PEDIATRIC ANESTHESIA UPDATE

CRASH 2015
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Stanford School of Medicine

PEDIATRIC ANESTHESIA UPDATE

LEAVING DENVER

OBJECTIVES:

Surgical Environment
Codeine
Anesthesia and neurodevelopment
PRAN Update
Lidocaine and laryngospasm
Clotting-differences in children
Machine washout

OPTIMAL RESOURCES FOR THE SURGICAL CARE OF CHILDREN IN THE US

AMERICAN PEDIATRIC SURGICAL ASSOCIATION

- American College of Surgeons
- Society for Pediatric Anesthesia
- American Academy of Pediatrics
- Children’s Hospital Association
- Created task force in 2012
- Met in 2012, 13, 14
- Develop “consensus recommendations”

NOTHING TO DISCLOSE

- Moved to California
- Working at Stanford and Lucille Packard Children’s Hospital
- This is my last year as CRASH Program Director
- Can’t ski cause I broke my wrist
- Please encourage next year’s organizer’s to invite me back 😊
Currently a "mismatch"
suboptimal care
35% of neonates in 2009 complex surgery at non-specialty institutions/units
"Appropriate pediatric anesthesia expertise, including both relevant training and an adequate level of ongoing clinical pediatric practice, was judged to be critical"
DEFINITIONS

Anesthesiologist with pediatric expertise
Anesthesiologist with pediatric expertise is defined as an anesthesiologist either eligible to certify or with a current certificate of the American Board of Anesthesiology, or equivalent. In addition, this individual will demonstrate ongoing pediatric clinical engagement in patients younger than 18 years of age, as well as 10 relevant category 1 CME credit hours annually.

Pediatric anesthesiologist
Pediatric anesthesiologist is defined as an individual certified in anesthesia by the American Board of Anesthesiology or equivalent, in addition to being certified or eligible for certification in pediatric anesthesia by the American Board of Anesthesiology or equivalent organization. Such an individual must demonstrate adequate ongoing engagement in the practice of pediatric anesthesia in patients younger than 18 years of age.

OPTIMAL RESOURCES

- Information being widely disseminate
- Plan to start voluntary reviews
- Administered by American College of Surgeons

HOPEFULLY YOU ARE NOT STEAMING HOT OR FEELING LIKE YOU'RE ABOUT
Editorials: Editorial

The Elephant in the Room: Lethal Apnea at Home after Adenotonsillectomy
Brown, Karen A. MD*; Brouillette, Robert T. MD†

APRIL 2014
Too Much Codeine Still Prescribed for Kids: Study
ERs give potentially dangerous drug to thousands of children each year

WHAT SHOULD WE USE INSTEAD?
Hydrocodone
Oxycodone
Ibuprofen
Acetaminophen
Tramadol
Diclofenac

SUMMER 2014
Wake Up Safe
Acetaminophen Warning

Warning: Risk of acetaminophen overdose
**ANESTHESIA AND NEURO DEVELOPMENT**

Anesthesia Before Age 2 May Link Learning Disability Later On

- Over-inhibition
- All volatile anesthetics, midazolam, propofol and ketamine have been implicated
- Many species including primates
- So far opioids seem to be OK

**VOLATILE AND OTHER ANESTHETICS**

**ANESTHESIA AND NEUROTOXICITY**

- New FDA statement coming soon
  - Much Stronger Warning

**OF MICE AND MEN**

- Mice
  - Brain Growth Spurt: first 1-2 weeks of life
  - Anesthetized for 5-6 hours
  - Many unmonitored
  - Pain and surgical stress are harmful

- Humans
  - Brain Growth Spurt: prenatal-24 months
  - Equivalent to several days-months
  - Monitored
  - Pain and surgical stress are harmful

**Table 1. Characteristics of eligible studies for meta-analysis.**

<table>
<thead>
<tr>
<th>Study</th>
<th>Authors</th>
<th>Year</th>
<th>Population</th>
<th>Gender (N)</th>
<th>Age (months)</th>
<th>Preoperative Anesthesia</th>
<th>N</th>
<th>Type of Analgesia</th>
<th>Neurodevelopmental Outcome</th>
<th>Follow-up (years)</th>
<th>2-Year Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wang X, Xu Z, Miao C-H</td>
<td>2014</td>
<td>Children</td>
<td>Male (50)</td>
<td>2-6</td>
<td>Ketamine</td>
<td></td>
<td>Midazolam</td>
<td>Motor Control</td>
<td>2</td>
<td>0.96</td>
</tr>
<tr>
<td>2</td>
<td>Agarwal, Rita</td>
<td>2015</td>
<td>Adults</td>
<td>Female (100)</td>
<td>18-24</td>
<td>Propofol</td>
<td></td>
<td>Fentanyl</td>
<td>Memory</td>
<td>2</td>
<td>0.88</td>
</tr>
</tbody>
</table>

http://www.plosone.org/article/info:doi/10.1371/journal.pone.0085760

**PlOe One. 2014 Jan 20.9(1):e85760.**
All children undergoing pyloric stenosis b/w 1986-1990 in Denmark
Compared with 5% age matched sample
9th grade standardized educational test
Small % of Danish children do NOT take these tests
Variables: sex, birth weight, parental education and age.
Exclusions: congenital malformation, hyperbilirubinemia, neonatal jaundice

RESULTS

<table>
<thead>
<tr>
<th></th>
<th>Pyloric Stenosis</th>
<th>No Pyloric Stenosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>% male</td>
<td>80</td>
<td>51.6</td>
</tr>
<tr>
<td>Parental Age</td>
<td>similar</td>
<td>similar</td>
</tr>
<tr>
<td>Parental Education</td>
<td>slightly lower</td>
<td></td>
</tr>
<tr>
<td>Mean Birth Weight (g)</td>
<td>3345</td>
<td>3434</td>
</tr>
<tr>
<td>Age at time of surgery</td>
<td>40 days</td>
<td></td>
</tr>
<tr>
<td>Congenital malformations</td>
<td>6.8%</td>
<td>4.4%</td>
</tr>
<tr>
<td>Non-attainment-boys</td>
<td>22%</td>
<td>10%</td>
</tr>
</tbody>
</table>
| Non-attainment-girls    | 13%              | 10%                 | OR=1.37

Mean test scores similar once low birth weight and congenital malformation are excluded
Higher incidence of test Non-Attainment in exposed patients boys > girls

CONCLUSION

100 children who had surgery < 1yr of age
Performance on “high stakes” test at age 12
Diagnosis of “learning disability”
Phone surveys
Slightly higher incidence of “learning disabilities”
PROBLEMS WITH THE STUDY

- Small
- Retrospective
- GA group was 90% male
- Maternal education slightly lower
- Learning disabilities not defined

ING ET AL. ANESTHESIOLOGY 2014

- Data sets derived from children born between 1989-1992
- Extensive and repeated individual neurodevelopmental tests
  - ICD 9 diagnoses of “ADHD”
  - Neuropsychological test
  - Group Academic tests
- No difference in group tests
- Neuropsych testing and ICD diagnosis alterations

FLICK EDITORIAL

Most studies with negative results used were large and reviewed group tests of achievements
Most positive studies were small and looked at individual cognitive evaluation
Use of ICD-9 codes for ADHD are controversial and inaccurate

PERIOPERATIVE MEDICINE

Comparative Analysis of Outcome Measures Used in Examining Neurodevelopmental Effects of Early Childhood Anesthesia Exposure

Anesthesia & Analgesia:
June 2014 - Volume 118 - Issue 6 - p 1160–1162
Editorials: Editorial
Good Gas, Bad Gas: Isoflurane, Carbon Monoxide, and Which Is Which?
Jevtovic-Todorovic, Vesna MD, PhD, MBA

PROTECTORS
- Subclinical carbon monoxide
- Dexmedetomidine
- Erythropoetin
- Magnesium
- Lithium
- Xingnaojing
- Curcumin

SELECTED REFERENCES
**SELECTED REFERENCES**


**SHOULD WE WAIT?**

- What should we tell families?
- Informed consent?
- Are some medication better?
- Can anything help?

**UPDATE FROM PEDIATRIC REGIONAL ANESTHESIA NETWORK**

**CAUDAL**

<table>
<thead>
<tr>
<th>Incidence (95% confidence interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block failure</td>
</tr>
<tr>
<td>Blood aspiration</td>
</tr>
<tr>
<td>Positive test dose</td>
</tr>
<tr>
<td>Dural puncture</td>
</tr>
<tr>
<td>Cardiac arrest</td>
</tr>
<tr>
<td>Seizure</td>
</tr>
<tr>
<td>Sacral pain</td>
</tr>
<tr>
<td>Muscle spasm</td>
</tr>
</tbody>
</table>

Anesthesia & Analgesia: January 2015 - Volume 120 - Issue 1 - p 151-156
Pediactric Anesthesiology: Research Report

Are Caudal Blocks for Pain Control Safe in Children? An Analysis of 18,650 Caudal Blocks from the Pediatric Regional Anesthesia Network (PRAN) Database
Suathar, Sunthanam MD2, Long, Justin MD1; Birmingham, Patrick K. MD1, De Oliveira, Gilda S. Jr MD, MSCI1
Table 3: Detailed Patient Information on Serious but Infrequent Complications

<table>
<thead>
<tr>
<th>Patient Data</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mo)</td>
<td>1-12</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
</tr>
<tr>
<td>Local anesthetic</td>
<td>Bupivacaine + Epi</td>
</tr>
<tr>
<td>Total dose (mg/kg)</td>
<td>1.0</td>
</tr>
<tr>
<td>Patient status</td>
<td>Uninfected</td>
</tr>
<tr>
<td>Comments</td>
<td>1.2-6.5 kg bupivacaine dose</td>
</tr>
</tbody>
</table>

CAUDALS

- Mean dose 1.4 mg/kg bupivacaine + epi
- >4000 received more than 2mg/kg
- Almost 1000 received more than 2.5mg
- Dosing variability
- Decreasing use of ultrasound

INTERSCALENE BLOCKS

- 7.7% with Anatomic landmarks
- 88% with U/S
- 13% with nerve stimulation
- No postoperative neurologic symptoms (PONS)
- No local anesthetic systemic toxicity (LAST)
- One post-op infection
- One intravascular puncture

"Kiddie" Caudal: Safe but More to Learn

- Almost 19,000 patients and no temporary or permanent sequelae
- A great deal of dosing variability with the only 2 cases of possible systemic toxicity occurring at doses well below currently recommended doses
ASLEEP VS. AWAKE

<table>
<thead>
<tr>
<th>Age Group</th>
<th>-5 mm</th>
<th>1 to &lt;6 mm</th>
<th>6 to -12 mm</th>
<th>3 to &lt;5 y</th>
<th>5 to &lt;10 y</th>
<th>10 -18 y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-shot blocks</td>
<td>764</td>
<td>13729</td>
<td>6962</td>
<td>2147</td>
<td>1290</td>
<td>732</td>
</tr>
<tr>
<td>Upper extremity</td>
<td>37</td>
<td>93</td>
<td>129</td>
<td>123</td>
<td>725</td>
<td>940</td>
</tr>
<tr>
<td>Lower extremity</td>
<td>12</td>
<td>46</td>
<td>185</td>
<td>246</td>
<td>1967</td>
<td>715</td>
</tr>
<tr>
<td>Hand and neck</td>
<td>16</td>
<td>226</td>
<td>185</td>
<td>281</td>
<td>538</td>
<td>712</td>
</tr>
<tr>
<td>Other</td>
<td>185</td>
<td>690</td>
<td>629</td>
<td>1434</td>
<td>3641</td>
<td>2027</td>
</tr>
<tr>
<td>Catheter blocks</td>
<td>914</td>
<td>375</td>
<td>214</td>
<td>1384</td>
<td>2076</td>
<td>292</td>
</tr>
<tr>
<td>Upper extremity</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>10</td>
<td>36</td>
<td>107</td>
</tr>
<tr>
<td>Lower extremity</td>
<td>5</td>
<td>4</td>
<td>38</td>
<td>45</td>
<td>286</td>
<td>1224</td>
</tr>
<tr>
<td>Total</td>
<td>1129</td>
<td>5285</td>
<td>7626</td>
<td>7917</td>
<td>10448</td>
<td>17206</td>
</tr>
</tbody>
</table>

TAP BLOCKS

- 1994 patients
- Dosing Variability-median 1mg/kg
- 2 complications-blood aspiration and peritoneal puncture
- Most performed under GA with U/S

MORE ON TAP BLOCKS

- Suresh et al (Ped Anesth 2014) compared 2.5 vs.1.25 mg/kg bup→ longer duration
- Lorenzo et.al (J Urol 2014) TAP vs, field infiltration by surgeon
  - TAP not better
- A&A Case Reports
  - 2013: Cardiac Arrest from TAP+ field infiltration-failure to communicate
  - 2014: TAP for VP shunts
The Efficacy of Antifibrinolytic Drugs in Children Undergoing Noncardiac Surgery: A Systematic Review of the Literature

Faraoni, David MD, FCCP*; Goobie, Susan M. MD, FRCPC†

TXA and EACA seem to decrease blood loss in spine fusion patients

Most studies small and retrospective

Pharmacokinetics of Aminocaproic Acid in Adolescents Undergoing Posterior Spinal Fusion Surgery

Paul Stricker, Devika Singh, John Fladjo, et al.
Children’s Hospital of Philadelphia,

EACA clearance increased with weight and age.

- weight < 25 kg: 100 mg/kg loading dose and 40 mg/kg/hr infusion;
- weight < 50 kg: 100 mg/kg loading dose and 35 mg/kg/hr infusion, and
- weight ≥ 50 kg: 100 mg/kg loading dose and 30 mg/kg/hr infusion.

Improving Outcomes After Neuromuscular Scoliosis Surgery: Have We Learned From Massive Transfusion Protocols?
Kesavan Sadacharam, M.D., Bruce R. Brenn, M.D et.al
Alfred I. duPont Hospital for Children

Preliminary results show that patients who received high ratio FFP and PRBC and less crystalloid had less total blood loss, less percentage of blood volume loss and better urine output suggesting better outcomes.

Capnography Fails as a Continuous Respiratory Monitor in Pediatric Patients Treated with IVPCA Opioids
Myron Yaster, M.D., Karen M. Miller, B.A., Andrew Y. Kim, B.S., Elizabeth White, R.N., Constance L. Monitto, M.D., Sapna R. Kudchadkar, M.D., James Fackler, M.D.

Children treated with IV PCA did not tolerate continuous monitoring of respiration using capnography. Until better, kid friendly monitors are available, guidelines and recommendations geared to adult patients cannot be extended to children.

Survey Says: What Do Pediatric Clinicians Really Know About the “Sedation or Anesthesia” Required When Ordering an MRI “With Sedation”?
Glenn E. Mann, M.D., Scott Lipson, M.D., Jerry Diao, M.D., Terry-Ann Chambers, M.D., Rachel Zilber, M.D., Montefiore Medical Center, Albert Einstein College of Medicine, Bronx, New York, United States

A majority of pediatric care providers do not appreciate the differences between the depths of anesthesia required to perform MRIs in children. In addition, they are unaware of the possible need for intubation and apnea associated with certain MRI studies.

Anesthesia & Analgesia:
July 2014 - Volume 119 - Issue 1 - p 67–75
Technology, Computing, and Simulation: Research Report
The Sevoflurane Washout Profile of Seven Recent Anesthesia Workstations for Malignant Hyperthermia-Susceptible Adults and Infants: A Bench Test Study
Cottron, Nicolas MD; Larcher, Claire MD; Sommet, Aghès MD, PhD; Fesseau, Rose MD; Alacoque, Xavier MD; Minville, Vincent MD, PhD; Fourcade, Olivier MD, PhD; Kern, Delphine MD, PhD

Anesthesia & Analgesia:
July 2014 - Volume 119 - Issue 1 - p 9–10
Editorials: Editorial
How Will We Ever Know if Our Machine Is Adequately Flushed?
Martin, Timothy W. MD, MBA; Block, Frank E. Jr MD
Preventing Laryngospasm

- Propofol
- Deep vs Awake extubation
- Remifentanil
- Magnesium sulphate
- Lidocaine

Lidocaine and Its Role in Laryngospasm

Table 1: Effect of lidocaine on laryngeal and respiratory reflex responses in anaesthetized children. Ped Anaesth. 2012 Apr;22(4):345-50

Technique for Simulating Airway Reflexes

- Sevo induction
- LMA
- FOB with 20G epidural catheter
- 0.25 cc sterile water
- Video taped and observed
- 3 times points

Topical Lidocaine Study

Table 2: Incidence of laryngospasm, coughing, and desaturation during induction of anaesthesia with and without topical lidocaine. Ped Anaesth. 2012 Apr;22(4):345-50
**INTRANEOUS LIDOCAINE STUDY**

<table>
<thead>
<tr>
<th>Table 2: Details of respiratory and haemodynamic variables and arterial depth. Data are mean (SD).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stimulaton 1 (baseline)</td>
</tr>
<tr>
<td>Respiratory rate, breaths/min</td>
</tr>
<tr>
<td>Minute ventilation, ml/kg/min</td>
</tr>
<tr>
<td>ProClot carbon dioxide levels, kPa</td>
</tr>
<tr>
<td>Heart rate, beats/min</td>
</tr>
<tr>
<td>Mean arterial pressure, mm/Hg</td>
</tr>
<tr>
<td>Sequential index values</td>
</tr>
<tr>
<td>Indirect serum carbon dioxide concentration</td>
</tr>
</tbody>
</table>

**SELECTED REFERENCES**

- Agarwal, Rita, MD
- Pediatric Anesthesia Update

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**LARYNGOSPASM-TREATMENT**

- 100% oxygen + Fink maneuver (painful jaw thrust)
- Positive pressure ventilation to PIP of 20cm H20
- Propofol 0.5 - 2mg/kg
- Lidocaine
- Sux 10-20% of intubating dose
- Magnesium Sulphate ?

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**IV LIDOCAINE**

<table>
<thead>
<tr>
<th>Table 3: Details of laryngeal and respiratory reflex responses to laryngeal stimulation. Data are number (proportion).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laryngospasm &gt; 10 s after Stimulation 1 (baseline) (n = 30)</td>
</tr>
<tr>
<td>Laryngospasm</td>
</tr>
<tr>
<td>Central apnea &gt; 10 s</td>
</tr>
<tr>
<td>Hypoxia</td>
</tr>
<tr>
<td>Epiglottic reflex</td>
</tr>
<tr>
<td>Spasmotic parox</td>
</tr>
<tr>
<td>p value Baseline vs. lidocaine at 2 min</td>
</tr>
<tr>
<td>p value Baseline vs. lidocaine at 10 min</td>
</tr>
</tbody>
</table>

Decreased incidence of laryngospasm at 2min, not so much at 10 minutes

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**META-ANALYSIS**

- Meta-analysis says yes:
  - 9 studies, 787 patients
  - Topical and IV lidocaine help

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**The efficacy of lidocaine to prevent laryngospasm in children: a systematic review and meta-analysis.**

Mihara T, Uchimoto K, Morita S, Goto T.