Systematic Literature Review of the Economics of Intravenous Patient-Controlled Analgesia

Alex Macario, MD, MBA

ABSTRACT

Purpose: Intravenous patient-controlled analgesia (IV PCA) is often used to control pain after many types of surgery. The advent of several new alternatives in the management of postoperative pain warrants an updated examination of the costs of this modality. The goal of this study was to review the published literature to evaluate the economics of IV PCA.

Methods: We identified clinical trials in the international, peer-reviewed, published English literature related to IV PCA economics by searching MEDLINE and other databases for studies from 1990 to 2004. Adopting a societal perspective, we identified IV PCA cost drivers for the 72-hour period after surgery. Direct medical and nonmedical costs and intangible costs (e.g., adverse events from programming errors). A scientifically more rigorous analysis needs to be conducted to account for the costs of alternatives, including health care resource utilization, as well as the benefits, which are easily identified but not necessarily easily quantified.

INTRODUCTION

Patients are often anxious about having pain after surgery.1–5 The literature supports the efficacy of and patients’ preferences for intravenous patient-controlled analgesia (IV PCA) over intramuscular (IM) techniques for postoperative pain.6,7 As a result, IV PCA is frequently used for parenteral opiate administration for the control of pain after various surgical procedures in the U.S. The advent of new options for managing postsurgical pain warrants a re-examination of the costs of this technique.

Few studies, however, have examined the economics of postoperative analgesia. In a review article of nine studies published between 1984 and 1995, the cost-effectiveness of IV PCA remained unclear because of the variability in methods used to determine costs, the various settings and patient populations in which IV PCA was applied, and the organization of IV PCA management.8

The objective of this study was to perform a systematic review of the literature to quantify the economics of IV PCA. We focused mainly on cost drivers of IV PCA not associated with the costs of opiate adverse effects, because we assumed that the opiate side-effect profile would be similar, regardless of the delivery system used to administer the opiate.

METHODS

Literature Review

We reviewed the literature to identify resources associated with the use of IV PCA. Systematic reviews apply strategies that limit bias to the assembly, appraisal, and synthesis of relevant studies on a specific topic.9,10 We followed guidelines11,12 in compiling all clinical trials in the international, peer-reviewed, published literature related to IV PCA economics. Articles not printed in English were excluded.13

We used electronic searches of the National Library of Medicine’s MEDLINE database, the Cochrane Central Register of Controlled Trials, and the Cochrane Database of Systematic Reviews for studies conducted on human subjects from 1990 to June 2004. Studies prior to 1990 were excluded because IV PCA technology and medical/nursing practices have changed over the past 15 years and have made those data less applicable to today’s environment.14–19

Disclosure: This study was funded in part by Cardinal Health, a medical education company in Philadelphia, Pennsylvania.
We entered the terms “IV PCA,” “safety,” “adverse events,” “economics,” “postoperative pain,” “costs,” and “patient controlled analgesia” separately as medical subject headings and as text words. No minimum sample sizes were invoked for inclusion of studies. We included only studies of adults older than 18 years of age.

The contents of 37 full-text articles identified during the literature search were read in full. We checked the reference list of each of the analyzed articles for additional studies. A manual search, conducted by screening citation lists in review articles, yielded another 18 articles. The data were then extracted.

The following study characteristics were recorded:

- first author’s name
- year of publication
- method of patient enrollment (prospective or retrospective) and whether the trial was randomized
- type of surgery
- the number of patients
- details of the economic analysis

Studies of IV PCA that did not report resource utilization were excluded. For this paper, studies of nonsurgical groups, such as patients with cancer or critically ill patients, were not considered.

Cost Drivers

In general, costs can be analyzed from different points of view: the patient, the provider, the payer, or society as a whole. For example, the cost of IV PCA to the insurance company equals the percentage of charges actually paid by the payer. However, the relevant cost to the patient is any out-of-pocket expense plus other costs (e.g., the inability to participate in rehabilitation as a result of being tethered to IV PCA) related to the quality of recovery.

In quantifying IV PCA cost drivers, we assumed a societal perspective, as recommended by an expert panel, because society expects physicians to be able to act as patient advocates and to fulfill their responsibilities to manage resources prudently.

Using data gathered from the literature, we tabulated the following types of costs:

- direct medical expenses (nursing and pharmacy labor, the pump, and disposables)
- direct nonmedical costs
- indirect morbidity and mortality costs
- intangible costs (unexpected events, such as breakthrough pain from malfunctioning pumps, analgesic gaps from IV line failures, or line infiltration)

It was difficult to assign a monetary value to these consequences. Rates of adverse events were captured from retrospective safety studies of IV PCA.

We converted all costs measured in individual studies to 2004 U.S. dollars using the Medical Care Services component of the Consumer Price Index.

RESULTS

Data from 18 studies of 37 initially screened studies were fully analyzed. Ten studies were randomized controlled trials, three were prospective but nonrandomized studies, and five were retrospective safety studies. Nine of the 10 randomized trials compared IV PCA with IM analgesia. One paper reported two separate randomized controlled trials, both of which were analyzed. Only one of these 10 randomized trials was published after 1999.

The sample sizes for IV PCA patients studied averaged 37 patients (range, 12–98).

Cost drivers are presented in Tables 1 to 3. Most published studies do not include the full scope of costs associated with IV PCA. Direct medical costs include the electronic (or, in some cases, disposable) pump device, disposables (such as IV tubing), and pharmaceuticals (e.g., the drug cartridge).

Table 1  Direct Medical Costs of Intravenous Patient-Controlled Analgesia (IV PCA)

<table>
<thead>
<tr>
<th>Nursing staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Process the order and retrieve the pump.</td>
</tr>
<tr>
<td>2. Initiate the PCA pump.</td>
</tr>
<tr>
<td>3. Load the syringe.</td>
</tr>
<tr>
<td>• Connect tubing and extension set.</td>
</tr>
<tr>
<td>• Turn the pump on.</td>
</tr>
<tr>
<td>• Purge the system.</td>
</tr>
<tr>
<td>4. Pump programming time (two nurses needed to verify)</td>
</tr>
<tr>
<td>• Select delivery mode</td>
</tr>
<tr>
<td>• Review settings</td>
</tr>
<tr>
<td>• Refill the 30-ml syringe (morphine 1 mg/ml)</td>
</tr>
<tr>
<td>5. Educate patient to:</td>
</tr>
<tr>
<td>• call for IV PCA assistance</td>
</tr>
<tr>
<td>• differentiate the PCA push-button from the nurse-call button</td>
</tr>
<tr>
<td>• avoid tampering with the PCA</td>
</tr>
<tr>
<td>6. Guard against the loss of the nurse’s IV PCA pump key (the key lock is designed to prevent tampering)</td>
</tr>
<tr>
<td>7. Troubleshoot the IV PCA pump; common alarms include:</td>
</tr>
<tr>
<td>• a low drug level</td>
</tr>
<tr>
<td>• occlusion of the IV tubing</td>
</tr>
<tr>
<td>• an out-of-charge battery</td>
</tr>
<tr>
<td>8. Adjust the drug dosage</td>
</tr>
<tr>
<td>9. Discontinue the IV PCA</td>
</tr>
<tr>
<td>10. Obtain a second witness, as required by regulations, for disposal of any unused drug documentation</td>
</tr>
<tr>
<td>11. Record syringe readings and PCA pump program settings.</td>
</tr>
<tr>
<td>12. Place a new IV line dedicated to PCA.</td>
</tr>
<tr>
<td>13. Redress the existing line.</td>
</tr>
</tbody>
</table>

Pharmacy preparation (with fentanyl or hydromorphone used in IV PCA)

1. Gather supplies; prepare the sterile area.
2. Draw up the drug; mix, seal, and label the syringes.
3. Allow 1–2 minutes per syringe for handling a batch of 100 syringes.
4. Deliver the syringes.
Time–motion studies (Tables 4 and 5) indicated that the mean nurse labor time per day used for IV PCA ranged from 0.5 to 0.75 hours, decreasing to a mean of 0.25 hours on the second and third days. One study categorized the 58 minutes of nursing labor time for IV PCA–related interventions during a 48-hour period as follows:

- 29% for patient care (patient instruction, respiratory problems)
- 24% for pump logistics (pump retrieval from central supply, initial pump set-up, dismantling of the pump)
- 21% for record-keeping
- 14% for line-related problems (occlusion, recatheterization, insertion of a second IV line, IV infiltration)
- the remaining 12% of nursing time for administration tasks (additional drug cartridges, dose increases or decreases, obtaining narcotics from pharmacy)

It is interesting that in a retrospective analysis involving eight community and teaching hospitals, the incidence of postoperative surgical-site infection after intestinal surgery (n = 515 patients, 214 with IV PCA) was significantly greater with IV PCA (10.7%) than with IM analgesia (4.0%) (Table 6).

Combining the results of three retrospective safety studies, 25 of 6,722 patients (0.37%) receiving IV PCA experienced a respiratory adverse event. Risk factors were a continuous opiate infusion and concomitant administration of sedative–hypnotics.

**DISCUSSION**

IV PCA facilitates the matching of patients’ desire for pain relief and analgesic delivered. Unlike other literature reviews of IV PCA that focus on analgesic outcomes, this systematic review pooled data to quantify the resources used to deliver IV PCA. Although economic evaluations of many treatments used in health care have become more rigorous in the last decade as payers demand proof of value, we found that published studies of IV PCA did not include the full scope of drug, equipment, and labor costs, or other associated expenses, such as those arising from failures in treatment. In addition, because the sample sizes for these studies were small (approximately 37 patients), all possible events might not have been captured.

Direct medical costs included the electronic (or disposable) pump device, disposables, and pharmaceuticals. Nurse labor time for IV PCA included tasks related to the following:
- record-keeping
- patient care
- IV line–related problems
- pump logistics
- administration

The calculations of the IV PCA pump cost per patient must include:

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**Table 2 Other Costs of Intravenous Patient-Controlled Analgesia (IV PCA)**

| 1. Storage |
| 2. Preventive maintenance every six months by biomedical engineering (pumps expected to last 10 years) |
| 3. Central supply orderly (5–10 minutes per pump/day): |
| • Collecting and cleaning the IV PCA pump |
| • Storing in the postanesthetic care unit (PACU) |
| • Repairing any malfunctioning pumps |
| • Delivery to the patient’s room |
| 4. Physical damage to pump: cracked case, jammed lock |
| 5. Spontaneous triggering of IV PCA |
| 6. Electronics failure: uncontrolled delivery of entire syringe contents |
| 7. Electrical corruption of the pump program from disconnection or connection to main power |
| 8. Operator error: battery installed backwards, failure to recharge |
| 9. Physician orders |
| 10. Acute pain service to manage; consultations |
| 11. Heavy equipment (a pump weighs 15 pounds) for nurses to lift; interference with patient transport for testing and therapy |
| 12. Allocation of hospital overhead |

**Table 3 Intangible Costs (Pain and Suffering) and Indirect Morbidity and Mortality Costs from Intravenous Patient-Controlled Analgesia (IV PCA)**

| 1. Adverse events (e.g., deaths) from programming errors |
| • Infusion of the wrong drug product |
| • Infusion of the wrong drug concentration, resulting in overdose |
| 2. Oversedation as the IV PCA button is pushed at the illumination of the green light on the PCA machine |
| 3. Defective one-way valve |
| 4. Cracked glass syringes |
| 5. Inability of the patient to ambulate or participate in rehabilitation, such as after joint replacement |
| 6. Skin puncture: discomfort related to the needle-based system (IV line sometimes needed for other reasons) |
| 7. Line infiltration |
| 8. Breakthrough pain from malfunctioning pumps |
| 9. Analgesic gaps from IV line failures |
| 10. Inability to use the pump in a hyperbaric chamber or in the MRI suite |

MRI = magnetic resonance imaging.
# Economics of IV PCA

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of Patients</th>
<th>Surgery Type</th>
<th>IV PCA Cost (in U.S. Dollars)*</th>
<th>Study Duration</th>
<th>IV PCA-Related Time (Minutes)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smythe⁴⁴ (1994)</td>
<td>PCA (19) IM (17)</td>
<td>Hysterectomy</td>
<td>$47a ± 30</td>
<td>20 hours</td>
<td>17 (RN)</td>
<td></td>
</tr>
<tr>
<td>Chang²² (2004)</td>
<td>PCA (62) IM (63)</td>
<td>Gynecology</td>
<td>NR</td>
<td>24 hours</td>
<td>18c</td>
<td>$19 for disposables and pump</td>
</tr>
<tr>
<td>Colwell³⁷ (1995)</td>
<td>PCA (93) IM (91)</td>
<td>Joint arthroplasty and spine</td>
<td>$84e</td>
<td>72 hours</td>
<td>14</td>
<td>Cost data from sample of 20 patients in each group; disposable no longer in use</td>
</tr>
<tr>
<td>Cohen S⁶¹ (1991)</td>
<td>PCA (98) IM (165)</td>
<td>Cesarean delivery</td>
<td>$252f</td>
<td>72 hours</td>
<td>NR</td>
<td></td>
</tr>
<tr>
<td>Cohen B⁶² (1997)</td>
<td>PCA (28) Epidural (26)</td>
<td>Spine</td>
<td>$440g</td>
<td>72 hours</td>
<td>NR</td>
<td>Charges, not costs</td>
</tr>
<tr>
<td>D’Haese³³ (1998)</td>
<td>PCA (20) IM (20)</td>
<td>Abdominal hysterectomy</td>
<td>$586h</td>
<td>72 hours</td>
<td>34 (day 0), 12–15 (days 1–2)</td>
<td>The IV PCA system studied was disposable</td>
</tr>
<tr>
<td>Choiniere³⁰ (1998)</td>
<td>PCA (63) IM (63)</td>
<td>Hysterectomy</td>
<td>$99i</td>
<td>48 hours</td>
<td>80</td>
<td>Assumed pump cost = $0</td>
</tr>
<tr>
<td>Sanansilp⁶³ (1995)</td>
<td>PCA (21) IM (21)</td>
<td>Elective major orthopedic</td>
<td>$10</td>
<td>48 hours</td>
<td>9 calls to RN (PCA)/21 calls to RN (IM)</td>
<td></td>
</tr>
<tr>
<td>Chan⁵⁵ (1995)</td>
<td>PCA (12) IM (11)</td>
<td>Open cholecystectomy</td>
<td>NR</td>
<td>37 hours</td>
<td>36i</td>
<td>Disposables and pump costs not computed</td>
</tr>
<tr>
<td>Chan⁵⁵ (1995)</td>
<td>PCA (24) IM (20)</td>
<td>Lumbar laminectomy</td>
<td>NR</td>
<td>51 hours</td>
<td>49k</td>
<td>Disposables and pump costs not computed</td>
</tr>
</tbody>
</table>

* $ values are standardized to 2004 dollars.

¹ Pump maintenance and depreciation + pharmacy time (measured via stopwatch). Includes 24% indirect cost added to direct costs.

² 5 minutes = prepare syringe (3 minutes) + pump delivery (1.6 minutes) + Quality Assurance (0.5 minute).

³ Communication (0.23 minutes) + documentation (0.9 minutes) + drug administration (2.6 minutes) + patient observations (14.3 minutes).

⁴ Infusor (Baxter), a disposable IV PCA unit.

⁵ Assume an hourly wage of $17, $31 for disposables and pump.

⁶ Side effects + analgesia + monitoring.

⁷ Physician, pharmacy, equipment, and hospital charges for a three-day postoperative course.

⁸ Seventy-two percent of the cost was for a disposable PCA device.

⁹ Registered Nurse time @ $32/hour + pharmacy technician time @ $15/hour + orderly @ $15/hour + occlusion + infiltration + recatheterization + drug.

¹⁰ Checking PCA machine (6 minutes) + syringe change (1 minute) + PCA programming (1 minute) + obtaining and recording (1.1 minutes) + charting (12 minutes) + checking patient and IV line (15 minutes).

¹¹ Checking PCA machine (8 minutes) + syringe change (3 minutes) + PCA programming (4 minutes) + obtaining and recording (3 minutes) + charting (14 minutes) + checking patient and IV line (14 minutes) + checking of analgesia order (1 minute) + selecting the drug (1 minute) + preparing drug (1 minute).
Costs: A Hospital versus a Societal Perspective

Although medical companies are concerned with justifying the price of their products so that hospitals will buy them, health economists want to know whether the investment in that product is a good overall value to society. For this reason, health economists usually recommend that economic analyses adopt a societal perspective so that the overall impact of an intervention is fully captured, regardless of who benefits and who bears the cost.

In contrast to this approach, hospitals are more interested in the aspects of the intervention that have a direct impact on them. Furthermore, hospitals might want to know the short-term effects (e.g., variable costs) rather than the long-term effects (e.g., fixed costs).

Total hospital costs can be fixed (they do not change in proportion to the number of patients using IV PCA) or variable. Most hospital costs are fixed (overhead-driven). From the hospital's point of view, attempts to reduce costs through changes in medical practice (using IV PCA instead of IM injections) can affect their variable costs only and thus might seem to have limited ability to affect overall costs. However, with IV PCA, any new alternate therapies for analgesia may reduce the hospital's investment in new pump technology.

Nursing Time

Hospitals might consider the nursing care time spent on IV PCA to be a fixed cost, because the staff is paid regardless of the number of patients receiving treatment. However, health economists assume that having a health care provider take care of an additional IV PCA patient results in an incremental cost to society. From society's point of view, this reflects the fact that there is a cost for the provider's time and expertise (adjusting the IV PCA pump) even if the nurse is salaried and in the patient ward anyway.

Time–motion studies showed that the mean nurse labor time used for IV PCA ranged from 0.5 to 0.75 hours for the first 24 hours, declining to a mean of 0.25 hours on the second and third days. However, because of the controlled conditions and the Hawthorne effect (in which participants' behaviors and the study results may change if they know that they are being monitored as part of a study), this type of study may underestimate the time that tasks would take under real-world clinical conditions. This may be especially pertinent in light of the increased use of per diem or temporary nursing staff, who are sometimes less familiar with a specific hospital's IV PCA pumps and procedures.

According to nurse evaluations, the mean time required to become comfortable in using one of five different IV PCA systems ranged from seven to 50 minutes. Even though hospitals might consider nursing time a fixed cost, it has value for society; that is, if time could be liberated from activities such as pump monitoring, it could be applied to providing other types of quality care.

Safety

Processing an IV PCA medication order—ordering, transcribing, dispensing, and administering—is a complex task that involves multiple individuals and hospital departments. Analgesics, including opiates, are the drugs most often

Table 5 Nonrandomized Studies of the Economics of Intravenous Patient-Controlled Analgesia (IV PCA)

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of Patients</th>
<th>Surgery Type</th>
<th>IV PCA Cost (in U.S. Dollars)*</th>
<th>Study Type and Duration</th>
<th>IV PCA Related Time (Minutes)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shapiro64</td>
<td>IV PCA (101) Epidural (167)</td>
<td>Major intra-abdominal</td>
<td>$19\textsuperscript{a}</td>
<td>Prospective</td>
<td>NR</td>
<td></td>
</tr>
<tr>
<td>Smith65</td>
<td>PCA (85) Epidural (76)</td>
<td>Cesarean section</td>
<td>$91/day\textsuperscript{b}</td>
<td>Prospective 24 hours</td>
<td>NR</td>
<td>Labor not measured</td>
</tr>
<tr>
<td>Ammar66</td>
<td>IV PCA (40) Epidural (40)</td>
<td>Abdominal aorta</td>
<td>$577\textsuperscript{c} (hospital charges)</td>
<td>Prospective</td>
<td>NR</td>
<td>Charges (on the patient's hospital bill) do not reflect true facility cost of providing care</td>
</tr>
</tbody>
</table>

NR = not reported.

\textsuperscript{a} PCA device ($6) + morphine ($6) + disposables ($4) + pain service nurse ($3).

\textsuperscript{b} Lease PCA pump ($70) + drug and infusor lines ($21).

\textsuperscript{c} $443 is reported, but it is converted to $577, assuming a Medical Care Services component of the Consumer Price Index. Includes initial set-up + pump + medication + no physician charges generated for PCA.

- the number of patients who use it per year.
- inventory costs related to the fraction of the time the pump is being used versus the time it is being stored.
- the lifetime duration of the pump.
- service and maintenance costs.

Pharmacy technician time and central supply orderly time must also be considered. A scientifically more rigorous study, with a large sample size representative of various types of surgical procedures and institutions (e.g., by geography or by teaching status), is needed for itemizing IV PCA costs properly.
associated with adverse events in hospitals. The most common type of error is giving the wrong dose.\textsuperscript{40} In the pediatric care unit, a separate study found that of 645 medication-error records, IV PCA was a recurring problem; 7% of these errors harmed the patient, and most of the errors involved an improper dose.\textsuperscript{41}

IV PCA pumps exhibit variable levels of performance, differ in their resistance to accidents, and are not uniform in ease of use.\textsuperscript{42–45} Better knowledge of the incidence and consequences of IV PCA pump safety is needed.\textsuperscript{46} Frequent PCA errors have been reported to the U.S. Pharmacopeia–Institute for Safe Medication Practices (USP–ISMP) Medication Errors Reporting Program.\textsuperscript{47} To reduce the frequency of such errors, manufacturers of IV PCA equipment are redesigning pumps. With one of the new IV PCA devices, a bar-coded imprinted syringe is recognized, allowing the automatic loading of information about the drug and its concentration. After the drug concentration is read by the bar code, it is always listed on the screen.

Future “smart” pump technologies should reduce programming time, the mental workload, and errors. This may work if the pump employs fewer steps, has a review screen to confirm programming before infusion begins, and has clearer labels and messages.\textsuperscript{48} The next-generation PCA pumps may also include additional information technology, such as communicating with pharmacy computers and the patient’s medical record via wireless data flow.

In response to the frequency of errors associated with IV PCA, hospitals have changed patient care practices. For example, such efforts include:

- instituting standardized IV PCA order sets.
- educating the staff.
- having a second Registered Nurse double-check pump programming.
- adding continuous pulse oximetry for patients receiving IV PCA.
- requiring more frequent (every two hours) respiratory rate measurements.

Computerized physician order entry (CPOE) systems may also reduce the risk of IV PCA errors, for example, by including the patient’s age on the computer order form so that the dosage can be adjusted for elderly patients. All of these additional safety-enhancing activities may add to the overall cost profile of IV PCA.

**CONCLUSION**

Certainly, each facility can do its own IV PCA cost-identification analysis, because each hospital probably compensates its staff differently and may be able to negotiate individual contracts for IV PCA pumps, disposable items, and drugs. Cost analysis alone is not necessarily appropriate if two competing intervention strategies are being evaluated; it is appropriate only if the outcomes of the two competing strategies are equivalent.

### Table 6  Retrospective Safety Studies of Intravenous Patient-Controlled Analgesia (IV PCA)

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of Patients</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horn\textsuperscript{36}</td>
<td>515 adults (301 with IM analgesia, 214 with IV PCA) who had major rectal or intestinal surgery (1994–1997) at eight community or teaching hospitals along the U.S. West Coast</td>
<td>Postoperative surgical site infection was significantly greater when IV PCA was used (10.7% vs. 4.0% with IM analgesia)</td>
</tr>
<tr>
<td>Vicente\textsuperscript{67}</td>
<td>Seven deaths resulting from IV PCA misprogramming</td>
<td>Estimate of mortality from programming errors Low: 5 in one million High: 20 in one million</td>
</tr>
<tr>
<td>Looi-Lyons\textsuperscript{48}</td>
<td>4,000 postoperative patients receiving IV PCA</td>
<td>Nine patients (0.225%) had a respiratory adverse event. Risk factors: drug interaction with sedatives, continuous opioid infusion, nurse- or physician-controlled analgesia, inappropriate PCA use</td>
</tr>
<tr>
<td>Fleming\textsuperscript{69}</td>
<td>1,122 patients receiving IV PCA</td>
<td>Eight patients (0.713%) with complications; five were from continuous infusion, and two were from other people pushing the PCA button</td>
</tr>
<tr>
<td>Etches\textsuperscript{70}</td>
<td>1,600 adult orthopedic and general surgery patients receiving IV PCA</td>
<td>Eight cases (0.5%) of serious respiratory depression. Risk factors: concurrent background infusion, advanced age, concomitant administration of sedative–hypnotic medications, and pre-existing sleep apnea. No cases were attributed to operator error or equipment malfunction.</td>
</tr>
</tbody>
</table>

IM = intramuscular.
Economics of IV PCA

The benefits of alternative delivery systems to IV PCA need to be quantified for appropriate full economic comparison with IV PCA. One potential benefit of new treatment options may be earlier patient mobility, which can lead to previous physical rehabilitation for certain patients and, therefore, to earlier hospital discharge. A recent study showed that a decreased length of stay after surgery can save as much as $500 per patient-day.49

For an evaluation of the full scope of costs associated with IV PCA, a scientifically more rigorous study is needed in which all cost drivers are considered: direct medical costs (nurse and pharmacy labor, pumps and disposables), direct nonmedical costs, intangible costs, and indirect morbidity and mortality costs (see Tables 1 to 6).50–70

Acknowledgment: The author wishes to acknowledge the contribution of Zhang Mingliang, PhD.

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