Pediatric anesthesia update
Pediatric anesthesia update

Scott D. Cook-Sather, M.D.*

* Department of Anesthesiology and Critical Care Medicine, Children’s Hospital of Philadelphia, University of Pennsylvania. School of Medicine.

OVERVIEW

• Improving safety in pediatric anesthesia
  – POCA
  – Pediatric care environment
  – Evolving patterns
• Preparatory issues
  – Respiratory problems: OSA, RAD, UTI, ETS
  – Parental presence versus sedatives at induction
  – Awareness and general anesthesia
• Intraoperative management
  – Tracheal intubation
  – Newer drugs in pediatric practice
  – Regional techniques and ultrasound
• Postoperative considerations
  – Emergence delirium
  – Nausea and vomiting

POCA: PEDIATRIC PERIOPERATIVE CARDIAC ARREST REGISTRY

• 289 cardiac arrests in registry
• 150 (52%) related to anesthesia
• Incidence of 1.4 in 10,000 anesthetics
• 55% in infants <1 year of age
• 33% occurred in ASA PS 1-2 patients

Giaufre E et al. Anesth Analg 1996;83:904

THE SAFETY OF REGIONAL ANESTHESIA AND ANALGESIA IN CHILDREN

• 85,412 pediatric procedures in France
• 15,013 caudal blocks and 9,396 peripheral blocks
• Most common complications
  – dural penetration
  – intravascular injection
• Morbidity incidences
  – 0.7/1000 caudal
  – 0.0/1000 peripheral
  – 0.9/1000 overall
AMERICAN ACADEMY OF PEDIATRICS SECTION ON ANESTHESIOLOGY

- Evaluation and preparation of pediatric patients undergoing anesthesia
  

- Guidelines for the pediatric perioperative anesthesia environment
  
  *Hackel A. Pediatrics 1999;103:512.*

PEDIATRIC PERIOPERATIVE ENVIRONMENT

- Risk of anesthesia varies with age
- Facilities, equipment, staff training appropriate for infants and children
- Minimum case volumes to maintain clinical competence
- Special clinical privileges: pediatric anesthesia fellowship or equivalent

CHOP AMBULATORY SURGERY CRITERIA

- ASA PS 1-3; well-controlled IDDM & SSDz allowed for short, non-airway procedures
- Age: > 1 mo for FT infants, > 60 wk PCA for former pre-matures, > 3 years for T&A
- No apnea monitoring, no severe OSA
- Approved surgical procedure
- Oral postoperative analgesics sufficient

AMBULATORY SURGERY FACILITY CRITERIA

- ASA PS 1-2
- Age > 6 mo, > 4 yr for T&A
- BMI = Wt (kg)/BSA (m^2) < 50; Wt < 100 kg
- Normal airway, no significant OSA
- Short, well-defined procedures
- Oral postoperative analgesics sufficient

CARDIAC ARREST AFTER SUCCINYLCHOLINE

<table>
<thead>
<tr>
<th>Patients</th>
<th>Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receptor upregulation</td>
<td>64</td>
</tr>
<tr>
<td>Thermal trauma, muscle trauma, denervation, ICU milieu, Misc.</td>
<td>57</td>
</tr>
<tr>
<td>Rhabdomyolysis, Duchene, Becker, Myopathy, Unknown diagnosis</td>
<td>57</td>
</tr>
</tbody>
</table>

*Rivene SM. Anesth 2001;94:223*

RAPACURONIUM AND BRONCHOSPASM:
A RETROSPECTIVE COHORT STUDY

<table>
<thead>
<tr>
<th>Bronchospasm</th>
<th>None</th>
<th>RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 12</td>
<td>n = 275</td>
<td></td>
</tr>
<tr>
<td>ASA III-IV (%)</td>
<td>6 (50)</td>
<td>81 (30)</td>
</tr>
<tr>
<td>RAD Hx (%)</td>
<td>7 (53)</td>
<td>59 (22)</td>
</tr>
<tr>
<td>RSI (%)</td>
<td>11 (92)</td>
<td>106 (39)</td>
</tr>
</tbody>
</table>


RAPACURONIUM AND BRONCHOSPASM:
A CASE CONTROL STUDY

<table>
<thead>
<tr>
<th>Cases</th>
<th>Controls</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 23</td>
<td>n = 92</td>
<td></td>
</tr>
<tr>
<td>RAD (%)</td>
<td>11 (48)</td>
<td>20 (22)</td>
</tr>
<tr>
<td>Rapacuronium (%)</td>
<td>12 (52)</td>
<td>9 (10)</td>
</tr>
</tbody>
</table>


CARDIAC INDEX IN INFANTS: SEVOFLURANE VERSUS HALOTHANE

[Graph showing CI values for Halothane and Sevoflurane at Awake, MAC 1.0, and MAC 1.5]

*Wodey E. Anesthesiology 1997;87:795*

SEVOFLURANE OVER HALOTHANE

- Decreased OCR incidence during strabismus surgery in children
- Duration of preop fast correlates with ABP response to halothane in infants
  - Friesen RH. Anesth Analg 2002;95:1572
- Preservation of CI, HR, and less profound decreases in BP in infants/children with CHD
  - Rivenes SM. Anesth Analg 2001;94:223
  - Russell IA. Anesth Analg 2001;92:1152
RESPIRATORY ISSUES IN PEDIATRICS

- Obstructive sleep apnea
- Reactive airway disease
- Upper respiratory tract infection
- Secondhand tobacco smoke

DECREASED VENTILATORY RESPONSE TO CO₂ IN CHILDREN WITH OBSTRUCTIVE SLEEP APNEA

<table>
<thead>
<tr>
<th>T&amp;A + OSA</th>
<th>T&amp;A + OSA</th>
<th>Non AW - OSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>558</td>
<td>607</td>
<td>747</td>
</tr>
</tbody>
</table>

Slope: mL *min⁻¹ *mmHgETCO₂⁻¹
Corrected slope:
slope*m⁻² 538 ± 338† 828 ± 234 850 ± 380

†p < 0.05 for OSA vs none

SALBUTAMOL PREVENTS THE INCREASE OF RESPIRATORY RESISTANCE CAUSED BY TRACHEAL INTUBATION DURING SEVOFLURANE ANESTHESIA IN ASTHMATIC CHILDREN

PARENTAL ANXIETY AT INDUCTION

Subgroup       | N     | Parent VAS at reception | Induction |
---------------|-------|--------------------------|-----------|
Calm-treatment | 30    | 12.2 ± 11.0              | 31.2 ± 33.5|
Calm-control   | 33    | 19.2 ± 13.3              | 42.1 ± 35.1|
Anxious-treatment | 24  | 78.8 ± 16.6              | 81.7 ± 18.7|
Anxious-control | 25   | 72.5 ± 18.0              | 65.6 ± 29.3|

PARENTAL ANXIETY AT INDUCTION: CHILDREN'S MOOD RESPONSE

Subgroup       | N     | Child Ōs GMS at reception | Induction |
---------------|-------|---------------------------|-----------|
Calm-treatment | 30    | 1.7 ± 0.9                 | 3.4 ± 1.6  |
Calm-control   | 33    | 2.1 ± 1.4                 | 3.5 ± 1.8  |
Anxious-treatment | 24  | 1.7 ± 1.2                 | 4.5 ± 1.5* |
Anxious-control | 25   | 1.6 ± 0.8                 | 3.4 ± 1.5  |

* p < 0.05 A-T vs A-C at induction

LARYNGOSPASM AND THE URI

Risk variable                           | OR   | 95% CI      | P value |
----------------------------------------|------|-------------|---------|
Parent: active URI                      | 2.05 | 1.21-3.45   | 0.01    |
Age (continuous variable)               | 0.92 | 0.87-0.99   | 0.02    |
Procedure: Airway vs non                | 2.08 | 1.21-3.59   | 0.01    |
Midazolam vs none                       | 0.57 | 0.32-1.05   | 0.07    |
Inexperienced vs experienced supervisor | 1.69 | 1.04-2.7    | 0.03    |

PPIA: ELEMENTS THAT UPSET PARENTS

1) Separation from the child
2) Watching or feeling the child go limp
3) Seeing the child upset

Skolnick ET. Anesthesiology 1998;88:1144

Strauss SG. Anesth Analg 1999;89:328

Scalfaro P. Anesth Analg 2001;93:898


Schreiner MS. Anesthesiology 1996;85:475


Vessey JA. Can J Anaesth 1994;41:276

Revista Mexicana de Anestesiología
**PEDIATRIC PERIOPERATIVE ANXIETY: PPIA VS SEDATIVE PREMEDICATION**

![Graph](image)

*Kain ZN. Anesthesiology 1998;89:1147*

**SEDATIVE PREMEDICATION AND BEHAVIOR**

![Graph](image)

*Kain ZN. Anesthesiology 1999;90:758*

**TRACHEAL INTUBATION WITHOUT MUSCLE RELAXANT IN PEDIATRIC ANESTHESIA**

- **Rationale**
  - Muscle relaxant not needed for intubation or surgery
  - NDMRs last too long, prefer to avoid succinylcholine
  - Lack assistant to start IV, difficult venous access
  - Educational tool

  *Politis GD. Anesth Analg 1999;88:737*

- **Timing**
  - 140-190 sec under 8% sevoflurane
  - Ablation of SV associated with better conditions

  *Politis GD. Anesth Analg 2002;95:615*

**CUFFED VERSUS UNCUFFED TRACHEAL TUBES IN PEDIATRIC ANESTHESIA**

<table>
<thead>
<tr>
<th></th>
<th>Cuffed N = 251</th>
<th>Uncuffed N = 237</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>3.3 ± 2.4</td>
<td>2.9 ± 2.2</td>
<td>NS</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>15.4 ± 7.4</td>
<td>14.3 ± 7.7</td>
<td>NS</td>
</tr>
<tr>
<td>Intubation duration (min)</td>
<td>55</td>
<td>60</td>
<td>NS</td>
</tr>
<tr>
<td>Pts needing TT change</td>
<td>3 (1.2%)</td>
<td>54 (23%)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Pts needing &gt; 2 lpm FGF</td>
<td>3 (1.2%)</td>
<td>26 (11%)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Pts with croup sx</td>
<td>6 (2.4%)</td>
<td>7 (1.3%)</td>
<td>NS</td>
</tr>
<tr>
<td>Treated</td>
<td>3 (1.2%)</td>
<td>3 (1.3%)</td>
<td>NS</td>
</tr>
<tr>
<td>Admitted</td>
<td>1 (0.4%)</td>
<td>1 (0.4%)</td>
<td>NS</td>
</tr>
</tbody>
</table>

*Khine HH. Anesthesiology 1997;86:627*

**REMIFENTANYL COMPARED TO ALFENTANYL, ISOFLURANE, OR PROPFOFOL FOR PEDIATRIC STRABISMUS SURGERY**

- No difference in times to tracheal extubation, purposeful movement, PACU or hospital DC
- Remifentanil group: higher PACU pain scores
- Alfentanil group had greater incidences of decreased SpO2 and need for naloxone
- No difference in incidences of emesis
- Hemodynamic profiles similar

*Davis PJ. Anesth Analg 1997;84:982*

**EPINEPHRINE TEST DOSING IN CHILDREN DURING SEVOFLURANE VERSUS HALOTHANE ANESTHESIA**

![Graph](image)

*Kozek-Langenecker SA. Anesth Analg 2000;90:579*
**ROPIVACAINE IN PEDIATRIC CAUDAL BLOCKS**

<table>
<thead>
<tr>
<th></th>
<th>Bupivacaine 0.25%</th>
<th>Ropivacaine 0.25%</th>
<th>Ropivacaine 0.5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>17</td>
<td>18</td>
<td>21</td>
</tr>
<tr>
<td>Analgesia duration</td>
<td>220</td>
<td>208</td>
<td>1,440</td>
</tr>
<tr>
<td>med. &amp; range (min) (100-390)</td>
<td>(175-340)</td>
<td>(335-1,440)*</td>
<td></td>
</tr>
<tr>
<td>Stand (min)</td>
<td>253 ± 39</td>
<td>248 ± 30</td>
<td>362 ± 42*</td>
</tr>
<tr>
<td>Void (min)</td>
<td>248 ± 75</td>
<td>243 ± 30</td>
<td>291 ± 75***</td>
</tr>
</tbody>
</table>

* p < 0.0001 R0.5 vs other groups; ***p < 0.05 R0.5 vs other groups

Koening H. Anesthesiology 1999;90:1339

**PEDIATRIC EPIDURAL ADJUVANTS**

- Ketamine
  - Koening H. Anesth 2000;93:976

- Clonidine
  - De Negri P. Anesth Analg 2001;93:71
  - Hager H. Anesth Analg 2002;94:1169
  - Fellmann C. Paed Anaesth 2002;12:637

- Neostigmine
  - Abdulatif M. Anesth Analg 2002;95:1215

**DELIRIUM AFTER SEVOFLURANE ANAESTHESIA**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Preschool Halo</th>
<th>Sevo</th>
<th>School Halo</th>
<th>Sevo</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>30</td>
<td>30</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>3 ± 1</td>
<td>3 ± 1</td>
<td>8 ± 1</td>
<td>9 ± 1</td>
</tr>
<tr>
<td>Wt (kg)</td>
<td>18.9 ± 3.4</td>
<td>18.6 ± 3.3</td>
<td>29.5 ± 3.7</td>
<td>28.3 ± 2.8</td>
</tr>
<tr>
<td>Surg (min)</td>
<td>29 ± 4</td>
<td>28 ± 8</td>
<td>41 ± 6</td>
<td>43 ± 6</td>
</tr>
<tr>
<td>Ext (min)</td>
<td>13 ± 3</td>
<td>8 ± 2*</td>
<td>12 ± 2</td>
<td>8 ± 3*</td>
</tr>
<tr>
<td>Emg (min)</td>
<td>15 ± 3</td>
<td>12 ± 3</td>
<td>15 ± 4</td>
<td>12 ± 4</td>
</tr>
<tr>
<td>Delirium</td>
<td>3/30</td>
<td>12/30</td>
<td>4/26</td>
<td>3/26</td>
</tr>
<tr>
<td>Incidence</td>
<td>(10%)</td>
<td>(40%)*</td>
<td>(15.4%)</td>
<td>(11.5%)</td>
</tr>
</tbody>
</table>

* p < 0.0001, p < 0.01, p < 0.05, ***p < 0.01, 0.03

Aono J. Anesthesiology 1997;87:1298

**RECOVERY CHARACTERISTICS: HALOTHANE VERSUS SEVOFLURANE**

<table>
<thead>
<tr>
<th>Group</th>
<th>Agitation PACU pain</th>
<th>PACU emesis</th>
<th>24 hr emesis</th>
<th>Home pain med</th>
</tr>
</thead>
<tbody>
<tr>
<td>H/K</td>
<td>12*</td>
<td>2</td>
<td>10</td>
<td>48</td>
</tr>
<tr>
<td>H/P</td>
<td>42</td>
<td>13</td>
<td>17</td>
<td>61</td>
</tr>
<tr>
<td>S/K</td>
<td>14***</td>
<td>6</td>
<td>12</td>
<td>65</td>
</tr>
<tr>
<td>S/P</td>
<td>38</td>
<td>6</td>
<td>11</td>
<td>61</td>
</tr>
</tbody>
</table>

Values in %; * p < 0.05 vs H/P group; ***p < 0.05 vs S/P group

Davis PJ. Anesth Analg 1999;88:34

**NASAL FENTANYL & RECOVERY CHARACTERISTICS AFTER BILATERAL MYRINGOTOMY/Tube PLACEMENT**

<table>
<thead>
<tr>
<th>Group</th>
<th>CHEOPS max</th>
<th>Agitation score of 4</th>
<th>PACU VAS</th>
<th>Emesis hospital</th>
<th>Emesis home</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP</td>
<td>8.6 ± 1.8</td>
<td>2.7 ± 1.0</td>
<td>16/69 (23%)</td>
<td>53 ± 36</td>
<td>13%</td>
</tr>
<tr>
<td>SF</td>
<td>7.2 ± 1.6*</td>
<td>1.8 ± 0.0*</td>
<td>1/64 (2%)</td>
<td>82 ± 25*</td>
<td>18%</td>
</tr>
<tr>
<td>HP</td>
<td>8.4 ± 2.0</td>
<td>2.3 ± 1.0</td>
<td>7/63 (11%)</td>
<td>62 ± 37</td>
<td>19%</td>
</tr>
<tr>
<td>HF</td>
<td>6.8 ± 1.7*</td>
<td>1.5 ± 0.0*</td>
<td>1/67 (1%)</td>
<td>85 ± 25*</td>
<td>26%</td>
</tr>
</tbody>
</table>

* p < 0.05 when compared to both placebo groups; ***p < 0.05 H vs S.

Galinkin JL. SPA Abstract 2000

**SYSTEMIC POSTOPERATIVE ANALGESIA**

- Acetaminophen (20-40 mg/kg PR)
  - Birmingham PK. Anesthesiology 1997;87:244

- Ketorolac (0.5-1.0 mg/kg IV)
  - Romsing J. Anaesthesia 1997;52:673

- Morphine sulfate (0.05-0.1 mg/kg IV)
  - Weinstein MS. Anesthesiology 1994;81:572

- Oxycodone (0.05-0.15 mg/kg PO)

- Tramadol (50 mg tablets, un-scored)

**SINGLE-DOSE ONDANSETRON FOR PEDIATRIC AMBULATORY SURGERY: PREVENTION OF POSTOPERATIVE EMETIC EPISODES**

<table>
<thead>
<tr>
<th>Placebo</th>
<th>Ondansetron</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2 h</td>
<td>153/215 (71%)</td>
</tr>
<tr>
<td>0-24 h</td>
<td>86/215 (40%)</td>
</tr>
</tbody>
</table>

* p < 0.001 ondansetron vs placebo

Patel RI. Anesth Analg 1997;85:538

**ONDANSETRON ± DEXAMETHASONE: EFFECT ON VOMITING AFTER STRABISMUS SURGERY**

<table>
<thead>
<tr>
<th>Emetic episode location</th>
<th>Ondansetron 50 mg/kg + dexamethasone 150 mg/kg</th>
<th>Ondansetron 150 mg/kg</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-hospital</td>
<td>1%</td>
<td>7%</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>At home day of surgery</td>
<td>7%</td>
<td>14%</td>
<td>NS</td>
</tr>
<tr>
<td>Next day</td>
<td>5%</td>
<td>15%</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Overall</td>
<td>9%</td>
<td>28%</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

Splinter WM. Anesthesiology 1998;88:72