Managing Epidurals in Children

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Over the last 25 years a renaissance of pediatric epidural analgesia has occurred. Although regional anesthesia is rarely employed as the sole means of providing surgical anesthesia for pediatric patients, it is increasingly used in combination with general anesthesia to reduce the amount of general anesthetics administered, attenuate the stress response of surgery, facilitate a rapid emergence from general anesthesia, and most importantly to provide incomparable postoperative analgesia.

Many of the principles of safe pediatric epidural anesthesia practice are adopted from those developed for adult patients. However, children are not small adults and several principles have been modified so that children can enjoy the benefits of epidural anesthesia. Most notably, epidural anesthesia is routinely performed with the adult patient awake or lightly sedated so that they can report symptoms during the block. A report of paresthesias during the placement of the block needle or during the injection of local anesthetic heralds the close proximity of the needle to neural structures or an intraneural injection prompting an immediate cessation of the block and avoidance of nerve injury. The fully conscious adult can also report symptoms of ringing in the ears or a metallic taste indicating an inadvertent intravascular injection. However, the performance of epidural blocks can be associated with significant discomfort which is to be avoided in children and can result in severe anxiety, an inability to cooperate, and sudden, unpredictable movement. Finally, children are not able to understand the concept of paresthesia nor can they reliably differentiate between pain and pressure at the site of the block and paresthesia. Thus the performance of epidural anesthesia in awake children can be difficult and dangerous, and the information obtained from a conscious child during the block may be unreliable or misleading. Consequently, as has been recently expressed in an editorial, many pediatric anesthesiologists believe that regional anesthesia must be performed in sedated or anesthetized children (Krane et al. The Safety of Epidurals Placed During General Anesthesia. Regional Anesthesia and Pain Medicine 23: 433-438; 1998). This belief is based on mounting clinical data involving pediatric patients and the collective experience and judgement of pediatric anesthesiologists from around the world. The actual risk of permanent neurological injury as a consequence of placing epidural catheters in anesthetized children is unknown but believed to be small. In fact there is no data to suggest that performing regional blocks in awake children reduces these complications. Many Pediatric anesthesiologists believe that complications such as neural injury, soft tissue injuries, dural puncture, and block failure would be increased by routinely performing regional anesthesia in awake children.

In this workshop we will be exploring several topics pertaining to the practice of pediatric epidural analgesia including a review of neurological complications of epidural analgesia, thoracic epidural analgesia in neonates and small infants, the pharmacology of epidural analgesia, and troubleshooting common problems that occur in children receiving epidural analgesia.
1. Baby Epidurals: A Review of Techniques

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Objectives:
At the end of the workshop, participants will be able to:
1. identify approaches to the thoracic epidural space in neonates and infants
2. discuss the pros and cons of each approach
3. appreciate issues in post-operative management of such epidurals

Introduction:
There are both limitations as well as advantages to the technical approach to the neuraxis in neonates. The emphasis here is on epidurals whose site of action is the thoracic level. Four approaches present themselves, and can be used for infants of any age; we use them most for infants under 6 months of age. Before proceeding with any neuraxial procedure in neonates, one must check the sacrum for evidence of spinal dysraphism (sinus tract, deep pit, hair patch).

Thoracic Approach:
Proponents of this technique suggest using a Crawford needle, due to its very blunt bevel. There are those who consider the risks of spinal cord injury too high with this approach and do not perform it. Certainly, it is not a technique for beginners, and will not be discussed further.

Lumbar to thoracic Approach:
The depth at the lumbar levels is deeper than in the thoracic levels. Additionally, the risks pursuant to a dural puncture are less, assuming that the puncture occurs below the conus medullaris. Note, however, that the conus is found at the L2-3 level in neonates, as opposed to the L1 level in older children and adults. LOR to saline with continuous pressure is preferred. Coaxing the catheter into the thoracic region can be challenging. Fluoroscopic guidance can be very helpful here, as there can be a tendency for the catheter to loop in the lumbar epidural space.

Modified Taylor Approach:
This approach is my preferred technique. The reasons are several. The L5-S1 interspace is the largest in the neuraxis, allowing easy identification, and manipulation of the needle (see below). The ligament is relative thick promoting good LOR, and a dural puncture here would fall well below the conus medullaris in all neonates. In addition, the space is high enough above the anus to reduce the risk of stool contamination.

Landmarks include the posterior superior iliac spines, which are almost exactly at the L5-S1 level. The spinous processes are not prominent, but the interspace feels like a large, soft depression in the midline. We use a Crawford needle and styletted catheter. The distance form the level of insertion to the desired final dermatome is measured prior to needle insertion. The initial approach is a modestly angled rostrally, using LOR to saline with continuous pressure. Once LOR is felt, we inject a small amount of saline to open the space, and drop the angle of the needle to ~20-30 degrees (almost parallel with the lumbar spine). The catheter is then inserted, being very careful not to use undue pressure to advance the catheter to the premeasured distance. If any resistance is felt, the catheter is withdrawn, and rotated slightly and readvanced. Sometimes a twisting motion can aid smooth advancement of the catheter. Other times, a little more saline is useful, or dropping the angle of the needle will give the desired result. The catheter usually ends up where you want it, although fluoroscopy can be quite helpful. Although the Tsui nerve stimulation technique was described for caudal catheters, it could be used here as well.

Caudal to Thoracic Approach:
There are a couple techniques to consider. One technique is to use a Crawford (or Touhy) needle with LOR to saline. A small amount of saline is injected to open the space, and the catheter advance carefully to the desired level. Another approach (the one we use) is to insert an 18ga IV catheter as one would for a one shot caudal. Care must be taken to prevent advancing the relatively long-beveled stylet needle through the dura. The IV catheter is advanced over the stylet as far as possible, then the epidural catheter inserted through that. Once the epidural catheter is at the correct level, the IV catheter is removed along with the epidural catheter’s stylet. The next issue is dressing the insertion site. The main challenge is that the site is just above, or at, the top of the intergluteal fold. Finding a way to prevent the dressing from being lifted off of the skin and stool from tracking along the intergluteal
fold and under the dressing requires generous amount of mastic gum or benzoic acid and creative use of dressing materials.

Post-Operative Issues:

Once the catheter is in proper position, an infusion of medication can be started. We use either 0.1% bupivacaine with 2 mcg/mL Fentanyl at ~0.2 mL/kg/hr or 1.5% chloroprocaine at rates between 0.3 – 1 ml/kg/hr. We monitor all neonates and infants for apnea and bradycardia. One of the larger practical issues to deal with is coordination of care with the neonatology team. Epidural analgesia is still a rather new modality in many NICUs. You may need to educate the nursing staff and medical staff about the use of epidurals, the function and management of the pumps, what the site should look like, and the role for adjunct medications.

2. Epidural Pharmacology

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Local anesthetics for epidural use in children

Amides: Commonly used in pediatric practice: Bupivacaine, Ropivacaine, Levobupivacaine.
The choice of the agent is based on the time of the onset of the block, duration of action, safety profile, degree of the motor block, and cost effectiveness.
Some differences in metabolism and distribution of the drugs make the use of local anesthetic more challenging in children compared to adults:

1. Limited ability to metabolize amide local anesthetics secondary to immature cytochrome P450 system. These enzymes reach adult activity by the first year of life.
2. Increased steady-state volume of distribution and as a result a prolonged half-life.
3. Decreased plasma concentrations of alpha (1)-acid glycoprotein, leading to increased concentrations of unbound drug (bupivacaine) in newborns and neonates, the form, which is responsible for the toxicity. After injection into the epidural space, absorption into the bloodstream follows a biphasic process. The buffering properties of the epidural space are important and prevent a rapid rise in concentration. In infants and children, the epidural space seems to protect patients in a similar manner.

Bupivacaine.

Racemic mixture of equimolar amounts of R(+)-bupivacaine and S(-)-bupivacaine.
One of the most commonly used anesthetic secondary to high potency and long duration of action. Undesirable cardiac toxicity, difficult resuscitation makes it less favorable after the introduction of newest drugs: ropivacaine, levobupivacaine.

CC/CNS ratio: the ratio of the dosage required for irreversible cardiovascular collapse and the dosage that produce CNS toxicity is lower compare to Lidocaine. Because most of the blocks are performed when child is asleep symptoms of CNS toxicity very easy to miss. In neonates, the level of alpha1-acid glycoprotein can be less than 50% which can make free bupivacaine concentration exceed 20% compare to 5% in an adult. The toxic plasma concentration is 4 mcg/ml. The maximum recommended single bolus dose of bupivacaine is 2.5-3 mg/kg. In a study of 45 children (4 months to 12 years) Eyres demonstrated that caudally administered 0.25% bupivacaine in a dose of 3 mg/kg produces plasma levels well below the toxic limits (1.2-1.4 mcg/ml) (1). Later the same group of doctors measured plasma levels of bupivacaine following lumbar epidural administration of 3 mg/kg of 0.5% plain solution in sixteen children. The peak levels were generally between 1.0 and 2 micrograms/ml, the highest being 2.9 mcg/ml(2).

In most of the cases of convulsions and cardiac toxicity in infants and children receiving bupivacaine, the level exceeded the toxic plasma concentration of 4 µg/ml. Several cases of toxicity came from Children’s Hospital, Denver. A 3 yr-old girl had a continuous infusion of 0.25% bupivacaine through the intraplural catheter started at the rate 0.1 ml/ kg/h (0.25 mg /kg/h) and increased twice later. After 16 h she developed seizure and her blood
bupivacaine level was 5.6 mcg/ml. Other case was similar but epidural catheter was used. (3) McCloskey and colleagues described one case of cardiotoxicity in newborn (3.8 kg) who underwent bladder defect closure under general anesthesia and caudal/epidural catheter. The infusion rate was 4ml/h (2.5 mg/kg/h) of 0.25% bupivacaine with epinephrine 1:200000. After 10 hours the baby developed hypotension and bradycardia followed by ventricular tachycardia and seizures. The blood level of bupivacaine was 5.6 mcg/ml (4).

Meuneier and colleagues showing the pharmacokinetics of bupivacaine in 22 infants who received continuous epidural infusion of 0.375 mg/kg/h during two days after the surgery did very informative study. Unbound and total bupivacaine concentration in serum was measured up to 48 h after infusion initiation. AAG concentration was measured in serum before and two days after surgery: Because of a low AAG concentration and a low intrinsic clearance, unbound bupivacaine increased to concentrations greater than 0.2 mcg/ml in two infants. The increase in AAG observed after surgery did not fully buffer this unbound fraction. They recommended the use of a maximum dose of 0.25 mg/ kg/ h in infants younger than 4 months and a maximum of 0.3 mg/ kg/ h in infants older than 4 months. (5)

We are using Bupivacaine in our institution for the single shot caudal and epidural infusion.

Caudal: 0.125% solution- 1cc/kg
Epidural lumbar: 0.1% solution. Max dose 0.4 mg/kg/h, children less than 6 mo- 0.2 mg/kg/h
Thoracic epidural: Max dose-0, 3mg/kg/h

Ropivacaine (0.2% to 1%)

Introduced in 1996. US brand name-Naporin
Pure S-enantiomer has very similar onset and duration of action profile with bupivacaine. It produces less motor blockade by a greater degree of block in nerve fibers of pain transmission (Adelta and C) than a motor function (Abeta) and has higher threshold for CNS and cardiac toxicity.

Acute toxicity of ropivacaine compared with that of bupivacaine and was studied on volunteers by intravenous infusion. Ropivacaine caused less CNS symptoms and was at least 25% less toxic than bupivacaine in regard to the dose tolerated. (6). In infant and adult rats, the LD50 for ropivacaine was about 50% higher than for bupivacaine.

The minimum concentration of ropivacaine to provide intraoperative analgesia in children is 0.11%. Investigators did not study postoperative analgesia.

Dosage: caudal block – 0.2% 1 ml/kg. This dose has been supported by study that came from Sweden. They performed 20 caudals for children 1-8 y/old. They confirmed the safe free plasma concentration of ropivacaine, satisfactory postoperative pain control, absence of motor block (7)

Continuous infusion-0, 2% 1 mg/kg bolus, continuous rate- 0, 4 mg/kg/h. Study done on 18 children from four months to seven years old and there were no signs of toxicity, total and free concentrations were within the safe range as in adult. (7)

In 2004, a study was published in Pediatric Anesthesia looking into pharmacokinetics of ropivacaine in 37 neonates and infants. (8) The conclusions were:
1. 2 mg/kg of ropivacaine for caudal block was safe and has adequate analgesia
2. No clinical signs of toxicity were found
3. Plasma concentrations of both unbound and total ropivacaine were highest in neonates, but still well below potential toxic concentrations reported in adult

That study was followed by the publication of pharmacokinetics of ropivacaine for continuous epidural infusion in neonates and infants. The results were conclusive for the safety of an initial bolus dose 1-2 mg/kg followed by an infusion rate: 0, 2 mg/kg/h for infants <180 days or 0, 4 mg/kg/h for infants >180 days. (9)
After continuous epidural infusions of 0.2% ropivacaine 0.4 mg/kg/h for postoperative pain control free plasma concentrations varied between 10 and 56 mcg/l. (11) Central nervous system toxicity has been seen in healthy adult volunteers at arterial free plasma concentrations of 340–850 mcg/l after rapid i.v. Infusion of ropivacaine (10 mg min)(6)

Several studies compared ropivacaine and bupivacaine:
1. Ropivacaine has slower systemic absorption than caudal space (10, 11)
2. At 0,1% ropivacaine is less effective and has a shorter duration of action
3. 0,2% of ropivacaine provides similar analgesic effect as 0,2% bupivacaine, and children have less motor block (12). That clinically significant separation between the motor and sensory blockade can have an advantage in children’s use.
4. The potency of the block with ropivacaine is not improved with the increase in concentration. 0,3% was associated with a higher incidence of motor block.

Possible toxicity:
1. Inadvertent injection of 18 mg (6 cc of 0,3% solution of ropivacaine) to a 30-month-old child showed no signs of CNS or cardiac toxicity. Plasma level of a drug was not measured (13).
2. Inadvertent administration of intravenous ropivacaine during 2 hours secondary to the wrong connection of epidural solution to the IV tubings. No signs of toxicity noted.(14)
3. Plowman and co-workers reported the onset of a grand mal seizure in a 13-yr-old boy after injecting ropivacaine 0.5 mg /kg into the epidural space. The total plasma concentration of ropivacaine 30 min later was 1.4 mg /l (15)

Levobupivacaine

Levobupivacaine as the S (-)-isomer of bupivacaine has recently been introduced as a new long-acting local anesthetic with a potentially reduced cardiac toxicity. Toxicity was extensively studied on animals:
1. The potentially lethal intravascular injection of levobupivacaine is higher compared to bupivacaine.
2. In awake sheep, for example, almost 78% more levobupivacaine was required to cause death.

Three clinical studies have been conducted using surrogate markers of both cardiac and CNS toxicity. In these studies levobupivacaine or bupivacaine were given by intravascular injection to healthy volunteers. Levobupivacaine was found to cause smaller changes in indices of cardiac contractility and the QTc interval of the electrocardiogram and also have a less depressant effect on the electroencephalogram.

Pharmacokinetics was studied in children less than three months after single caudal and found that its clearance was half that described in adults, suggesting immaturity of P450 CYP3A4 and CYP1A2 enzyme isoforms that metabolize levobupivacaine in infants (16).

Another study came from Australia where they looked at pharmacokinetics in 49 children less than two y/old. With the use of 2 mg/kg, peak plasma concentration was within the safe range. Smith reported 79 cases of single shot caudal in Booth Hall Children’s Hospital in Manchester. He concluded that 2,5 mg/kg can be safely used (18)

Degree of motor block: Bupivacaine > ropivacaine = levobupivacaine at 0,2%, 0,125%. Almost equal postoperative analgesia.

Additives:
1. To improve the quality of the block intraoperatively
2. To decrease the degree of motor block
3. To increase the duration of action of the block
4. Lower the concentration of local anesthetics
5. Have less cardiovascular side effects compared to local anesthetics
Epinephrine
Has been used for several reasons: as an indicator of inadvertent intravascular injection and to increase duration of action of epidural local anesthetics. The effect on duration is altered by the high lipid solubility of bupivacaine and ropivacaine. There is some controversy in the effectiveness use of epinephrine as an additive: it is more effective with the use of lower (0.125%, 0.25%) concentration of bupivacaine, the effect depends on the site of surgery or the age of a patient. 1/400000 epinephrine can significantly prolong duration of a caudal clock in children less than five years old (19). Some studies did not indicate any benefit (20).

In the study that came from France, doctors looked at intraoperative hemodynamic changes in 48 children with caudal, thoracolumbar epidural who received 0,8mg/kg of mixture (1% lidocaine, 0,25% bupivacaine, 1mcrgr/kg fentanyl, 1:200 000 epinephrine. Using noninvasive hemodynamic monitoring they reported an increase in cardiac output, a decrease in arterial blood pressure and systemic vascular resistance when epinephrine was added to epidurally-injected local anesthetics (21)

An interesting paper published by a group of doctors from Belgin. They concluded that adding of epinephrine significantly modifies the pharmacokinetics of ropivacaine injected caudally by:

1. decrease C (max) 2. Increase in T (max)(22)
The time of postoperative voiding was not prolonged when epinephrine 1:200000 was added to 0,25% bupivacaine solution for caudal block (20).

Opioids

Morphine - Hydrophilic opioid, rostral spread, can cover wider range of dermatomes
First publication in 1981 by Jensen reported the use of morphine in caudal in children. The duration of action was increased three times compared to bupivacaine caudal only. Several studies confirmed that the duration of analgesia with morphine was significantly longer (12-24 hours)

Single caudal dose of Morphine was studied extensively. A dose as low as 25 mcg/kg provides adequate postoperative analgesia with a low side effects profile. The latest report of using 11,2 mcg/kg of morphine showed good pain control for more than 12 hours in children undergoing hip surgery (23)

76 children were followed after abdominal surgeries; they received 50 mckg/kg of epidural morphine every eight hours. After one case of respiratory depression was recorded, a suggestion to monitor the patients in the ICU was made (24).

There were several case reports of respiratory depression following epidural morphine. In the first one a baby was having Kasai’s procedure; epidural was injected with 0,125% bupivacaine 1 cc/kg, epinephrine 1:400000 and 50 mcgr/kg of morphine. Six hours later the baby developed desaturation, symptoms of respiratory depression, miosis. Reversed with Naloxone.

The other case is 15-mo child who underwent ureteral reimplantation procedure and received 40 mcgr/kg of Morphine, the child developed symptoms of respiratory depression two hours after the medication was given.

In retrospect, of 138 children given caudal morphine 70 mcg/kg, there were 11 cases of hypoventilation. Most of the children were less than 3 months of age, seven received additional narcotics for pain control. Another study reported 500 cases of safe caudal morphine use in children with not one case of respiratory depression.
**Fentanyl**
Highly lipid soluble, fast onset, short duration of action, less rostral spread.
348 children who had postoperatively epidural catheters were treated with continuous infusion of bupivacaine and 5 mcg/kg/day of fentanyl. Study showed that all children had good pain control with minor side effects (pruritus, nausea, urinary retention). (25)

Comparison of the epidural continuous infusion of bupivacaine with fentanyl (2 mcg/cc) with intermittent dose (30 mcg/kg) of morphine was done by Kart and colleges. Patients were significantly more comfortable in the fentanyl group (26).

Starting from 1992 there were several studies that showed no advantage of bupivacaine-fentanyl mixture over bupivacaine alone after single shot caudal. In one of them the level of epinephrine (E) and norepinephrine (NE) was checked in children blood who received caudal block with bupivacaine-fentanyl or bupivacaine. Adding of fentanyl did not influence plasma level of E and NE and did not improve the analgesia

Nonopioid additives

**Ketamine**
Mechanism of action: NMDA receptor antagonist, mu –receptor agonist, interaction with sodium channels.

Advantages:
1. Lack of opioids induced side effects
2. Does not cause motor blockade
3. Can be used as a sole agent (1mg/kg)
4. Inadvertent intravascular injection will not cause CNS or cardiovascular toxicity
5. Can be used instead of opioids in premature children and children with chronic respiratory failure

Reports of using ketamine have been in literature since 1991. In all of them, 0,25-0,5 mg/kg of ketamine had used for caudal block in children and showed increased in analgesia up to 8 hours with decrease requirement for further analgesia in the first 24 hours.

Three doses of ketamine had been studied; 0,25 mg/kg, 0,5 mg/kg, 1 mg/kg in a mixture with 0,25% bupivacaine 0,75 mg/kg. The optimal dose was 0,5 mg/kg and gives 22 h of postoperative analgesia without side effects. Children after 1mg/kg of ketamine showed higher incidence of odd behavior, agitation, restlessness.

The same behavioral side effects with using 1 mg/kg of ketamine were supported by the other study.

Hager and colleagues used a mixture of bupivacaine/ 1 mg/kg ketamine/ 1-2 mcg/kg clonidine in caudal block. They found that using 1 mcg/kg of clonidine prolong the block up to 22 hours without significant side effects.

The major concern about using ketamine is neurotoxicity, which is possibly secondary to the preservative (benzethonium chloride) in the commercially available preparation. Preservative –free S (+) ketamine is available in some countries and has about twice the analgesic potency of the racemic.

**Clonidine**
Produce less nausea, itching, ileus, urinary retention, and respiratory depression
Clonidine is an alfa-2-adrenoreceptor agonist, available as a preservative-free solution.
Since 1994, multiple publications showed an increase the duration of postoperative analgesia after single shot caudal when 1-5 mcgr/kg of clonidine was added to the local anesthetic solution.
Mechanism of action:
1. Stimulation of the receptors in the dorsal horn and inhibition of the release of substance P.
2. Potentiating the effect of local anesthetics, possibly by vasoconstriction and reduction of absorption.

There are several studies when clonidine was used as an additive for continuous infusion in children.
Clonidine infusion 1 mcg/ml at rate 0.2 ml/kg/h compared with a mixture of clonidine 1 mcg/ml and ropivacaine 0.1% at rate of 0.2 ml/kg/h. The authors concluded that both modalities could be used for pain control. Some decrease in blood pressure and sedation noticed in children who received clonidine boluses. (27)

The dose-response relationship were investigated by adding 0.04 mcg/kg/h, 0.08 mcg/kg/h, 0.12 mcg/kg/h of clonidine to a continuous postoperative epidural infusion of 0.1% ropivacaine 0.2 mg/kg/h. The results suggested that clonidine can be used safely in children and 0.08-0.12 mcg/kg/h of clonidine was found to improve postoperative pain relief in children. No clinically significant signs of sedation were or other side effects were observed (28)

The main side effects are hypotension, bradycardia and sedation. Haemodynamic side effects appear to be less pronounced in children than in adults.

Sedation is significantly prolonged in the clonidine group of patients compared to local anesthetic and the effect is dose-dependant.

More serious complications such as respiratory depression and apnea also have been reported in 4 week-old preterm 2.8 kg infant. Caudal block was performed with 1 ml/kg of 0.2% ropivacaine with 1 mcg/kg clonidine. 15 min later respiratory depression, desaturation, bradycardia was noticed. Oxygen mask ventilation was initiated with resolution of the episode (29). Several more cases reported intra-postoperative apnea in neonates. All authors concluded that caudal clonidine should not be used in neonates and small infants.

Drug selection depends on:
1. Age of patient,
2. Amount of dermatomes that need to be covered
3. Patient’s pre-existing medical condition
4. Maximum calculated volume that can be given: Initial bolus can be calculated by using the formula:
   Volume (ml) = 0.05 ml/kg/ x number of dermatomes to be blocked.

Neonates and infants:

Neonates have a higher risk for the toxicity with amide anesthetics, the amino-ester 1.5% chloroprocaine can be used. Formulation does not have preservatives. It is cleared rapidly even in premature babies, due to this the rate of infusion can be increased. Starting rate from 0.3 ml/kg/h can be maximized up to 1.2 ml/kg/h.

If additives to be used than the concentration per ml of local anesthetic is reduced because of the more rapid infusion rate: fentanyl 0.4 mcg/ml, clonidine 0.2 mcg/ml.

Older children:

0.1% bupivacaine with: fentanyl 1-3 mcg/ml (with major painful surgery we increase up to 10 mcg/ml); morphine 20 mcg/ml; hydromorphone 10 mcg/ml; and clonidine 1 mcg/ml.

PCEA

Is a widely used method of pain control in children in our hospital. We published a prospective study of PCEA in 128 children, which were provided with satisfactory analgesia. Total hourly doses should not exceed 0.4 mg/kg/hr, including the theoretical maximum number of demand doses that could be given every hour (30). Anton and colleagues studied patient-controlled epidural analgesia (PCEA) and continuous epidural infusion analgesia (CEA) with 0.2% ropivacaine during the postoperative period in children. They found PCEA and CEA with plain ropivacaine 0.2% a good adequate pain relief but adequate analgesia was obtained with 50% less volume infused with PCEA compared with CEA (31).
References


3. Management of Common Problems during Epidural Analgesia in Children

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The use of the epidural space for the management of pediatric pain has become increasingly accepted due to its obvious benefits and safety, even though these benefits are only documented in a few controlled studies with large enough numbers to allow evidence-based decision making. To assure the safety during use of this type of pain modality, monitoring guidelines have been established, but there was a survey conducted in pediatric anesthesia services in the United States and Canada that documented institutional practice variability among the specific choice of continuous monitor(s) and the way of recoding other parameters. The same institutional variability can be encountered for the management of pediatric epidurals when they are associated with adverse effects that interfere with effective analgesia that translates in children and parental satisfaction.

In this workshop, the most common adverse events to be discussed are pruritus, nausea, urinary retention, respiratory depression, and fever. And some of the most serious complications that are documented in case reports, such as nerve damage, transverse myelitis, and epidural abscess.