YOUR CHILD IS HAVING AN OPERATION:
CURRENT MORBIDITY IN PEDIATRIC ANESTHESIA

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MORBIDITY AND MORTALITY IN ANESTHETIZED CHILDREN: OVERVIEW (I)

- a concern since Hannah Greener in 1848
- what are reasonable endpoints?
- identification of risk factors & risk reduction strategies
MORBIDITY AND MORTALITY IN ANESTHETIZED CHILDREN: OVERVIEW (II)

basic mechanisms for anesthetic-related mishaps

• cardiorespiratory depressant effects of anesthetics
• technical airway problems, including aspiration
• miscellaneous drug issues / errors
• surgical misadventure (with inadequate resuscitation)
What is the risk of a *serious* complication to a *healthy* child undergoing a routine, peripheral procedure?
OLDER OUTCOME STUDIES IN PEDIATRIC SURGICAL PATIENTS: MORTALITY

DEATHS PER 10,000

- BALT ANES STUDY 1963
- CHMC 1966
- CHMC 1978
- SALT LAKE 1975
- CHOP 1979

PEDiatric
ADULT
IMPROVED SAFETY FOR ANESTHETIZED CHILDREN OVER THE PAST QUARTER-CENTURY

- improved (standardized) cardiorespiratory monitoring
- modern anesthetic agents / techniques / machines
- high-risk pts → perioperative specialty management
- JCAHO driven quality assurance programs
- ASA practice guidelines
- specialty organizations devoted solely to safety
### EVOLVING NATURE OF SERIOUS COMPLICATIONS IN PEDIATRIC ANESTHESIA: CLOSED CLAIMS (CC)

<table>
<thead>
<tr>
<th>Event</th>
<th>1970's</th>
<th>1980's</th>
<th>1990's</th>
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<tbody>
<tr>
<td>all respiratory</td>
<td>51%</td>
<td>41%</td>
<td>23%</td>
</tr>
<tr>
<td>↓ ventilation</td>
<td>26%</td>
<td>14%</td>
<td>3%</td>
</tr>
<tr>
<td>cardiovascular</td>
<td>19%</td>
<td>18%</td>
<td>26%</td>
</tr>
<tr>
<td>equipment</td>
<td>9%</td>
<td>11%</td>
<td>15%</td>
</tr>
<tr>
<td>death/brain damage</td>
<td>78%</td>
<td>75%</td>
<td>62%</td>
</tr>
<tr>
<td>monitoring preventive?</td>
<td>63%</td>
<td>41%</td>
<td>16%</td>
</tr>
</tbody>
</table>

CLOSED CLAIMS:LESSONS LEARNED

• Morray compared pediatric and adult CC; pediatrics →
  • ↑ median payment; ↑ respiratory etiology; ↑ likelihood death as injury;
    ↑↑ payment (11X higher) if “better monitoring” deemed preventive

• Jiminez analyzed trends, reviewed CC from the 1990’s in detail
  • ↑ death/brain damage in ASA III-V, age < 3 (trend to younger age)
  • CV events surpassed respiratory as dominant cause of liability
  • resp events trended towards ↓ preventable, such as aspiration
  • specific preventable causes injury include prompt Rx of blood loss in infants; recognition of bleeding after T & A; appropriate med doses

1 Anesthesiology 1993;78:461
2 Anesth Analg 2007;104:147
OLDER OUTCOME STUDIES IN PEDIATRIC SURGICAL PATIENTS: CARDIAC ARREST

- Beecher & Todd: ↑ risk children compared to adults (1954)
- Closed Claims (1961): respiratory events predominant
- Keenan (1983-90): arrest 3-fold more likely < 12 years
  - ALL (1.2) < PEDI (2.9) << INFANT (9.2)
- Cohen (1990): risk stratified to first month of life
ANESTHESIA-RELATED CARDIAC ARREST IN CHILDREN: INITIAL FINDINGS OF THE PEDIATRIC PERIOPERATIVE CARDIAC ARREST REGISTRY (POCA)

- 1994: anonymous voluntary data bank
  - 63 institutions in US and Canada
  - 75% university / 40% children’s hospital
- 289 cases (1994-1997) reviewed
- cardiac arrest → chest compressions and/or death
- 150 deemed anesthetic related (1.4:10,000)

POCA Registry: Causes of Cardiac Arrest (2000)

- Cardiovascular: 32%
- Medication: 36%
- Respiratory: 20%
- Equipment: 7%
- Multiple: 3%
- Other: 2%
POCA REGISTRY: SUMMARY OF INITIAL FINDINGS (1994-1997)

• surprising finding: medication-related > respiratory
  • better monitoring (SPO₂ and ETCO₂) compared to “historical” studies where respiratory more common diagnosis

• 33% of anes-related arrests in ASA I-II; 64% of these are medication related, predominantly halothane (↑ infants)
  • infants → 55% of anesthesia-related arrests; low mortality

• sicker patients less likely to be anes-related, higher likelihood cardiovascular etiology, higher mortality

POCA REGISTRY AND ASA STATUS (2000)

Mortality 26% ↑ ASA III-V, emergency

COMPLICATIONS RELATED TO ANAESTHESIA IN INFANTS AND CHILDREN: PROSPECTIVE SURVEY OF 40,240 ANESTHETICS

**Tiret L. Br J Anaesth 61:263;1988**
COMPlications RELATED TO ANAESTHESIA IN INFANTS AND CHILDREN: PROSPECTIVE SURVEY OF 40,240 ANESTHETICS

Complications per 1000

Tiret L. Br J Anaesth 61:263;1988
ANESTHESIA-RELATED CARDIAC ARREST IN CHILDREN: UPDATE FROM THE PEDIATRIC PERIOPERATIVE CARDIAC ARREST REGISTRY (POCA)

- 193 anes-related cases 1998 - 2004
- cardiovascular ↑; medication ↓ (sevo effect)
- infants account for 38% arrests (↓ from 55%)
- mortality (28%) → ASA III-V; emergency (ND)

Bhananker et al. Anest Analg 2007;105:344
POCA REGISTRY: CAUSES OF CARDIAC ARREST (2007)

- Cardiovascular: 41%
- Medication: 18%
- Respiratory: 27%
- Equipment: 5%
- Other: 7%
- Multiple: 2%

Bhananker et al. *Anest Analg* 2007;105:344
• cardiovascular arrests most commonly attributed to inadequate resuscitation; hyper-K\(^+\) from rbc transfusion
  • preventability in these cases is often discretionary, but consideration to better lines and monitoring emphasized
  • rapid transfusion stored and/or irradiated blood ↑ K risk
• half equipment-related due to CVL insertion (w/out US)
• most common respiratory etiology was laryngospasm
ANESTHESIA-RELATED CARDIAC ARREST IN CHILDREN WITH HD: DATA FROM POCA REGISTRY

- 373 anes-related arrests 1994-2005 / 34% with heart disease
- 24/127 single ventricle / highest mortality: AS, cardiomyopathy
- 54% occurred in general OR’s (26% card OR / 17% cath lab)

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<thead>
<tr>
<th></th>
<th>With HD (127)</th>
<th>Without HD (245)</th>
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<tbody>
<tr>
<td>ASA III - IV</td>
<td>92%</td>
<td>62%</td>
</tr>
<tr>
<td>Emergency case</td>
<td>14%</td>
<td>24%</td>
</tr>
<tr>
<td>CV etiology</td>
<td>50%</td>
<td>38%</td>
</tr>
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PERIOPERATIVE CARDIAC ARRESTS (POCA) IN CHILDREN AT TERTIARY CENTER 1988-2005

• 92,881 anesthetics Mayo Clinic; 5% repair of CHD
• poca 2.9:10,000 non cardiac / 127:10,000 cardiac
  • incidence of neonates with cardiac surgery 435:10,000
  • 88% of children who had poca had some form of CHD
• incidence of *anesthesia-related* poca 0.65:10,000
  • unlike POCA registry, excludes poca related to hemorrhage
  • unlike POCA registry, does not depend on self-reporting

Flick et al. *Anesthesiology* 2007;106:226
CRITICAL INCIDENTS (CI) IN PAEDIATRIC ANAESTHESIA: AUDIT OF 10,000 ANESTHETICS IN SINGAPORE

- 1997-1999; full spectrum, including complex CHD repair
- CI: “affected or could have affected patient safety” (297)
- 80% occurred in ASA I-II but 4x likely in ASA III-IV patients
- elective vs. emergency equally likely to have CI (2.7-2.9%)
- infants 4X likely to have a CI, especially with lower weight
- most CI (80%) occurred during maintenance phase
- respiratory (77%) most common (laryngospasm 36% total)

Tay. Paediatric Anaesthesia 2001;11:711
30 MONTH MORBIDITY IN A PEDIATRIC TEACHING HOSPITAL: 24,165 ANAESTHETICS

- 724 adverse intraoperative events (3.1%)
  - respiratory most common (53%) - ↑ infants, ENT, ETT
  - 19 episodes aspiration → 2 had clinical significance
  - cardiac 12.5% of events with risk ASA III-V
  - 8 cardiac arrests (2 anesthesia related)
- no anesthesia related mortality

Murat. Pediatric Anesthesia 2004;14:158
PERIOPERATIVE PULMONARY ASPIRATION IN INFANTS AND CHILDREN (MAYO CLINIC)

• prospective 63,180 pediatric GA 1985-1997
• 24 cases pulmonary aspiration (3.8:10,000)
• emergency surgery (26.8) >> elective (2.2)
• 9/24 (1.2) had symptoms - all by 2 hours
  • 3 required mechanical ventilation
• no mortality or long-term sequelae

Warner MA. Anesthesiology 90:66,1999
INCIDENCE AND RISK FACTORS OF PERIOPERATIVE RESPIRATORY ADVERSE EVENTS (PRAE) IN CHILDREN UNDERGOING ELECTIVE SURGERY

• prospective Swiss study 755 children 1-14 (exclude URI)
• overall incidence 21% in OR and 13% in PACU
  • most common occurrence was recurrent cough (OR & PACU)
  • laryngospasm (3.9% incidence) was confined to OR
• risk ↑: younger age, ENT surgery, lack of pediatric specialist
• tracheal intubation less likely to result in PRAE if use of NMB
• most PRAE easily managed without sequelae
DOES IT MATTER WHO ADMINISTERS THE ANESTHETIC?

• **Frequency of Anesthetic Cardiac Arrests in Infants: Effect of Pediatric Anesthesiologists**¹
  • P: 0 arrests in 2310 cases / NP: 4 arrests in 2033 cases (although none anesthesia-related)

• **Bradycardia During Anesthesia in Infants**²
  • 2.12% (NP) Vs. 0.82% (P) occurrence rate

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² Keenan RL. *Anesthesiology* 80:976, 1994
COMPLICATIONS OF PEDIATRIC ANESTHESIA AND VOLUME OF PEDIATRIC ANESTHETICS


complications per 1000

volume pediatric anesthetics

EFFECTING MORBIDITY IN ANESTHETIZED CHILDREN

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"A MAJORITY OF HOSPITALS CARE FOR A FEW CHILDREN, AND MOST CHILDREN ARE CARED FOR IN A FEW HOSPITALS"

- retrospective - 1 year northern California
- children < 5 years 162/205 institutions
- total 14,435 "procedure days"
- 59% institutions < 20 procedure days

PERIOPERATIVE RISK IN CHILDREN: NEED ALL CHILDREN BE ANESTHETIZED BY PEDIATRIC ANESTHESIOLOGISTS?

**NO**
- manpower issues
- definition not clear
- benefit uncertain for “routine” cases

**YES**
- there is no “routine” case
- outcome improved in higher risk situations
- more efficient
- parents more at ease
NATIONAL SOCIETIES ADVOCATE FOR SPECIALIZED CARE OF ANESTHETIZED CHILDREN

• importance of the perioperative environment as a whole (specialists, labs, ICU, equipment etc)

• AAP section on Anesthesiology has published guidelines to “reduce risk adverse events” ¹

• credentialing for pediatric specialists advocated for by Society for Pediatric Anesthesia

¹ Hackel et al. Pediatrics 1999;103:512
## EFFECTING MORBIDITY IN ANESTHETIZED CHILDREN

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PREPARATION FOR SURGERY: MEDICAL

• history and physical examination
  • ASA status, meds, drug allergies, prior anesthetics
  • focused physical exam, including airway assessment

• routine labs no longer mandated
  • CBC, coags, C-spine (TRI 21) all discretionary

• preoperative fasting
  • liberalized clear fluids encouraged
“CLEAR FOR SURGERY”: CURRENT ATTITUDES AND PRACTICES OF PEDIATRICIANS

- poll 2500 AAP members
- 7.6% had “training” in preop eval
- 17% felt expertise appreciated
- most had little contact with OR team
- variable (often incorrect) response to clinical management problems
- over half felt that they should “almost always” be consulted

PREPARATION FOR SURGERY: POTENTIAL ROLE OF THE PEDIATRICIAN

• elucidate medical problems
• optimize child’s condition
• consultation when appropriate
  • need for better communication and/or training regarding perioperative issues
• emotional support for child and family
PREPARATION FOR SURGERY: PSYCHOLOGICAL *

- hidden morbidity of pediatric anesthesia → behavioral stress with (relatively common) post-op regressive Δ’s
- preoperative education crucial to reduce child and parental anxiety, promote coping skills
- induction plan to alleviate behavioral distress might include premedication, parental presence and flexibility in mode of induction *

* covered more fully in PowerPoint presentations → induction techniques and behavioral stress
COMMUNICATING RISK TO PARENTS

- serious complications in a healthy child are very rare
- details about safety monitoring that prevent or allow early and effective Rx of untoward responses, such as “allergy”*
- anticipatory guidance “common” side effects, especially if might witness in OR/PACU (distress, vomiting, agitation)
- unresolved risk of developmental neurotoxicity *→ only if initiated by parents (but then, at length, if need be)

* these topics covered in separate PowerPoint lectures
• attention to VS, airway, oxygenation a priority
• PACU presence “most important” to surveyed parents
  • parents in PACU may ↓ behavior Δ’s even if little apparent impact on agitation, which remains a vexing issue
• common side effects appear to have little impact on postoperative behavior changes (but deserve Rx)
  • nausea & vomiting, pain, shivering etc..
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CURRENT NATIONAL SAFETY INITIATIVES IN PEDIATRIC ANESTHESIA

• Society for Pediatric Anesthesia initiatives
  • Wake Up Safe (WUS) (with APSF)
    o 15 institutions self-reporting adverse events→QI initiatives
    o wrong-site surgery, syringe swap, medication errors
  • Pediatric Regional Anesthesia Network
    • ongoing QI initiative assessing risk w/regional anesthesia

• Smarttots – FDA and IARS partnership *
  • anesthetic developmental neurotoxicity

* covered in a separate PowerPoint presentation
ANESTHETIZING CHILDREN: RATIONAL STRATEGY FOR RISK REDUCTION

• modern perioperative safety monitoring
• anesthetic techniques that ameliorate risks
  • fiscally responsible use of “safer” anesthetic agents
  • attention - hidden morbidity of pediatric anesthesia
• some criteria for who does case
• ongoing quality assurance processes