Pediatric Anesthesiology 2007
Workshop C3 – Managing Epidurals in Children
1:30 PM – 3:30 PM, Saturday 3/10/2007

Faculty:
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Over the last 30 years pediatric epidural analgesia for managing post-operative pain after appropriate surgical procedures has gone from being a relatively uncommon intervention to the standard of care at most pediatric medical centers. 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. Adverse Neurological Events associated with Epidural Analgesia in Children: an update.

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The Pain Management Service at the Children's Hospital of Philadelphia designed a Pain Management Service Registry (PMSR) to provide a means for tracking adverse events (AE) in our patients. All AE are recorded prospectively in the PMSR by a member of the PPMS after making daily rounds on each patient. The PMSR was queried from its inception on 12/1/2001 through 6/6/2006 for all entries of epidural catheter placement.

There were 1267 epidural catheters placed under general anesthesia in children < 21 years old: 334 thoracic (26%), 440 lumbar (35%), and 493 caudal (39%). No AE were reported in 774 (61%) patients. Miscellaneous AE (i.e. nausea, vomiting, or pruritus) were reported in 423 (33%) patients. Neurological AE (n=74) were reported in 70 (6%) patients and included: motor block or weakness (n=26, 2.1%); sedation (n=14, 1.1%); muscle spasm or myoclonus (n=7, 0.6%); headache (n=7, 0.6%); paresthesias (n= 6, 0.5%), Horner's syndrome (n=6, 0.5%); dysesthesia (n=3, 0.2%); post-dural puncture headache (n=1, <0.1%); back pain (n=1,< 0.1%); seizure (n= 1, <0.1%); Foot Drop (n=1, <0.1%), and hysterical paralysis (n=1, <0.1%). There were no spinal cord injuries or epidural hematomas. Two patients with dysesthesias and 3 patients with paresthesias were due to the surgical procedure and not epidural placement. One patient, a 6 year old who underwent nissen fundoplication, had severe burning dysesthesias in the sole of her right foot and her thoracic epidural catheter was secured at 16 cm at the skin. Her epidural catheter was pulled back 9 cm and she immediately experienced resolution of her symptoms. One patient with post-operative foot drop following a 12 hour surgery in the lateral decubitus position for resection of osteogenic sarcoma in the contralateral lower extremity had and position injury to the peroneal nerve unrelated to epidural placement. All other neurological AEs resolved.

Review of our PMSR for patients who had epidural catheters placed during general anesthesia reveals transient neurological AEs are uncommon. No permanent neurological complications occurred which could be attributed to epidural placement in anesthetized children.

2. 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 (note: withdrawing through the needle risks shearing the tip of the catheter, so withdrawing the needle and catheter is often a better idea, although one must balance the shearing risk against that of repeated needle insertions), and rotated slightly and re-advanced. 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. As ultrasound has become more widely available, this imaging technique has great potential for aiding catheter placement. It is best used in babies less than 6 months of age, with the optimal images seen at the lumbar level.

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. Imagin assiatce for catheter placement is described above.

Post-Operative Issues

Once the catheter is in proper position, an infusion of medication can be started. We use either 0.1%bupivicaine with or without 2mCg/mL Fentanyl at ~0.2mL/kg/hr or 1.5% chloroprocaine at rates between 0.3 – 1 ml/kg/hr. Ropivicaine is another useful medication. 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. This latter point is important, in that these infants often have other sources of noxious stimuli (e.g. intubation/ventilation, A-lines, NG tubes) that will not be comforted by an epidural. Explaining the limitations of the epidural and integrating the medications infused in the epidural space with those given systemically will go a long way towards overall satisfaction with the technique.

3. Epidural Pharmacology

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I. Chemistry of Local Anesthetics

II. Pharmacokinetics: What the Body does to the Drug
   a. Systemic Absorption
   b. Distribution
   c. Elimination
   d. Differential Pharmacokinetics in Infants and Children

III. Pharmacodynamics: What the Drug does to the Body
   a. Mechanism of Action
   a. Potency and Minimum Local Analgesic Concentration (MLAC)

IV. Toxicity
   a. CNS Toxicity
   b. Cardiovascular Toxicity
   c. Cardiovascular Collapse/CNS Toxicity Ratio
   d. Lipid Infusion Resuscitation

V. Racemic Bupivacaine

VI. Levobupivacaine

VII. Ropivacaine

VIII. Chloroprocaine

IX. Pharmacology of Adjuvants
   a. Opiods
   b. Epinephrine
   c. Clonidine
   d. Ketamine

X. "Pharmacoeconomics"

4. Management of Common Problems during Epidural Analgesia in Children

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1. Placement of epidural catheter.

- Caudal versus lumbar or thoracic approach including methods used to verify proper catheter placement.
- Role of ultrasound.

2. Insufficient dermatomal coverage and how to deal with it.
    - How high can one go on the infusion?
    - Role of change in patient position on dermatomal coverage.
    - Role of supplemental analgesics.
    - When will you pull the catheter out?

3. Febrile patient and epidural catheter

4. Problems related to the catheter
    - Infection
    - Leakage
    - Dislodgement
    - Breach of dressing
    - Difficulty removing catheter

5. Problems related to the infusion
    - Hypotension
    - Epidural opioid related side effects
    - Local anesthetic toxicity