Management of PDA in the NICU

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Patent Ductus Arteriosus

- Ductus arteriosus part of the fetal circulation
- Diverts Blood away from the lungs
- In term infants ductus closes by 72 hrs
- In preterm infants patent ductus arteriosus is common, inversely related to gest age
- 75% in infants less than 28 weeks
PDA
Mechanism of Ductal Closure

• Fetal ductus is kept patent by low art PO2 and Protaglandin E2 produced partly by placenta
• At birth increase in PO2 and decrease in PGE2 triggers ductal constriction
• Functional closure in 10-15 hours
• Ductal tissue hypoxia leads to cell death
• In 2-3 weeks anatomic closure
Ductal Closure in Preterm

- Ductal closure delayed in preterm infants
- Risk inversely proportional to gest age
- Risk is higher in infants < 30 weeks
- Risk higher in infants with RDS
- Risk higher if no prenatal steroids
Ductal Closure in Preterm

- Oxygen has less constrictor effect due to greater sensitivity to PGE2 and NO
- Less ductal tissue hypoxia in preterm due to thin wall
Pathophysiology of PDA

- Decreased systemic organ blood flow and tissue oxygenation
- Increased blood flow to the lungs
- Doppler US and near infra red spectroscopy has shown decreased flow and oxygenation
Pathophysiology
Effects on the Lungs

- Increased lung water and pulmonary edema
- Reduction in lung compliance
- Increased ventilation and oxygenation requirements, lung injury
- Chronic Lung Disease
- Pulmonary hage
Pathophysiology
Effect on GI Tract

• Decreased mesenteric blood flow
• GI injury
• Translocation of bacteria
• Necrotizing enterocolitis (NEC)
• Local ischemia, spontaneous intestinal perforation (SIP)
Pathophysiology
Effects on CNS

• Alterations in cerebral blood flow, intraventricular hage (IVH)
Pathophysiology
Renal Effects

• Decreased blood flow to kidney
• Elevated BUN, creatinine
• Decreased kidney function, poor urine output
Signs

- Heart murmur
- Bounding pulses
- Wide Pulse Pressure
- Active precordium
- Metabolic acidosis
Symptoms

• Hypotension
• Resp distress
• Pul hage, bloody tracheal asp
• Poor urine output
Chest xray findings

• Cardiomegaly
• Pulmonary edema
Echocardiography

- Amount of ductal shunt
- Ductal diameter
- Size of chambers of heart, enlargement of atria, ventrical
- Myocardial function
Treatment of PDA

- Medical Treatment
- Surgical treatment
- Aggressive treatment
- Conservative or expectant management
Treatment of PDA
Medical

• Indomethacin --- FDA approved
• Ibuprophen ---- FDA approved

• Acetoaminophen --- Not FDA approved
Indomethacin

- Prostaglandin inhibitor
- PDA closure in 70%
- 1-2 courses are given
- Prophylaxis --- decrease in severe IVH
- Side effects:
  - Risk of bleeding
  - NEC
  - SIP
  - Renal dysfunction
Ibuprofen

• Prostaglandin Inhibitor
• Not approved for prophylactic use
• Does not decrease IVH
• Ductal closure in 70%
• Decreased risk of renal dysfunction and NEC
Acetoaminophen

- Not FDA labeled for neonatal use
- Prostaglandin inhibitor at another site (peroxidase) on the prostaglandin synthase enzyme
- Ductal closure 70%
- No effect on kidney or intestine
- Concern for hepatotoxicity
- Safety data lacking
Aggressive VS Conservative Treatment

• Aggressive Treatment
  Prophylactic treatment
  Early ECHO and treatment

• Medical treatment, if fails, ligation
Conservative Management

- Spontaneous closure in sig number of VLBW infants
- Treatment only if cardio-pulmonary compromise with a hemodynamically significant PDA
- Fluid restriction
- Diuretics
Surgical Treatment

- Ligation
- Percutaneous Transcatheter closure
Surgery

PDA Ligation

• Done if medical treatment fails
• Increased risk of BPD, severe ROP
• Increased risk of neurodevelopmental impairment
• Chylothorax
• Infection
• Vocal cord paralysis
Surgical Closure

- Percutaneous Transcatheter Closure
- Coil, other devices
- Less invasive
- Fewer adverse effects
- 94% success rate
- Usually 6 months, 6 kg
- Small study successful with < 3 kg
Lateral Aortogram in PDA
Post operative consequences of PDA ligation

Sudden and dramatic changes in cardiac physiology
Fall in preload due to sudden reduction in pulmonary blood flow
Increase in afterload due to increase in systemic vascular resistance
Myocardial dysfunction
Post Ligation cardiac Syndrome

Definition

• Fall in systolic pressure below 3rd %ile requiring ionotropes

• Increasing vent requirement and Fio2 at least 20%
Post Ligation Cardiac Syndrome

- 6-12 hrs post surgery
- Hypotension
- Hypoxemia
- High mortality, (33% vs 11%)
- Occurs in upto 50% of infants undergoing PDA ligation
Pre-operative risk factors for PLCS

- Early ligation, within the first 4 weeks, vs late ligation, after 4 weeks. 27% vs 5%
- Presence of NEC or preoperative shock
- Birth weight less than 1000 gms
- Less than 26 weeks gestational age
Pulmonary mechanics after PDA ligation

- Improved compliance after PDA ligation
- LV dysfunction may lead to pulmonary edema
- Lung collapse may interfere with ventilation
Management of PLCS

• Decreased Preload: Volume
• Increased afterload: Avoid dopamine and epinephrine, use dobutamine, milrinone
• Hydrocortisone
• Ventilator management: Compliance improves and weaning MAP prevents overdistension and improves venous return
• Left Ventricular dysfunction may cause pulmonary edema
• Lung collapse may interfere with ventilation
Outcomes

- Risks and benefits of treatments vs risks of continued PDA
- Comparable outcomes with both aggressive and conservative approaches in randomized controlled trials