Neurodevelopmental Outcomes and Bronchopulmonary Dysplasia

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Learning objectives

- Identify why bronchopulmonary dysplasia (BPD) may be associated with worse long term outcomes
- Recognize the adverse outcomes associated with BPD
Definition of BPD

- Epidemiological
  - Supplementary oxygen or respiratory support at >28 days
  - Supplementary oxygen or respiratory support at >36 wks
  - Spectrum of severity

- Clinical
  - Xray findings and clinical deterioration may start earlier at 7-14 days of life
Characteristics of BPD

- Higher rates with lower gestational age
- Comorbidities:
  - IVH and periventricular leukomalacia
  - Pneumothoraces
  - Sepsis
  - Poor growth and feeding problems
  - Hypoxia
  - Increased pain and stress
  - Prolonged hospital stay

(Anderson PJ, DoyleLW. Seminars in Perinatology 2006)
Types and Severity of BPD

- “Old” BPD (Northway 1967)
  - Typically > 32 wks GA, ventilated, barotrauma
  - CXR: hyperlucent cystic areas
  - Autopsy: pulmonary fibrosis and epithelial metaplasia

- “New” BPD NICHD consensus (Jobe 2001)
  - < 32 wks GA vs > 32 wks GA
  - Mild, moderate and severe
  - Alveolar arrest
Mechanisms of Injury

- “Brain injury” vs “brain dysmaturation”
  - IVH, PVL

  32 weeks

  40 weeks

- Environmental:
  - Parent bonding
  - Noise, bright light, painful procedures
  - Parental education and socioeconomic status
Factors that Cause BPD and Affect Brain Maturation
Complications & Treatments for BPD

- **Respiratory support**
  - Increased risk of pneumothoraces
  - Periods of hypoxia or variable oxygen saturation
  - More sedation and analgesia
- **Sepsis or ventilator associated pneumonia**
- **Poorer Nutrition**
- **Treatments**
  - Diuretics
  - Postnatal steroids
BPD and Cerebral Palsy (CP)

- **< 1500 g Rates of CP (Skidmore 1990)**
  - BPD (O2 > 27 days): 15%
  - No BPD: 3-4%

  - BPD and CP after adjustment for other risk factors:
    - OR 1.66 (95% CI 1.01-2.74)

- **TIPP trial < 1000 g 1996-1998 (Schmidt 2001)**
  - BPD and CP: OR 2.5 (95% CI 1.9-3.4)
BPD and other Motor Impairments

- BPD is a risk factor for DCD (Developmental Coordination Disorder)
  - motor impairment that interferes with the child's activities of daily living and academic achievement
  - No other neurological explanation
  - Motor worse than cognitive impairment
  - Defined using the MABC-2 or Bruininks-Oseretsky
- Poorer fine and gross motor skills (Vohr, 1991 and Short 2003)
BPD and Sensory Outcomes

- **Visual:**
  - Blindness is uncommon (CNFUN = 1.6%)
  - Strabismus: 19% in VLBW cohort
    - BPD is a risk factor

- **Hearing**
  - Sensorineural Hearing Loss  CNFUN = 2.6%
    - Use of loop diuretics, increased aminoglycosides, hypoxia
  - Conductive and other hearing losses CNFUN = 8.2%
    - BPD is a risk factor for conductive hearing loss
BPD and Cognitive Functioning

- Lower scores on the Bayley with BPD (2X)
- Lower IQ (80-90)
- BPD associated with loss of 4-10 IQ points
- Preterm with BPD:
  - 40% with IQ < 85
  - 20% with IQ < 70

(Doyle et al. Seminars in Fetal & Neonatal Med 2009)
BPD & Other Cognitive Outcomes

- **Attention (Farel 1998)**
  - BPD: 59% scored < -1 SD
  - No BPD: 32% scored < -1 SD

- **Attention Deficit**
  - In 8 yr olds BPD 15% (2x non-BPD) (Short 2003)

- **Memory (Farel 1998)**
  - BPD: 65% scored < -1 SD
  - No BPD: 29% scored < -1 SD

- **Visual-Spatial Perception (Doyle 2009)**
  - Children with BPD do worse on a variety of visual-spatial tasks (VMI, Perceptual motor, Rey Complex figure and Judgment of Line Orientation Test)
BPD & Language Problems

- Language problems (Doyle 2009)
  - Increased about two-fold with BPD:
    - Preschoolers (3-5 years):
      - Expressive language 43%
      - Receptive language 49%
    - School age
      - Expressive language 15%
      - Receptive language 9%
    - Worse articulation
    - About 50% receive speech and language therapy
Executive Functions: Definition

- A set of general purpose control mechanisms, often linked to the prefrontal cortex of the brain, that regulate the dynamics of human cognition and action (Miyake 2000; Miyake 2012)

- Core EF abilities (Diamond 2007; Miyake 2000)
  - Inhibitory Control
  - Working Memory
  - Cognitive Flexibility
Executive Skills (Doyle 2009)
- Negative correlation with executive function and weeks on oxygen

Academic performance (Doyle 2009)
- Delays and increased learning disabilities especially in math and reading- up to 47% in BPD
BPD and Psychological Problems

- Internalizing problems
- Attention Deficit Hyperactivity Disorder
- Autism Spectrum disorder
- Schizophrenia
- Social difficulties

(Anderson 2006)
Conclusions

- BPD is associated with global neurodevelopmental delay rather than a specific pattern of impairments.
- Though BPD is associated with prematurity and multiple other risk factors, BPD is independently associated with worse outcome.
- BPD is not dichotomous but a spectrum.
- Do we need a calculator to determine outcomes based on age at which baby is weaned off respiratory support?
Questions