SECTION 2

Analgesia, Anesthesia, and Sedation

CHAPTER 7

Acute Pain Management and Procedural Sedation

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Acute pain is present in 50% to 60% of all emergency department (ED) patients. Procedural sedation and analgesia often is needed for painful interventions or diagnostic studies.

CLINICAL FEATURES

Responses to pain vary and may include increased heart rate, blood pressure, respiratory rate, and behavioral changes. Because subjective impressions may be inaccurate, pain is often assessed with objective scales. Pain relief is a dynamic process and reassessment is mandatory.

EMERGENCY DEPARTMENT CARE AND DISPOSITION

Pharmacologic and nonpharmacologic interventions may be helpful for treating anxiety and pain in the ED. Nonpharmacologic interventions include the application of heat or cold, immobilization and elevation of injured extremities, explanation and reassurance, music, biofeedback, guided imagery, and distraction methods, such as feeding sucrose solution to infants. Discussing a painful intervention with a patient immediately before the procedure may decrease the anxiety created by anticipation. When pharmacologic intervention is needed, the selection of agent should be guided by the need for sedation or analgesia, the route of delivery, and the desired duration of effects.

Acute Pain Control

Nonopiate Analgesics, such as **acetaminophen**, 650 to 1000 milligrams (15 milligrams/kilogram PO or PR in children) or nonsteroidal anti-inflammatory drugs such as **ibuprofen,** 400 to 800 milligrams PO (10 milligrams/kilogram PO in children) can be used to treat mild to moderate pain. Parenteral NSAIDs are no more effective than oral medications. Adverse effects of NSAIDS include gastrointestinal irritation, renal dysfunction, platelet dysfunction, and impaired coagulation. Aspirin should be avoided in children because of an association with Reye syndrome.

Opiates, such as **morphine,** 0.1 milligram/kilogram IV (0.1 to 0.3 milligram/kilogram in children), **fentanyl,** 1.5 micrograms/kilogram IV

(1 to 2 micrograms/kilogram in children), and **hydromorphone,** 0.0125 milligram/kilogram IV (0.015 to 0.020 milligram/kilogram in children) are the agents of choice for moderate to severe pain. Additional doses are given every few minutes at half the original dose until pain is controlled. Side effects of opiates include respiratory depression, nausea and vomiting, confusion, pruritus, and urinary retention. Oral opioids, such as **oxycodone,** 5 to 10 milligrams PO (0.1 milligram/kilogram/dose in children) or **hydrocodone** (5 to 10 milligrams PO (0.1 milligram/kilogram/dose) may be tried for pain relief if procedural sedation and analgesia will not be used.

Procedural Sedation and Analgesia (PSA)

The indications for PSA include painful procedures, such as abscess drainage, wound management, tube thoracostomy, orthopedic manipulation, cardioversion, and diagnostic studies. Analgesia is relief from the perception of pain. Minimal sedation is a drug-induced state characterized by normal responses to voice and normal cardiac and ventilatory functions. Moderate sedation and analgesia (conscious sedation) are characterized by responsiveness to voice or light tactile stimulation with normal cardiac and ventilatory functions. Deep sedation and analgesia are characterized by responsiveness to repeated or painful stimulation, potentially inadequate ventilation, and potential loss of protective reflexes. Dissociative sedation is a type of moderate sedation.

Preparation

The risk of aspiration from recent oral intake increases with the depth of sedation. This risk must be balanced with the urgency of the procedure. The complication rate of PSA depends strongly on depth of sedation and patient's physiological reserve as determined by chronic or acute illness. Patients with significantly limited physiologic reserve, those with severe systemic disease, at the extremes of age, and those with predicted difficult airway (Chapter 1) may be best served with anesthesia consultation.

When PSA is performed, necessary equipment includes a continuous cardiac monitor and pulse oximetry, oxygen, suction, and immediate availability of appropriate-size resuscitation equipment. The patient should be under constant observation by a provider trained in airway management. Informed consent should be obtained. Blood pressure, heart rate, respiratory rate, and level of consciousness should be monitored. Some advocate routine use of capnography to monitor ventilation in sedated patients. The analgesic or sedative agents chosen should be individualized to the patient and the planned procedure. The agents used for PSA often have a narrow therapeutic index. Therefore, the nondissociative agents should be administered in small, incremental intravenous doses, with adequate time between doses to determine peak effect. All patients undergoing PSA should be reassessed continuously. Patients experiencing transient respiratory depression can usually be managed by bag-mask-valve ventilation.

Sedation Management

Table 7-1 describes selected sedation agents for procedural and sedation and analgesia.

TABLE 7-1 Sedation Agents for Procedural Sedation and Analgesia

Medication	Recommended Dosage	Route of Administration	Onset	Duration	Use
Nitrous oxide	50:50 mixture with oxygen	Inhalational	2-3 min	15-20 min	Minimal sedation
Midazolam	0.05-0.1 milligram/kilogram May repeat 0.05 milligram/kilogram every 2 min until adequately sedated	IV	1-3 min	1 h	Minimal or moderate sedation
	0.1 milligram/kilogram	IM	15-30 min	1-2 h	Minimal sedation
	Children: 0.1 milligram 0.5 milligram/kilogram 0.2 milligram/kilogram	 IM PO/PR Intranasally			
Fentanyl	1-3 micrograms/kilogram, can be titrated up to 5 micrograms/kilogram Children: 1-2 microgram/kilogram	IV	< 1 min	30-60 min	Minimal sedation
Fentanyl and midazolam	1-2 micrograms/kilogram fentanyl plus midazolam 0.05 milligram/kilogram to 0.1 milligram/kilogram, as needed, up to two times	IV	1-2 min	1 h	Moderate and deep sedation
Methohexital	1 milligram/kilogram	IV	1 min	10 min	Moderate or deep sedation
Pentobarbital	2 milligrams/kilogram to 2.5 milligrams/kilogram followed by 1.25 milligrams/kilogram, as needed, up to two times	IV rate should be < 50 milligrams/min	30-60 s	15+ min	Minimal and moderate sedation Used frequently for radiological procedures
Ketamine	1 milligram/kilogram 2-5 milligrams/kilogram Up to 4 milligrams/kilogram in children	IV IM	1-3 min 5-20 min	10-20 min 30-60 min	Dissociative sedation Dissociative sedation

(continued)

TABLE 7-1 Sedation Agents for Procedural Sedation and Analgesia (Continued)

Medication	Recommended Dosage	Route of Administration	Onset	Duration	Use
Ketamine and midazolam	Ketamine as above plus midazolam, 0.05 to 0.1 milligram/kilogram	IV	1-3 min	30-60 min	Dissociative sedation
Etomidate	0.15 milligram/kilogram, followed by 0.1 milligram/kilogram every 2 min, if needed Children: 0.1 milligram/kilogram–0.3 milligram/kilogram	IV	30-60 s	5-10 min	Moderate, deep sedation Associated with amnesia
Propofol	1 milligram/kilogram, followed by 0.5 milligram/kilogram every 3 min, if needed Children: 1-2 milligrams/kilogram	IV	1-2 min	5-10 min	Moderate and deep sedation
Propofol and ketamine	Propofol as above, ketamine 0.3 milligrams/kilogram–0.5 milligram/kilogram Use higher end dose in children	IV	1 min	Propofol–minutes, ketamine 15–45 min	Moderate and deep sedation

Weight based medication doses are the same in adults and children unless otherwise noted.

Fentanyl is the opiate of choice for most brief PSA procedures because of its rapid onset of action. Fentanyl is less likely to cause hypotension than are other opiates. Chest wall rigidity unresponsive to naloxone may occur at higher doses (5 to 15 micrograms/kilogram) or when rapidly administered potentially necessitating neuromuscular blockade and mechanical ventilation. A small dose of **naloxone (0.1 to 0.2 milligram)** may be used to reverse respiratory depression without blocking subsequent analgesia if needed.

Midazolam is commonly used as a sole agent for minimal sedation. Respiratory depression and hypotension may develop. Flumazenil quickly reverses sedation and respiratory depression due to benzodiazepines. Routine use to reverse sedation is not recommended.

Methohexital is an ultrashort acting barbiturate. The most common adverse effect is respiratory depression. Methohexital, which has been used PR in children, may precipitate seizures and should not be used in patients with a seizure disorder. Pentobarbital is an excellent choice for neuroimaging procedures in children.

Ketamine is a dissociative analgesic with sedative and amnestic properties that causes minimal respiratory depression. Ketamine may be administered IV, IM, PO, or PR. Ketamine may cause increased intracranial and intraocular pressure, hypersalivation, bronchorrhea, laryngospasm, and a hallucinatory emergence reaction in older children and adults. **Midazolam** (0.01 milligram/kilogram IM or IV or 0.1 milligram/kilogram PO) may attenuate the emergence reaction, but it may cause respiratory depression and delayed ketamine metabolism. Ketamine is contraindicated in children 3 months and younger and in those with airway abnormalities, a history of congestive heart failure, acute closed head or eye injury, altered mental status or psychosis, CNS mass, poorly controlled seizure disorder, active URI, or glaucoma.

Etomidate, is a sedative agent with minimal cardiovascular depression. Side effects include nausea and vomiting, myoclonus, and temporary adrenal insufficiency. Respiratory and CNS depressions may occur, especially when administered with opiates or benzodiazepines.

Propofol is an anesthetic agent with antiemetic properties administered by intravenous infusion. The most common side effect is respiratory depression and apnea. Side effects include dose-related cardiovascular depression with decreases in systolic blood pressure of 25% to 40%. Hypovolemia should be corrected before propofol administration. Adjunct analgesic is mandatory for painful procedures. Propofol use is contraindicated in patients who are allergic to eggs or soy products.

Children

Children of all ages feel pain, even neonates. Anxiety issues, pain control, and need for sedation must be addressed. Anxiety may be a significant barrier to a successful procedure performance, especially when patient's cooperation is needed. Parents can provide significant anxiety relief and should be allowed to stay with children. Age appropriate distraction techniques should also be employed. Benzodiazepines, such as midazolam, provide effective pharmacologic anxiety relief when needed. Procedural sedation and analgesia should be used when performing painful procedures or when

procedures require the patient to be still. Common medications used for pediatric procedural sedation are listed in Table 7-1.

Disposition

Patients are eligible for discharge only when fully recovered. When discharged, the patient must be accompanied by an adult and should not drive or operate machinery for 24 hours. Because many of the agents used for PSA produce anterograde amnesia, discharge instructions must be given to responsible accompanying adults.

Local and Regional Anesthesia

Local and regional anesthetics are essential tools for ED pain management. Agents can be administered topically, by infiltration directly into the area to be anesthetized or into the area of the peripheral nerves supplying the area to be anesthetized, and IV. This discussion focuses on topical and infiltrative anesthesia.

The toxicity of local anesthetics (LAs) is related to the total dose and the rate of plasma concentration increase and is increased in the setting of hypoxia, hypercarbia, and acidosis. The rate of plasma concentration increase is dependent on the vascularity of the site being infiltrated. Therefore, the maximum dose of LAs that can be administered for intercostal block is one-tenth the subcutaneous dose. Toxic effects include confusion, seizures, coma, myocardial depression, and dysrhythmias. Allergic reactions to LAs are uncommon and usually due to a preservative. If an allergy is suspected, the best approach is to use a preservative-free agent from the other class of LAs. Alternatively, diphenhydramine or benzyl alcohol may be used as an LA in the setting of a true allergy to conventional LAs.

LAs often cause pain during administration. Slow injection through a 27 or 30 gauge needle, injecting through the wound margin, using warm solution, and using buffered (with bicarbonate) solution decrease injection pain.

Epinephrine (1:100 000) is often added to LAs before administration. Addition of epinephrine increases the duration of anesthesia, provides wound hemostasis, and slows systemic absorption. Epinephrine causes vasoconstriction and therefore is avoided in an end-arterial field such as the digits, pinna, nose, and penis in patients with vascular disease.

Lidocaine, which is the most commonly used LA in the ED, has a 2 to 5 min onset of effect and a 1 to 2 hour duration of effect. The maximum dose of infiltrative **lidocaine** is 4.5 milligrams/kilogram without or 7 milligrams/kilogram with epinephrine. Lidocaine is buffered to decrease the pain of injection by adding 1 mL $NaHCO_3$ to 9 mL lidocaine. Bupivacaine, which has an onset of effect of 3 to 7 min and duration of effect of 90 min to 6 hours, is preferred for prolonged procedures. The maximum dose of infiltrative **bupivacaine** is 2 milligrams/kilogram without or 3 milligrams/kilogram with epinephrine. Buffer bupivacaine with 1 mL $NaHCO_3$ to 29 mL bupivacaine.

Regional blocks

Regional anesthesia is a technique that infiltrates local anesthetic agents adjacent to peripheral nerves ("nerve blocks") and is typically used for complicated lacerations, fractures, and dislocations. Distortion of the site is

avoided. US guidance can be used. Care must be taken not to inject the anesthetic solution directly into the nerve.

Digital Blocks

Finger and toe blocks are advantageous because less anesthetic is needed, better anesthesia is obtained, and tissues are not distorted. The onset of anesthesia is delayed when compared with that of LA. Assess and document neurovascular status before the procedure. Lidocaine and bupivacaine are the most commonly used agents and depend on the time needed to perform the procedure. Epinephrine is generally avoided. Complications include nerve injury and intravascular injection leading to systemic toxicity. Always aspirate before injecting to avoid inadvertent intravascular injection of LA.

The procedure for digital blocks involves sterile preparation of the skin, followed be the introduction of a 27 gauge or smaller needle into the skin (a skin wheal may be raised before deeper injection) and into one side of the extensor tendon of the affected finger just proximal to the web. After aspiration, approximately 1 mL LA is injected into the tissue on the dorsal surface of the extensor tendon. The needle is advanced toward the palm until its tip is seen beneath the volar skin at the base of the finger just distal to the web. After aspiration, 1 mL LA is injected. Before removing the needle, redirect it across the opposite side of the finger and inject approximately 1 mL across the dorsal digital nerve. Five minutes later, repeat the procedure on the opposite side of the finger (Fig. 7-1). An alternate method is to inject a 27 gauge needle

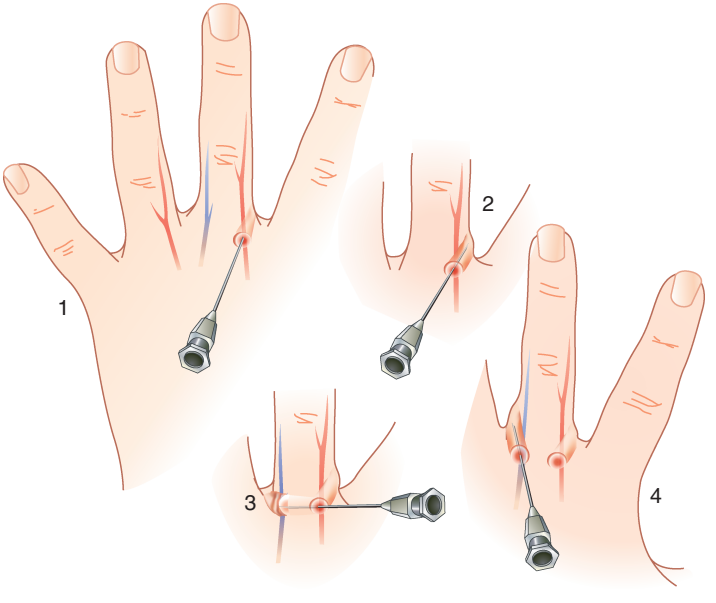

FIGURE 7-1. Needle positions for digital nerve block.

into the web space between the affected and an adjacent finger while directing the needle to the metacarpal joint of the affected finger. After aspiration, inject 1 to 2 mL into the area of the digital nerve. Before removal of the needle, advance the needle first dorsally and then volarly, and inject 1 mL LA; repeat on the opposite side. Toes can be blocked in similar fashion. Great toes also can be blocked with a modified collar block. A 27 gauge needle is introduced to the dorsolateral aspect of the base of the toe until it blanches the plantar skin. As the needle is withdrawn, 1.5 mL LA is injected. Before the needle is removed, it is passed under the skin on the dorsal aspect of the toe, and 1.5 mL LA is injected as the needle is withdrawn. The needle is reintroduced through the anesthetized skin on the dorsomedial aspect of the toe and advanced until the plantar skin is blanched; as the needle is withdrawn, 1.5 mL LA is injected.

Local Anesthetic Infiltration

LAs can provide anesthesia at a site by infiltrating directly into the site or by infiltrating around the peripheral nerves supplying the site. The most common use of LA is infiltration for wound repair or invasive painful procedures. When repairing wounds, LA can be infiltrated into the wound margins or as a "field block" surrounding the wound. When infiltrating intact skin, raising a wheal may cause less pain on subsequent infiltration. LA also can be used in orthopedic procedures, such as fracture and joint reduction, by directly injecting the LA into the affected joint or fracture hematoma.

For some wounds, LA infiltration around the peripheral nerves is advantageous due to decreased total LA required and decreased pain at the site of injection. This is most commonly used for procedures involving the hand, digits, or foot. Before a regional block, assess and document neurovascular status. During administration, the syringe plunger must be drawn back to avoid intravascular injection of LA. Onset of effect of anesthesia with peripheral nerve blocks often is delayed (up to 15 min).

Topical Anesthetics

Topical anesthetics can eliminate the need for LA infiltration, are applied painlessly, do not distort wound edges, and may provide hemostasis. Common preparations include lidocaine epinephrine tetracaine (LET), lidocaine prilocaine (EMLA), and various preparations of lidocaine. LET is applied by placing a LET-saturated cotton ball or gauze pad onto the wound for a minimum of 20 to 30 min. LET should not be used on mucous membranes or in end-artery fields.

Topical lidocaine is marketed in a solution, cream, jelly, or ointment. Viscous lidocaine can be used for the temporary relief of inflamed mucous membranes. Lidocaine jelly can be used to facilitate the insertion of urinary catheters, nasogastric tubes, and fiberoptic scopes. As with infiltrative use of lidocaine, care must be taken not to exceed maximal doses.

EMLA is a cream composed of lidocaine and prilocaine used on intact skin to relieve the pain associated with venipuncture, arterial puncture, port access, and other superficial skin procedures. It has a 45 to 60 min onset of effect and a 60 min duration upon withdrawal. Because prilocaine

may cause methemoglobinemia, EMLA should be used with caution in infants younger than 3 months and avoided in patients predisposed to methemoglobinemia.

For further reading in *Emergency Medicine: A Comprehensive Study Guide,* 7th ed., see Chapter 38, "Acute Pain Management in Adults," by James Ducharme and Chapter 39, "Pain Management in Infants and Children," by William M. Lennarz; and Chapter 40, "Local and Regional Anesthesia," by Douglas C. Dillon and Michael A. Gibbs; and Chapter 41, "Procedural Sedation and Analgesia," by James R. Miner.