

Development of an Anesthesiology-based Postoperative Pain Management Service

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EFFECTIVE PAIN CONTROL is an important aspect of optimal care of surgical patients.^{1,2} Despite advances in knowledge of pathophysiology, pharmacology of analgesics, and the development of more effective techniques for postoperative pain control, many patients continue to experience appreciable discomfort.¹⁻⁷ Just as chronic pain management has become a special area of medical practice, treatment of acute pain deserves a similar commitment by practitioners with special expertise. This paper describes the development and first 18 months of experience of an Acute Pain Service (APS).

Anesthesiologists are a logical choice to provide pain relief in the immediate postoperative period, since they are familiar with the pharmacology of analgesics, are aware of the short- and long-term effects of drugs given intraoperatively, are knowledgeable about pain pathways and their interruption, and are skilled in the techniques needed to offer multiple forms of pain control, including intravenous and epidural narcotics. Anesthesiologists in many parts of the world have become involved in the provision of postoperative analgesia, and have published numerous reports concerning the efficacy and safety of certain techniques.⁸⁻¹⁰ The goals of developing and implementing the APS were: 1) to im-

prove postoperative analgesia; 2) to train anesthesiology residents in methods of postoperative pain management; 3) to apply and advance new analgesic methods; and 4) to carry out clinical research in the area of postoperative pain management.

In recent years, two new therapeutic modalities for treatment of postoperative pain have become available: epidural opiate analgesia (EOA)⁸ and patient-controlled analgesia (PCA).⁹ Several factors have limited the widespread use of these techniques: the cost of PCA machines, the time required by anesthesiologists to manage epidural analgesia, fear of respiratory depression with EOA, and lack of structured programs for the provision of PCA and EOA. In this paper, we describe our approach for dealing with these issues so as to extend the advantages of EOA and PCA to greater numbers of postsurgical patients.

Organization and Functions of the Acute Pain Service

It is essential that a service for postoperative pain management be responsive at all times to the needs of the patients it serves. To make EOA available 24 hours a day to appropriate surgical patients, an educational program was developed jointly by the Department of Anesthesiology and the Nursing Services to teach nurses on the surgical wards to administer epidural narcotics.

Physician staffing for the APS is provided entirely by the Department of Anesthesiology. One of five interested faculty members provides daily attending physician coverage, along with an anesthesiology resident or pain fellow assigned to the service for 1-month rotations. Clinical rounds on all patients receiving EOA or PCA are made each morning by the entire team, which includes a clinical nurse specialist, and thereafter throughout the day as necessary by the resident or fellow. For each patient, quality of analgesia and side effects are assessed, effective narcotic dose is noted, the epidural catheter site is inspected, and documentation of care is completed. Information from each patient is

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recorded and subsequently entered into a computerized data base. Additional daily activities of the APS include consultation for postoperative pain management, informal education of ward nurses and medical and surgical house staff, and assisting operating room anesthesiologists in planning analgesic care for their patients. After regular working hours and on weekends, a pain fellow or senior anesthesiology resident is on call for the APS. Patients having emergency surgery may be referred at any time to the APS. If urgent medical attention is needed during the night or on weekends, in-hospital anesthesiology personnel respond immediately.

Care of patients by the APS may be initiated either by the surgery or anesthesia team. Surgeons seek consultation when they identify a patient in whom pain control is especially important or expected to be difficult. Usually, APS care is initiated by the anesthesiology team caring for the patient perioperatively. These individuals consider postoperative pain management, discuss available options with patients during the routine preoperative visit, and obtain informed consent along with that for the anesthetic. Before implementation, the recommended plan for postoperative pain management is discussed with the surgeon to confirm its suitability.

When EOA is selected, an epidural catheter is usually inserted preoperatively and used for surgery solely or in combination with sedation or general anesthesia. Because correct placement of the catheter in the epidural space is essential for postoperative EOA, neural blockade with a local anesthetic is demonstrated before induction of general anesthesia. The epidural catheter is covered with a transparent dressing (Tegaderm®, 3M, St. Paul, MN) to facilitate daily inspection of the insertion site. To minimize the risk of accidental epidural injection of drugs intended for intravenous administration,¹¹ a bright yellow intermittent injection cap (Product #IN1000, Burrion Medical, Inc., Bethlehem, PA), which is distinctly different from intravenous injection ports, is placed on the epidural catheter connector, and a brightly colored label that reads "EPIDURAL CATHETER" is placed on the catheter near the injection cap. The initial epidural narcotic dose is given by the operating room anesthesiologist 1 h before the expected completion of surgery.

Occasional surgical patients receive a single dose of intrathecal narcotic mixed with the local anesthetic injected for spinal anesthesia. However, except for patients undergoing cesarean section, this technique is not widely used because of the limited period of analgesia.

When PCA is selected, instruction in the correct use of the PCA pump (LifeCare® PCA Infuser, Abbott Laboratories, Chicago, IL) is provided to the patient by nursing staff prior to surgery.

TABLE 1. Contraindications to Epidural Opiate Analgesia (EOA) and Patient-controlled Analgesia (PCA)

EOA:
1. Contraindications to epidural catheter placement ^{19*}
2. Previous serious adverse reactions (including allergy) to narcotics
3. Following laminectomy if dura was opened
4. Untrained nurses†
PCA:
1. Previous serious adverse reactions (including allergy) to narcotics
2. Inability (e.g., paralysis, mental retardation) or unwillingness of patient to self-administer narcotics
3. History of inappropriate narcotic use and drug-seeking behavior
4. Untrained nurses ^{20†}

* In our practice, the technique is used at the discretion of the operating room anesthesiologist when prophylactic subcutaneous heparin is given prior to surgery or iv heparin is administered during surgery.

† This limitation no longer applies in our institution.

Contraindications to the use of EOA and PCA are listed in table 1. These techniques may be beneficial to patients with serious medical and surgical conditions.¹⁰ Each case is considered individually with regard to advantages *versus* risks.

Standard Protocols

The APS has developed protocols to promote a consistent standard of care. These include physician orders, nursing care protocols, and communication between operating room anesthesiologists and the APS physicians.

Standard orders for PCA (see Appendix A) include the choice of narcotic, the incremental dose, the lockout interval between doses, and the 4-h dose limit. The orders also include options to change the pump parameters if analgesia is inadequate with the initial settings. Treatment for possible side effects is also prescribed.

For EOA, the standard orders (see Appendix B) include a notation of the initial narcotic dose (given about 1 h prior to completion of surgery), an order for subsequent doses (to be given by the ward nurse), monitoring instructions, and orders for the treatment of side effects. These orders provide for a fixed narcotic dose with a variable injection interval (e.g., preservative-free morphine 4 mg every 6–12 h). This gives the ward nurses some discretion in determining how frequently the dose will be administered. The standard PCA or EOA orders are completed in the recovery room by the operating room anesthesiologist. The APS is then notified and assumes responsibility for the patient's comfort. (Standard orders should be tailored to the patient population, nursing practices, and medical preferences of a given institution.)

TABLE 2. Criteria for Determining When to Use a Respiratory Monitor*

A respiratory monitor is not required:	
A.	When all the following criteria are met:
1.	Age < 50.
2.	ASA physical status—I or II.
3.	Surgical site—all except thorax or upper abdomen.
4.	Duration of surgery < 4 h.
5.	Anesthetic—little or no narcotics or other long-acting CNS depressants used before or during surgery.
6.	Epidural morphine dose—6 mg or less. Subarachnoid morphine dose—0.5 mg or less.
OR	
B.	Postoperative care location provides continuous nursing surveillance.

* These are only guidelines. A respiratory monitor may be ordered for any patient at the discretion of the operating room anesthesiologist, the Acute Pain Service, or the Unit Charge Nurse.

The use of EOA or PCA does not influence the choice of locations where patients will be nursed following surgery. Admission to ICU is based on customary criteria, such as medical status and type and duration of surgery. However, because of concern for the possibility of respiratory depression, patients using PCA in any location have vital signs and sedation level monitored

DISTRIBUTION OF ACTIVITY ACUTE PAIN SERVICE

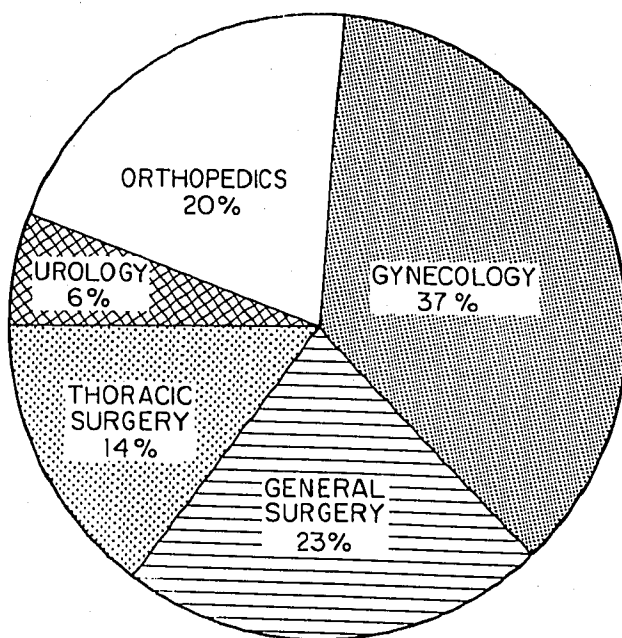


FIG. 1. Distribution of activity among the surgical specialties served by the Acute Pain Service.

every 2 h for the first 8 h; and every 4 h thereafter. Patients receiving EOA are evaluated hourly for 48 h. During the first 24 h, ventilation, including respiratory rate, and sedation level are monitored. During the second 24 h, only the hourly sedation level is noted. Backup mechanical respiratory monitors (Model 510 Respiratory Monitor, Biochem/Trimed®, Inc., Waukesha, WI; or Model 78202C Respiratory Monitor, Hewlett Packard, Waltham, MA) are used for some patients according to the criteria listed in table 2. These criteria are based on published information regarding the risk of respiratory depression¹² and on analysis of 15 months of local experience.

One factor that may be associated with spinal opiate-induced respiratory depression is concurrent administration of other central nervous system depressants (*e.g.*, narcotics, sedatives). Therefore, large doses of perioperative narcotics or long-acting sedatives are avoided, and parenteral narcotics are not used postoperatively in patients receiving EOA. To avoid confusion, the standard orders specify that all orders for pain control and sedatives are to be given by a member of the APS as long as PCA or EOA are in use. Responsibility for analgesic therapy reverts to the surgical team when patients can obtain satisfactory pain relief with oral analgesics. To facilitate a smooth transition, the surgeons write oral analgesic orders immediately after surgery to become effective when EOA or PCA are discontinued. Epidural and intravenous catheters are left in place until efficacy of oral analgesics is confirmed.

The decision to limit the writing of analgesic orders to members of the Acute Pain Service while PCA or EOA are in use raised initial concern from some surgical colleagues regarding loss of control of the management of their patients. In most cases, these concerns have been replaced by enthusiasm for the quality of care being provided by the APS.

Post-cesarean section patients who receive a single dose of epidural or intrathecal morphine for pain relief are managed by the obstetric anesthesia team. (The same nurse education program and monitoring protocols are applied in that area.)

Activity of the Acute Pain Service

During the first 18 months of service, the APS has cared for 820 patients. Of these patients, 623 were treated with epidural narcotics, 167 with PCA, and 30 have had some other form of therapy (intrathecal narcotics, nitrous oxide, intercostal blocks, iv narcotic infusions, pain cocktails, etc.). The mean number of days of care provided per patient was 3.8, with a range of 1–15. In addition, 192 women received a single injection of

epidural morphine, and 171 women received intrathecal morphine for post-cesarean section analgesia.

Figure 1 depicts APS experience according to type of surgery performed. Although patients having thoracotomies only represent 14% of the total activity of the APS, 95% of patients having thoracic surgery in our institution receive epidural narcotics.

The narcotic most commonly used in EOA is preservative-free morphine sulfate (Duramorph®, AH Robbins, Richmond, VA). The usual initial dose in a number of clinical situations is shown in table 3. Supplemental epidural fentanyl boluses of 50–75 µg are given if immediate analgesia is required because the initial dose of morphine is inadequate.

During the first 6 months of APS experience, four patients developed marked respiratory depression apparently caused by epidural narcotics. Table 4 summarizes the important clinical details of these patients. Respiratory depression has not been seen in patients using PCA. Although there has been concern that prolonged epidural catheterization might lead to infection in the epidural space, none has occurred in a total experience of 2,451 catheter days.

A daily fee for care provided by the APS is submitted beginning with the first postoperative day and continuing until analgesia therapy reverts to the surgical team. The daily consultation charge is not affected by the modality used to achieve analgesia (*i.e.*, a patient receiving EOA will be charged the same professional fee as a patient receiving PCA). A procedural fee is charged if an epidural catheter is inserted by the APS. The hospital charges for respiratory monitors and PCA pumps. Third party carriers have provided reimbursement, and the collection rate is comparable to that associated with operating room anesthesia for surgery. Reimbursement is now at a level where the APS is self-sustaining.

One of the goals of the APS is to educate anesthesia trainees in the management of postoperative pain. In

TABLE 3. Starting Dose (mg) of Epidural Morphine for Incisional Pain*

Patient Age (yr)	Nonthoracic Surgery (Lumbar or Caudal Catheter)	Thoracic Surgery	
		Thoracic Catheter	Lumbar Catheter
15–44	5	4	6
45–65	4	3	5
66–75	3	2	4
76+	2	1	2

These doses should only be considered as guidelines. Safe and effective doses for individual patients may vary considerably.

* Undiluted 0.1% preservative-free morphine is used.

addition to one-on-one teaching during daily clinical rounds, a set of learning objectives was developed and a syllabus of relevant journal articles assembled and provided to the resident or fellow each month. The APS faculty and house staff attend and participate in the weekly didactic sessions of the University of Washington Multidisciplinary Pain Center.

Current research includes a study of transdermal fentanyl analgesia following shoulder surgery, comparison of intermittent injections *versus* continuous infusions of epidural morphine, and the relationship between age and effective epidural morphine dose.

The Role of Nursing

Teaching ward nurses to inject narcotics into epidural catheters has greatly facilitated use of EOA. The curriculum includes anatomy of the spinal canal, nociceptive pathways, spinal opiate actions, side effects and their treatment, epidural catheter injection technique, monitoring skills, and analgesia assessment. Aseptic precautions taught for injection of epidural catheters are the same as those used to inject drugs into chroni-

TABLE 4. Cases of Marked Respiratory Depression

	Case 1	Case 2	Case 3	Case 4
Age (yr)/sex	69/F	68/F	62/M	57/F
Surgery	Esophagogastrectomy	Whipple	Colectomy, ileal loop	Colectomy
Narcotics during surgery	0	Fentanyl 0.6 mg	Sufentanil 0.225 mg	Fentanyl 0.75 mg
Epidural catheter site	T7	L2	L2	L3
Epidural morphine dose	4 mg	5 mg	5 mg	5 mg
Time: initial morphine to depression	13.5 hr	9.5 hr	8.75 hr	2.75 hr
Oxygen saturation	95%	89% (O ₂ mask off)	97%	99%
Highest PaCO ₂	66	95	85	63
Lowest pH	7.19	7.12	7.07	7.17
Lowest respir. rate	8	12	8	11
Mental status	Marked sedation	Unconscious	Unconscious	Marked sedation

cally implanted central venous catheters (*e.g.*, Hickman catheters). The course is taught by a clinical nurse specialist who has proved invaluable not only in nurse education, but also in solving nursing problems related to EOA.

Unlike local anesthetics injected into the epidural space, where serious side effects may occur soon after injection, the onset of side effects from epidural narcotics usually occurs many hours later. In addition to learning the importance of an aspiration test and what action to take if clear fluid or blood is seen, nurses are taught to watch for delayed respiratory depression.

The Washington State Board of Nursing agrees that nurses can inject epidural narcotics. The Board, in establishing its policy, stated ". . . that such administration of narcotics is within the scope of practice of the registered nurse. . . . The practice of nursing means the performance of acts requiring substantial specialized knowledge, judgement and skill based upon the principles of the biological, physiological and social sciences. . . . The procedure must be performed under policies and protocols that have been mutually developed by the nurse, the appropriate physician and administrator."

Respiratory Complications

The cases of marked respiratory depression noted (table 4) had a number of features in common: all were elderly patients; all occurred in high-risk patients who had undergone major and prolonged surgical procedures and were being cared for in the ICU; and three of the four patients had received narcotics as part of their anesthetic for surgery.

Others have reported that respiratory rate is not a reliable predictor of adequate ventilation when epidural narcotics are used.¹³⁻¹⁵ Hourly recording of respiratory rate with continuous respiratory monitoring backup in our patients showed no apnea. The lowest recorded respiratory rates were 8, 12, 8, and 11 breaths per minute. The corresponding peak PaCO₂ levels were 66, 95, 85, and 63 mmHg. In each case, the diagnosis of hypercarbia was made when blood gas analysis was prompted by an altered level of consciousness. All four patients who were initially alert and responsive lapsed gradually into somnolence from which they could not be easily aroused. These observations resulted in the addition of a simple five-level sedation scale to routine monitoring practice. All four patients were receiving supplemental oxygen. Their arterial blood oxygen saturations were maintained (95%, 89%, 97%, and 99%) at the time of peak respiratory depression.

Times from initial dose of morphine to peak respiratory depression were 13.5, 9.5, 8.75, and 2.75 h. Depression occurred after the initial dose in two patients, and after the second dose in the other two. Morphine doses were 4 mg in one patient and 5 mg in the other three. Respiratory depression was rapidly and effectively reversed with 0.2 mg of intravenous naloxone.

All four incidents occurred during our first 6 months of activity. Since then, respiratory depression of this magnitude has not been observed. A number of factors may account for the change. Preoperative and intraoperative narcotics are now avoided or used sparingly, and lower epidural narcotic doses are now used. Nurses are taught to assume that deterioration in level of consciousness is due to hypercarbia until disproved by blood gas analysis.

These observations are consistent with other case reports of severe respiratory depression which, without exception, have occurred within the first 24 h after starting epidural narcotics.¹⁶ They are remarkably similar to the experience reported in a large prospective series.¹⁷ Sedation is well known to accompany marked hypercarbia. In normal volunteers rebreathing CO₂, marked somnolence or unconsciousness was seen when PaCO₂ levels reached 80 mmHg.¹⁸

Future Developments

Alternatives to current respiratory monitors are being evaluated for use when backup monitoring is indicated. Devices that measure adequacy of ventilation rather than respiratory rate would be desirable. Transcutaneous CO₂ measurement may be particularly applicable.

Under development is a two-bed special unit for use by the Acute Pain Service. This unit will be equipped for monitoring in a manner intermediate between the ICU and a regular ward. Patients with special needs will be admitted to this unit to permit the application of new analgesic modalities under evaluation or modalities with risks that make them less suitable for routine ward use. Examples include epidural infusions of mixtures of local anesthetics and narcotics or infusions of local anesthetics into the area of a nerve plexus.

Our department is currently developing a curriculum for the additional year of training that is now part of anesthesiology residencies in the United States. The management of acute pain is expected to be part of that new curriculum.

In summary, a commitment has been made by our Department of Anesthesiology to provide full time postoperative pain management. This has been facilitated

by training ward nurses to inject narcotics into epidural catheters and to more intensively monitor patients who receive this form of analgesia. After 18 months of operation, continuing growth reflects the popularity of the service among patients and surgeons. Anesthesiology trainees are learning postoperative pain management, and clinical research related to postoperative pain is in progress. As a result of the APS, anesthesiologists are playing an important new role in the care of surgical patients.

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Appendix A

PCA STANDARD ORDERS

1. Drug:
 - _____ MORPHINE (1 mg/ml)
 - _____ MEPERIDINE (10 mg/ml)
 - _____ OTHER _____ Concentration _____
 2. Loading Dose (optional) _____ mg Time _____
 3. Incremental Dose _____ mg, *i.e.*, _____ ml
 4. Lockout Interval—8 minutes
 5. Four Hour Limit (ml) _____ (Max. = 30 ml/4 hours)
 6. If pain not controlled after one hour, increase incremental dose by _____ mg, *i.e.*, _____ ml, one time only.
 7. If pain still not controlled after one additional hour, reduce lockout interval by _____ minutes, one time only.
 8. No systemic narcotics to be given except by order of Acute Pain Service.
 9. Monitoring:
 - Respiratory rate, analgesic level, sedation level—q2h for 8 hours, then q4h.
 10. Documentation:
 - Record drug use on Vital Signs sheet at each monitoring interval and 8 hour totals on Medication Sheet.
 11. Treatment of side effects:
 - A. DROPERIDOL 0.25 mg for nausea/vomiting. MR × 1.
 - B. "In and out" bladder catheter prn for urinary retention
 - C. NALOXONE 0.1 mg IV stat for respiratory rate <8. MR × 3.
Call Acute Pain Service.
 12. For inadequate analgesia or other problems related to PCA, call the Acute Pain Service.
Date _____, M.D.
- Dr. _____ on the Acute Pain Service was notified about this patient at _____ hours.

Appendix B

EPIDURAL NARCOTIC STANDARD ORDERS

1. Initial Dose: Drug _____ mg _____ Time _____

2. Drug for Continuing Analgesia:
 - A. PF MORPHINE (1 mg/ml) _____mg q 6-12 hours.
 - B. FENTANYL (5 μ g/ml) Infuse _____ μ g (_____ml) per hour with infusion controller.
 - C. OTHER: drug/conc _____ Dose _____ Interval _____
3. Maintain IV access (drip, heparin lock) for 24 hours after last dose of epidural narcotic.
4. NALOXONE 0.4 mg at bedside.
5. *No systemic narcotics* to be given except as ordered by Acute Pain Service.
6. Monitoring:
 - A. Respiratory rate and sedation scale q1h for first 24 hours. Sedation scale q1h. for second 24 hours. After 48 hours, sedation scale q4h.
 - B. Respiratory monitor for first 24 hours. Yes _____ No _____
7. Nausea/Vomiting Prophylaxis:
METOCLOPRAMIDE 10 mg iv slowly q8h \times 3; then q8h prn for nausea/vomiting.
8. Treatment of side effects:
 - A. RR < 10/min,—call Acute Pain Service.
RR < 8/min—NALOXONE 0.4 mg *iv stat.* MR prn. Call Acute Pain Service.
 - B. NALOXONE 0.1 mg iv for severe itching. MR q 10 min. \times 5
 - C. DROPERIDOL 0.25 mg iv if Metoclopramide ineffective for nausea/vomiting. MR \times 1.
 - D. NALOXONE 0.1 mg iv for urinary retention. MR q 10 min. \times 5. If ineffective, "in and out" bladder catheter.
9. For inadequate analgesia or other problems related to epidural, call Acute Pain Service.
Date _____ M.D.
Dr. _____ on the Acute Pain Service was notified about this patient at _____ hours.