response to the conduction block as occurs in other types of neurologic injury. As innervation to the muscle returns, these extrajunctional receptors would be expected to disappear, but no data are available on the time course of this phenomenon. Although the underlying pathophysiology is not completely understood, this patient's clinical course indicates that recovery from GBS preceded return of normal receptor physiology.

SUMMARY

This report describes a parturient who, within 1 month of recovering from a neurologic deficit, suffered cardiac arrest secondary to succinylcholine-induced hyperkalemia. This patient's course may not apply to all patients with GBS because the diagnosis of GBS, although supported on clinical grounds, was not supported by conclusive objective data. Furthermore, pregnancy, drug abuse, and malnutrition may have had a unique impact on her muscle physiology. Nevertheless, it is important to note that, in any patient who is recovering or has clinically recovered from a neurologic deficit, a normal neurologic examination does not ensure that succinylcholine-induced hyperkalemia will not occur. Although these patients should eventually not be susceptible to succinylcholine-induced hyperkalemia, current data do not support a specific recommendation of when succinylcholine would be safe.

The authors wish to thank Edward Valenstein, M.D., Professor of Neurology, University of Florida College of Medicine, for review of the manuscript and valuable commentary.

REFERENCES


Accidental Epidural Cephazolin Injection: Safeguards for Patient-Controlled Analgesia

DAN J. KOPACZ, M.D.,* ROBIN B. SLOVER, M.D.†

Lumbar epidural infusions have become increasingly prevalent not only for providing continuous analgesia during labor but also as a means of providing profound postoperative analgesia with the infusion of epidural opioid or opioid/local anesthetic combinations. The technique has been further advanced by combining patient-controlled analgesia injection devices (PCA pumps) to epidural catheters and allowing patients to assist in determining their own analgesic requirements during labor or the postoperative period.12 We report a case of an accidental epidural infusion of cephazolin that was intended to be administered intravenously. We also describe our modifications of epidural infusions and patient-controlled epidural analgesia that help safeguard these techniques against accidental injections during the postoperative period.

* Assistant Professor.
† Senior Instructor.

Received from the Department of Anesthesiology, University of Colorado Health Sciences Center, Denver, Colorado. Accepted for publication December 21, 1989.

Address reprint requests to Dr. Kopacz: University of Colorado Health Sciences Center, Department of Anesthesiology, Campus Box B 113, 4200 East Ninth Avenue, Denver, Colorado 80262.

CASE REPORT

A 17-yr-old, 60-kg ASA physical status 2 woman with a known history of juvenile rheumatoid arthritis underwent an extensive left knee synovectomy/debridement with continuous lumbar epidural anesthesia. She had no significant past medical history, and apart from her left knee discomfort and a moderate amount of knee swelling, physical and laboratory examinations were normal. Her only medications included oral piroxicam 20 mg/day and a left knee intra-articular injection of 40 mg of methylprednisolone suspension approximately 4 months prior to surgery.

On arrival to the operating suite, an epidural catheter was inserted 3 cm at the L2-3 interspace without difficulty. Adequate surgical anesthesia to the T10 dermatome was obtained bilaterally with the incremental epidural injection of a total of 20 ml of 2% lidocaine with 1:200,000 epinephrine. Surgery proceeded uneventfully and lasted 105 min. Because of the extensive nature of the synovectomy and the plan for several days of intensive in-patient physical therapy, it was decided to provide postoperative analgesia with a continuous epidural infusion of fentanyl.

The patient began complaining of a moderate amount of knee discomfort 45 min after arrival in the recovery room as the epidural block resolved. Analgesia was rapidly re-established with an epidural bolus injection of 100 μg fentanyl in 10 ml of preservative-free saline. A continuous epidural fentanyl infusion at 100 μg/h via an IVAC volumetric infusion pump was then instituted.

In our institution, at that time, the only IVAC pump tubing available had three injection ports along its length. Although the epidural pump and tubing had been clearly marked in several places, one injection port had been mistakenly left exposed. That evening, on the hospital ward, an infusion of cephazolin (1 g in 50 ml 5% dextrose ordered for perioperative antibiotic prophylaxis) was accidentally piggybacked into an injection port in the epidural fentanyl infusion tubing rather than its intended iv tubing. This error went unnoticed until approximately 2 h after the completion of the cephazolin when the empty bag was recognized. At this time the entire epidural fentanyl infusion and tubing were replaced and the epidural catheter was immediately flushed with 20 ml of preservative-free saline. Immediate contact with pharmacy revealed that the 5% dextrose used to dilute the cephazolin was preservative-free. No solution remained in the cephazolin bag or tubing for laboratory analysis or culture.

The patient was immediately informed of the occurrence and as she had no complaints and as the excellent analgesia persisted, the fentanyl infusion was continued. There were no detectable changes in immediate or daily physical examinations, including extensive neurologic examinations, during the remainder of her hospitalization. No febrile episodes or evidence of infection developed. The epidural fentanyl infusion continued to provide excellent analgesia for another 24 h when the catheter was removed intact. She was discharged from the hospital without symptoms 3 days after surgery. No delayed sequelae were detectable at follow-up contact with the patient 1–10 months after discharge.

DISCUSSION

Accidental epidural administration of potassium chloride,4-5 diazepam,5 thiopental,6 methohexital,7 magnesium sulfate,8 total parenteral nutrition (TPN) solution,9 hypertonic saline, and collodion10 have all been reported. To this list we can now add cephazolin, which appears, at least when given in a dilute solution as in this one case, to be without neurologic effect. Most cases of mistaken epidural injection report only minor and transient symptoms of back pain and muscle spasms, though permanent paralysis has occurred in three instances.3,10

Receptor-specific toxicity, osmolarity, and pH of the injectates have been suggested as contributing to adverse effects of accidental epidural injections. High osmolarity solutions would be expected to cause the greatest damage, yet the reported case of epidural TPN infusion resulted in no symptom or sequelae despite a moderate amount (160 ml) of a high osmolarity (2000 mOsm/l) solution being infused. We could not directly measure these parameters in our patient as the entire bag of cephazolin had already infused, but when mixed in this concentration, the osmolarity of this solution ranges from 310–380 mOsm/l and the pH from 4.5–7.‡

Numerous remedies have been suggested once a mistaken epidural injection has been recognized. As a first step, aspiration of the injectate should be attempted, as is recommended after an inadvertent subarachnoid injection.11 However, in the epidural space, this generally results in the ability to withdraw only a small amount of the material. If more than a few minutes have passed, usually no material can be recovered. Attempting to dilute the remaining drug by flushing the epidural space with saline (including the placement of a second epidural catheter in a nearby interspace for epidural ‘‘lavage’’),6 administering epidural or iv corticosteroids for their anti-inflammatory effect, and administering epidural hyaluronidase to enhance dispersion and absorption of the agent have also been suggested.4,6,7 Since 2 h had passed since the completion of the cephazolin infusion, it is unlikely that flushing the epidural space with saline was of any benefit in this case. Although all of these measures theoretically make sense, there is no direct experimental evidence documenting that they result in any beneficial effect.

Theoretic hazards of flushing the epidural space in a patient who has received epidural opioids are that the analgesia could be diminished or eliminated by dilution, or that the increased epidural volume might increase the risk of respiratory depression by spreading opioid up the epidural space toward brainstem respiratory centers. An elevation of block height is known to occur if saline is given shortly after the epidural space has been injected with local anesthetic. Flushing the epidural space after an accidental injection of a potentially neurotoxic substance could likewise spread the damaging substance to additional portions of the neuraxis. In the case of accidental diazepam injection, progression of the sensory block was noted after flushing the epidural space with saline, resulting in the discontinuation of this treatment.5

All of the above techniques are intended to minimize potential damage after a mistaken epidural injection has already occurred. However, prevention of such events should be more important.

We now employ a PCA pump as a simple volumetric infusion pump for continuous epidural infusions of fentanyl, even when the PCA mode is not used. Thus, the opioid solution is contained within a locked compartment to deter theft and tampering. Also, the infusion rate can not be altered, either intentionally or accidentally, without a key. Most importantly, the tubing used with the PCA pump is free of injection ports.

The window display of the PCA pump we currently use is designed primarily for iv morphine and automatically displays the labels "mg," "mg/ml," etc. However, as we must first specify the concentration of the solution to be delivered (mg/ml, μg/ml), we are actually programming the pump to deliver a volume of solution. Because of the difference in potency between fentanyl and morphine (μg vs. mg), confusion can arise when a pump with these labels is used to deliver fentanyl. Therefore, after consultation with our pharmacy and risk management personnel, we have designed an overplate that serves two functions (fig. 1).§ First, the overplate is boldly colored and labelled with "EPIDURAL" and "FENTANYL" to distinguish it from iv infusions. Second, the overlay transforms the previous preset labels from "mg" to "μg" so that the amount being delivered is obvious without any calculations.

However, there are also drawbacks to this modification. When using epidural fentanyl, a moderate volume of diluent may be required to increase the surface area and number of opioid receptors exposed to the opioid for maximal analgesic effect. All commercial PCA pumps currently available restrict the syringe size that can be included within the locked compartment to a maximum volume of 60 ml. This may necessitate changing the syringe as often as every 4 h. Each time a new fentanyl syringe is inserted, the risk of contamination and/or a dosage mistake is introduced.

The occurrence of human errors in anesthesia have been described many times. The recent increased interest in patient safety will hopefully prompt better data acquisition regarding the incidence of human errors. Absolute incidence data is presently not known, but Cooper et al. report that technical human errors (infusion errors, syringe swaps, etc.) represent 40% of all anesthesia-related critical mishaps with "significant negative outcome." This case actually represents two such technical errors that occurred consecutively: failure of anesthesia personnel to label an injection port, and failure of the ward nurse to differentiate the epidural from the iv infusion. The increasing complexity of perioperative patient care necessitates an enhanced vigilance and additional security measures, especially concerning the human factors, if these errors that may lead to potentially disastrous consequences are to be averted.

Infusion tubing that contains injection ports along its length should be avoided. If it is necessary to use such tubing, we strongly recommend boldly and clearly identifying it as "for epidural use only" or "for anesthesia use only." The injection ports should be meticulously occluded so that it is very difficult to gain entry to the system.

§ IVAC Corporation, like most pump manufacturers, does not specifically label the Model 310 PCAInfuser syringe pump for epidural use. Modification of the labelling (user interface) of the pump is also without direct permission of the manufacturer.
Special tubing is now manufactured with colored stripes bonded in the tubing walls that can be used to differentiate epidural infusions from iv infusions. Alternatively, “stripes” of tape can be added to clear tubing to distinguish it as epidural infusion tubing. It has also been recommended that if intermittent bolus injections of opioids are used instead of infusions, it is best to delineate clearly this injection port by covering it with a brightly colored cap, preferably in combination with a discriminating label. 

Descriptions of accidental drug administrations into the epidural space have been rare. The explosive growth in anesthesiologist-directed postoperative pain management services and the use of epidural opioid analgesia will increase the potential for these errors. We describe a case in which no neurologic sequelae resulted from the mistaken epidural infusion of cephalolin. Treatment consisted of changing the infusion tubing, flushing the epidural space with saline, and continuing the epidural fentanyl infusion. We further describe the measures we have taken to safeguard postoperative epidural infusions of fentanyl for patient-controlled epidural analgesia.

REFERENCES


Anesthesiology
72:947–950, 1990

Spinal Epidural Hematoma Associated with Epidural Anesthesia: Complications of Systemic Heparinization in Patients Receiving Peripheral Vascular Thrombolytic Therapy

CURTIS A. DICKMAN, M.D.,* STEVEN A. SHELLEH, M.D.,† ROBERT F. SPETZLER, M.D.,‡ ANDREW G. SHEETER, M.D., § VOLKER K. H. SONNTAG, M.D., F.A.C.S.¶

Spinal epidural hematomas have been reported as rare complications of spinal and epidural anesthesia. They most commonly occur in patients who require intraoperative or postoperative anticoagulant administration but may also develop in the absence of anticoagulant therapy. Uncorrected coagulopathies or continuous anticoagula-

* Resident, Division of Neurological Surgery, Barrow Neurological Institute.
† Attending Anesthesiologist, Director of Education, Department of Neuroanesthesiology, Barrow Neurological Institute.
‡ Attending Neurosurgeon, Director, Barrow Neurological Institute.
 § N. Harber Chairman of Neurological Surgery, Professor and Chairman, Division of Neurological Surgery, University of Arizona College of Medicine.
¶ Attending Neurosurgeon, Chairman, Section of Functional and Stereotactic Neurosurgery, Director, Pain Research Laboratory. Clinical Professor of Surgery (Neurosurgery), University of Arizona College of Medicine.
† Attending Neurosurgeon, Vice Chairman, Division of Neurological Surgery, Chairman, BNI Spinal Cord Injury Committee. Clinical Professor of Surgery (Neurosurgery), University of Arizona College of Medicine. Received from the Barrow Neurological Institute, Phoenix, Arizona; and the University of Arizona College of Medicine, Tucson, Arizona. Accepted for publication January 16, 1990. Address reprint requests to Dr. Spetzler: Barrow Neurological Institute, Editorial Office, 550 West Thomas Road, Phoenix, Arizona 85013-4496.

Key words: Anesthetic techniques: epidural; spinal. Complications: epidural hematoma. Heparin.