ANESTHESIA FOR THE EX-PREMATURE INFANT: Considerations throughout childhood

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PREMATURE (<37 weeks)
- Extreme Low Birth Weight (ELBW)
  - <750 g <25 weeks
  - 750-1000 g 26-28 weeks
- Very Low Birth Weight (VLBW)
  - 1000-1500 g 29-32 weeks

What’s so special about premies?
- Skin/metabolic regulation
- BRAIN
- Heart
- LUNGS
- GI function
- Endocrine function
- Renal function

“disorders relating to short gestation and low birth weight” are the second leading cause of infant death (16-17%), second only to congenital malformations, deformations, and chromosomal abnormalities

National Vital Statistics report April, 2010
Extreme prematurity: Life-long diagnosis

<table>
<thead>
<tr>
<th>BIRTH WEIGHT</th>
<th>#/YEAR</th>
<th>% SURVIVAL</th>
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<tbody>
<tr>
<td>1000-1500 g</td>
<td>50,000</td>
<td>90%</td>
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<tr>
<td>(VLBW)</td>
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<tr>
<td>500-999 g</td>
<td>10,000</td>
<td>70%</td>
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<tr>
<td>(ELBW)</td>
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Survival without short term complications (BPD, PVL, NEC) still largely dependent on degree of prematurity.

LONG- & SHORT-TERM OUTCOME
- Chronic lung disease
- ROP
- Neuropsychological

Lung disease in the premature newborn
CHRONIC LUNG DISEASE: “Old” vs “New”

- OLD: severe epithelial injury, extensive fibrosis, Smooth muscle hyperplasia, over-inflation + atelectasis: 
  O₂, mechanical ventilation; rare
- NEW: negligible epithelial lesions, fewer, larger alveoli, decreased dysmorphic capillaries, variable interstitial fibroproliferation: 
  gentle ventilation (CPAP), surfactant

Bronchopulmonary dysplasia

- BPD occurs in 60-90% of babies born at 23 weeks and 50-70% of those born at 25 weeks
- Pulmonary dysfunction occurs in expremature infants without BPD
- Surfactant use has not decreased the incidence of BPD in ELBW infants, though it may be milder
- Neurodevelopmental abnormalities are common in infants with BPD
- CLD often coexists with FTT and frequent pulmonary infections and hospitalizations over the first year of life

BRAIN INJURY IN THE PRETERM INFANT

- Germinal matrix-IVH
- IVH-Post-hemorrhagic hydrocephalus
- Periventricular leukomalacia ‘encephalopathy of prematurity’ signal abnormalities, loss of volume, cystic abnormality, enlarged ventricles, thinning of the CC, delayed myelination

Severity of abnormalities is associated with adverse early ND outcome
- 1/3 of cohort: moderate to severe (GA: 24-28 w)
- Early lesions associated with impaired cerebral development: GM + WM
- Ventriculomegaly: no IVH implying parenchymal tissue loss
Prematurity = Life-long Diagnosis
Ex-premature: Nonspecific

- 40-60 weeks PCA
- 60 weeks PCA-1 year
- 1-2 years
- 2-5 years
- 5-10 years
- > 10 years-adult

Anesthetic considerations: age-related

RESPIRATORY OUTCOME: BEYOND INFANCY
Effect of Surfactant Therapy

“Regardless of surfactant therapy &/or BPD, bronchial obstruction associated with bronchial lability & increased bronchial responsiveness remain common in school children (7-12 yo) born very prematurely.”

CLD 91%
No CLD 35%

RESPIRATORY OUTCOME: BEYOND INFANCY

- Symptoms include cough & wheeze
- Airway obstruction/hyperinflation
- Airway hyper-responsiveness
- Impaired cardioventilatory performance during exercise
- CLD > Premature without CLD > Term Control

FEV1 Values in Children, Adolescents, and Young Adults Who Were Born Prematurely and Had Bronchopulmonary Dysplasia, as Compared with Controls Born at Term

CLD 91% No CLD 35%
Neurodevelopmental effects of prematurity: Long term

<table>
<thead>
<tr>
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<th>ELBW (~30 M)</th>
<th>TERM</th>
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<tbody>
<tr>
<td>Cerebral Palsy</td>
<td>10-18%</td>
<td>0.2%</td>
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<tr>
<td>Developmental II, &gt;2SD mean</td>
<td>26-37%</td>
<td>2-3%</td>
</tr>
<tr>
<td>Sensorineural Hearing Loss</td>
<td>2-3%</td>
<td>0.1-0.3%</td>
</tr>
<tr>
<td>Visual (&lt;20/200) Strabismus*</td>
<td>2%</td>
<td>19%</td>
</tr>
<tr>
<td>Cognitive Problems (school age)</td>
<td>50%</td>
<td>??</td>
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Neurologic outcome

- At least 50% of VLBW infants have MRI findings consistent with white matter injury
- Although neurosensory deficits like blindness and deafness have declined, neurocognitive and behavioral dysfunction have increased
- Higher incidence of anxiety and depressive disorders have been noted in exprematures

Preoperative Evaluation of the Expremie

- Chronic lung disease
- Infancy beyond infancy
- Neurologic deficits
- Seizures, cerebral palsy, vision and hearing impairments
Factors associated with adverse respiratory events in children with URI's

• ETT
• Parental smoking
• History of RAD
• Isoflurane, maintenance
  Prematurity
• Surgery involving the airway
• Nasal congestion

The Expremature Infant: Common Procedures

• Hernia repair
• MRI
• Tappable CSF reservoir (Ommaya) and/or VP shunt
• Eye surgery for ROP
• Bowel surgery - stricturoplasty/ reanastamosis of stomas from NEC
• Airway procedures

Timing of hernia repair

• Still on ventilator
• Days prior to d/c
• As an outpatient?

Postanesthesia apnea in the expremature infant

• Gestational age at birth and postconceptual age (PCA) at time of anesthesia statistically significant impact on incidence of postoperative apnea
  – The risk of apnea for a baby born at 35 weeks is not less than 5% until a PCA of 48 weeks and not less than 1% until 54 weeks
  – For a baby born at 32 weeks, the incidence is not less than 5% until a PCA of 50 weeks and not less than 1% until 56 weeks.

*Cote et al, 1995
The Expremature Child: Common procedures

- VP shunt revisions
- Orthopedic procedures for spasticity
- ENT surgery - cochlear implants, T&A
- Ophthalmologic surgery - strabismus

PRE-OPERATIVE EVALUATION

“He is 6 yo, ex-27 GA scheduled for T&A, “BPD” as an infant, is now healthy, only mild RAD.”

- weight/growth
- meds
- symptoms
- consultants?

PRE-OPERATIVE EVALUATION

“She is 3 yo, ex-24 week GA for strabismus repair, “BPD” as infant, is now healthy, URI a week ago.”

- wheezing?
- meds
- RSV
- CLD?

PITFALLS IN PRE-OPERATIVE EVALUATION

Chronic Disease

- “Parental protection of ELBW children at age 8 years”: higher rates of over protection
- Personality traits of ex-prematures
- Pre-operative evaluation: takes time!

Richards AL. J Dev Behav Pediatr 2011; 32: 281
Richards AL. Pediatrics 2006; 117: 309-316
PULMONARY CONSIDERATIONS

- RAD
- Less responsive to bronchodilators
- Structural airway problems - subglottic stenosis
- More susceptible to viral illnesses

NEUROLOGIC CONSIDERATIONS

Implications for Perioperative Care:
- altered responses to sedatives/anesthetic agents
- pre-medication
- post-operative pain control
- NPO guidelines in the setting of GERD

Anesthetic Management

- Induction techniques
- Intubation? and ventilation
- Fluid management
- Positioning challenges
- Pain Management strategies
- Postoperative care

The Ex-Premature: “Life long Diagnosis”