Patent Ductus Arteriosus (PDA)

DEFINITION: The ductus arteriosus is patent in all newborns at the time of delivery. It is closed by 48 h after birth in 100% of infants delivered at ≥40 wks gestation and by 72 h after birth in 90% of infants delivered at ≥30 wks gestation. A ductus open beyond 72 h can be considered to be a persistently patent ductus arteriosus. Twenty-five percent of infants with birth weights 1,000-1,500 g will have a PDA at 72 h, and 70% of these will require treatment for their PDA. Sixty-five percent of infants with birth weights <1,000 g will have a PDA at 72 h, and 85% of these will require treatment for the PDA.

CLINICAL FINDINGS: These include:

- **Heart murmur:** PDA is almost always associated with a systolic murmur that may extend into early diastole and be heard best along the mid to lower left sternal border. In infants on respiratory support, the murmur may be difficult to hear. When listening for a murmur, it may be helpful for another person to disconnect the ventilator very briefly (3 to 5 heart beats) while you listen for the murmur.
- **Wide pulse pressure, low diastolic pressure or accentuated pulses to palpation.**
- **Hyperactive precordium**
- **Increased vascular markings** on chest radiograph. Increased heart size is a late sign.
- **Apnea** or a worsening in respiratory status
- **Prolonged capillary filling time** when there is decreased systemic output due to a very large left to right shunt through the PDA. In these cases, metabolic acidosis is an ominous sign.

MEDICAL TREATMENT:

General Considerations: Conventional treatment of congestive heart failure (fluid restriction, diuretics, digoxin) is not effective and will delay proper treatment. Unless the PDA is not hemodynamically significant, infants with PDA should be NPO.

Indomethacin:

1. Gestation ≥28 weeks at birth: These infants are usually treated only when a hemodynamically significant PDA is present. This practice is aimed to avoid unnecessary treatment. A PDA is considered hemodynamically significant if, in addition to a murmur, two or more of the following signs are present:

- -increased pulse volume or widened pulse pressure
- -hyperactive precordium
- -increased pulmonary vascular markings on chest radiograph

An untreated hemodynamically significant PDA will prolong the need for oxygen therapy and delay the establishment of feedings. An echocardiogram should be obtained to rule out structural congenital heart disease.

Indomethacin Dosage (IV):

Birthweight >1,250 g: Give three doses of 0.2 mg/kg; give the 2nd dose 12 h after the first, and the 3rd dose 24 h after the 2nd.

Birth weight 1,000-1,250 g: 1st dose is 0.2 mg/kg; 12 h later, give 0.1 mg/kg for 2nd dose; 24 h after the 2nd dose, give 0.1 mg/kg.

2. Gestation <28 weeks at birth – (Prophylactic Indomethacin, UCSF approach): Seventy percent of infants <28 weeks gestation will require therapy for a PDA at some point during their hospitalization. Indomethacin is not as effective in this group and surgery is frequently necessary. The earlier infants are treated with indomethacin, the more effective it is in producing permanent closure. At UCSF, all infants <28 weeks gestation are treated prophylactically with indomethacin by 12-15 h after birth. An echocardiogram and serum creatinine are not usually obtained prior to giving the 1st dose. Platelet count >100,000 should be demonstrated prior to the first dose. The 1st dose should be delayed if there is any concern about a bleeding diathesis or coagulopathy. PT and PTT should be measured if there is concern about a coagulopathy.

Prophylactic Indomethacin Dosage (IV): Three initial doses: 1st = 0.2 mg/kg, 2nd = 0.1 mg/kg (24 h after the first dose), 3rd = 0.1 mg/kg (24 h after the 2nd dose). Serum creatinine and platelet count should be checked before 2nd and 3rd doses.

Just prior to the 3rd indomethacin dose, obtain an echocardiogram. If there is echocardiographic evidence of patency of the ductus (even if there are no clinical signs), give 4th, 5th, and 6th doses of indomethacin (0.1 mg/kg at 24 h intervals). Repeat the echocardiogram after the 6th dose.

Contraindications to Indomethacin:

-Active bleeding:GI and other (Note that presence of an ICH is not a contraindication)
-Active or suspected Necrotizing Enterocolitis (NEC)
-Creatinine ≥2.0 mg/dL
-Urine output <1 mL/kg/h (indomethacin may be restarted when urine output >1mL/kg/h)
-Platelet count <50,000 (consider platelet transfusion prior to indomethacin)
-Active (and untreated) infection
-Suspected Congenital Heart Disease
-Known gastrointestinal or renal anomaly

Management During Indomethacin Treatment: Because indomethacin decreases gastrointestinal blood flow, infants should be kept NPO until at least 48 h after the indomethacin therapy has been completed.

Because indomethacin may cause a transient decrease of urine output (similar to excessive ADH action), IV fluids should be adjusted every 8-24 h, taking into consideration not only fluid intake in mL/kg, but more importantly, the relationship between urine output and fluid intake. An acceptable output to intake ratio in these circumstances is between 0.3 and 0.7, taking the infant's anticipated weight change into consideration. A decrease in serum Na^+ should prompt additional fluid restriction because of retention of free water with indomethacin administration.

SURGICAL CLOSURE OF PDA should be considered in the following situations:

-Failure of indomethacin therapy
-Hemodynamically significant PDA and presence of contraindication(s) to indomethacin
-Presence of PDA and NEC. In this circumstance, operative closure of the PDA is almost always necessary before the NEC will resolve and may be required as an emergency procedure.