Care of the Child with Bronchopulmonary Dysplasia and Pulmonary Hypertension

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Has documented that he has no financial relationships to disclose or Conflicts of Interest (COIs) to resolve.

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Pulmonary Hypertension (PH) in Bronchopulmonary Dysplasia (BPD)

• Strongly associated with morbidity and mortality
• PH is one manifestation of pulmonary vascular disease (PVD)
• Lung disease, cardiac shunts, and cardiac dysfunction may exacerbate PVD and PH in BPD
• High clinical suspicion and comprehensive evaluations are required to identify the factors contributing to PVD and PH
• Advances in basic pulmonary vascular biology have directly led to novel therapies
PH is Associated with High Mortality in BPD

![Graph showing the probability of survival for PH patients with mild and severe PH.](Adapted from Khemani E, et al, Pediatrics 2007)

The Pulmonary Circulation in BPD

![Images of pulmonary circulation in BPD.](Mourani, Alman. In Bronchopulmonary Dysplasia, 2009)

Pulmonary Vascular Disease in BPD

**Decreased Growth**
- Angiogenesis
- Alveolarization

**Abnormal Function**
- High vascular tone
- Altered vasoreactivity
- Impaired metabolic function

**Abnormal Structure**
- SMC proliferation
- Altered extracellular matrix

- Surface area for gas exchange
- Prolonged oxygen therapy
- Altered redistribution of blood flow in response to infection
- Exercise intolerance
- Pulmonary Hypertension

Persistent Controversies Regarding PH in BPD

- What is the definition of PH in BPD?
- What is the incidence of PH in BPD?
- What is the contribution of PH to outcomes in BPD?
- What is the best approach to identify BPD infants with PH?
- What are the optimal treatment strategies for PH in context of BPD?
Incidence of PH in BPD

Echocardiograms performed at 36 wks PMA in conjunction with physiologic assessment for BPD according NIH criteria.

Subjects followed until 2 years of age

Two Center Prospective Study of PVD in Preterm Infants

- University of Colorado and Indiana University
- Inclusion Criteria:
  - Birthweight: 500 - 1250 grams
  - Gestational age < 34 weeks
  - Less than 7 days old at enrollment
- Echocardiograms performed at 36 wks PMA in conjunction with physiologic assessment for BPD according NIH criteria.

Subjects followed until 2 years of age

Echo PH Criteria

- All Echocardiograms read by a single cardiologist blinded to clinical status
- **PH Criteria 1:**
  - R>L or bidirectional Cardiac Level Shunt
  - Estimated RVSP >40 mm Hg, or RVSP/Sys BP >0.5
- **PH Criteria 2:**
  - Inclusive Criteria 1, or
  - Moderate or severe septal wall flattening
- **PH Criteria 3:**
  - Inclusive of Criteria 1 and 2, or
  - Mild septal wall flattening

Lung Disease
- Hypoxemia
- Hyperinflation
- Atelectasis
- Hypercarbia

Heart Disease
- RV dysfunction
- Impaired LV contractility
- LV diastolic dysfunction
- L>R shunt lesions

Pulmonary Hypertension in BPD

Pulmonary Vascular Disease
- High tone and reactivity
- Hypertensive vascular remodeling
- Decreased vascular growth
- Systemic-pulmonary collateral vessels
- Pulmonary vein stenosis

Diagnostic Approach to Pulmonary Hypertension in BPD

- Screening echocardiograms (ECHO) for:
  - Severe BPD at 36 weeks
  - Infants with prolonged ventilator and/or oxygen requirements
  - Cyanotic episodes
  - Marked hypercarbia
  - Persistent pulmonary edema, diuretic dependence
  - Poor growth, IUGR, oligohydramnios
- General evaluation and treatment for factors contributing to persistent respiratory disease and PH
- Consider cardiac catheterization

Role of Cardiac Catheterization in BPD

- Assess severity of PH
- Anatomic heart disease/shunt lesions
- Structural vascular abnormalities (e.g., arterial stenosis, pulmonary venous obstruction, systemic to pulmonary collateral vessels, others)
- Catheter-based interventions
- Assess cardiac function (LV diastolic dysfunction)
- Acute vasoreactivity/hypoxia testing for selection of chronic therapy

Pulmonary Vascular Effects of Inhaled NO and Oxygen in Children with BPD

Mourani PM et al, AJRCCM 2004

Patients with Neonatal CLD Receiving Sildenafil Exhibited Improved Pulmonary Pressures

Mourani PM et al J. Pediatrics 2008
Sildenafil use is Associated with Hemodynamic Improvement

Longitudinal Evaluation of PH in BPD

- Serial monitoring:
  - echocardiogram
  - BNP and pro-BNP
  - Respiratory course
  - Growth and activity
- Patients who fail to improve/deteriorate:
  - Repeat extensive respiratory evaluation
  - Consider repeat cardiac catheterization
- Additional Therapies:
  - Endothelin receptor blockers, prostacyclin analogues
- Weaning of drug therapies

Summary: PH in BPD

- PH contributes to worse outcomes in BPD, but limited data exist regarding the natural history of PH in BPD
- Cardiopulmonary interactions contribute significantly to PVD in BPD
- Cardiac catheterization plays an important diagnostic role for PVD in BPD (PH severity, anatomic abnormalities)
- More data are needed to define the utility, timing, and duration of drug treatments for PH in BPD

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