Neuraxial and Regional Anesthesia in the Pediatric Population

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Conflict of Interest Disclosure

Conflicts of Interest for ALL listed contributors.
• None
• Sharon Wrona
• Lauren Renner

A conflict of interest is a particular financial or non-financial circumstance that might compromise, or appear to compromise, professional judgment. Anything that fits this should be included. Examples are owning stock in a company whose product is being evaluated, being a consultant or employee of a company whose product is being evaluated, etc.

• Taken in part from “On Being a Scientist: Responsible Conduct in Research”. National Academies Press. 1995.

Objectives

• The learner will be able to identify different regional techniques used in pediatrics for pain management.
• The learner will be familiar with education for the patients and staff in regards to regional techniques.
• The learner will be familiar with some data of when and how often Nationwide Children’s Hospital (NCH) uses regional techniques.
Outline

• Discuss different techniques and medications used
  – Epidural and Caudal catheters
  – Peripheral nerve and paravertebral catheters
  – Single shot blocks
• Discussion implementation process at NCH.
  – Discuss Educational handouts
  – Electronic module education
  – IV opioid class prior to taking care of a patient with an epidural or PNC
  – The process that that took place prior to implementation of home going PNC’s
• Discuss how many patient have we have used the different regional techniques
• Incidences of complications
• Review case scenarios

Regional techniques used in pediatrics
PRAN

- Pediatric Regional Anesthesia network (PRAN)
  - A multi-institutional study of the use and incidence of complications of pediatric anesthesia

### Single injection neuraxial

<table>
<thead>
<tr>
<th>Single injection neuraxial</th>
<th>Total Procedures</th>
<th>Total Complications</th>
<th>Complication Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neuraxial type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>caudal</td>
<td>2381</td>
<td>1</td>
<td>0.04%</td>
</tr>
<tr>
<td>thoracic</td>
<td>2</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>lumbar</td>
<td>5</td>
<td>1</td>
<td>20.00%</td>
</tr>
<tr>
<td>subarachnoid</td>
<td>2</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Total</td>
<td>2490</td>
<td>3</td>
<td>0.12%</td>
</tr>
</tbody>
</table>
**Single shot caudal**

- Single shot caudal blocks are used commonly for pediatric surgical procedures
  - Commonly a local anesthetic (+/-) opioid or clonidine
- If there is an opioid further monitoring needs to be in place post operatively
- Respiratory depression may peak 6-12 hrs after administration

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**Single injection upper extremity**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Total Procedures</th>
<th>Total Complications</th>
<th>Complication Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supraclavicular</td>
<td>52</td>
<td>0.00%</td>
<td></td>
</tr>
<tr>
<td>Infraclavicular</td>
<td>46</td>
<td>0.00%</td>
<td></td>
</tr>
<tr>
<td>Axillary</td>
<td>4</td>
<td>0.00%</td>
<td></td>
</tr>
<tr>
<td>Musculocutaneous</td>
<td>1</td>
<td>0.00%</td>
<td></td>
</tr>
<tr>
<td>Elbow</td>
<td>1</td>
<td>0.00%</td>
<td></td>
</tr>
<tr>
<td>Wrist</td>
<td>0</td>
<td>0.00%</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>11</td>
<td>0.00%</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>116</td>
<td>0.00%</td>
<td></td>
</tr>
</tbody>
</table>

PRAN data for Nationwide Children's Hospital (Apr/01/2007 - Jul/20/2015)
Supraclavicular

Infraclavicular

Infraclavicular
**Single injection head & neck**

<table>
<thead>
<tr>
<th>Block Type</th>
<th>Total Procedures</th>
<th>Total Complications</th>
<th>Complications Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head &amp; Neck</td>
<td>1</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Greater</td>
<td>1</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Infraorbital</td>
<td>1</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Greater auricular/superficial cervical</td>
<td>1</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Occipital</td>
<td>1</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Greater palatine</td>
<td>1</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>4</td>
<td>0</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

PRAN data for Nationwide Children's Hospital (Apr/01/2007 - Jul/20/2015)

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**Single injection other**

<table>
<thead>
<tr>
<th>Block Type</th>
<th>Total Procedures</th>
<th>Total Complications</th>
<th>Complications Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercostal</td>
<td>1</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Ilioinguinal/iliohypogastric</td>
<td>45</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Rectus sheath</td>
<td>111</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Paravertebral</td>
<td>28</td>
<td>2</td>
<td>7.14%</td>
</tr>
<tr>
<td>Penile</td>
<td>5</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>TAP</td>
<td>159</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Other</td>
<td>13</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>364</td>
<td>2</td>
<td>0.55%</td>
</tr>
</tbody>
</table>

PRAN data for Nationwide Children's Hospital (Apr/01/2007 - Jul/20/2015)

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**Transversus Abdominis Plane Block (TAP)**
Catheter

<table>
<thead>
<tr>
<th>Block Level</th>
<th>Total Procedures</th>
<th>Total Complications</th>
<th>Complication Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neuraxial</td>
<td>246</td>
<td>36</td>
<td>14.63%</td>
</tr>
<tr>
<td>Upper Extremity</td>
<td>14</td>
<td>1</td>
<td>7.14%</td>
</tr>
<tr>
<td>Lower Extremity</td>
<td>100</td>
<td>4</td>
<td>4.00%</td>
</tr>
<tr>
<td>Other</td>
<td>22</td>
<td>4</td>
<td>18.18%</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>382</td>
<td>45</td>
<td>11.78%</td>
</tr>
</tbody>
</table>

Catheter

- Neuraxial
- Upper Extremity
- Lower Extremity
- Other

**Catheter - Neuraxial**

<table>
<thead>
<tr>
<th>Block Level</th>
<th>Total Procedures</th>
<th>Total Complications</th>
<th>Complication Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caudal - Sacral</td>
<td>24</td>
<td>1</td>
<td>4.17%</td>
</tr>
<tr>
<td>Caudal - Lumbar</td>
<td>4</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Caudal - Thoracic</td>
<td>28</td>
<td>5</td>
<td>17.86%</td>
</tr>
<tr>
<td>Lumbar</td>
<td>60</td>
<td>5</td>
<td>8.33%</td>
</tr>
<tr>
<td>Thoracic</td>
<td>129</td>
<td>25</td>
<td>19.38%</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>245</td>
<td>36</td>
<td>14.69%</td>
</tr>
</tbody>
</table>

PRAN data for Nationwide Children's Hospital (Apr/01/2007 - Jul/20/2015)
**Catheter - Epidural**

- Upper needle lies in the subarachnoid space for the injection of the anesthetic. Lower needle is in the epidural space. A small catheter is inserted through the needle into the epidural space after which the needle is removed leaving the catheter in place. © T. Graves

**Dermatome diagram**


**Catheter - Epidural**

- Good to excellent analgesia with less side effects than with the use of systemic opioids
  - infrequent nausea
  - minimal sedation
  - earlier ambulation
  - retention of cough reflex
  - decreased pulmonary dysfunction
  - decreased neuroendocrine and metabolic response to surgical stress
Assessment use guidelines

Catheter - Epidural

- Example of NCH guidelines in nursing orders
- Call Anesthesia for:
  - Severe back pain at or below the site of epidural - may indicate epidural hematoma
  - Change in mental status – increasing sedation
  - Decreased Oxygen saturation
  - Temperature > 100.4 – could indicate abscess
  - Neurovascular changes
  - Inadequate pain relief
  - Redness, swelling, pain or leaking at epidural catheter site
  - Disconnection or break of epidural catheter

State Laws regarding epidurals
Epidural documentation

Epidural catheter patient education
Epidural catheter patient education


Epidural abscess


Epidural hematoma

## Catheter – Other block type

<table>
<thead>
<tr>
<th>Other Block type</th>
<th>Total Procedures</th>
<th>Total Complications</th>
<th>Complication Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interscalene</td>
<td>10</td>
<td>2</td>
<td>20.00%</td>
</tr>
<tr>
<td>Interclavicular</td>
<td>10</td>
<td>2</td>
<td>20.00%</td>
</tr>
<tr>
<td>Ilioinguinal</td>
<td>10</td>
<td>2</td>
<td>20.00%</td>
</tr>
<tr>
<td>Rectus sheath</td>
<td>10</td>
<td>2</td>
<td>20.00%</td>
</tr>
<tr>
<td>Paravertebral</td>
<td>20</td>
<td>2</td>
<td>10.00%</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>2</td>
<td>10.00%</td>
</tr>
</tbody>
</table>

PRAN data for Nationwide Children's Hospital (Apr/01/2007 - Jul/20/2015)

## Paravertebral

![Paravertebral injection image](image)

## Complications

- Positive test dose
- Dural puncture
- Vascular puncture
- Abandoned block
- Respiratory
- Cardiovascular
- Neurologic
- Inadequate analgesia
- Unintentional unilateral blockade
- Catheter problem
- Excessive motor blockade
- Adverse drug reaction
- Hematoma
- Infection
Home PNC infusions

- Home peripheral nerve catheter programs for postoperative pain have been shown to be safe and effective in adults.
  - However, peripheral nerve catheters have been used in children primarily as an inpatient pain management therapy.

Home PNC infusions

• Prior to launching the program, a systemic approach was performed using the Healthcare Failure Mode and Effect Analysis (HFMEA) system to identify potential adverse effects and develop an infrastructure to make home infusions of local anesthetics a safe and effective practice.


Home PNC infusions

• Retrospectively review our initial 24 months experience with our home infusion program to evaluate the efficacy, adverse effects and technical problems with a home peripheral nerve catheter program in children.
  - A total of 78 patients were identified with home peripheral nerve catheters. Of those 78 patients, 67 were lower extremity catheter and 11 were upper extremity catheters.
  - The majority of catheters were placed under general anesthesia (97%). All of the catheters were placed with ultrasound guidance.
  - Ropivacaine was used in all blocks for the initial bolus as well as the continuous infusion.
    - The percentage of ropivacaine was 0.1% in 2 catheters (3%) and 0.2% in 76 catheters (97%).
  - The infusion rate ranged between 4ml/hr and 10ml/hr.
  - The catheter was left in place for 0 days (3%), 1 day (9%), 2 days (73%), 3 days (9%), or 4 days (3%).
  - The family removed the catheter at home when the catheter was no longer needed in the majority of patients (96%).
  - The catheter was removed early in only 3 patients in whom the catheter fell out or was leaking.
  - There were no major complications.

Peripheral nerve catheter patient education
Epidural case study

• H.C. is a 16 yr old healthy female who presented 6/11/14 with a L tibia fracture. She was diagnosed during that admission with high grade osteosarcoma of the L Tibia
• She underwent chemotherapy
• H.C. went to the OR 8/28/14 and had a L tibia resection and reconstruction

Epidural case study

• Treatment plan after resection
  – L4-L5 epidural placed in the OR. 0.2% ropivacaine with hydromorphone 10mcg/ml @ 7 ml/hr
  – Gabapentin 800 mg TID
  – Diazepam 2 mg q 6hr PRN
  – Acetaminophen 650 mg q 6hr
  – POD #1-Had motor weakness to R leg so changed epidural solution to 0.1% ropivacaine. Added hydromorphone PCA 0.2mg q 10 min
  – POD #2-Motor weakness to R leg improved. No changes made
  – POD #3-Added methadone 2.5 mg TID
  – POD #4-No changes

Epidural case study

• POD #5-Epidural removed. Changed methadone to 5 mg BID and added oxycodone 5 mg q 4hr PRN. Continued hydromorphone PCA
• POD #6-Decreased PCA dose from 0.2mg to 0.1mg
• POD #7-PCA off
• POD #8-No changes. Continued methadone, oxycodone, gabapentin and diazepam.
• POD #10-Patient discharged home with a follow up appointment in the pain clinic
Epidural case study

• 2/27/15 H.C. returned to the OR for thoracoscopy and biopsy of lung nodule
• Home meds: oxycodone 5mg q 4hr PRN, gabapentin 900 mg TID, diazepam 2 mg q 6hr PRN
• POD #0-Placed on a hydromorphone PCA: 0.2mg basal / 0.3mg dose q 10 min
• POD #1-Increased PCA settings: 0.2mg basal / 0.25mg dose q 10 min
• POD #2-Basal off and added oxycodone 10 mg q 4hr
• POD #3- Increased oxycodone to 12.5mg
• POD #4- PCA d/c'd
• POD #5- Discharged home with a follow up appointment in pain clinic

Epidural case study

• 6/1/15-OR for L thoracotomy and pulmonary nodule resection
  – Epidural placed T5. Running ropivacaine 0.2% with fentanyl 2 mcg/ml @ 8ml/hr
  – Hydromorphone 0.4mg q 2hr PRN
  – Diazepam 5 mg q 6hr PRN
• 6/1/15-OR for L thoracotomy and pulmonary nodule resection
• POD #1-Added ketorolac and oxycodone
• POD #2-D/C’d epidural and increased oxycodone to 7.5mg. Discharged home.

My Wish: Michael Phelps
PNC case study

- K.P is a 25-yr old with h/o R radial metastatic osteosarcoma
- OR 2/12/14 for R below the elbow amputation
- Home meds: methadone 10 mg BID, gabapentin 300 mg BID
- POD #0: Brachial plexus catheter placed. Infusing ropivacaine 0.2% @ 8ml/hr
  - Morphine IR 15 mg q 4hr PRN
  - Neurontin 600 mg BID
  - Methadone 10 mg BID
- POD #1: Increased methadone to TID dosing and increased PNC infusion rate from 8 ml to 10 ml/hr
- POD #2: Catheter was removed in preparation for discharge home
- Patient discharged home with:
  - Methadone PO 15mg q 3hr
  - Morphine IR 15 mg q 3hr PRN
  - Hydromorphone PO 6 mg q 3hr PRN
  - Gabapentin 900 mg TID

PNC case study

- K.P returned to the OR 2/5/15 and was s/p further resection of his RUE above the elbow for symptom management
- Home medications prior to surgery:
  - Methadone PO 15mg q 3hr
  - Morphine IR 15 mg q 3hr PRN
  - Hydromorphone PO 6 mg q 3hr PRN
  - Gabapentin 900 mg TID
- He had a supraclavicular nerve catheter placed in the OR
  - The catheter was infusing 0.2% ropivacaine @ 6ml/hr

PNC case study

- K.P. was sent home 2/6/15 with his nerve catheter in place
- NCH homecare provided an epidural pump to run the infusion of ropivacaine
References