Lesson S35: PreAnesthetic Assessment of the Pediatric Patient With Pain: Part 2

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Professional Gaps

While most anesthesiologists appreciate the need to provide pain relief for children perioperatively, pain in this patient population remains undertreated. In Part 2 of this two part series, the treatment of pain and the development of perioperative pain management strategies in children are outlined.

Learning Objectives

At the end of this activity, the participant should be able to:

1. Acknowledge some of the age-related factors present in pediatric patients.
2. Examine a multimodal approach to perioperative analgesia.
3. Review preemptive analgesia.
4. Discuss acetaminophen use in pediatric patients.
5. Explore the use of NSAIDS in pediatric patients.
6. Discuss opioid medications used in the pediatric population.
7. Examine the role of regional/neuraxial analgesia in the pediatric population.
9. Become familiar with adjuvant therapy used in the pediatric patient.

Case History

An 8-year-old boy with a past medical history significant for anorectal malformation and fecal incontinence was scheduled for a continent neo-appendicostomy under general anesthesia. The patient was otherwise healthy. He lived with his parents and had recently completed the third grade. He weighed 25 kg, and his vital signs and physical examination were normal. The surgeon noted that
postoperative pain could be significant. The surgeon and the parents asked that a plan for postoperative pain relief be in place and explained to them ahead of time.

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**Treatment of Perioperative Pain in the Pediatric Population**

Perioperative pain and its treatment in pediatric patients has many facets – as discussed in Part I - and for that reason is best approached by a multimodal analgesia model. The goal of this technique is to minimize the use of opioids as sole therapy thereby reducing opioid–related side effects, shortening hospital stay and improving patient outcomes. In addition to pharmacologic interventions, a wide range of non-pharmacologic techniques have been integrated into the multimodal regimen with positive results.

**Figure 1. Multimodal Analgesic Techniques.**

Preemptive analgesia is defined as the administration of analgesics prior to noxious stimuli (e.g. surgical incision, injury, etc.), and is a component of multimodal analgesia. It aims to prevent sensitization of the central nervous system (CNS) responsible for further exaggeration of responses to painful stimuli. As several randomized controlled trials investigating efficacy of this technique have failed to demonstrate consistent results, the timing and use of analgesics that act at different pain pathways seem crucial for success.

Apart from developmental behavioral aspects affecting perioperative pain management in children, age-related differences in pharmacokinetics and pharmacodynamics of drugs used in pain management must be taken into account. These factors influence dosing, efficacy and side effects,
especially in the youngest, most vulnerable patients. Interplay of these elements may result in decreased doses, longer dosing intervals, and avoidance of some other drugs. (See Table 1.)

**Table 1. Examples of Age-Related Physiologic Factors as they Pertain to Pharmacokinetics and Pharmacodynamics**

<table>
<thead>
<tr>
<th>AGE-RELATED PHYSIOLOGIC FACTORS</th>
<th>CONSEQUENCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher metabolic rate</td>
<td>Increased oxygen consumption</td>
</tr>
<tr>
<td>Cardiac output (CO) increased</td>
<td>More side effects at lower drug concentrations</td>
</tr>
<tr>
<td>Blood preferentially distributed to vessel-rich groups</td>
<td>Increase passage of water-soluble medications (i.e. morphine)</td>
</tr>
<tr>
<td>Immature blood-brain barrier (BBB)</td>
<td>Higher CNS drug concentration</td>
</tr>
<tr>
<td>Newborns have decreased muscle mass and fat stores</td>
<td>Decrease in drugs bound to inactive sites</td>
</tr>
<tr>
<td>Increased hepatic blood flow</td>
<td>Drugs are conjugated slowly</td>
</tr>
<tr>
<td>Immature cytochrome P450</td>
<td>Less protein binding in plasma; improves by 6 months of age</td>
</tr>
<tr>
<td>Decreased quantity of serum albumin and alpha-1 acid glycoprotein (AAG)</td>
<td>Increased concentration of unbound drugs</td>
</tr>
<tr>
<td>GFR decreased (mature by 1 year of age)</td>
<td>May need to increase dosing intervals</td>
</tr>
<tr>
<td>Clearance delayed</td>
<td>Affects volume of distribution for water-soluble drugs</td>
</tr>
<tr>
<td>Increase in total body water about 80% (drops to about 60% by 2 years of age)</td>
<td></td>
</tr>
</tbody>
</table>


Following is a more detailed review of non-opioid, opioid, and adjunct analgesics; various analgesic techniques – intravenous, patient controlled, regional and neuroaxial; and specific considerations for application of these techniques for pediatric patients.

**Non-Opioid Analgesics**

**Acetaminophen**

Acetaminophen (N-acetyl-p-aminophenol) is commonly utilized in the pediatric population either alone or in combination with other analgesics. It has minimal anti-inflammatory properties. It has been noted to have central effects involving the inhibition of cyclooxygenase (COX), endogenous cannabinoid modulation, N-methyl-D-aspartate (NMDA) receptor antagonism and serotonin receptor agonism. Acetaminophen is mostly eliminated via glucuronidation and sulfation. In the event of excessive acetaminophen ingestion, oxidation is increased and the hepatotoxic metabolite N-acetyl-p-benzocinon-imine is created.

Despite these risks, acetaminophen is one of the most commonly used drugs for treatment of fever, mild-moderate pain, and moderate-severe pain when combined with opioids. Addition of acetaminophen has demonstrated an opioid sparing effect. It may be used in patients who cannot take NSAIDs secondary to gastrointestinal injury, renal insufficiency, or asthma.
It may be administered orally, rectally and via the intravenous route. IV acetaminophen was approved by the FDA on November 2, 2010 for use in patients 2 years of age and older. Some of the disadvantages of intravenous acetaminophen use include cost, large volume vials, dosing errors and hepatotoxicity.

Acetaminophen dosing for pediatric patients is presented in Table 2.

**Table 2. Recommended Pediatric Dosing of Acetaminophen**

<table>
<thead>
<tr>
<th>Route</th>
<th>Age</th>
<th>Dose</th>
<th>Interval</th>
<th>Maximum daily dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV</td>
<td>1 month - 24 months</td>
<td>7.5-15 mg/kg</td>
<td>Every 6 hours as needed</td>
<td>60 mg/kg/day</td>
</tr>
<tr>
<td></td>
<td>2-12 years</td>
<td>15 mg/kg</td>
<td>Every 6 hours as needed</td>
<td>75 mg/kg/day or 3750 mg/day</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12.5 mg/kg</td>
<td>Every 4 hours as needed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;12 years, &lt;50 kg</td>
<td>15 mg/kg</td>
<td>Every 6 hours</td>
<td>Max 750 mg/dose or 75 mg/kg/day</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12.5 mg/kg</td>
<td>Every 4 hours</td>
<td>Max 1000 mg per dose or 4000 mg/day</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1000 mg</td>
<td>Every 6 hours</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;50 kg</td>
<td>650 mg</td>
<td>Every 4 hours</td>
<td></td>
</tr>
<tr>
<td>PO</td>
<td>10-15 mg/kg</td>
<td></td>
<td>Every 4-6 hours as needed</td>
<td>Not to exceed 5 doses/day; not to exceed above recommended daily dose</td>
</tr>
<tr>
<td>Rectal</td>
<td>10-20 mg/kg</td>
<td></td>
<td>Every 4-6 hours as needed</td>
<td>Not to exceed 5 doses/day</td>
</tr>
</tbody>
</table>

*Modified from Cincinnati Children’s Hospital Medical Center Formulary. Use caution in hepatic impairment. If creatinine clearance <10 mL/min, dose every 8 hours.*

**Nonsteroidal Anti-inflammatory Drugs (NSAIDS)**

NSAIDS are also widely used in the pediatric population. Their mechanism of action consists of reversible inhibition of cyclooxygenase enzymes (both constitutional and inducible), which may lead to an inhibition of inflammatory mediators (i.e. prostaglandins) in the periphery. NSAIDS are highly protein bound to albumin and are oxidized in the liver by cytochrome P-450 or conjugated by glucuronide.11 NSAIDs have limited penetrance of the blood-brain barrier and most of their effects occur at peripheral sites.10

Several adverse effects have been associated with their use including the potential for bleeding, gastric irritation, cardiovascular consequences, and asthma activation in predisposed individuals. Special attention must be paid to renal function as these agents may negatively affect kidneys by reducing renal blood flow.8 Renal ischemia and acute tubular necrosis may result. There may also be cardiovascular consequences of long-term use of NSAIDs, attributed to prolonged COX-2 inhibition, which may lead to an increase in thrombotic events and an increase in cardiovascular morbidity, myocardial infarction and stroke.8

NSAIDS provide analgesic and antipyretic properties. They may be administered orally, intramuscularly, and intravenously. NSAIDs are commonly used for the treatment of mild-moderate
pain. When used in conjunction with opioids, NSAIDs may decrease opioid consumption as well as opioid related adverse effects. NSAIDs may be used in all age groups but limited data exist regarding their safety and efficacy in neonates and young infants (below 6 months of age). NSAIDs dosing for pediatric patients are presented in Table 3.

### Table 3. NSAIDs Commonly Prescribed in Pediatric Population

<table>
<thead>
<tr>
<th>Medication</th>
<th>Route</th>
<th>Dose</th>
<th>Dosing Interval</th>
<th>Maximum daily dose for Patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ibuprofen</td>
<td>PO</td>
<td>8-10 mg/kg</td>
<td>Every 6 hours</td>
<td>&lt;60 kg patient: 40 mg/kg/day</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt;60 kg patient: 2400 mg/day</td>
</tr>
<tr>
<td>Ketorolac</td>
<td>IV</td>
<td>0.25-0.5 mg/kg</td>
<td>Every 6 hours</td>
<td>&lt;60 kg patient: 2 mg/kg/day</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt;60 kg patient: 120 mg/day</td>
</tr>
</tbody>
</table>


### Opioid Analgesics

Opioids are the cornerstone of perioperative analgesia and are the most commonly prescribed analgesics to treat moderate to severe pain in the pediatric population. The pharmacokinetics and pharmacodynamics vary markedly amongst children of different ages. Infants less than 3 months of age have been shown to have a decreased opioid clearance secondary to decreased hepatic and renal function; thus the starting dose should be decreased by 25-50%.

Opioids are eliminated through hepatic metabolism via cytochrome-P450 and conjugation reactions into water-soluble metabolites that are renally excreted. Infants achieve an adult hepatic functional level at about the age of 6 months and renal function reaches adult level at about 8-12 months of age. Given the variance between patients, the perioperative physician must recognize that infants and neonates are at increased risk of respiratory depressive effects and thus opioid dosage should be titrated to effect.

Opioids may be administered via oral, intramuscular, transdermal, intrathecal, intravenous and patient-controlled routes. Some of the other side effects specific to pediatric population are related to neuroexcitatory phenomena, manifesting as myoclonus. Similar to adults, common side effects in children include nausea, vomiting, constipation, urinary retention, pruritus and tolerance.
**Morphine**

Morphine is widely used in the pediatric population, especially in infants and children. All children, but especially infants younger than 2 months of age should be monitored by continuous pulse oximetry.\(^{14}\) Morphine is metabolized by the liver and excreted by the kidneys. Morphine has two active metabolites, morphine-6-glucuronide (6x more potent an analgesic than morphine) and morphine-3-glucuronide (has neuroexcitatory properties)\(^ {12}\), both with longer elimination half-life compared to morphine which may lead to accumulation and excessive side effects in renal failure patients. Avoidance or reduction of dosage would be advised in this situation. The analgesic duration of morphine has been estimated to be around 3-4 hours.

Morphine may cause hypotension, erythema and hives in predisposed individuals due to histamine release. These symptoms are usually easily treated either by discontinuing use of the drug, or by administering fluids and/or antihistamines. In infants, morphine may cause neuroexcitatory symptoms more often than other opioids, although myoclonus have been observed during both fentanyl and hydromorphone administration.

Morphine dosing for pediatric patients are presented in Table 4.

**Hydromorphone**

Hydromorphone is similar to morphine in many aspects. It is estimated to be about 8-10 times more potent an analgesic than morphine. It is also more sedating than morphine, so it is not unusual to come across a patient who appears sedated, but when asked, complains of pain. Hydromorphone may be used safely in the presence of renal dysfunction, as there is a decrease in the accumulation of active metabolites when compared to morphine.\(^ {12}\) It may be administered via oral or intravenous routes.

Hydromorphone dosing for pediatric patients is presented in Table 4.

**Fentanyl**

Fentanyl is a synthetic opioid, which is estimated to be about 50-100 times more potent than morphine. It is highly lipid-soluble with a very rapid onset (about 2-5 minutes) and short duration of action (about 30-45 minutes). Fentanyl undergoes hepatic metabolism and may be a great substitute for morphine when there are dose-limiting side effects of morphine. It may be administered via intravenous, intrathecal, epidural or transdermal route.

Fentanyl dosing for pediatric patients are presented in Table 4.

**Methadone**

Methadone is a synthetic opioid with a long and variable half-life, which may range from 6-30 hours.\(^ {12}\) It exhibits NMDA receptor antagonism that may reduce pain and hyperalgesia as well as delay the onset of tolerance to opioids.\(^ {13}\) Due to methadone’s prolonged half-life, the presence of delayed onset sedation and hypoventilation may be an indication that the patient might be at increased risk of overdosing and withholding the next dose might be indicated.\(^ {12}\) It may be administered via intravenous or oral routes. Several caveats govern the use of methadone; start low, go slow, do not increase the dose or dosing interval more often than every 5 days. It takes that long to achieve steady
state. Methadone can prolong the QT interval and cause ventricular dysrhythmias. Patients who require methadone, frequently take drugs that either prolong QT interval or increase plasma levels of methadone, both increasing the risk of over sedation or arrhythmias. It is the only long acting opioid available in a liquid form which makes its administration more acceptable in children.

Methadone dosing for pediatric patients is presented in Table 4.

**Oxycodone**

Oxycodone is a semisynthetic opioid recommended for use in treating moderate to severe pain. It may be used alone or in combination with NSAIDs or acetaminophen. It undergoes hepatic metabolism to an active metabolite, oxymorphone, which is excreted via the urine. Oxycodone may be administered via the oral route and it is usually better tolerated in patients with marginal oral intake than other opioids.

Oxycodone dosing for pediatric patients is presented in Table 4.

**Table 4. Opioid Analgesics Commonly Prescribed in the Pediatric Population**

<table>
<thead>
<tr>
<th>MEDICATION</th>
<th>EQUIANALGESIC DOSES</th>
<th>TYPICAL IV STARTING DOSE</th>
<th>TYPICAL ORAL STARTING DOSE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Morphine</strong></td>
<td>PO: 30mg&lt;br&gt;IV: 10 mg</td>
<td>0.1 mg/kg every 2-4 hours&lt;br&gt;Infusion: 0.03 mg/kg/h</td>
<td>5-10 mg every 3-4 hours&lt;br&gt;Infusion: 1.5 mg/h</td>
</tr>
<tr>
<td><strong>Hydromorphone</strong></td>
<td>PO: 6-8 mg&lt;br&gt;IV: 1.5-2 mg</td>
<td>0.015 mg/kg every 3-4 hours&lt;br&gt;Infusion: 0.006 mg/kg/h</td>
<td>1-1.5 mg every 3-4 hours&lt;br&gt;Infusion: 0.3 mg/h</td>
</tr>
<tr>
<td><strong>Oxycodone</strong></td>
<td>PO: 15-20 mg&lt;br&gt;IV: N/A</td>
<td>N/A</td>
<td>N/A&lt;br&gt;0.1-0.2 mg/kg every 3-4 hours&lt;br&gt;5-10 mg every 3-4 hours</td>
</tr>
<tr>
<td><strong>Methadone</strong></td>
<td>PO: 10-20 mg&lt;br&gt;IV: 10mg</td>
<td>0.1 mg/kg every 4-8 hours</td>
<td>5-8 mg every 4-8 hour&lt;br&gt;0.1-0.2 mg/kg every 4-8 hours&lt;br&gt;5-10 mg every 4-8 hours</td>
</tr>
<tr>
<td><strong>Fentanyl</strong></td>
<td>IV: 100 mcg (0.1 mg)&lt;br&gt;Infusion: 0.5-2.0 mcg/kg/h&lt;br&gt;Infusion: 25-100 mcg/h</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**IV Patient-Controlled Analgesia (PCA)**

IV PCA involves frequent self-administration of small preset doses of opioid by the patient or in some cases the nurse or parents. It has been demonstrated to be safe and effective in children as young as 6 years of age. Safety features, such as a lockout period, prevent the administration of repeated doses in a short period of time. A PCA may also utilize a low-dose basal infusion but has the potential to increase the risk of adverse events, such as hypoxemia, if proper monitoring is not established. Some of the advantages of the PCA include improved pain scores, greater patient satisfaction and fewer complications. Nurse- or parent-controlled analgesia (PCA by proxy) is widely used in children younger than 6 years of age at pediatric centers worldwide and may prevent delays in the treatment of pain. (See Table 5.)

**Table 5. IV PCA Dosages for Commonly Medications Prescribed in the Pediatric Population**

<table>
<thead>
<tr>
<th>Medication</th>
<th>Loading dose</th>
<th>Demand dose</th>
<th>Lockout time</th>
<th>Continuous infused rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morphine</td>
<td>50 mcg/kg every 4-6 hours</td>
<td>20 mcg/kg</td>
<td>7-15 minutes (NCA 10-15 minutes)</td>
<td>0-20 mcg/kg/h</td>
</tr>
<tr>
<td>Hydromorphone</td>
<td>10 mcg/kg every 4-6 hours</td>
<td>4-5 mcg/kg</td>
<td>Same</td>
<td>0-3 mcg/kg/h</td>
</tr>
<tr>
<td>Fentanyl</td>
<td>0.5-1 mcg/kg every 4-6 hours</td>
<td>0.2-0.3 mcg/kg</td>
<td>Same</td>
<td>0-0.15 mcg/kg/h</td>
</tr>
<tr>
<td>Butorphanol</td>
<td>50 mcg/kg every 4-6 hours</td>
<td>4-5 mcg/kg</td>
<td>Same</td>
<td>0-3 mcg/kg/h</td>
</tr>
</tbody>
</table>


**Regional and Neuraxial Anesthesia/Analgesia**

Regional and neuraxial techniques may be performed safely in the anesthetized pediatric patient without further increase in the risk of complications. These procedures not only significantly reduce postoperative pain, but also reduce the amount of opioids needed to achieve pain relief.

Epidural infusions may provide excellent postoperative analgesia in infants and children undergoing thoracic, abdominal and lower extremity procedures. Solutions may contain local anesthetics, opioids and/or clonidine. (See Table 6 for details.) The perioperative physician must follow these patients closely and routinely assess the dermatome levels achieved in order to assure the adequacy of treatment and coverage as well as to assess for any changes indicative of an impending adverse event (i.e. increasing back pain or excessive lower extremity weakness).
Table 6. Pediatric Dosages for Epidural Infusions

<table>
<thead>
<tr>
<th>Medication</th>
<th>Loading Dose</th>
<th>Concentration of Solution</th>
<th>Infusion limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bupivacaine</td>
<td>2.5-3 mg/kg</td>
<td>0.0625-0.1%</td>
<td>0.2-0.4 mg/kg/h</td>
</tr>
<tr>
<td>Ropivacaine</td>
<td>2.5-3 mg/kg</td>
<td>0.1-0.2%</td>
<td>0.2-0.4 mg/kg/h</td>
</tr>
<tr>
<td>Fentanyl</td>
<td>1-2 mcg/kg</td>
<td>2-5 mcg/mL</td>
<td>0.5-2 mcg/kg/h</td>
</tr>
<tr>
<td>Morphine</td>
<td>10-30 mcg/kg</td>
<td>5-10 mcg/mL</td>
<td>1-5 mcg/kg/h</td>
</tr>
<tr>
<td>Hydromorphone</td>
<td>2-6 mcg/kg</td>
<td>2-5 mcg/mL</td>
<td>1-2.5 mcg/kg/h</td>
</tr>
<tr>
<td>Clonidine</td>
<td>1-2 mcg/kg</td>
<td>0.5-2 mcg/mL</td>
<td>0.1-0.5 mcg/kg/h</td>
</tr>
</tbody>
</table>


Peripheral nerve blocks have been proven to be safe and effective in children, and are usually performed on an anesthetized patient — similarly to neuraxial techniques — with ultrasound guidance. The spectrum is broad and ever expanding - in the upper limb (i.e. interscalene or infraclavicular), lower limb (i.e. femoral nerve or sciatic nerve) and increasingly more and more popular truncal region (i.e. transverse abdominus plane) of the patient. Blocks effectively reduce the opioid requirements and related side effects (i.e. nausea, vomiting or urinary retention). They may also help avoid some of the potential complications associated with neuraxial techniques (i.e. hematomas, abscesses, or paralysis). Peripheral nerve blocks improve patient satisfaction, interfere less with ambulation and are a great adjunct to first session of physical therapy.

Special Groups: Pediatric Patient with Obstructive Sleep Apnea and the Perioperative Setting

Obstructive sleep apnea (OSA) is a disorder described as periodic, partial or complete closure of the upper airways during sleep. The condition is not uncommon in the pediatric population, especially in obese children and those with tonsillar hypertrophy. Children suffering from OSA are at increased risk of respiratory complications during the perioperative period. They are known to be sensitive to the effects of opioids; thus, vigilance and dosage adjustments should be done carefully as the tendency to become apneic with normal dosages is common. Regional and neuroaxial analgesia while minimizing opioids may provide satisfactory analgesia and are a viable alternative for patients at risk for respiratory complications.

Adjuvants

Adjuncts are pharmacologic agents not traditionally used for their analgesic properties but shown to significantly reduce pain. These agents may be used alone or in combination with other traditional analgesics. Examples of the adjuvant medications may include antidepressants, anticonvulsants, alpha-2 agonist, and muscle relaxants. (See Table 7.)
Table 7. Adjuvants Commonly Prescribed in the Pediatric Population

<table>
<thead>
<tr>
<th>Medication</th>
<th>Dose</th>
<th>Adjuvant quality</th>
<th>Class of Medication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gabapentin</td>
<td>5 mg/kg PO (Max: 300 mg) Day 2: 5 mg/kg BID Day 3: 5 mg/kg TID</td>
<td>Neuropathic pain</td>
<td>Anticonvulsant</td>
</tr>
<tr>
<td>Pregabalin</td>
<td>50 mg PO TID, increase to 300 mg/day over 7 days</td>
<td>Neuropathic pain</td>
<td>Anticonvulsant</td>
</tr>
<tr>
<td>Diazepam</td>
<td>0.05-0.1 mg/kg PO q6h; 0.03 mg/kg IV q6h</td>
<td>Muscle relaxant; anxiolytic</td>
<td>Anxiolytic</td>
</tr>
<tr>
<td>Clonidine</td>
<td>1-2 mcg/kg epidurally; 3-5 mcg/kg PO; 0.1-0.3 mg/day transdermally</td>
<td>Analgesia; sedative</td>
<td>Alpha-2 agonist</td>
</tr>
<tr>
<td>Ketamine</td>
<td>0.5-2 mg/kg IV; 6-10 mg/kg PO</td>
<td>Analgesic effects</td>
<td>NMDA-antagonist</td>
</tr>
<tr>
<td>Methocarbamol</td>
<td>15 mg/kg (max: 1000 mg) IV/PO q6h</td>
<td>Reduces muscle spasm which may cause pain</td>
<td>Muscle relaxant</td>
</tr>
</tbody>
</table>


Nonpharmacologic Techniques

Table 8 highlights some of the nonpharmacologic techniques which - when used in conjunction with pharmacologic therapy - may significantly reduce amount of pain in the perioperative period.

Table 8. Non-pharmacologic Techniques Used in the Pediatric Population

<table>
<thead>
<tr>
<th>Education</th>
<th>➢ Effective in children ➢ Sets realistic expectations ➢ Provides reassurance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complementary and Alternative Medicine (CAM)</td>
<td>➢ Massage: soothing ➢ Deep breathing exercises ➢ Relaxation: decrease anxiety and muscle tension ➢ Acupuncture: may decrease nausea/vomiting</td>
</tr>
<tr>
<td>Child Life Specialists</td>
<td>➢ Provide distraction tools (bubbles, music, conversation and activity rooms)</td>
</tr>
</tbody>
</table>

Management of the Case Presented

During the preoperative assessment, the analgesic plan was discussed. The parents refused neuraxial or peripheral nerve blocks secondary to their fear of paralysis.

The planned surgery was uneventful. Patient’s postoperative analgesic regimen included the use of a morphine patient controlled analgesia (PCA) (patient bolus 20 mcg/kg every 7 minutes with no continuous infusion rate) as well as intravenous acetaminophen (15 mg/kg every 6 hours), ketorolac (0.5 mg/kg every 6 hours), and diazepam (50 mcg/kg every 6 hours as needed for urinary bladder spasms). In the PACU, his score was 3 on the FLACC scale. During the next two post-op days, his scale was changed to NRS and ranged from 2-5. He was transitioned off the morphine PCA on post-op day two, and was prescribed oxycodone (0.1 mg/kg every 4 hours as needed for pain). He reported tolerable analgesia and was discharged from the hospital on postoperative day 8 with a prescription for Acetaminophen (300mg every 6 hours as needed for pain).

Conclusion

The treatment of pain in the pediatric patient may prove to be challenging. With the advent of age-appropriate techniques for assessment and treatment of pain, the management of this historically undertreated patient population may be greatly improved.

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REFERENCES

Post-test

1. Predominantly central cyclooxygenase (COX) inhibition may be demonstrated by which of the following?
   a. Ketorolac
   b. Acetaminophen
   c. Ibuprofen
   d. Naproxen

2. Which of the following exhibits NMDA-receptor antagonism?
   a. Oxycodone
   b. Morphine
   c. Methadone
   d. Hydromorphone

3. Alpha-2 agonism has been demonstrated by which of the following adjuvant medications?
   a. Methocarbamol
   b. Diazepam
   c. Clonidine
   d. Ketamine

4. Active metabolites of morphine that may accumulate in the presence of renal insufficiency include:
   a. Morphine-6-glucuronide and Morphine-3-glucuronide
   b. Di-morphine acetate
   c. None of the above
   d. All of the above

5. Which of the following is a component of multimodal analgesic approach used in pediatric patients in the perioperative period?
   a. Complementary and alternative medicine
   b. Adjuvant therapy
   c. NSAIDS
   d. All of the above
6. **Regarding the incidence of OSA in pediatric patients:**
   a. It rarely occurs
   b. The risk of respiratory complications is increased
   c. Confirmed presence does not alter the technique of pain relief
   d. Normal dosages of narcotics seldom cause respiratory depression.

7. **Which of the following may present in infants?**
   a. Increased cardiac output
   b. Immature blood-brain barrier
   c. GFR decreased
   d. All of the above

8. **Which of the following is a true statement regarding the multimodal analgesic approach to pediatric patients?**
   a. The goal is to decrease the amount of opioids used by adding other therapies.
   b. It is seldom useful for children
   c. Efficacy has not been proven in the pediatric population
   d. Use is restricted only to the most severe cases of postoperative pain

9. **NSAIDS provide reversible inhibition of which of the following enzymes?**
   a. BOX
   b. Depends on the drug administered
   c. COX
   d. All of the above

10. **Prolonged COX-2 inhibition may lead to which of the following?**
    a. Stroke
    b. Myocardial infarction
    c. Thrombotic events
    d. All of the above