EPIDURALS (PEDIATRIC)

Surgical Specialty:	Pediatric Pain/Regional Anesthesia
Authors:	Ashlee E. Holman, MD, Kathleen M. Gibbons, MD University of Michigan, Ann Arbor, MI

Background:

- General Considerations[1,2]
  - Epidural anesthesia/analgesia (EA) is performed via injection of local anesthetic (+/– adjuvant) into the epidural space, usually via a catheter left in place at thoracic, lumbar, or sacral (caudal) levels.
  - In pediatrics, EA is most commonly performed in addition to general anesthesia (GA) for postoperative analgesia and/or to decrease GA requirements but may be used as the sole anesthetic technique in select situations.
  - EA can provide reliable motor, sensory, and autonomic blockade over mid/low thoracic, lumbar, and sacral dermatomes.
  - In pediatric patients, EA is typically placed after induction of GA.
  - EA may facilitate a decrease in exposure to GA agents, reduce the painful autonomic and hormonal response to surgery, lower the risk of postoperative pulmonary complications, allow for better postoperative analgesic outcomes with a reduction of opioid requirements and associated side effects, decrease the risk of postoperative nausea and vomiting (PONV), and hastens recovery of bowel function[3].
- Patient Considerations[1,2]
  - The use of EA may be considered for all pediatric age groups.
  - In neonates and infants, a caudal epidural catheter may be placed through the sacral hiatus and advanced rostrally to provide EA at higher lumbar or thoracic levels.
  - EA may be used as the sole anesthetic technique in certain situations (e.g. cooperative older pediatric patients or in patients at risk for hemodynamic or respiratory complications under GA, such as premature infants or those with cardiac/pulmonary morbidity) or may be used with sedation to avoid airway manipulation and exposure to general anesthetic agents.
  - The sole use of local anesthetic (LA) agents may decrease the risk of postoperative apnea in at-risk patients (e.g. premature infants, high-risk neonates). The addition of adjuvants (e.g. clonidine, opioids) negates this advantage[4,5] but may improve the quality of EA.
- Associated Comorbidities/Syndromes
  - The presence of CNS abnormalities (e.g. neural tube defects, tethered cord, Chiari malformation, increased intracranial pressure, etc.), concerning sacral dimple without associated diagnostic evaluation, infection, trauma, or coagulopathic disease may preclude the use of EA.

Anesthetic Planning:

- Pre-Anesthetic Evaluation
  - Standard preoperative anesthetic evaluation (i.e. NPO status, presence of respiratory symptoms or illness, etc.) as well epidural-specific considerations such as pre-existing neuropathy, presence of sacral dimple, allergy to LA agents, rash or infection over the site of needle placement, and coagulopathy or use of anticoagulant medications[1].
  - Discuss Risks/Benefits/Alternatives to proceeding with EA with caregivers and surgeon.
    - Benefits of EA listed above.
    - Provides predictable, targeted anesthesia/analgesia over the dermatomes at, above, and below the level of the epidural catheter, allowing for decreased use of opioid and sedative medications.
    - EA is 100% elective. The alternative to EA is oral or intravenous analgesic medications, peripheral nerve blockade, and/or infiltration by the surgeon.
    - Risks associated with EA include inadequate blockade, complete failure of blockade, intrathecal injection, headache, infection, hematoma, local anesthetic systemic toxicity (LAST), and rarely, nerve injury[5].
  - Additional labs/tests indicated during work-up
    - Lab work, if indicated by history, to evaluate for coagulopathic abnormalities or systemic infection.
    - Evaluation of sacral dimple with ultrasound or MRI.
    - Document pre-existing neurological deficits prior to EA placement.
  - Discussions to have with surgeon/family
    - Failure of block requiring adjustment or replacement of epidural catheter or use of alternative pain control methods.
    - Postoperative neurological exam may be compromised secondary to motor and sensory blockade.
    - Depending on the catheter level, urinary catheterization may be necessary.
- Specific or Unique Room Set-Up Requirements[1,2]
  - Airway
    - Natural airway versus use of nasal cannula for the administration of supplemental O_2 if needed as well as for CO_2 monitoring.
    - Secured airway for EA placement after induction of GA.
  - Equipment
    - Sterile gloves
    - Antiseptic solution for skin disinfection
    - Lidocaine in 1 mL syringe with 25G needle for skin wheal if performing awake placement
    - Epidural/Caudal Catheter kit
  - Emergency Equipment
    - O_2 source
    - Suctioning
    - Resuscitation medications and equipment
  - Drugs/Infusions[1]
    - Topical local anesthetic cream (e.g. LMX, EMLA) and oral sucrose for use in small, awake children
    - LA Medications (institutional practice may vary)

            - LA
                - 0.05-0.2% ropivacaine
                - 0.0625-0.25% bupivacaine
                - 1.5-3% 2-chloroprocaine
                - 1-2% lidocaine
            - Bolus dose: 1 mL/kg, maximum 20 mL or 0.05 mL/kg/dermatome
            - Infusion rate
                - Bupivacaine: 0.2-0.5 mg/kg/hr
                - Ropivacaine: 0.25-0.6 mg/kg/hr
                - 2-Chloroprocaine: 5-12 mg/kg/hr
        - Adjuvants (institutional practice may vary)
            - Epinephrine 1:200,000
            - Opioid (hydromorphone, fentanyl)
            - Clonidine
            - Dexmedetomidine
        - Premedication (as needed for awake epidural placement)
        - Rescue Medications (in the event of LAST)[6]
            - Epinephrine, midazolam
            - Lipid emulsion
    - Monitors[1,2]
        - Standard ASA monitors.
    - Blood Availability
        - Dependent on surgical procedure.
    - PICU Bed Availability
        - Institutional practice may vary in specific requirements for monitoring.
    - Other Indicated Resources
        - Bring sucrose, pacifier, blanket, and personal comfort objects with the patient to the OR if planning for awake anesthetic.
        - Ultrasound, electrical stimulation, or fluoroscopy in the OR for confirmation of catheter location if indicated.

Intraoperative Considerations:

- General
    - All-stop patient/procedure time out with verification of maximum hourly LA dose and level/extension of surgical incision and exposure.
    - Epidural placement typically occurs under GA in pediatric patients.
    - Consider the use of sedative medications in awake patients if needed.

- Positioning[2]
    - Sitting or lateral position.
    - Curled in the "fetal position" to maximize the distance between interspinous processes.
    - Goals of positioning include maintenance of airway patency, stabilization of the head, neck, and spine, and minimization of movement.
- Technique[2]
    - Sterile preparation of supplies.
    - Skin disinfection.
    - Insertion of the needle at the level of desired epidural catheter placement using a paramedian or midline approach.
    - Estimation of depth to epidural space[1]:

        - < 25 kg ~ 1 mm/kg
        - > 25 kg ~ 10 + (age in years x 2) = depth in mm
    - Needle advancement through subcutaneous tissue and supraspinous ligament, into the interspinous ligament and ligamentum flavum. Upon entering ligamentum flavum, attach a saline syringe for loss of resistance technique with further needle advancement. The use of air for loss of resistance is strongly discouraged due to the risk of pneumocephalus or vascular air embolus.
    - Obtaining "loss of resistance" typically indicates entrance into the epidural space and further advancement of the needle should cease.
    - Inject sterile saline into the epidural space to expand the area for catheter placement.
    - Thread the epidural catheter gently through the needle, making note of the distance from the skin to the epidural space and advancing slightly farther than the goal insertion depth, to allow for accidental withdrawal with removal of the needle.
    - Withdraw the catheter to the desired depth at the skin.
    - Aspirate to confirm the end of the catheter is not intravascular or intrathecal.
    - Following negative aspiration of blood and CSF, a test dose with 0.5-1 mcg/kg epinephrine (maximum 3 mL of 1:200,000 epinephrine) may be injected to further confirm the lack of intravascular placement. 60 seconds of EKG observation for changes suggestive of intravascular injection (i.e. ST segment or T wave changes as heart rate changes are a less sensitive marker in pediatric patients, tachycardia, hypertension) is recommended.
    - Confirmation of correct catheter placement may be via sensory exam, fluoroscopy, ultrasound guidance, or nerve stimulation (nerve stimulation epidural catheters are not approved for use in the USA). Confirmation of level for caudally-placed epidural catheters threaded up to thoracic and lumbar levels is recommended.
    - Consider tunneling of the catheter to decrease the risk of dislodgement, leaking, and infection.
- Positioning for Surgery
    - If EA is used as the sole anesthetic technique, the patient should be positioned near the head of the OR table for access to the airway if needed.
    - Care should be taken to avoid dislodging or kinking the epidural catheter during positioning for surgery.
- Maintenance
    - Intermittent bolus versus continuous infusion.
- Hemodynamic/Physiologic goals[5]
    - Treatment of hypotension or bradycardia as indicated with the use of intravenous volume or vasopressors.
    - Consider decreasing the concentration or rate of the epidural infusion if hemodynamic instability occurs.
- Post-op Care
    - Pediatric patients with EA should be seen in the recovery room and followed postoperatively by a dedicated Pediatric Pain Service.
    - Standard PACU discharge criteria.
    - Urinary retention may occur with EA and may require intermittent catheterization or placement of an indwelling Foley catheter.

Case-Specific Complications/Pitfalls[2,5]:

- Epidural Failure: test catheter level with lidocaine, troubleshoot as below
  - Partial but bilateral blockade: consider increasing volume via boluses and increased infusion rate, consider adding an adjuvant to improve blockade
  - Unilateral blockade: consider placing the patient on the side of tihe nadequate block and bolusing, consider withdrawing the catheter, and replace epidural catheter if needed.
  - No blockade: replace epidural catheter if possible
- Local Anesthetic Systemic Toxicity (LAST) (< 0.05% risk)[6]
  - Signs/Symptoms
    - Neurotoxicity (e.g. dizziness, agitation, myoclonic movements, seizures, loss of consciousness)
    - Cardiotoxicity (e.g. arrhythmias, cardiac arrest) is more likely to manifest first under GA
  - Prevention via negative aspiration, injection of a test dose, intermittent aspiration, incremental injection, use of continuous infusion as opposed to bolus technique
  - Decrease maximum LA dose by 50% for infants < 6 months as this population is at higher risk for LA toxicity
    - 20-40% lower alpha-1 acid glycoprotein levels compared to adult values
    - Immature hepatic metabolism and impaired hepatic blood flow
    - Decreased renal clearance
    - Larger volume of distribution
    - Increased cardiac output and systemic uptake of LA
    - Increased free fraction of drug
  - Treatment
    - O_2 supplementation
    - Support ventilation with the goal of avoiding respiratory acidosis
    - Support circulation
      - Low-dose epinephrine
      - Intralipid: initial bolus of 1.5 mL/kg over 1 minute, repeated every 3-5 minutes as necessary up to 3 mL/kg, followed by infusion of 0.25-0.5 mL/kg/min
- Intrathecal Injection (0.2% risk)
  - Unintentional injection of dose intended for EA
  - May manifest as partial subarachnoid block or total spinal anesthesia
  - Treatment requires the support of cardiopulmonary systems until the block recedes
- Other Complications (most are extremely rare):
  - Epidural Hematoma
    - Consider MRI for concerning symptoms (i.e. bilateral lower extremity weakness, back pain, urinary retention) and early neurosurgery consultation.
  - Infection (including cellulitis, epidural abscess, meningitis)
    - Less common with single-shot techniques, more common with catheter use
    - Order MRI for concerning features (i.e. back pain with localized tenderness, weakness, fever, leukocytosis), consider antibiotics, and obtain early neurosurgery consultation
  - Allergic Reaction/Anaphylaxis
  - Nerve Injury
  - Post-Dural Puncture Headache

References

1.) Polaner DM, Karmakar M, Sunder R, Suresh S, Cote CJ. Regional Anesthesia. In: *Cote CJ, Lerman J, Anderson BJ, editors. Cote, Lerman, and Anderson's A Practice of Anesthesia for Infants and Children*. 7th ed. Philadelphia: Elsevier; 2025. p. 1053-1133.
2.) De Jose Maria B, Tielens L, Roberts S. Pediatric Epidural and Spinal Anesthesia and Analgesia. *NYSORA*. https://www.nysora.com/topics/sub-specialties/pediatric-anesthesia/pediatric-epidural-spinal-anesthesia-analgesia/. 2022. Accessed 9/7/2022.
3.) Bosenberg A. Benefits of regional anesthesia in children. *Paediatr Anaesth.* 2012 Jan; 22(1): 10-18. PubMed Link
4.) Attia J, Ecoffey C, et al. Epidural morphine in children: pharmacokinetics and CO2 sensitivity. *Anesthesiology*. 1986 Dec;65(6):590-4. PubMed Link
5.) Narchi P, Benhamou D, Hamza J, Bouaziz H. Ventilatory effects of epidural clonidine during the first 3 hours after caesarean section. *Acta Anaesthesiol Scand*. 1992 Nov;36(8):791-5. PubMed Link
6.) Dryden AM, Tsui BCH. Complications of Regional Anesthesia in the Pediatric Population. In: *Tsui BCH, Suresh S, editors. Pediatric Atlas of Ultrasound- and Nerve Stimulation-Guided Regional Anesthesia*. 1st ed. New York: Springer; 2016. p. 111-131.
7.) Neal JM, Bernards CM, et al. ASRA practice advisory on local anesthetic systemic toxicity. *Reg Anesth Pain Med*. 2010 Mar-Apr; 35(2): 152-61. PubMed Link

---

Reviewed by:

Reviewer #1: Todd Glenski, MD, MSHA, FASA, Children's Mercy Kansas City

Reviewer #2: Rita Agarwal MD, FAAP, FASA, Stanford University

Reviewer #3: Amy Burns, MD, Nemours Children's Health, Jacksonville

---

Created: 9/28/2022; Last revised: 6/6/2025