Pain Management Solutions for Children

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Acute Pain Management

Pain in children has a history of being unrecognized and poorly treated. Children have traditionally been under-prescribed and under-dosed for opioid and non-opioid analgesics due to unwarranted concerns of respiratory depression and/or poor understanding of the need for pain medications in children. Specific training in pediatric pain is rare and little data is available for dosing many pain medications in children. In fact, the majority of pain medications available on the market today are unlabeled for use in pediatric patients.

It is essential to have protocols for the recognition and treatment of pain for children during their perioperative stay. Standardizing pain measurements require the use of appropriate pain scales. There are many pain scales available, all of which have advantages and disadvantages. It is not so important which of these pain scales is used, but that they are used on a consistent basis. At our institution, pain scales are stratified by age (table 1) and are used not only in the PACU but institution wide. This allows all parties to "speak the same language" when discussing pain issues for patients.

Table 1: Pain scales – Description of and age appropriate use.

Name of Scale	Type	Description	Age Group
Numeric	(0-10 Scale)	Self-Report Verbal 0-10 scale; 0 = no pain, 10 = worst pain you could ever imagine	Children who understand the concept of numbers, rank, and order. Approximately > 8 yrs
Bieri Faces	Self-Report	6 faces that range from no pain to the worst pain you can imagine. See Appendix 1	Younger children who have difficulty with numeric scale. Cognitive age – 3-7 years.
FLACC	Behavioral Observer	5 categories: face, legs, activity cry and consolability. Range of total score is 0-10. Score ≥7 is severe pain. See Appendix 1	Non-verbal children > 1 year of age
CRIES, NIPS, PIPP	Behavioral Observer	Rates a set of standard criteria and gives a score.	Non-verbal infant < 1 year of age.

Treatment of postoperative pain often begins before surgery starts. Analgesics such as acetaminophen and oxycodone can be used as premedications to help establish blood levels of analgesic medications for short duration procedures. Although debate about pre-emptive analgesia exists, many of us use regional techniques and intravenous opioids on a routine basis prior to incision. Regional anesthesia is also an important adjunct for postoperative pain relief and, regardless of technique chosen, can significantly decrease postoperative opioid use. Regional techniques are discussed below.

Treatment of pain postoperatively is dependent on the disposition of the individual patient. Patients undergoing outpatient surgery generally receive a combination of intravenous and oral drugs for the treatment of pain. Acetaminophen is the most commonly used NSAID. Acetaminophen is administered *via* the oral or rectal routes. An intravenous formulation will be available soon in the US. Acetaminophen is more predictable in its effects as an oral dose. Rectal absorption is unpredictable and studies have shown that a loading dose of ~40mg/kg is needed to establish therapeutic levels as a on time dose. In neonates and infants delay administration of repeat doses for a minimum of 8 hours due to a slower metabolism of drug. It has also been found that round the clock administration (oral 10-15 mg/kg, rectal 20 mg/kg) is better than PRN dosing for both minor pain or as an adjunct for major pain. The toxicity of acetaminophen is low in clinically used doses. Liver damage or failure can occur with doses exceeding 200 mg/kg/day. Other non-steroidal anti-inflammatory drugs such as ketorolac 0.5-1.0 mg/kg are used as an adjunct for pain both intra- and postoperatively. Side effects are the same as for adults: renal insufficiency, gastric irritability and prolonged bleeding times due to decreased platelet adhesiveness. Patients undergoing T&A should not receive ketorolac. Celecoxib, a COX-2 inhibitor has the potential to promote analgesia similar to ketorolac with less platelet dysfunction but is only available in tablets.

Other oral analgesics are often provided for children without intravenous access and also for those with intravenous access prior to discharge from the hospital. Drugs commonly used and available in a syrup base are oxycodone 0.5-1.5 mg/kg, acetaminophen 10-20 mg/kg and ibuprofen 10mg/kg. Less commonly used, but also available in syrup, is naproxen 10-20mg/kg.

For severe pain an intravenous opioid is titrated to effect, for patients admitted to the hospital following surgery, options for pain relief are dependent on severity and location of pain and age. Patient controlled analgesia pumps can be used in children as young as six with proper instruction and coaching (table 2). At our institution, morphine and hydromorphone are the most commonly used drugs for PCA management. Continuous epidural analgesia and patient controlled epidural analgesia work well for the long-term management of pain. In the recovery room, where pain assessments can be made as often as every 15 minutes, it is imperative to frequently assess these patients to assure adequate pain relief prior to discharge to a lower acuity area.

Table 2: PCA dosing recommendations

	Morphine	Fentanyl	Hydromorphone
Solution	1 mg/ml	Solution 10	0.1mg/ml or

		mcg/ml	1mg/ml
Initial dose	15-20 mcg/kg (max 1.5mg)	0.25mcg/kg	3-4mcg/kg (max 0.3mg)
Lockout time	8- 10 minutes	8-10 minutes	8-10 minutes
Basal infusion	0-20mcg/kg-/hr	0- 1mcg/kg/hr	0- 4mcg/kg/hr
Maximum starting dose	100mcg/kg/-hr	1- 2mcg/kg/hr	20mcg/kg/hr

Regional Analgesia

Common Peripheral Nerve Blocks for Children
Ilioinguinal / Iliohypogastric Nerve Block

1) The ilioinguinal and iliohypogastric nerves derive from L_1 and T_{12} and supply the lower abdomen and inguinal region.
2) Blocking these nerves provides intra-operative and postoperative analgesia for inguinal surgery but will not prevent pain from traction on the spermatic cord or peritoneum.
3) Failure of the block occurs in 10-15% of patients.

Technique

1) Following betadine prep, a 22G short beveled needle is inserted one of the child's fingerbreadth's medial to the anterior superior iliac crest.
2) The needle is advanced until there is loss of resistance.
3) Approximately ½ of the dose is injected in a fan like pattern. The remainder of the dose is injected as the needle is withdrawn.
4) Bupivacaine 0.25% 1mg/kg with or without epinephrine can be used.

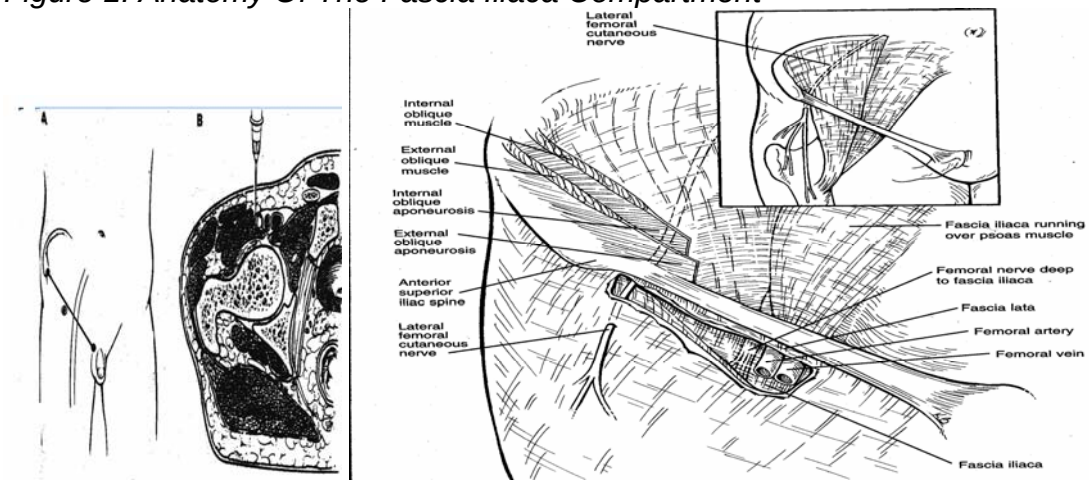
Penile Nerve Block

1) Provides excellent surgical anesthesia and postoperative analgesia for operations of the penis.
2) **It is essential that epinephrine containing solutions are not used**.
3) Bupivacaine 0.5% 1mg/kg (not to exceed 5 ml) is used.
4) The dorsal penile nerves are found approximately 3-5 mm below the skin's surface in buck's fascia.
5) A 25 G needle is inserted at 1:30 and 10:30.
6) A midline or ring block can also be performed.

Fascia Iliaca Block

1) This is a compartment block that provides analgesia to the upper leg and knee. The femoral, lateral cutaneous and obturator nerves are anesthetized. Patients undergoing muscle biopsies, skin grafts, femoral osteotomy, or patients with femur fractures can benefit from this block.
2) High volumes are required, so it is extremely important to calculate the toxic dose
   a) Bupivacaine 0.25 %, ropivacaine 0.2% or lidocaine 0.5-1% can be used in a dose of 0.3 -1 ml/kg up to 20 ml.
   b) Although there are no studies in children using any drug other than B, both R and LB offer theoretical advantages.
3) The patient is in the supine position and a line is drawn from the anterior superior iliac spine to the symphasis pubis This line represents the location of the inguinal ligament
4) Needle is inserted perpendicularly 0.5-1 cm below the inguinal ligament at the junction of the lateral 1/3 with the medial 2/3 of the ligament.
5) Two distinct pops should be felt as the needle crosses the fascia lata, followed by the fascia iliaca. The “pop going through the fascia iliaca is often more subtle than the one felt going through the fascia lata. Maintain distal pressure to force the local anesthetic proximally and improve the chances of getting all 3 nerves.

Figure 1: Anatomy Of The Fascia Iliaca Compartment



Femoral Nerve Block

1. An isolated femoral nerve block can be performed using a nerve stimulator in an anesthetized or sedated child. Eliciting paresthesias in children is very difficult to do. Muscle relaxants should be avoided for this and any block requiring a nerve stimulator in children.
2. Position—supine, legs slightly abducted.
3. Site of needle insertion is 1 cm below the inguinal ligament, and 0.5-1 cm lateral to the femoral artery.
4. Needle is directed rostrally at about a 30° angle until paresthesia or muscle twitches are elicited. DO NOT use a nerve stimulator in an awake patient with a femur fracture; a fascia iliaca block is probably a better choice.
5. Maintain distal pressure to promote proximal spread.

6. Bupivacaine 0.25 %, ropivacaine 0.2% or lidocaine 0.5-1% can be used in a dose of 0.3 -1 ml/kg up to 20 ml.

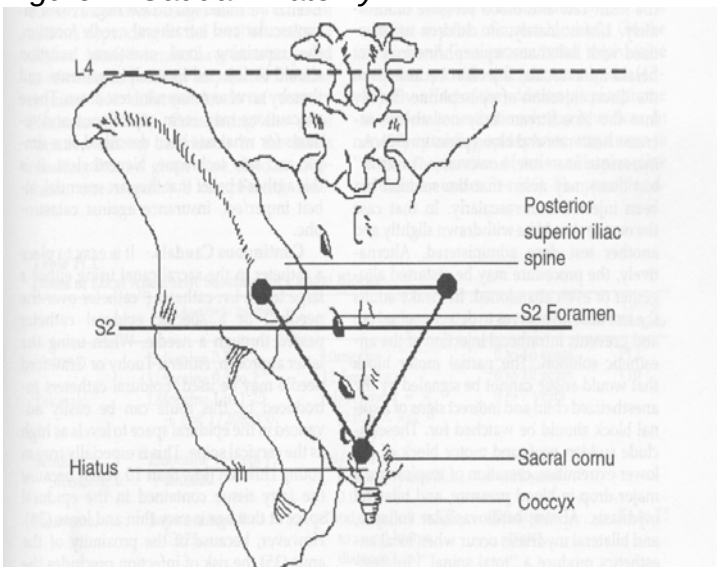
Epidural Analgesia

1. Usually placed under general anesthesia or deep sedation.
2. Can be placed from the caudal, lumbar or thoracic route, based on the site of the operation and the age of the child.

Caudal Epidurals

1. In childhood the sacral topography usually conforms to the ideals, however with aging, variations of the sacral hiatus are common.
2. This makes it an easy, safe and simple block to perform in young children.
3. Malformations of the sacrum occur in ~ 10% of the population.
4. The sacral cornua mark the lateral edge of the sacral hiatus, and are well above the gluteal crease (Figure 1).
5. The sacral cornua can be confused with the coccygeal cornua, especially in infants.
6. The sacrum is cartilaginous in infants and children which can allow for inadvertent intra-osseous injection
7. The spinal cord reaches L_{3-4} in a neonate and the dural sac can be found at S_{3-4}, the adult levels of L_1 and S_1 are usually reached by 1 year of age.
8. The caudal or sacral intervertebral (S_2) approach can be used to provide analgesia for any procedure below the waist and in some cases upper abdominal or thoracic areas

Figure 4: Caudal Anatomy



S2 Approach

1. Alternative to the classic caudal approach, especially when the sacral hiatus is difficult to palpate. This approach can also help decrease fecal contamination in patients in whom the catheter is being left in place.
2. The patient is positioned -lateral with the legs flexed or prone
3. A line is drawn between the posterior superior iliac spines. The S2-S3 interspace is located 0.5-1 cm below the inter-iliac line.
    a. The needle is inserted at a 90° angle and the epidural space is identified by loss of resistance.
4. Dosing for caudals varies depending on the level of analgesia required.

0.5-1 ml/kg	lumbo-sacral level
0.75-1 ml/kg	mid lumbar - low thoracic
1 ml/kg	low thoracic - mid
1.25ml/kg	mid to high thoracic (remember to decrease concentration of bupivacaine to avoid toxicity)

5. Bupivacaine concentrations of 0.1% -0.25% are commonly used and 0.2% for Ropivicaine. Toxic dose for all three agents is considered to be 2.5-3mg/kg

Epidural Opioids

1. Fentanyl is safe and effective as well as popular in continuous epidural infusions in children; however its efficacy for one-shot caudals is unproven.
2. Campbell and colleagues found no difference in pain or sedation scores in children who a received a one shot caudal with 1ml.kg of bupivacaine 0.125%. +/- 2 ug/kg fentanyl, undergoing urologic procedures. There was no difference in morphine consumption or the incidence of side effects,
3. These findings were confirmed by Gaitini et.al., who measured plasma catecholamine levels, as well as pain scores and opioid consumption in children undergoing inguinal hernia repairs. All the children received caudal bupivacaine 0.25% 1ml/kg +/- 1ug/kg fentanyl. There were no differences in any of the parameters.
4. Caudal morphine in a dose of 20-33ug/kg has been shown to prolong analgesia with minimal side effects. However since its duration of action is longer than most day surgery patients it should be used cautiously

Lumbar and Thoracic Epidural

Technique

1. The technique is the same as in adults, but should only be placed by skilled operators, especially in neonates and infants.
2. Care must be taken in children to prevent dural puncture or cord damage. I prefer the
3. The distance from the skin to the epidural space is approximately:
    - 0-.5 -1 cm neonates and infants
    - 1.0 -2 cm 1-5 yr.
    - 2.0 -3 cm 5-10 yr.
    - 3.0- 5 cm 10-16 yr.
    - (age x 2) + 10 = mm from skin to epidural space

- weight x 0.8 = mm from skin to epidural space

4. Most epidurals are placed in an anesthetized child, therefore warning signs of nerve injury are absent.
5. Dosing for lumbar and thoracic epidurals is the same because in younger children because the cord is not much thinner in this area and their anatomy promotes the spread of drugs.
6. There have been several reported cases of seizures occurring in pediatric patients on continuous infusions of bupivacaine. Based on these reports and available pharmacokinetic data, Berde recommends limiting the maximum infusion of bupivacaine to 0.5 mg/kg/hr in children and 0.25 mg/kg/hr in infants.
7. Significant respiratory depression can occur with epidural narcotics, especially in infants < 1 year of age. Most of these episodes occurred with the use of larger doses of epidural morphine (> 50 ug/kg).
8. The maximum infusion rates should not exceed 0.5 mg/kg /hr of bupivacaine in children and 0.25 mg/kg/hr in neonates

Table 3: Epidural Dosing--Continuous Infusions

Agents	**Concentration**	**Infusion**
Bupivacaine	0.1-0.--125%	0.15-0.4 cc/kg/hr
Bupivacaine / Fentanyl	0.1-0.--125% / 2-4 ug/cc	0.15-0.4 cc/kg/hr
Fentanyl	2-5 ug/cc	0.3-0.75 ug/kg/hr
Morphine (PF)	50-100 ug/cc	2-10 ug/kg/hr
Hydromorphone	10 ug/cc	1-3 ug/kg/hr

1) The maximum infusion rates should not exceed 0.5 mg/kg /hr of bupivacaine in children and 0.25 mg/kg/hr in neonates

Table 4: Patient controlled epidural analgesia dosing recommendations

	Bupivacaine plus fentanyl
Solution	0.75mg/ml bupivicaine + 5 mcg/ml fentanyl
Initial dose	0. 1ml/ kg/ dose
Lockout time	20 -30 minutes
Basal infusion	0.2ml/kg/hr (max 9.9ml/hr)
Maximum dose	0.4ml/kg/hr

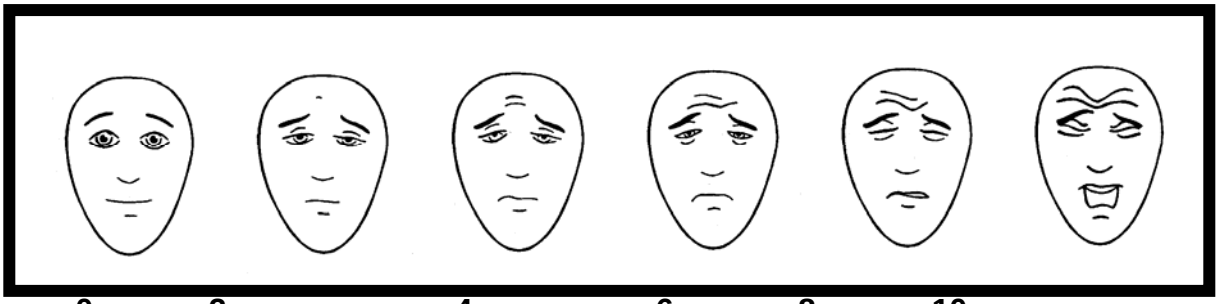
Chronic Pain Management

Chronic pain in children is an increasingly recognized problem in children. It is estimated that this problem may affect as much as 10-15% of the population. Some of the common problems we see as a regional referral center include headache, chronic abdominal pain, myofacial pain, fibromyalgia, JRA, CRPS, phantom limb and pain associated with cancer. Chronic pain in children often has multiple other contributing factors including psychological issues, psychosocial factors, sociologic factors and family dynamics. In dealing with these children “one must abandon the mind-body dualism. To continue to think that pain is associated with a single physical cause can result in the physician investigating the patient with repeated invasive testing, laboratory tests, and procedures and lead to over prescription of medications. One needs to acknowledge the patient’s multidimensional experience of pain and treat it from the various angles to which each participant in the multidisciplinary team can contribute”[15] It is recommended that pre- and early adolescent children be managed at regional referral hospitals that specialize in the management of these difficult patients and have specialized teams equipped to handle these patients.

The multidisciplinary approach is standard of care for treating chronic pain in children. All children evaluated for chronic pain should be seen by all primary members of the team on their initial visit. At this time a complete history and physical is taken and a management strategy is established. Staff recommended to include in a multidisciplinary pain team include: pain physician, pediatric psychologist and or psychitatrist, OT/PT, APN’s, social worker. Pediatric pain physicians cross many specialties but most commonly they are anesthesiologists, rheumatologists, or neurologists without formal training in pediatric pain. Although, multiple approaches exist in caring for these patients the most successful programs base their approach on combined intensive rehabilitation and intensive psychotherapy relying minimally on invasive procedures and pharmacotherapy.

Appendix 1: Commonly used pain scales

Bieri Faces Pain Scale-Revised



FLACC Pain Assessment Tool			
Categories	**Score 0**	**Score 1**	**Score 2**
Face	No particular expression or smile	Occasional grimace or frown, withdrawn, disinterested	Frequent to constant frown, clenched jaw, quivering chin
Legs	Normal position or relaxed	Uneasy, restless, tense	Kicking, or legs drawn up
Activity	Lying quietly, normal position, moves easily	Squirming, shifting back and forth, tense	Arched, rigid, or jerking
Cry	No cry (awake or asleep)	Moans or whimpers, occasional complaint	Crying steadily, screams or sobs, frequent complaints
Consolability	Content, relaxed	Reassured by occasional touching, hugging, or being talked to, distractible	Difficult to console or comfort

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