (Opsite IV 3000; Smith & Nephew United, Largo, FL). Adhesive tape (Hypafix; Smith & Nephew United) was placed on the edges of the clear dressing and used to affix the catheter along the patient’s back. Preoperative sedation and administration of intraoperative anesthesia was at the discretion of the managing anesthetic team. On arrival in the postanesthesia care unit, a patient-controlled analgesia device (Abbott Pain Manager II; Abbott Laboratories, North Chicago, IL) was connected to the patient’s epidural catheter. An analgesic solution of bupivacaine (0.05%) and fentanyl (4 μg/ml) was used for all patients. Initial PCEA settings were a background infusion of 4 ml/h with a PCEA bolus of 2 ml and lockout interval of 10 min (Appendix 1). Inadequate analgesia (verbal pain score at rest ≥5) was treated with a 5-ml loading dose of the bupivacaine plus fentanyl solution followed by an increase in the background infusion of 2 ml/h. No changes were made to the PCEA bolus dose or lockout interval. A standard-ized intraoperative loading dose of epidural bupivacaine and fentanyl was not given, because most of our patients receive either combined general and epidural or epidural anesthesia. All patients were transferred from the postanesthesia care unit to the surgical ward unless surgical practice required intensive care observation.

Patients were visited twice a day by staff of the Anesthesia Pain Service (APS) between 8:00 and 11:00 A.M. and between 3:00 and 6:00 P.M. and whenever clinically necessary 24 h a day. Initial treatment of inadequate analgesia (verbal pain score at rest or with activity ≥5) and side effects, and intensity of nursing observation were standardized (Appendices 1–3). Additional loading doses of bupivacaine/fentanyl and additional treatments for side effects beyond those specified in the standing orders were allowed at the discretion of the APS. Adjunctive analgesics such as nerve blocks, ketorolac, and systemic opioids were allowed at the discretion of the APS. Routine surgical practice at our institution is for Foley catheters to remain in place until epidural analgesia is discontinued and for patients to ambulate on postoperative day 1. Initial data collection included patient’s sex, age, weight, surgical procedure, type of surgical procedure, vertebral level of epidural catheter, and length of epidural catheter inserted into the epidural space. The following prospective data were collected by the APS during visits: (1) Verbal pain scores (0.0 = no pain, 10.0 = worst pain imaginable, with decimals allowed) were collected from the patient at rest and with activity. Activity consisted of ambulation or patient movement during examination of epidural catheter if a patient was not ambulatory. (2) Sedation was judged by the observer on a five-point scale (0 = alert, 1 = mildly drowsy, 2 = moderately drowsy, easily rousable, 3 = very drowsy, rousable, 4 = difficult to rouse, or 5 = unrousable). (3) Presence of nausea was defined as patient request for antiemetic treatment. Patients were reminded at each visit that treatment was available. (4) The presence of pruritus was defined as patient requests for antipruritic treatment. Patients were reminded at each visit that treatment was available. (5) Presence of respiratory depression was defined as respiratory rate <8 bpm or administration of naloxone due to respiratory embarrassment. (6) The presence of motor block was defined as an inability to ambulate due to lower extremity weakness. The presence of hypotension was defined as systolic blood pressure <90 mmHg. Patient consumption of bupivacaine and fentanyl was recorded from the PCEA device. (9) Epidural catheter location and infectious potential were assessed by visual inspection and palpation. (10) The use of adjunctive analgesics was recorded. Data were collected during APS rounds by

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the investigators (primarily S.S.L. and G.L.O.). Data collection was initially recorded on a standardized paper form and then transferred to a computer database (Excel 5.0; Microsoft Corporation, Redmond, WA).

Epidural analgesia was terminated at the discretion of the APS in consultation with the surgical service. Reasons for termination of epidural analgesia were defined as (1) elective if patients were successfully changed to oral analgesics; (2) coagulation if high-dose anticoagulants were administered or if patients developed significant coagulation abnormalities; (3) infection if epidural catheter insertion site appeared infected or if significant systemic infection developed; (4) side effect if termination was due to nausea, pruritus, sedation, hypotension, motor block, or respiratory depression that could not be controlled by adjustment of PCEA or pharmacologic intervention; (5) pain if PCEA was inadequate despite the addition of adjunctive analgesics; and (6) other. Collected data (side effects, pain scores, and so on) were included for analysis regardless of functionality of epidural catheter. After removal of catheters, the surgical service managed postoperative analgesia, and no further data were collected.

Descriptive statistics were used for the primary analysis. Continuous data are expressed as means ± SD. The frequency of side effects (pruritus, nausea, sedation, hypotension, motor block, and respiratory depression) are expressed as incidences. The maximal risk for side effects was defined as the upper 95% confidence interval of incidence based on a binomial distribution. Risk factors for pruritus, nausea, sedation, hypotension, and motor block were determined from patient (sex, age, and weight) and clinical characteristics (type of surgery, vertebral level of epidural catheter, epidural solution consumption, and use of adjuncts). Initial determination of a significant association between side effect and risk factor was based on contingency table analysis. Continuous variables were divided into dichotomous variables based on examination of raw data for contingency table analysis. Significance was defined as \( P < 0.05 \). Independent risk factors were then determined with forward stepwise logistic regression using the maximum likelihood technique (SPSS 6.1; SPSS Inc., Chicago, IL). Significant \( (P < 0.05) \) independent risk factors are expressed as odds ratios with 95% confidence intervals.

**Results**

**Efficacy and Side Effects of Patient-controlled Epidural Analgesia**

During the study, 1,251 patients were seen by staff of the APS for postoperative pain management. Complete data were collected for 1,030 patients receiving PCEA, and thus this study represents 82% of our clinical practice during this period. Of the 1,030 patients, 813 (79%) were transferred directly from the postanesthesia care unit to the surgical wards, and 217 (21%) were initially observed in the intensive care unit before transfer to the ward. There were 552 women (53.6%) and 477 men (46.4%) enrolled in this study. Patients' ages were 59 ± 16 yr (range, 12-96 yr), and weights were 76 ± 18 kg (range, 36-250 kg). The duration of PCEA ranged from 1-10 days (fig. 1). Of 1,030 patients, 822 (80%) underwent combined general and epidural anesthesia, 163 (16%) underwent epidural anesthesia, 42 (4%) underwent combined spinal-epidural anesthesia, and 3 (0.3%) underwent general anesthesia during operation. Table 1 displays the distribution of the types of surgical procedures, patient age, and characteristics of PCEA. Because the vertebral level of epidural catheter placement was based on the dermatomal level of surgery, most epidural catheters were placed in thoracic vertebral levels (fig. 2). PCEA provided good analgesia (fig. 3) with modest consumption of bupivacaine and fentanyl (fig. 4). Incidences of side effects and maximal risk of side effects were low (table 2). Two patients required naloxone due to respiratory depression and sedation. In one patient, PCEA was temporarily halted and then reinstated with a decreased background infusion. In the other patient, the fentanyl was removed from the analgesic solution because the patient had a history of sleep apnea. Use of analgesic adjuncts was modest, and most epidural catheters were terminated.

Fig. 1. Distribution of durations of postoperative analgesia with patient-controlled epidural analgesia.
PATIENT-CONTROLLED EPIDURAL ANALGESIA

Table 1. Clinical Characteristics of PCEA per Type of Surgery

<table>
<thead>
<tr>
<th>Type of Surgery</th>
<th>N</th>
<th>%</th>
<th>Patient Age (yr)</th>
<th>Level of Epidural Catheter (median/mode)</th>
<th>Duration of PCEA (days) (median/mode)</th>
<th>Elective Termination of PCEA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal</td>
<td>454</td>
<td>44</td>
<td>60 ± 16</td>
<td>T10/T8</td>
<td>3/3</td>
<td>80</td>
</tr>
<tr>
<td>Gynecologic</td>
<td>165</td>
<td>16</td>
<td>53 ± 14</td>
<td>L2/L2</td>
<td>2/2</td>
<td>89</td>
</tr>
<tr>
<td>Urologic</td>
<td>126</td>
<td>12</td>
<td>55 ± 15</td>
<td>T11/L2</td>
<td>2/2</td>
<td>79</td>
</tr>
<tr>
<td>Vascular</td>
<td>108</td>
<td>11</td>
<td>68 ± 10</td>
<td>T10/L3</td>
<td>3/1</td>
<td>82</td>
</tr>
<tr>
<td>Thoracic</td>
<td>90</td>
<td>9</td>
<td>61 ± 14</td>
<td>T7/T7</td>
<td>3/3</td>
<td>80</td>
</tr>
<tr>
<td>Orthopedic</td>
<td>83</td>
<td>8</td>
<td>60 ± 18</td>
<td>L2/L2</td>
<td>1/1</td>
<td>89</td>
</tr>
<tr>
<td>Plastic</td>
<td>4</td>
<td>1</td>
<td>39 ± 16</td>
<td>L2/L2</td>
<td>3/NA</td>
<td>75</td>
</tr>
<tr>
<td>Total</td>
<td>1,030</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Values are mean ± SD unless otherwise noted.

PCEA = patient-controlled epidural analgesia; NA = not applicable.

electively (table 3). No patients had an epidural abscess or hematoma.

Risk Factors for Side Effects during Patient-controlled Epidural Analgesia

Contingency table analysis identified patient age (<58 yr), patient weight (<73 kg), female sex, lumbar vertebral level of epidural catheter placement, increased consumption of epidural analgesia (>9 ml/h), and use of analgesic adjuncts as potential risk factors for side effects. Risk factors for respiratory depression were not analyzed because of the low incidence. Contingency table analysis showed a significant association between pruritus and patient age and consumption of epidural analgesia; between nausea and the type of surgery, female sex, use of adjuncts, and patient weight; between sedation and female sex; between hypotension and female sex, use of analgesic adjuncts, and patient weight; and between motor block and patient weight and lumbar epidural catheter. Independent risk factors for side effects were identified using logistic regression (table 4).

Discussion

Use of PCEA with bupivacaine and fentanyl provided good analgesia after a wide variety of surgical procedures. Previous surveillance studies have also reported effective postoperative analgesia with continuous epidural infusions of bupivacaine and morphine, bupivacaine and fentanyl, bupivacaine and sufentanil, and boluses of epidural morphine. Direct comparisons between techniques are not possible due to different methods. Our method also allowed use of analgesic adjuncts that may have improved the quality of our postoperative analgesia.

Patient-controlled epidural analgesia may provide several benefits over conventional epidural continuous infusion or bolus techniques. Preliminary studies examining obstetric and surgical patients reported better analgesia with PCEA using bupivacaine and fentanyl (37% better on average) compared with continuous epidural infusion. Provision of a patient-control function has been shown to improve patient satisfaction with PCEA with bupivacaine compared with an epidural bolus technique in obstetric patients, but the published experience is limited. Extensive experience with intravenous patient-controlled analgesia corroborates improved patient satisfaction with provision of a patient-controlled device. Use of continuous infusion or inter-

Fig. 2. Distribution of vertebral level of epidural catheter placement.

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mittent bolus epidural analgesia is labor intensive, because all analgesic adjustments require either nursing or physician intervention. Use of PCEA offers the potential to decrease the amount of nursing and physician time required because patients can self-titrate analgesia. Although the effects of PCEA on nursing and physician time commitment have not been directly examined, previous experience with intravenous patient-controlled analgesia indicates that decreased nursing time can be realized with the use of patient-controlled analgesia. Thus the use of PCEA could improve analgesia, improve patient satisfaction, and reduce costs.

Use of PCEA resulted in low incidences of side effects (maximal risk, 0.4-19% incidence). Previous surveillance studies examining continuous epidural infusions of bupivacaine and morphine, bupivacaine and fentanyl, bupivacaine and sufentanil, and boluses of morphine reported comparable incidences of side effects. These studies reported a range of maximal risk for pruritus of 12-28%, for nausea of 6-32%, for hypotension of 3-8%, for sedation of 9-24%, for motor block of 4-12%, and for respiratory depression of 0.2-1.9%. Direct comparisons of techniques are not possible due to different methods. Use of PCEA might pro-

Fig. 3. Verbal pain scores at rest and with activity in the morning. The box plot displays 10th, 25th, median, 75th, and 90th percentiles of values. POD = postoperative day. Values in parentheses represent the number of patients.

Fig. 4. Hourly consumption of bupivacaine and fentanyl solution with patient-controlled epidural analgesia. The box plot displays 10th, 25th, median, 75th, and 90th percentiles of values. POD = postoperative day. Values in parentheses are the number of patients.
vide lower incidences of side effects than conventional epidural analgesia techniques do. PCEA has been shown to decrease patient requirements for epidural bupivacaine and fentanyl (50% decrease on average) for equivalent analgesia when compared with continuous epidural infusions in obstetric16 and surgical populations.16,18 Decreased use of bupivacaine and fentanyl with PCEA with equivalent analgesia would be valuable

Table 2. Incidence and Maximal Risk of Side Effects

<table>
<thead>
<tr>
<th>Side Effect (definition)</th>
<th>% Incidence (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pruritus (patient request for antipruritic)</td>
<td>16.7 (14.7–18.7)</td>
</tr>
<tr>
<td>Nausea (patient request for antiemetic)</td>
<td>14.8 (12.8–16.8)</td>
</tr>
<tr>
<td>Sedation:</td>
<td></td>
</tr>
<tr>
<td>Mildly drowsy</td>
<td>11.7 (9.7–13.7)</td>
</tr>
<tr>
<td>Moderately drowsy</td>
<td>0.9 (0.3–1.5)</td>
</tr>
<tr>
<td>Very drowsy</td>
<td>0.5 (0.1–0.9)</td>
</tr>
<tr>
<td>Difficult to rouse</td>
<td>0.1 (0.0–0.2)</td>
</tr>
<tr>
<td>Hypotension (systolic blood pressure &lt;90 mmHg)</td>
<td>6.8 (5.0–9.0)</td>
</tr>
<tr>
<td>Motor block (inability to ambulate due to lower extremity weakness)</td>
<td>2.0 (1.0–3.0)</td>
</tr>
<tr>
<td>Respiratory depression (respiratory rate &lt;8 breaths/min)</td>
<td>0.3 (0.0–0.6)</td>
</tr>
<tr>
<td>Requiring naloxone</td>
<td>0.2 (0.0–0.4)</td>
</tr>
</tbody>
</table>

CI = confidence interval based on binomial distribution.

Table 4. Risk Factors* for Side Effects with PCEA

<table>
<thead>
<tr>
<th>Side Effect</th>
<th>Risk Factor</th>
<th>Odds Ratio (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pruritus</td>
<td>Patient age (&lt;58 yr)</td>
<td>1.3 (1.2–1.4)</td>
<td>0.01</td>
</tr>
<tr>
<td>Increased consumption</td>
<td>PCEA (&gt;9 ml·h⁻¹⁻)</td>
<td>1.3 (1.1–1.5)</td>
<td>0.008</td>
</tr>
<tr>
<td>Nausea</td>
<td>Female gender</td>
<td>1.4 (1.2–1.7)</td>
<td>0.009</td>
</tr>
<tr>
<td>Sedation</td>
<td>Female gender</td>
<td>1.2 (1.0–1.5)</td>
<td>0.032</td>
</tr>
<tr>
<td>Hypotension Female gender</td>
<td>1.5 (1.1–2.1)</td>
<td>0.006</td>
<td></td>
</tr>
<tr>
<td>Motor block Lumbar epidural catheter</td>
<td>1.4 (1.0–1.8)</td>
<td>0.036</td>
<td></td>
</tr>
<tr>
<td>Motor block Lumbar epidural catheter</td>
<td>1.4 (1.1–1.8)</td>
<td>0.009</td>
<td></td>
</tr>
<tr>
<td>Motor block Lumbar epidural catheter</td>
<td>2.1 (1.5–3.2)</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>Motor block Lumbar epidural catheter</td>
<td>1.7 (1.0–2.7)</td>
<td>0.031</td>
<td></td>
</tr>
</tbody>
</table>

* Risk factors determined with logistic regression.

Table 3. Use of Analgesic Adjuncts and Reasons for Termination of PCEA

<table>
<thead>
<tr>
<th>Analgesic adjunct</th>
<th>N</th>
<th>Incidence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ketorolac</td>
<td>242</td>
<td>23</td>
</tr>
<tr>
<td>Nerve block</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>Systemic opioids</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>Combination</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>286</td>
<td>27</td>
</tr>
<tr>
<td>Reason for termination of PCEA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elective</td>
<td>846</td>
<td>82</td>
</tr>
<tr>
<td>Displaced</td>
<td>118</td>
<td>12</td>
</tr>
<tr>
<td>Coagulation</td>
<td>32</td>
<td>3</td>
</tr>
<tr>
<td>Infection</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>Pain</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Side effect</td>
<td>9</td>
<td>0.9</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>0.4</td>
</tr>
<tr>
<td>Intrathecal migration of epidural catheter</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Total</td>
<td>1,030</td>
<td>100</td>
</tr>
</tbody>
</table>

PCEA = patient-controlled epidural analgesia.

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if side effects related to bupivacaine and fentanyl could be reduced. Although these previous studies have not observed significant reduction of side effects with PCEA, the small number of enrolled patients (<100) does not allow conclusions to be drawn. One study has reported fewer episodes of hypoxemia (pulse oximetry <85%) with use of PCEA with fentanyl compared with epidural continuous infusions.11 Thus the use of PCEA could potentially reduce the incidence of side effects and improve safety of epidural analgesia.

Logistic regression analysis identified several independent risk factors for side effects. The strongest risk factor was lumbar placement of epidural catheters for development of motor block. The segmental nature of epidural administration of local anesthetics well explains this increased risk of lower extremity motor block.27 A previous study noted decreased lower extremity motor block with high lumbar (L1–L2) compared with low lumbar (L4–L5) administration of epidural local anesthetic.27 Although we know that thoracic placement of epidural catheters should produce less motor block than lumbar, this is the first large scale surveillance study to demonstrate this association. Increased consumption of epidural bupivacaine and fentanyl (>9 ml/h) was a slight risk factor (odds ratio, 1.3) for development of pruritus. Epidural fentanyl commonly causes pruritus that is antagonized by naloxone.28 Although our data suggest a dose-response relation between epidural fentanyl and pruritus, previous studies have reported inconsistent relations between the dose of epidural opioid and the incidence of pruritus.29 Female sex was a slight risk factor (odds ratio, 1.4) for development of nausea. Previous studies have
also reported an increased incidence of postoperative nausea in women, perhaps due to gender differences in gonadotropin hormonal levels.  

The ideal combination of local anesthetic and opioid for PCEA is unknown. We selected fentanyl for its rapid onset and low risk for delayed respiratory depression. A 4 μg/ml solution of fentanyl was chosen, because previous work has demonstrated more rapid onset of action and longer duration of analgesia with similar dilution of fentanyl. Other lipophilic (alfentanil, sufentanil) and hydrophilic (hydromorphone, meperidine) opioids also have suitable characteristics of rapid onset and modest duration for PCEA. Morphine may be a less obvious choice for PCEA. Epidural morphine has a delayed onset of analgesia, long duration, and a risk for delayed respiratory depression, although more selective spinal analgesia may be provided. We chose to add 0.05% bupivacaine to our analgesic solution, as previous dose-ranging studies suggest that the addition of approximately 0.05% bupivacaine to fentanyl improves analgesia and reduces epidural fentanyl use.  

The segmental nature of epidural analgesia with bupivacaine and fentanyl explains our practice of placing epidural catheters at a vertebral level compatible with dermatomal level of surgical incision. Because of the large percentage of abdominal and thoracic procedures at our institution, most of our epidural catheters were placed at thoracic vertebral levels. Although increased risk of neurologic injury may be a concern with placement of thoracic epidural catheters, recent studies suggest that complications with placement of thoracic epidural catheters are no greater than with lumbar placement and that maximal risk of neurologic injury is approximately 0.07%. Thus use of a dilute combination of bupivacaine and fentanyl for PCEA is reasonable, but further studies are needed to determine optimal analgesic solution, background infusion rates, and PCA settings for PCEA.

We conclude that PCEA provided effective and safe postoperative analgesia on the hospital ward after various surgical procedures.

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References


PATIENT-CONTROLLED EPIDURAL ANALGESIA


Appendix 1: Standing Orders for Patient-controlled Epidural Analgesia Settings and Analgesic Therapy

1. Epidural analgesic solution is 4 μg/ml 0.05% bupivacaine with fentanyl.
2. Set the background infusion rate to 4 ml/h.
3. Set the loading dose to 5 ml.
4. Set 1-h limit to 14 ml.
5. Set PCEA bolus to 2 ml and lockout to 10 min.
6. If analgesia is inadequate (verbal pain score ≥5 at rest or with activity), then administer a 5-ml loading dose, increase the infusion rate by 2 ml/h, and increase the 1-h limit to 24 ml.
7. If more than two adjustments to PCEA are needed within a 24-h period, then call the Anesthesia Pain Management Service.
8. No other analgesics or hypnotics are to be given without notifying the Anesthesia Pain Management Service.

Appendix 2: Standing Orders for Treatment of Side Effects

1. Respiratory Depression

If respiratory rate ≤8 breath/min and unable to arouse patient, then give 0.1 mg naloxone intravenously STAT (may repeat ×3). Call the Anesthesia Pain Management Service STAT.

If respiratory rate is ≥10 breath/min, call the Anesthesia Pain Management Service.

2. For nausea and vomiting, administer 0.5 mg droperidol intravenously every 4 h as needed.
3. For pruritus, administer 25-50 mg diphenhydramine intravenously or by mouth every 4 h as needed.
4. If systolic blood pressure is <90 mmHg, call the Anesthesia Pain Management Service.
5. Allow assisted ambulation only. Call the Anesthesia Pain Management Service for motor weakness.

Appendix 3: Standing Orders for Nursing Observation

1. Check respiratory rate, level of consciousness, and blood pressure/heart rate
   - Every 1 h × 12 h
   - Every 2 h × 12 h
   - Every 4 h thereafter
2. If systolic blood pressure is <90 mmHg, call the Anesthesia Pain Management Service.
3. Postural pressure on the morning of postoperative days 1 and 2
4. Check the level of sensory block every 8 h. Notify the Anesthesia Pain Management Service for T4 block or rising sensory level.
5. Maintain intravenous access for 2 h after epidural infusion is discontinued.

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