

An overview of neuraxial anesthesia

Understand the basics so you can effectively manage your patients.

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LEARNING OBJECTIVES

1. Differentiate types of neuraxial anesthesia.
2. Identify complications of neuraxial anesthesia.
3. Discuss the nursing care of patients receiving neuraxial anesthesia.

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NEURAXIAL ANESTHESIA is the administration of medication into the subarachnoid or epidural space to produce anesthesia and analgesia. It can lead to the complete absence of sensory and/or motor function at or below the site of injection. Depending on the dose and concentration of the anesthetic used, neuraxial anesthesia doesn't always result in a complete absence of motor function. For example, the goal of neuraxial anesthesia administered to a woman in labor is to provide analgesia as she progresses through active labor but not remove her ability to move her lower extremities. The three most commonly used neuraxial techniques are spinal, epidural, and combined spinal-epidural (CSE). (See *When is neuraxial anesthesia used?*)

A major benefit of neuraxial anesthesia is the reduced need for parenteral opioids, which have many side effects (including respiratory depression, delirium, and GI disturbances) that are associated with cardiac, pulmonary, and kidney complications. A recent meta-analysis and systematic review by Meng and colleagues found that neuraxial anesthesia is associated with a lower incidence of these complications as well as decreased blood loss and risk of thromboembolism when compared to general anesthesia. In addition, perioperative and obstetric pain management with neuraxial anesthesia has led to improved patient satisfaction scores because of enhanced pain control and shortened hospitalizations.

To ensure competent care of patients who receive neuraxial anesthesia, you should have a fundamental knowledge of spine anatomy to help you understand the important differences between spinal and epidural anesthesia administration. (See *Do you know your spine anatomy?* online at myamericannurse.com/?p=65158) You also should know how to effectively monitor patient response to anesthesia, respond to complaints of pain, and address complications. Adverse events must be immediately communicated to the patient's surgical team to mitigate harm.

Neuraxial techniques

Neuraxial anesthesia can be administered via spinal, epidural, or CSE routes. (See *Spinal vs. epidural administration*.)

Spinal administration. To administer spinal neuraxial anesthesia and/or analgesia, a needle is inserted through the ligaments between the vertebrae and a one-time injection of medication (approximately 1 to 2 mL of local anesthesia with or without an opioid) is placed into the *subarachnoid space* (the area between the arachnoid and pia mater).

Epidural administration. An epidural is administered using a Tuohy needle that pierces the ligaments between the vertebrae. The needle is inserted into the *epidural space* (the area between the dura mater and the

vertebrae). A catheter is threaded through the Tuohy into the epidural space, and an infusion of a local anesthetic with or without an opioid is initiated. Epidurals can be used to produce anesthesia but are more commonly used to provide intra- and postoperative analgesia.

CSE administration. CSE anesthesia is a two-step process. First, a Tuohy needle is placed in the *epidural space*. The spinal needle is then placed through the Tuohy, and a bolus of local anesthetic is administered into the *subarachnoid space*. After the spinal needle is removed, the epidural catheter is threaded through the Tuohy needle and its position is confirmed. Local anesthetic can be administered either as a bolus or an infusion.

How it works

Anesthesia (the complete absence of sensory and motor function) is achieved when high concentrations of local anesthetic are used, such as 0.75% bupivacaine for spinal administration and 0.25% bupivacaine for epidural administration. Analgesia (absence of pain) is achieved when a lower concentration of local anesthetic is used, such as 0.125% bupivacaine for epidural administration. Analgesic concentrations of local anesthetics are rarely used for spinal administration.

Local anesthetics work by bathing the nerve roots of the spinal cord, inhibiting sodium channel transmission to block pain signals to the central nervous system. The most commonly used local anesthetics for neuraxial anesthesia are lidocaine, bupivacaine, and ropivacaine. Opioids such as fentanyl, morphine, and hydromorphone can be coadministered with local anesthetics to produce a synergistic effect that inhibits pain transmission.

Analgesia duration depends on the type of local anesthetic used and whether it's administered via a single injection or as a continuous infusion through epidural or CSE technique. Single spinal injections generally last 60 to 150 minutes depending on the anesthetic used; epidural administration achieves anesthesia and/or analgesia as long as the catheter remains in the epidural space and a continuous infusion of medication is running. (See *How long will it last?*)

Managing neuraxial analgesia

In addition to monitoring analgesic efficacy, side effects, and complications, nurses must

When is neuraxial anesthesia used?

Neuraxial anesthesia is used in a variety of clinical situations, including surgical, obstetric, and procedural.

Surgical

- Abdominal
- Orthopedic
- Thoracic
- Urologic

Obstetric/gynecology

- Cesarean delivery
- Labor epidural
- Tubal ligation

Procedural

- Cervical, thoracic, and/or lumbar epidural steroid injections
- Chronic pain management

About dermatomes

Extending from the spinal cord are 31 spinal nerve roots, each of which provides sensory innervation to a dermatome (specific area of skin). For example, a patient who has knee arthroplasty and receives an epidural for postoperative pain management will have analgesia at or below sensory dermatome level L1 (first lumbar vertebrae). Other common procedures and corresponding dermatome levels include:

Dermatome level	Procedure
T4-T6	Cesarean delivery
T8-T10	Urologic procedures
T10	Hip arthroplasty
T11-T12	Knee arthroplasty

assess the catheter insertion site, manage epidural infusions, and potentially remove an epidural catheter if a patient transitions to oral pain medications. Be sure to follow organization protocols and order sets.

When caring for a patient who's received neuraxial anesthesia, you'll closely monitor his or her blood pressure (BP), heart rate (HR), pulse oximetry, respiratory rate, pain perception, and level of consciousness. Use a dermatome map to assess the level of sensory block and determine current motor function to establish a baseline level of analgesia. (See *About dermatomes*.) The American Society of Anesthesiologists recommends that nurses follow a patient-specific protocol established either by the patient's care team or the organization's policy.

If a catheter is present, assess the insertion site. Also assess the infusion system and tubing to identify any detached connections, malfunctioning infusion pumps, or medication errors. Ensure catheters are clearly labeled, and avoid using tubing with any type of injection ports to limit the risk of inadvertently administering a medication intended for I.V. injection into the site. You'll also want to be vigilant for inadequate analgesia and complications.

Complications

Prompt recognition and treatment of complications related to neuraxial anesthesia are essential in preventing lethal outcomes.

Inadequate analgesia. If a patient who received a spinal anesthetic begins to complain of worsening pain, parenteral or oral analgesia may be required. If an epidural catheter is present, assess the catheter, the insertion site, and the level of dermatomal block. If an infusion hasn't been started, initiate it to treat the

pain per the anesthesia provider's order. For infusions already running, the provider may increase the infusion rate. Instruct patients with patient-controlled epidural analgesia (PCEA) how to use the bolus option to control pain. All changes to the infusion should be guided by a clearly written anesthesia provider order. The most common medications used for PCEA are bupivacaine 0.625%-0.25% and ropivacaine 0.625%-0.25% (either drug also may be given with fentanyl, morphine, or hydromorphone). Both are typically administered at a basal infusion rate of 4 to 10 mL/hr and a bolus dose of 3 to 6 mL. The lockout interval is usually 10 to 15 minutes, with the maximum hourly dose 22 to 34 mL.

If the patient continues to complain of inadequate analgesia even after the infusion rate is increased, recheck the infusion system and tubing and ensure the catheter hasn't migrated (the distance of the catheter from the insertion site should be marked on insertion) or been dislodged. Follow provider orders for breakthrough pain, bolus dosing, and infusion pump settings related to an inadequate or absent level of analgesia. Notify the anesthesia provider if the patient doesn't experience any improvement in pain.

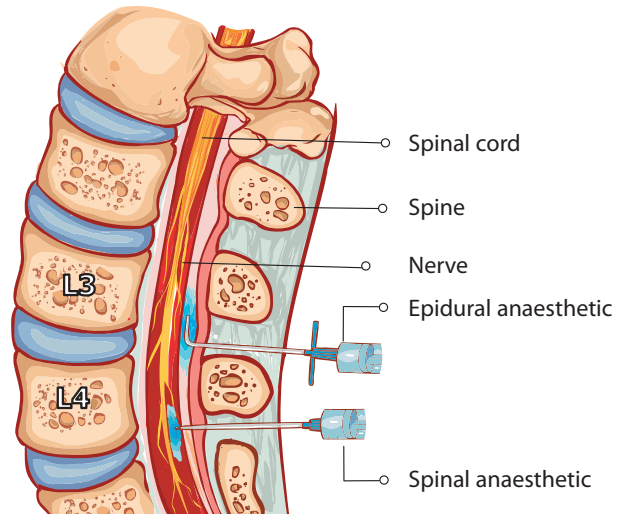
Hypotension and bradycardia. Neuraxial anesthesia can cause variable BP decreases that frequently are accompanied by a decreased HR. Keep in mind that hypotension can be defined in absolute parameters (for example, systolic BP less than 90 mmHg or mean arterial pressure less than 65 mmHg) and in relative terms (for example, a decrease in systolic BP greater than 20% of the patient's baseline).

Decreased BP with evidence of hypoperfusion, such as mental status changes, requires prompt treatment. Place the patient in the supine position. If the patient has adequate cardiac and renal function, the provider may order a fluid bolus. Patients who don't respond to these initial treatments will require vasopressor or inotropic agents, such as ephedrine, phenylephrine, or epinephrine. Treat bradycardia (HR less than 60 beats per minute) as ordered with glycopyrrolate or ephedrine if mildly symptomatic, or atropine if severe.

Respiratory depression. Neuraxial anesthesia can affect the diaphragm and accessory muscles of respiration, resulting in an impaired cough reflex that diminishes the patient's ability to clear secretions. This effect is

Spinal vs. epidural administration

As illustrated below, a spinal anesthetic is injected into the subarachnoid space and an epidural is injected into the epidural space.



more noticeable in patients with preexisting pulmonary disease.

Opioids (particularly morphine) administered into the subarachnoid or epidural space have a duration of action up to 24 hours. In that time frame, any additional parenteral or oral opioids can amplify side effects. Monitor for signs of respiratory depression such as bradypnea (less than eight breaths per minute), desaturation (pulse oximetry less than 90% on room air), grunting, or airway obstruction. If respiratory depression occurs, stop any analgesic infusion and administer oxygen via a face mask at a minimum of 6 L/minute. Elevate the head of the bed to 45 degrees or higher, notify the anesthesia provider, and consider administering naloxone per provider order.

Nausea and vomiting. Nausea and vomiting secondary to neuraxial anesthesia may be attributed to hypotension, neuraxial opioids, or GI hyperperistalsis. Aggressively treating hypotension frequently prevents nausea and vomiting. For symptoms unrelated to hypotension, administer antiemetics as ordered by the provider. Small doses of anticholinergics, such as atropine or glycopyrrolate, also may be ordered.

Urinary retention. Anesthetic block of the lumbar and sacral nerve roots leads to temporary loss of bladder function and an inhibited void reflex. If a urinary catheter isn't present, assess the patient for bladder distension until he or she is able to void. The incidence of urinary retention has been reported to be as low as 5% and as high as 70%; however, urinary retention may be influenced by factors beyond neuraxial anesthesia, including urology surgery and whether I.V. opioids were used during surgery.

Pruritis. Incidence of pruritis related to opioid administration via spinal or epidural routes ranges from 69% to 83%. Opioid antagonists (such as naloxone) or mixed opioid agonist-antagonists (such as nalbuphine) can effectively treat opioid-induced pruritis. Diphenhydramine also may be effective.

Postdural puncture headache (PDPH). PDPH is a positional headache caused by cerebral spinal fluid (CSF) leakage through a dural puncture. A PDPH is most common after a "wet tap" in which the anesthesia provider inadvertently punctures the dura with the Tuohy needle. A recent meta-analysis by Choi and colleagues showed that although the risk

of a dural puncture from a Tuohy needle is only about 1.5%, a greater than 50% chance exists that patients will develop PDPH from that puncture. The constant, throbbing headache typically is located in the frontal or occipital regions. Hallmark symptoms include a headache that worsens with sitting or standing but improves when supine, neck stiffness, visual changes, subjective hearing loss, nausea, and vertigo.

Notify the anesthesia provider if you suspect PDPH. Encourage patient bedrest in the supine position, oral hydration, and increased caffeine consumption. Administer oral analgesics such as acetaminophen, butalbital, or caffeine as ordered and antiemetics as needed. For debilitating PDPH that doesn't respond to conservative treatment, the anesthesia provider may place an epidural blood patch (injection of a small amount of autologous blood into a patient's epidural or spinal space to stop a CSF leakage) after patient consent.

High regional block/total spinal anesthesia. A high block or total spinal anesthesia can occur when large doses of local anesthetic are injected via a catheter that's mistakenly placed in the intrathecal space or migrates after placement. High block symptoms have a rapid onset (usually less than 60 seconds) and include nausea, dyspnea, hypotension, bradycardia, and weakness and numbness in the upper extremities. A total spinal presents with unconsciousness, apnea, and profound hy-

How long will it last?

Neuraxial anesthesia onset and duration of action depends on the administration route and anesthetic used.

Spinal anesthesia	Onset (minutes)	Duration of action (minutes)
Bupivacaine	5-8	90-150
Ropivacaine	3-5	60-100
Chloroprocaine	2-4	80-120

Epidural anesthesia		
Bupivacaine	10-15	Continuous with infusion
Ropivacaine	10-15	Continuous with infusion

potension. Notify the anesthesia team immediately and prepare for possible advanced cardiac life support (ACLS) interventions. The incidence of a high regional block or total spinal anesthesia is approximately 0.02%.

Systemic toxicity. Large volumes of local anesthesia can mistakenly be injected into a blood vessel during epidural placement, causing the anesthetic serum level to rise above a toxic threshold and resulting in local anesthesia systemic toxicity (LAST). LAST, which is rare (less than 0.2%), affects the neurologic and cardiovascular systems and may be fatal if treatment is delayed. Early symptoms include tinnitus and a metallic taste in the mouth. Signs of toxicity can rapidly progress to seizure, loss of consciousness, hypotension, arrhythmia, and circulatory collapse. Notify the anesthesia team and prepare for possible ACLS interventions. Lipid emulsion therapy, administered by the anesthesia provider, also is indicated for LAST. Become familiar with where and how to obtain lipid emulsions because timely administration is essential to reduce the risk of cardiac arrest.

Epidural and spinal hematoma. Epidural and spinal hematomas are among the rarest neuraxial anesthesia complications (incidence ranges from 1 in 150,000 to 1 in 220,000). Patients with a hematoma usually will complain of sudden sharp back pain (from the insertion site) that radiates to the leg. Generalized weakness along with bladder and bowel dysfunction also may indicate a hematoma. Because a definitive diagnosis can be achieved only with magnetic resonance imaging and computed tomography, you should have a high degree of suspicion when patients sud-

denly complain of these symptoms and alert the anesthesia team immediately. Hematomas will be surgically evacuated.

Neuraxial anesthesia and antithrombotic therapy

Some surgical patients take antithrombotic therapy (for example, warfarin, clopidogrel, and aspirin) to treat conditions such as venous thromboembolism or atrial fibrillation or, in the case of those with cardiac stents and/or mechanical heart valves, as a preventive measure. The decision to proceed with neuraxial anesthesia for surgery in patients receiving antithrombotic therapy is based on an assessment of the risks of bleeding and thrombosis when therapy is discontinued. Failure to discontinue antithrombotic medications before neuraxial anesthesia administration predispose these patients to the risk of a spinal or epidural hematoma.

Instruct surgical patients to stop taking antithrombotic medications before the day of surgery. (The time frame for stoppage depends on the medication.) After surgery, monitor patients for signs of a spinal or epidural hematoma and ensure they resume antithrombotic medications per provider orders. Some patients will require postoperative bridge therapy (for example, low molecular weight heparin [such as enoxaparin] or unfractionated heparin). The American Society of Regional Anesthesia and Pain Medicine has developed guidelines for when to remove neuraxial catheters and when to re-initiate antithrombotic medications to reduce bleeding risk. The University of Washington has an excellent reference that can be found online at bit.ly/3bwqBin.

Ensuring good outcomes

Proper nursing care and management helps ensure good outcomes for patients who receive neuraxial anesthesia. Prompt identification and communication of complications and adverse events coupled with swift intervention can mitigate harm and ultimately prevent permanent injury.

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Visit myamericannurse.com/?p=65158 to view references, a case study, and information on spine anatomy.

*Name is fictitious.

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Please mark the correct answer online.**1. To administer spinal anesthesia, a needle is**

- a. inserted between the dura mater and vertebrae.
- b. inserted into the center of the dura mater.
- c. placed into the subarachnoid space.
- d. placed into the vertebral space.

2. Which statement about how local anesthetics work is correct?

- a. They bathe the nerve roots of the spinal cord, inhibiting sodium channel transmission to block pain signals to the central nervous system.
- b. They block the nerve roots of the spinal cord, inhibiting calcium channel transmission to block pain signals to the central nervous system.
- c. They block the nerve roots of the spinal cord, inhibiting chloride channel transmission to block pain signals to the central nervous system.
- d. They bathe the nerve roots of the spinal cord, inhibiting potassium channel transmission to block pain signals to the central nervous system.

3. Depending on the anesthetic used, single spinal injections usually last for

- a. 25 to 30 minutes.
- b. 30 to 45 minutes.
- c. 60 to 150 minutes.
- d. 90 to 180 minutes.

4. The dermatome level for an anesthetic administered for a patient undergoing hip arthroplasty is

- a. lumbar 2.
- b. thoracic 4.
- c. lumbar 10.
- d. thoracic 10.

5. The middle meningeal layer of the spinal cord is called

- a. subarachnoid.
- b. arachnoid.
- c. pia mater.
- d. dura mater.

6. Which medication used for spinal anesthesia starts working in 2 to 4 minutes?

- a. Chloroprocaine
- b. Bupivacaine
- c. Ropivacaine
- d. Lidocaine

7. A common basal infusion rate for patient-controlled epidural anesthesia (PCEA) with ropivacaine is

- a. 1 to 3 mL/hr.
- b. 3 to 5 mL/hr.
- c. 4 to 10 mL/hr.
- d. 12 to 14 mL/hr.

8. Which statement about respiratory function and neuraxial anesthesia is correct?

- a. Neuraxial anesthesia does not affect the diaphragm or accessory muscles.
- b. If respiratory depression occurs, the patient should be placed flat in bed.
- c. Respiratory depression is unlikely to occur more than 2 hours after drug administration.
- d. Neuraxial anesthesia can cause an impaired cough reflex.

9. Aggressive treatment of what condition frequently prevents nausea and vomiting after neuraxial anesthesia?

- a. Hypotension
- b. Hypertension
- c. Rapid respiratory rate
- d. Bradycardia

10. A complication that is associated with an anesthesia provider inadvertently puncturing the dura with a Tuohy needle is

- a. systemic toxicity.
- b. urinary retention.
- c. postdural puncture headache.
- d. bradycardia.

11. Lipid emulsion therapy is indicated to treat the complication of

- a. high regional block.
- b. local anesthesia systemic toxicity.
- c. total spinal anesthesia block.
- d. epidural hematoma.