When chronic pain becomes intolerable or severely restricts use of the affected area, and analgesics have no effect, flooding the related nerve fibers with an anesthetic may bring the pain under control.

Continuous extravascular infusion (CEI) delivers a small volume of local anesthetic, for example, bupivacaine (Marcaine), or an analgesic, such as meperidine (Demerol), over five to seven days. Once the pain has been relieved, the affected area can be mobilized with physical therapy. The exercise will increase nutrition and blood supply to the affected part, which in turn will promote healing as well as reduce pain.

CEI was introduced in 1966 by British physicians Green and Dawkins who continuously infused lidocaine into the epidural space to provide postoperative analgesia(1). Although too complicated and risky for routine analgesia, the technique can be invaluable for intractable pain. More than 450 patients have benefited from continuous extravascular infusions at the University of Cincinnati Pain Control Center over the past four years(2).

Mr. J, a 35-year-old telephone lineman, fell from an electric pole and twisted his back. About three days later, he developed intolerable back pain that radiated down his left leg. He had five back operations over the next four years for pain. When he arrived at the Pain Control Center, he was taking codeine every hour and meperidine every four hours. He was barely able to walk and was depressed and anxious. Lumbar arachnoiditis was diagnosed.

Mr. J was hospitalized, and an epidural catheter was inserted while he was sitting. After the procedure, Mr. J was encouraged to lie on his affected side or back. He received a CEI of bupivacaine for five days, which seemed to break the pain cycle; that is, it reduced the pain so he could increase movement. After that, transcutaneous electrical nerve stimulation (TENS) was started, and the epidural catheter was removed. When Mr. J was discharged, his pain had declined by 50 percent without medication. He was able to participate fully in a home physical therapy program and continued to be followed as an outpatient.

L, an 11-year-old, jumped from the couch while watching the Super Bowl and twisted her right ankle. She had immediate severe pain, but x-rays showed no fractures. The ankle was treated with elevation, cold compresses, and rest. About one week later, her right leg suddenly became cold and white; at times, the lateral aspect would turn purple and blue, and then return to normal color. The foot became extremely tender; her toes were so painful she could not tolerate a blanket over her foot and she could only bear slight weight on her right heel. Posttraumatic sympathetic dystrophy of her right foot was diagnosed.

L was hospitalized, and a catheter was placed in the right lumbar sympathetic chain under fluoroscopy. A continuous infusion of bupivacaine was started. On the fifth day, the catheter began to leak and was removed. When L was discharged, she still was unable to use her toes. Even six weeks after the infusion, she was unable to bear full weight on her foot.

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For pain in the trunk, continuous extravascular infusion is given in the epidural space.
L was readmitted and another lumbar sympathetic catheterization was done. She received a continuous bupivacaine infusion in addition to physical therapy for six days. During this time, L became very demanding and seemed to thrive on the attention she received by being ill. Nursing management became very involved as the nurses on the unit and from the pain control center collaborated with a psychologist and the family to set limits on L’s behavior in an attempt to encourage her to become more independent and more involved in her own care—for instance, by taking responsibility for going to physical therapy. At discharge, L could bear full weight on her right foot. Four months later she was waterskiing.

Ms. B, age 72, was referred to the Pain Control Center from the dermatology clinic. She had had a non-healing left leg ulcer for two years which had recently developed cellulitis. Thalgia (pain due to increased sympathetic fiber activity) secondary to vascular insufficiency and stasis leg ulcer was diagnosed.

In the hospital, a catheter was inserted next to Ms. B’s femoral nerve and bupivacaine was infused continuously. After six days, her pain had diminished by 75 percent, and the catheter was removed. By the time she was discharged, two weeks after admission, Ms. B was free of pain and her leg ulcer had healed.

CEI also has been found to work well in management of pain that is not chronic. For example, the anesthesiology and orthopedic departments at the University of Cincinnati now use continuous epidural infusion during total knee replacement surgery and for five days postoperatively. In a retrospective study (Jan. 1983-May 1984), 83 patients with continuous epidural infusions were compared with 33 patients receiving conventional therapies for total knee replacement. Preliminary studies have shown that these patients benefit from CEI, but this does not completely eliminate the need for analgesics because movement can still be painful. However, preliminary observations suggest that these patients require less pain medication and have greater mobility after surgery. CEI has also shortened the length of stay for total knee replacement from the usual 22 days to 18 days.

**HOW CEI WORKS**

To understand the physiologic basis of CEI, consider how the sympathetic nervous system functions under stress: fight or flight. If someone commanded, “Hands up! This is a robbery,” your heart would beat faster and more forcefully, and your blood vessels would constrict, causing your blood pressure to rise and your skin temperature to drop.

By contrast, an extravascular infusion of a local anesthetic blocks the sympathetic nervous system locally. A sympatholytic response in the area of pain, then, would cause vasodilation that would lower the blood pressure, increase blood flow to the affected area, and increase the skin temperature.

Also, local anesthetics, such as bupivacaine, seem to stop pain by reducing conduction of the anesthetized nerve fiber peripherally, thus blocking the A Delta- and C-fibers that conduct pain sensations through the nerve. Narcotics act differently: They stimulate the opiate receptor sites in the central nervous system.4

The CEI must be done on an inpatient basis to ensure adequate monitoring. It is not generally used in a patient who has an active infection, is on anticoagulants, has a low platelet count, or anyone who would be a poor candidate for anesthesia.

Before the procedure, the patient is usually given an intravenous infusion of 300 to 500 cc of lactated Ringer’s to reduce the risk of hypotension secondary to the vasodilation that will occur with sympathetic block. Temperature probes applied to the skin measure temperature increase caused by the vasodilation. The patient is connected to a cardiac monitor during the procedure.
The site of catheter placement varies, depending on the area of pain:

- **epidural space** for pain in the trunk or lower extremities,
- **brachial plexus** for pain in the upper extremities,
- **celiac plexus** for pain in the upper abdominal viscera,
- **lumbar sympathetic chain** for pain in the pelvic viscera and lower extremities,
- **other sites** for pain in the region of those nerves (leg: femoral).

The area of catheter insertion is prepped with povidone-iodine (Betadine) and infiltrated with a local anesthetic. Then, the catheter needle is inserted and normal saline is used to ascertain proper placement. If the catheter is in the epidural space, the saline flows without resistance; to check placement in other areas, fluoroscopy is used. Finally, the catheter is threaded through the needle and the needle removed.

The patient is then given a test dose of the local anesthetic to determine if the pain diminishes, to measure the sympatholytic response, and to further verify catheter placement. If the catheter has inadvertently entered a vessel, the patient will have symptoms of systemic absorption or toxicity, such as metallic taste, blurred vision, ringing in the ears, hypotension, bradycardia, respiratory depression, tremors and convulsion.

After the test dose, the patient receives a loading dose to maintain analgesia until he returns to the unit, where his catheter will be attached to a volumetric infusion pump. The patient remains in the Pain Control Center at least one-half to one hour after the loading dose. During this time and after the procedure, the nurse notes any change in the patient's motor or sensory function and uses a dermatome chart to determine the patient's level of pain relief, describing it on the chart. The physician prescribes the drug flow according to the pain level.

**Drugs used.** Bupivacaine is used for CEIs at the University of Cincinnati. The concentration is determined according to the pain pathway involved. For example, if only the sympathetic (or C-fiber) pathway is involved, as was the case with Ms. B, a concentration of 0.125 percent may be adequate. When the A Delta-fiber (or sensory path) is also involved—for example, L's reflex sympathetic dystrophy—0.25 percent
may be used. When C-fiber, A Delta-fiber, and the A Gamma-fiber (or motor path) are all involved, as was the situation with Mr. J’s lumbar arachnoiditis, 0.5 percent is recommended. The appropriate concentration is prepared under sterile conditions in the hospital pharmacy, usually in a 300 ml bottle of normal saline.

The volume of bupivacaine delivered determines the amount of spread. For example, an epidural infusion at 15 ml/hr. spreads to the T-8 level; at 10 ml/hr. to the T-10 level; at 8 ml/hr. to the T-12 level. A 10 ml/hr. flow of a 0.25 percent solution usually maintains a bupivacaine blood concentration of approximately 0.8 mcg/ml, which is in the therapeutic, nontoxic level. Toxic levels occur with a blood concentration of about 3-5 mcg/ml.

The infusion rate may be adjusted depending on individual response. If the patient experiences bladder retention or increased numbness, the rate may be slowed to reduce the nerve block. If intolerable pain persists, the rate may be increased for more block. After the first 24 hours, the rate is gradually reduced until the catheter is removed.

Narcotics such as meperidine may be used with bupivacaine to enhance the pain relief. For example, if the bupivacaine concentration must be reduced to clear a motor block, meperidine can provide the extra analgesia needed. The nursing management then requires close assessment of respiratory rate and management of possible nausea.

**CARING FOR THE CEI PATIENT**

The continuous flow of anesthetic solution should be started via an infusion pump no later than one hour after catheter insertion to maintain analgesia and reduce risk of a clogged catheter. Blood samples are taken from the patient’s arm three to five hours after the infusion is started and every 12 hours thereafter to monitor the anesthetic concentration.

During the course of the infusion, the nurse may need to:

- Limit patient activity to prevent catheter displacement. Often a patient with an epidural or caudal catheter will be on bedrest for the first 12 hours. A patient with an axillary catheter will need to limit abduction of the affected arm throughout the CEI, but is otherwise fully mobile.
- Listen to the patient. Since pain is subjective, the patient is the best source of information.

Pain may indicate that the concentration of local anesthetic is not high enough to block the pain fibers or that the tubing is kinked or disconnected. Notify the physician if the patient complains of pain, but do not stop the infusion. Also check the dressing for dampness or discharge, which may indicate leaking. Check any leak around an epidural catheter with a Dextrostix; a positive glucose may mean cerebrospinal fluid is leaking. If the catheter becomes displaced, the patient may have partial or total return of pain. If so, the physician will need to remove the catheter; repositioning could result in sepsis.

- Adhere strictly to aseptic technique to prevent catheter-related sepsis. The entire line, including a 0.22 micron inline filter, should be changed every 24 hours according to a hyperalimentation-type protocol. The pharmacy will usually send a container of solution sufficient for 24 hours so the system does not need to be opened more often. The nurse evaluates the site for redness, swelling or draining each time the dressing is changed—usually at least every hour. As a rule, only the 4 × 4s are changed; the transparent dressing is left undisturbed.

The nurse also marks the tubing and bottle to ensure that nothing other than the prescribed anesthetic or analgesic solution is infused through the extra-vascular line. All connections are taped to prevent leaking or separation.

The patient’s level of pain, which reflects the level of sympathetic block, and his vital signs are closely monitored. Hypotension, respiratory depression, and bradycardia can be signs of systemic absorption or toxicity. Other signs are a metallic taste, blurred vision and ringing in the ears. If any of these problems occur, stop the infusion and call the physician.

Skin color and temperature are checked at the catheter site, as well as peripheral pulses and the strength and movement of the involved extremity. Reduced mobility could indicate a motor block; numbness, a sensory block.

The patient’s fluid intake and output are monitored; watch, too, for abdominal distention because urinary retention or fecal incontinence is especially likely with epidural or caudal blocks.

**Catheter removal.** The infusion is terminated when the objectives are met—that is, the patient has reduced pain with increased mobility. It will also be terminated if the patient develops an elevated temperature or white cell count indicating sepsis, or if catheter problems develop—for example, leakage or displacement. When the catheter is removed, the catheter length and condition of the tip are documented. The catheter site is swabbed and the culture sent to the lab along with the catheter tip. The site is then cleansed, painted with povidone-iodine and covered with a dry sterile dressing.

**Follow-up.** The hospital stay for a patient receiving CEI is usually five to 10 days. Individually tailored follow-up evaluations are done in the Pain Control Center. In general, the patient is evaluated within two weeks postinfusion, then at one, three, and six months.

During the follow-up, the patient is given a “pain diary” and asked to rate his pain on a scale of 0 to 10 every hour that he is awake. His ability to work or engage in regular activity is noted, and additional treatment—physical therapy, TENS therapy, behavioral medicine, nerve block or repeat CEI, or medications—is prescribed as needed. If the patient remains free of pain, he may be discharged from the Pain Center, told to call if the pain returns, and then contacted for follow-up 12 months later.

**REFERENCES**

3. Personal communication, P. Prithvi Raj, MD.