Managing Persistent Pulmonary Hypertension of the Newborn with Inhaled Nitric Oxide

A Case Study

Megan Crain, MSN, RN
Trey Poston, BSN, RN
College of Nursing
East Carolina University
Greenville, North Carolina

PURPOSE

To present a case study of the management of Persistent Pulmonary Hypertension of the Newborn (PPHN) in a term infant affected by perinatal asphyxia. An overview of pathophysiology and the infant's clinical presentation, diagnostic process, and medical management is displayed.

INTRODUCTION TO PPHN

- Incidence of 0.4-6.8 : 1,000 live US births
- Mortality rates approximate 7% of all infants
- 20% of infants with moderate-to-severe PPHN suffer neurologic damage
- Morbidities of PPHN among survivors includes seizures, stroke, heart failure, hearing loss, long-term oxygen dependence, and cerebral palsy

Manifestations

Labile hypoxemia
- Rapid fluctuations in saturations occur due to shunting due to elevated PVR

Differential cyanosis
- Suggests shunting at the DA
- May not occur if shunting occurs at PFO

PATHOPHYSIOLOGY OF PPHN

- Persistent elevation of pulmonary vascular resistance causes a right-to-left flow across the PFO or DA into systemic circulation, bypassing the lungs.
- Inflammatory responses following significant events, such as asphyxia, lead to production of Endothelin A and/or B.
- Endothelin A causes vasoconstriction by an increased influx of calcium into smooth muscle, while B promotes vasodilation through the release of nitric oxide and prostacyclin.
- The overproduction of Endothelin A after an event leads to excess vasoconstriction, exacerbating PPHN.

CASE REPORT

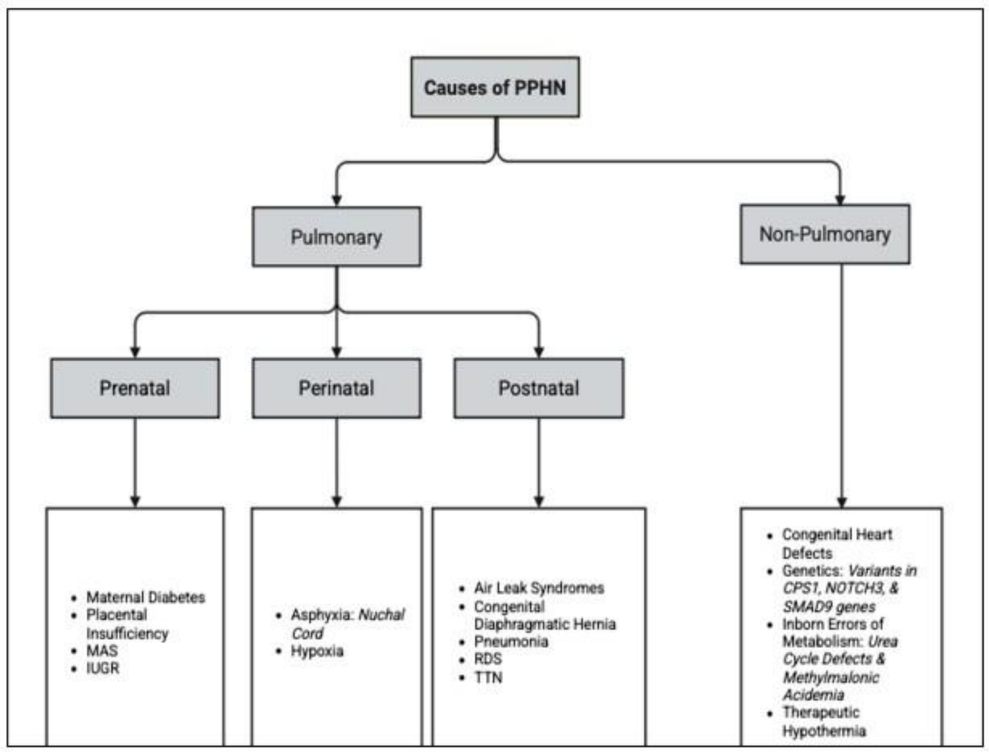
Delivery history: Caucasian, male infant born at 38 weeks and 2 days gestation via Cesarean section. Labor was induced due to intrahepatic cholestasis of pregnancy and complicated by fetal intolerance to labor and a single, tight nuchal cord.

Birth presentation included hypotonia with no spontaneous movement or respiratory efforts, producing Apgar scoring of 0, 1, and 5. The initial arterial cord gas was consistent with severe metabolic acidosis: pH 6.26 CO2 15 mmHg HCO3 3.5 mEq/L BD -21.

Transportation to a Level III NICU facility was accelerated. The infant received multiple normal saline boluses and dopamine in stabilization efforts of refractory hypotension with sustained hypoxemia and a 7-10% differential cyanosis. Severe HIE Sarnat scoring prompted passive cooling to begin prior to transfer.

HOSPITAL COURSE

- DOL 0: Intubation requiring 100% FiO2, initiation of dopamine, inhaled nitric oxide (iNO), hydrocortisone, and therapeutic hypothermia. An ECHO showed small-to-moderate PDA, systemic RV pressures, and TR jet pressure of 40 mmHg.
- DOL 3: Rewarmed and weaned from dopamine, iNO, and hydrocortisone. Infant extubated to CPAP.
- DOL 4: Post-cooling MRI of the brain completed. Transition to room air. Enteral feedings initiated.
- DOL 10: Infant was discharged home.



DIAGNOSTICS & MANAGEMENT

Echocardiogram
- Gold standard diagnostic test for PPHN
- Always consider cyanotic congenital heart disease until ruled out by an ECHO
- Dx: TR jet pressures >40mmHg or PASP > 25 mmHg (mild), 40-60 mmHg (moderate), or >60 mmHg (severe)

Arterial Blood Gas
- Analyzes blood pH, CO2, and PaO2 to assess respiratory failure
- Hypoxemia: PaO2 <50 mmHg

Oxygenation Index
- OI = 100 x [MAP x FiO2]/PaO2
- An OI >25 warrants iNO . An OI >40 consider ECMO

Acute Medical Management

Inhaled Nitric Oxide (iNO)

Vasopressors and inotropic agents

INHALED NITRIC OXIDE

- A pulmonary-specific vasodilator first approved for neonates >32 weeks in 1999.
- Mechanism of action includes the activation of soluble guanylate cyclase, promoting cGMP and Protein Kinase A to open potassium channels while effluxing calcium. Cell relaxation and pulmonary vasodilation occurs.
- Dosing can range as high as 80 ppm, although current research shows little benefit of dosage above 20 ppm.
- Redistribution of blood flow improves V/Q mismatch.
- Therapy is costly and FDA approval is limited to >/= 34 weeks, meaning insurance coverage could be difficult.
- Important to monitor methemoglobin while on iNO therapy.

WHEN TO SAY NO TO iNO

- Ductal-dependent heart disease
- Severe left ventricular dysfunction
- Severe methemoglobinemia
- Hypoxic respiratory failure without PPHN lacks evidence
- Not recommended for BPD prevention
- Neonates with CDH associated with LV dysfunction and PPHN are at risk for respiratory deterioration with iNO use

When to stop…
- Poor response to iNO, usually due to failure to recruit the lung, can lead to free radical damage.
- Methemoglobinemia >10%.