PREOPERATIVE EVALUATION OF THE PEDIATRIC PATIENT

Aru Reddy, M.B.,B.S
Assistant Professor
Department of Anesthesiology
University of Kentucky
THE OBJECTIVES

- Discuss Preoperative Evaluation of the Pediatric Surgical Patient
- Discuss the Complications of Anesthesia in children with Upper Respiratory Infections
- Discuss the Safety of anesthetic agents in the pediatric population
Is This Necessary?

- Helps streamline the day of surgery
- Helps eliminate the preventable causes for cancellation of surgery
- Helps to optimize medical management
- Helps familiarize child and parent to the hospital
- Reduce the percentage of cancellations and OR delays
- Enhance the utilization of OR time
Preoperative Evaluation

Objectives

- Obtaining a medical history
- Performing a physical examination
- Review of systems
- Family history
- NPO status
- Appropriate laboratory tests
## Preoperative Evaluation

### Maternal Health and Children

<table>
<thead>
<tr>
<th>Maternal Health</th>
<th>Implications to Children</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes Mellitus</td>
<td>Neonatal hypoglycemia, macrosomia, respiratory distress, cardiac anomalies, vertebral anomalies</td>
</tr>
<tr>
<td>Pre eclampsia</td>
<td>IUGR, preterm delivery, high incidence of meconium at birth</td>
</tr>
<tr>
<td>Alcohol Abuse</td>
<td>Mental retardation, congenital heart disease, cleft palate, skeletal anomalies</td>
</tr>
</tbody>
</table>
Preoperative Evaluation
An Outline

- Birth History: Full term or pre term baby
- Determine post conceptual age
- History of previous hospitalizations and surgical procedures
- Concurrent medical illnesses
- History of recent upper respiratory infection
- Allergies
Birth History

The Former Preterm Infant

Problems

- Pulmonary: lung immaturity, bronchopulmonary dysplasia, elevated pulmonary vascular resistance
- Airway: tracheomalacia, subglottic stenosis
- Multiple medications
- Apnea and bradycardia
Postoperative Apnea and Bradycardia

Factors affecting include:

- Prematurity
- Post conceptual age less than 60 weeks
- Anemia
- History of Apnea and bradycardia, on home apnea and bradycardia monitor
Preoperative evaluation
Physical Examination

Here, importance is given to the evaluation of:

- Airway
- Dentition
- Heart murmurs
- Neurological status and deficits
Preoperative evaluation
Physical Examination

Here, importance is given to the evaluation of:-

- Airway
- Dentition
- Heart murmurs
- Neurological status and deficits
Preoperative evaluation

Miscellaneous workups

- Laboratory studies
- Radiographs
- CT scans/MRI
- Cardiac/pulmonary/hematology consults where necessary
Preoperative Evaluation
Family History

Aspects of Family History with increased anesthetic risks include:

- Unusual reactions to surgery or anesthesia
- Malignant Hyperthermia
- Sickle cell disease
- Thalassemia
- Atypical Pseudo cholinesterase
- Neuromuscular disorders
Preoperative Evaluation
NPO Guidelines

- Clear liquids  2 hours
- Breast milk   4 hours
- Infant formula 6 hours
- Nonhuman Milk 6 hours
- Solids        8 hours
“My Child Has A Running Nose”
URIIs and Anesthesia
Upper Respiratory Infections

URIs affect the apparatus of the upper airways
Frequently occurring URIs include:

- The Common Cold
- Pharyngitis
- Laryngitis
- Croup
- Epiglottitis
- Sinusitis
### “My Child Has A Running Nose”
**URIs and Anesthesia**

<table>
<thead>
<tr>
<th>URI</th>
<th>Causative Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Cold</td>
<td>Rhino, Corona, RSV, Para influenza, Influenza, Adenoviruses</td>
</tr>
</tbody>
</table>
Bacterial: Streptococcus |
| Laryngitis | Viral: Influenza, Para influenza, Rhino, Adeno, RSV  
Bacterial: Streptococcus  
Fungal: Candida Albicans |
“My Child Has A Running Nose”
URIs and Anesthesia

<table>
<thead>
<tr>
<th>URI</th>
<th>Causative Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Croup</td>
<td>Para influenza viruses type 1, 2, 3; Influenza and RSV</td>
</tr>
<tr>
<td>Epiglottitis</td>
<td>H. Influenza type B</td>
</tr>
<tr>
<td>Sinusitis</td>
<td>S. pneumonia, H influenza, S. aureus, S. pyogenes, fungal infections</td>
</tr>
</tbody>
</table>
Symptoms and signs of URI

- Rhinorrhea, nasal congestion
- Cough with or without expectoration
- Sneezing
- Malaise and decreased activity
- Sore Throat
- Head ache
- Fever
URIs and Anesthesia

- One URI can progress to another type
- Signs and symptoms are similar
- Difficult to distinguish these infections from one another
- Most children develop 6-10 “colds” a year
- Less frequent after age 6
URI and Anesthesia

Differential diagnosis of URI:

- Vasomotor rhinitis
- Allergic rhinitis
Risk factors for Perioperative Complications

- Copious secretions
- ETT in children <3yrs
- History of prematurity
- Nasal congestion
- Parental smoking
- History of Reactive airway disease
- Surgery involving the airway
- Productive Sputum

URI and Pulmonary Function

Pulmonary Function following URI:-

- Reduced FEV1
- Decreased mucociliary clearance
- Increased airway reactivity
- Increased closing volumes
- Compromised diffusion capacity
- Increased intrapulmonary shunting and worsening ventilation perfusion mismatch
Causes for airway hyper-reactivity

- Respiratory epithelial cell damage
- Activation of the sub epithelial receptors
- Release of Mast cells, substance P
- Bronchial smooth muscle stimulation
Perioperative adverse events

- Laryngospasm
- Airway obstruction
- Croup
- Hypoxemia
- Bronchospasm
- Stridor
- Breath holding
Laryngospasm and URI
Schreiner, Anesthesiology vol. 85(3), Sept. ‘96

- Laryngospasm is 2 times more common
- More likely to be in the younger age group
- More likely to be scheduled for airway surgery
- Anesthesia supervised by a less experienced anesthesiologist
Cardiac surgery and URI
Malviya et al (Anesthesiology 98, March ’03)

Intraoperatively:
- Increased airway complications

Postoperatively an increased incidence of:
- Respiratory complications
- Bacterial infections
- Atelectasis
- Extended stay in the ICU
My Child has a LITTLE cough
Should surgery be cancelled?
Figure 1. Suggested algorithm for the assessment and anesthetic management of the child with an upper respiratory infection.
Child with symptoms of URI
Child with symptoms of URI

Proceed  Yes  Surgery Urgent  No
Child with symptoms of URI

Proceed

Yes

Surgery Urgent

No

Severe Symptoms

Yes

Cancel surgery

No
Child with symptoms of URI

- **Yes**
  - Surgery Urgent
    - **No**
      - Severe Symptoms
        - **Yes**
          - Cancel surgery
        - **No**
          - Proceed
    - **Yes**
      - Proceed
- **No**
  - Proceed
In Conclusion---
Upper respiratory infection and anesthesia

What seems like a little cough to me may not mean the same to my colleagues. And, when this cough is associated with other signs of infection like fever, sputum which is greenish-yellow, wheezes, lethargy, ------ it most definitely is not a Little Cough.
Is it safe for my baby to have anesthesia?
Pain And Its Effects In The Human Neonate And Fetus


- Cutaneous Sensory Perception
- Myelination
  - Nerve Tracts in the Spinal Cord and Brain Stem
  - Internal Capsule
  - Corona Radiata
- Cortical Maturation
  - Neuronal Migration
  - Dendritic Arborization
  - Synaptogenesis with Thalamocortical Fibres
- EEG Patterns
  - Intermittent
  - Pattern I EEG
  - Synchronous
  - Pattern 2 EEG
  - Pattern 3 EEG
  - Pattern 4 EEG
  - Cortical Evoked Potentials

Weeks of Gestation
Randomised Trial Of Fentanyl Anaesthesia In Preterm Babies Undergoing Surgery
Anand, Sippell and Aynsley-Green Lancet 1987

- Premature neonates for ligation of PDA
- Randomized
  - Nitrous oxide and curare with fentanyl (10 μg/kg)
  - Nitrous oxide and curare
- No fentanyl group
  - Metabolic acidosis
  - Hyperglycemia
  - Post operative
    - Ventilator requirements
    - Bradycardia
    - Intraventricular hemorrhages
    - hypotension
What We Think That We Know Now

- Based on Anand’s early work, Infants have a profound physiological response to surgical trauma
- This response has an impact on outcome
- Poor outcomes can be reduced by the judicious use of anesthetics
- Bottom line: Infants have pain
Commonly used Anesthetic Agents

<table>
<thead>
<tr>
<th>Anesthetic agent</th>
<th>NMDA antagonist</th>
<th>GABA-mimetic</th>
<th>μ-Opioid agonist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volatile anesthetics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Halothane</td>
<td>−/0</td>
<td>+++</td>
<td>0</td>
</tr>
<tr>
<td>Isoflurane</td>
<td>−/0</td>
<td>+++</td>
<td>0</td>
</tr>
<tr>
<td>Desflurane</td>
<td>−/0</td>
<td>+++</td>
<td>0</td>
</tr>
<tr>
<td>Enflurane</td>
<td>−/0</td>
<td>+++</td>
<td>0</td>
</tr>
<tr>
<td>Sevoflurane</td>
<td>−/0</td>
<td>+++</td>
<td>0</td>
</tr>
<tr>
<td>Injectable anesthetics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propofol</td>
<td>0</td>
<td>+++</td>
<td>0</td>
</tr>
<tr>
<td>Barbiturates</td>
<td>0</td>
<td>+++</td>
<td>0</td>
</tr>
<tr>
<td>Etomidate</td>
<td>0</td>
<td>+++</td>
<td>0</td>
</tr>
<tr>
<td>Benzodiazepines</td>
<td>0</td>
<td>+++</td>
<td>0</td>
</tr>
<tr>
<td>Ketamine</td>
<td>−/0</td>
<td>−/0</td>
<td>0</td>
</tr>
<tr>
<td>Medical gases</td>
<td>−/0</td>
<td>−/0</td>
<td>0</td>
</tr>
<tr>
<td>Nitrous oxide</td>
<td>−/0</td>
<td>−/0</td>
<td>0</td>
</tr>
<tr>
<td>Opioid analgesics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morphine</td>
<td>−/0</td>
<td>0</td>
<td>+++</td>
</tr>
<tr>
<td>Methadone</td>
<td>−/0</td>
<td>0</td>
<td>+++</td>
</tr>
<tr>
<td>Meperidine</td>
<td>−/0</td>
<td>0</td>
<td>+++</td>
</tr>
<tr>
<td>Fentanyl</td>
<td>−/0</td>
<td>0</td>
<td>+++</td>
</tr>
<tr>
<td>Other sedative hypnotics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chloral hydrate</td>
<td>−/0</td>
<td>+++</td>
<td>0</td>
</tr>
<tr>
<td>Trichloroethanol</td>
<td>−/0</td>
<td>+++</td>
<td>0</td>
</tr>
<tr>
<td>Ethanol</td>
<td>−/0</td>
<td>+++</td>
<td>0</td>
</tr>
</tbody>
</table>

Key: (−−−−), strong antagonism within the clinically relevant range based on available in vitro data; (+++), strong potentiation within the clinically relevant range based on available in vitro data; (−/0), little antagonism within the clinically relevant range based on available in vitro data; (+/0), little potentiation within the clinically relevant range based on available in vitro data; (0), no compelling data to support activity at this site within the clinically relevant range.

NMDA = N-methyl-D-aspartate; GABA = γ-aminobutyric acid.

*Receptor activity as noted in the table does not imply mechanism of action; rather it indicates potential to neurological injury. The table was adapted, in large part, from ref 9 and Hurlin (9) and by Dilger (10); for more detail, please refer these review articles.
Blockade of NMDA Receptors and Apoptotic Neurodegeneration in the Developing Brain

Chrysanthy Ikonomidou,* Friederike Bosch, Michael Miksa, Petra Bittigau, Jessica Vöckler, Krikor Dikranian, Tanya I. Tenkova, Vanya Stefovska, Lechoslaw Turski, John W. Olney

• Programmed cell death occurs during normal development
• Blockade of NMDA glutamate receptors produce widespread apoptotic neurodegeneration in developing rat brain
• Suggested that glutamate acting at NMDA receptors controls neuronal survival
• Question: Does this have relevance to human neurodevelopmental disorders?
Early Exposure to Common Anesthetic Agents Causes Widespread Neurodegeneration in the Developing Rat Brain and Persistent Learning Deficits

Jevtovic-Todorovic et al, J Neurosci, 2003

- Triple cocktail (P7 rat pups)
  - Midazolam
  - Isoflurane
  - Nitrous oxide

- Histological changes
  - neurodegeneration

- Functional changes
  - Memory impairments
  - Learning impairments
Of Mice and Men: Should We Extrapolate Rodent Experimental Data to the Care of Human Neonates?

* Children’s Hospital Boston and Harvard Medical School, Boston,
Human Babies are not Large Rat Pups!!

Problems with Rodent Experimental Paradigm

- Duration of exposure to drugs

7 rat days $\approx$ 27 human months

6 hour $\approx$ 1 month
Human Babies are not Large Rat Pups!!

Problems with Rodent Experimental Paradigm

- Duration of exposure to drugs
- Lack of precise physiological monitoring
Physiological Monitoring
Human Babies are not Large Rat Pups!!

Problems with Rodent Experimental Paradigm

- Duration of exposure to drugs
- Lack of precise physiological monitoring
  - End-organ perfusion
  - Varying anesthetic depth
    - MAC values
    - Target-controlled infusions
Human Babies are not Large Rat Pups!!

Problems with Rodent Experimental Paradigm

- Duration of exposure to drugs
- Lack of precise physiological monitoring
- Interspecies variation
Human Babies are not Large Rat Pups!!

Problems with Rodent Experimental Paradigm

- Duration of exposure to drugs
- Lack of precise physiological monitoring
- Interspecies variation
  - Dose-response
  - Drug metabolism
  - Peak susceptibility
Early Exposure to Anesthesia and Learning Disabilities in a Population-based Birth Cohort

Robert T. Wilder, M.D., Ph.D.,* Randall P. Flick, M.D., M.P.H.,† Juraj Sprung, M.D., Ph.D.,‡ Slavica K. Katusic, M.D.,§ William J. Barbaresi, M.D.,|| Christopher Mickelson, M.D.,# Stephen J. Gleich, M.D.,** Darrell R. Schroeder, M.S.,†† Amy L. Weaver, M.S.,††† David O. Warner, M.D.‡
Early exposure to Anesthesia and Learning Disabilities

- Population based birth cohort study
- Children born between 01/1976 - 2/1982
- Risk factor was exposure to general anesthesia <4yrs of age (total of 593)
- Tested for learning disabilities
- Higher incidence of LD
  1. in those exposed to 2 or more anesthetics
  2. in those receiving anesthesia >120mins.
Initiatives by the Pediatric Anesthesia Community

- Neonatal Drug Development Initiative Workshops
- Society for Pediatric Anesthesia
  - Awareness-educational programs
  - Registry and complications database
- American Society of Anesthesiology
  - Increased awareness
  - Funding investigators
- Multi-center Randomized Control Trial
GAS Study

- Multi-national, multi-center collaborative group
  - Andrew Davidson, Melbourne, Australia
  - Mary Ellen McCann, Boston, USA
  - Neil Morton, Glasgow, Scotland

- Randomized controlled equivalence trial
  - Inguinal hernia in infants
  - Spinal (bupivacaine) versus general (sevoflurane) anesthesia
  - Neurodevelopmental assessments at 2 and 5 years

<table>
<thead>
<tr>
<th><strong>Timeline</strong></th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recruit</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yr 2 assessment</td>
<td></td>
<td></td>
<td>×</td>
<td>×</td>
<td>×</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yr 5 assessment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
</tbody>
</table>
Is it safe for my baby to have anesthesia?

For now:

- Drug induced apoptosis is a valid concern
- Much needed area of research
- Does it affect just preterms or neonates or are adults vulnerable too?
- Is the plasticity of human brain able to overcome these insults
- Until we have more convincing data on this subject it is prudent that we continue with our current level of care
Is it safe for my baby to have anesthesia?

Remember:
1. Majority have been animal studies
2. Questionable intraop monitoring
3. Limited data in primates