Neonatal Emergencies

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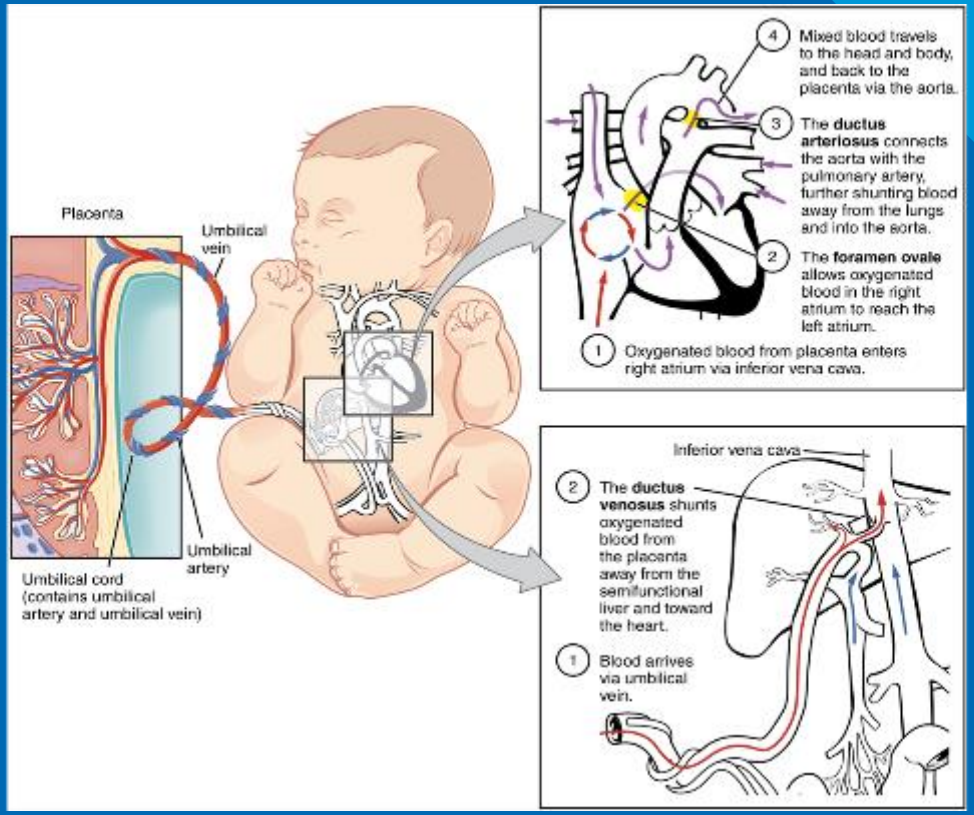
Children's Hospital Colorado
Here, it's different.™

Life in the Uterus

Key Points:

- Umbilical vein brings oxygenated blood from the placenta to the fetus
- Blood enters fetus through the liver and into right side of the heart
- Fetal shunts move oxygen rich blood from the right side of the heart to the left side and out to the body
- Pulmonary vascular resistance is high

(AHA, 2022)



https://en.wikipedia.org/wiki/Fetal_circulation#/media/File:2916_Fetal_Circulatory_System-02.jpg

Physiological Changes at Birth

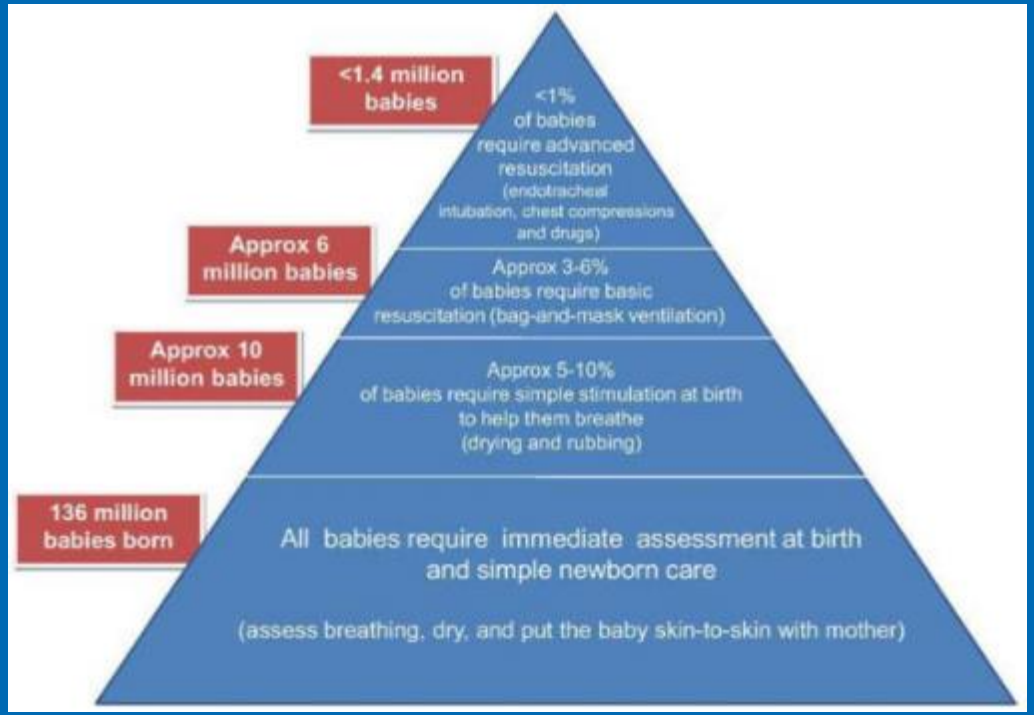
Increased systemic vascular resistance – closure of right to left shunts
Decrease in pulmonary vascular resistance
Fluid cleared from airways due to active sodium absorption and airway pressure changes
Increase metabolic rate = increased glucose needs
Increased catecholamine levels

https://www.sciencefocus.com/news/first-breath-system-babies/

(Morton & Brodsky, 2016)

Neonatal Resuscitation

- The approach to neonatal resuscitation adult resuscitation is very different
- The focus of neonatal resuscitation is **ventilation, ventilation, ventilation**!



https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2875104/figure/F1/

(Wall et al., 2009)

Delayed Cord Clamping

- Per NRP delay clamping the cord after birth for at least 30 – 60 seconds unless contraindicated

- Studies have shown that term infants receive approximately 80 ml of blood transferred from the placenta at 1 minute and 100ml at 3 minutes

- Benefits of Delayed Cord Clamping All Infants
  - Increased hemoglobin levels
  - Increased ferritin and HCT at 4 week of age
  - Less fluctuation in HR and Cardiac Output
  - Increased myelin content in the brain at 12 months

- Benefits of Delayed Cord Clamping Premature Infants
  - Decreased mortality prior to discharge
  - Decreased Intraventricular Hemorrhage (IVH)
  - Decreased Necrotizing Enterocolitis (NEC)
  - Decreased hospital stay

http://www.ogpnews.com/2015/11/delaying-umbilical-cord-clamping/13397

(Mercer et al, 2020) (Deepika et al., 2022) (Rabe et al. 2019) (Gupta et al, 2022) (Li et al., 2021) (Weinter & Zaichkin, 2021)

Delayed Cord Clamping

Contraindications:

- Placental circulation is not intact
  - Abruption
  - Maternal hemorrhage
  - Cord avulsion
- Situations where utero-placental or umbilical cord flow may be disrupted

(Weiner & Zaichkin, 2021)

- EFFECTIVE VENTILATION IS THE MOST IMPORATNT INTERVENTION FOR THE APNEIC OR BRADYCARDIC NEONATE

- Give just enough volume to see the chest rise
- If you are having trouble achieving good chest rise use MR. SOPA
  - M = Mask Reposition
  - R = Reposition the Head
  - S = Suction
  - O = Open the Mouth
  - P = Increase the Pressure
  - A = Alternate Airway

Rate is 40 – 60 Breaths per minute

(Weiner & Zaichkin, 2021)

https://www.moscmm.org/uploads/userfiles/Neonatal resustitation.pdf

Oxygen in the Delivery Room

What Fio2 should you start resuscitation in?

- Full Term Infant: Fio2 21%
- Premature Infant (<35 weeks): Fio2 21% – 30%

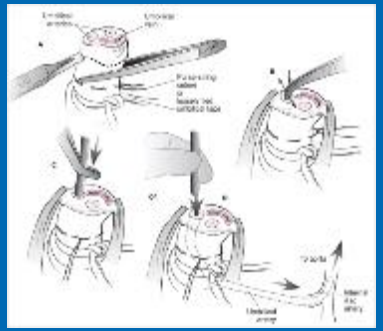
Targeted Preductal SpO_2 After Birth	
1 min	60%-65%
2 min	65%-70%
3 min	70%-75%
4 min	75%-80%
5 min	80%-85%
10 min	85%-95%

(Weiner & Zaichkin, 2021)

http://www.emdocs.net/em-cases-neonatal-resuscitation/

Access

- Umbilical Venous Access
  - Low lying UVC placement



https://obgynkey.com/umbilical-vessel-catheterization/

- Peripheral IV
  - 24G or 22G catheter
  - Can place anywhere you see a vein – always point towards heart
  - Vessels are very shallow – don't always get a flash back

https://emedicine.medscape.com/article/1348863-technique

- Intraosseous
  - Proximal Tibia placement
  - Hand placement vs IO drill may be more successful
  - Only attempt in full term infants

https://www.slideserve.com/anevay/routes-of-drug-administration-powerpoint-ppt-presentation

Post-Resuscitation Care

Hypothermia

- **Goal Temp: 36.5 - 37.5 Degrees Celsius**

- What does an infant do to conserve heat?
  - Vasoconstrict
  - Metabolize brown fat
  - Increase tone

- Detrimental Effects of Hypothermia
  - Bradycardia
  - Apnea
  - Lethargy
  - Acrocyanosis
  - Metabolic acidosis

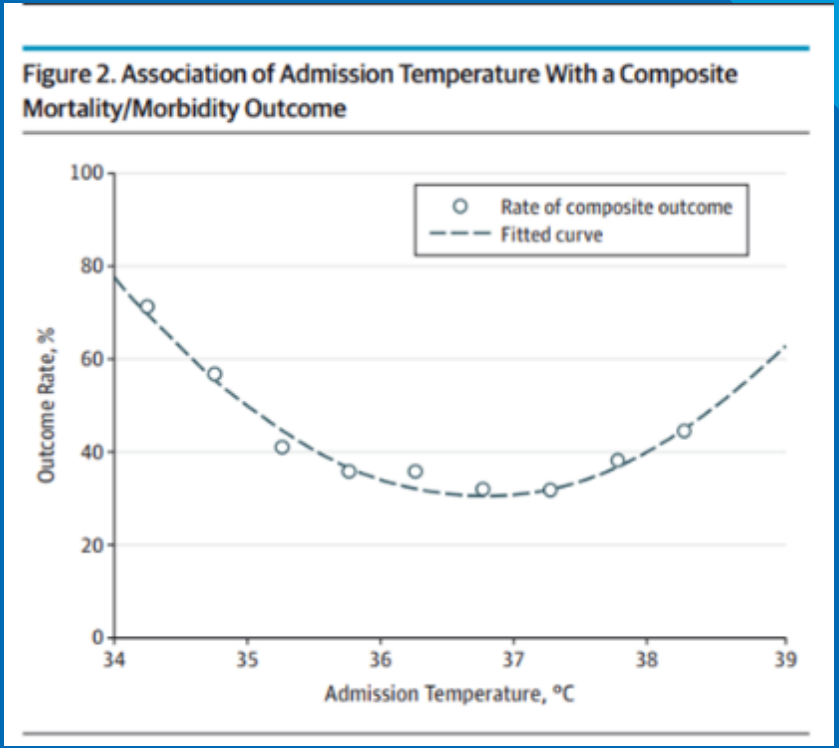
Impaired Immune function
Impaired surfactant production
Impaired coagulation

Post-Resuscitation Care

Hypothermia

- A 2015 study demonstrated a U-shaped relationship between outcomes and temperature
- Lowest rates of mortality and morbidity outcomes associated with temps between 36.5 – 37.2 degrees Celsius

(Lyu, et al, 2015)



Lyu, et al, 2015

Post-Resuscitation Care

Hypothermia:

- What can you do to prevent hypothermia:
  - Increase the temperature of delivery room
  - Provide warm blankets
  - Place hat on infant shortly after birth
  - If infant is stable – place skin to skin with mom

- Be careful with items that are not temp controlled

Post-Resuscitation Care

Hypoglycemia:

- Defined as a blood glucose <50mg/dl

- Most infants can maintain their blood glucose for a period time after birth

Post-Resuscitation Care

Hypoglycemia:

- Infants at risk for hypoglycemia:
  - Infants with Inadequate Glycogen Stores
    - Premature
    - Small for Gestational Age
  - Infants with Hyperinsulinemia
    - Infant of a diabetic mother
  - Infants with Increased Glucose Utilization
    - Sick infants
    - Respiratory Distress
    - Hypothermia
    - Infection

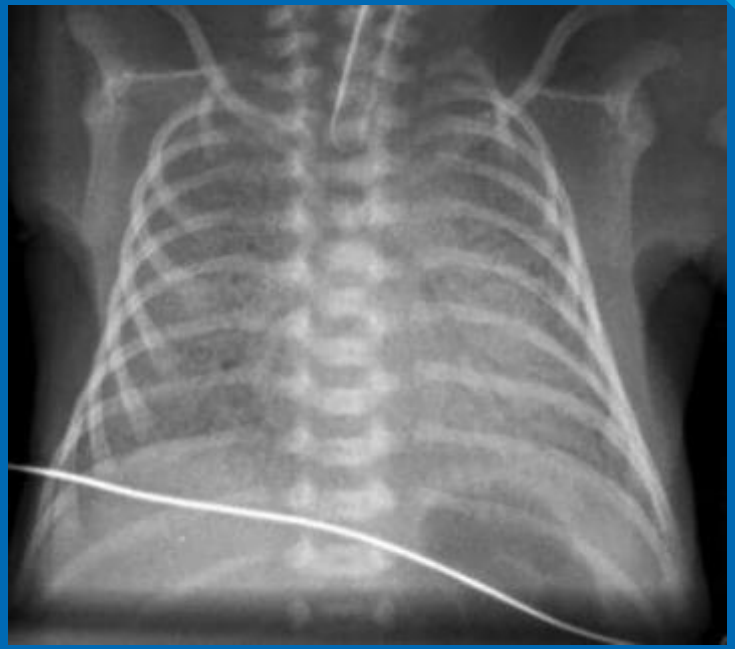
- Treatment:
  - D10 – 2ml/kg (rate 1ml/minute) – recheck in 15 minutes.
  - D10 infusion at 80ml/kg/day

Respiratory Emergencies

Respiratory Distress Syndrome

- Causes:
  - Surfactant Deficiency in premature lungs
  - Surfactant Deactivation
    - Meconium Aspiration
    - Blood Aspiration
    - Amniotic Fluid Aspiration
    - Pulmonary Hemorrhage
  - Genetic Causes:
    - Surfactant Protein B Deficiency

- Most commonly seen in preterm or late preterm infants



https://emedicine.medscape.com/article/409409-overview

Respiratory Distress Syndrome

- Symptoms
  - Onset is shortly after birth
  - Tachypnea, Retractions, Grunting
  - Decreased oxygen saturation
  - X-ray with granular opacities with or without air bronchograms
- Treatment:
  - Support Breathing
  - CPAP
  - Intubation if severe
  - Surfactant

Pneumothorax

- Can occur in any infant, but more common in infants that received PPV or CPAP or infant with meconium aspiration
- Symptoms:
  - Sudden deterioration
  - Decreased breath sounds on affected side
  - Hypoxemia
  - Skin mottling
  - Tachycardia or Bradycardia
  - Hypotension
- Treatment:
  - Thoracentesis

https://doclibrary-rcht.cornwall.nhs.uk/DocumentsLibrary/RoyalCornwallHospitalsTrust/Clinical/Neonatal/PneumothoraxNeonatalClinicalGuideline.pdf

Neurological Emergencies

THE MISFITS

The Critically Ill Infant

T 

Trauma: Both accidental and non-accidental. Consider the larger head, compliant chest wall, and less protected internal organs

H 

Heart: Includes structural congenital heart disease and acquired heart disease. Always check for hepatomegaly and a murmur. Consider PGEI.

E 

Endocrine: Acute salt-wasting crisis in undiagnosed CAH (↓Na, ↑K, ↓HCO3, ↓Glu). Treat with hydrocortisone (25mg for babies, 50mg for kids, 100mg for adults).

M 

Metabolic: Electrolyte abnormalities such as hypoglycemia (<60 in infant, <40 in neonate). Broad differential. Rule of 50s: D% x #ml/kg fluid = 50.

I 

Inborn Errors of Metabolism: Major classes include organic acidurias and urea cycle defects. Profound anion gap metabolic acidosis. Draw an ammonia.

S 

Sepsis: Leading cause of critical illness in infants. Draw cultures and cover broadly (e.g. vanc, cefepime or CTX, +/- acyclovir, anaerobic coverage.

F 

Formula: Incorrect mixing can lead to ↓Na (<130) or ↑Na (>150). Can lead to seizures and AMS. Correct hyponatremia with 3-5cc/kg of hypertonic saline.

I 

Intestinal Catastrophe: Includes malrotation with midgut volvulus, NEC, Hirschsprung's enterocolitis, intussusception. Radiographs and ultrasound.

T 

Toxins: Intentional or unintentional. One pill killers: CCB, TCA, opiates, sulfonylureas, Class 1 antiarrhythmics, antimalarials, camphor, oil of wintergreen.

S 

Seizures: High risk related to CNS abnormalities and metabolic disease. First-line: bentos (Ativan 0.1mg/kg); second-line: phenytoin/fosphenytoin, phenobarbital, keppra (all 20mg/kg except Keppra, which is 20-60mg/kg).

Created by Elan Duncan, MD, PhD, 12/2020

https://www.peminfographics.com/infographics/the-misfits

Seizures

- Neonatal seizures can be very subtle since their cortical development is not complete

- Signs and Symptoms:
  - Eye deviation
  - Lip Smacking
  - Abnormal tongue movements
  - Pedaling
  - Apnea

- Treatment:
  - Lorazepam IV (0.05mg/kg – 0.1mg/kg)
  - Midazolam IV or IN (0.05 – 0.1mg/kg)
  - Check Glucose

BRUE – Brief Resolved Unexplained Event

- Occurs in infant < 1

- Symptoms include at least 1 of the following:
  - Color change to cyanosis or pallor
  - Apnea or irregular breathing
  - Change in tone (either hypertonic or hypotonic)
  - Altered level of consciousness

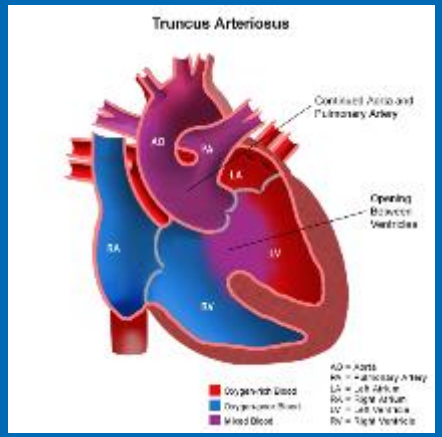
- Lasts < 1 min, usually 20-30 seconds

- Infant needs to be evaluated
  - Physical Exam
  - CHECK GLUCOSE
  - Rule out other causes
  - Infant should be monitored with EKG and pulse ox

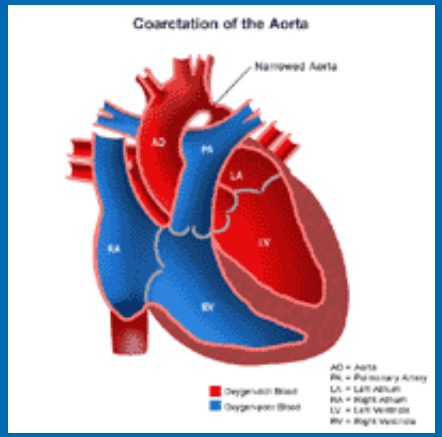
Cardiac Emergencies

Congenital Heart Disease

- Universal Screening for Cardiac Defects
- Congenital heart disease can be used to describe a large number of cardiac structural anomalies or anomalies of the vessels.
- When the cardiac defect is dependent on the ductus to maintain their systemic blood flow, known as obstructive left side lesions, the infant can present in significant shock.
- When the cardiac defect is dependent on the ductus for pulmonary blood flow, known as obstructive right sided lesions, the infant can present with severe cyanosis.



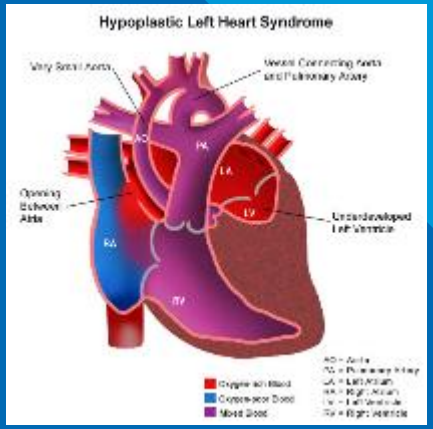
https://www.choc.org/heart/congenital-heart-defects/truncus-arteriosus/



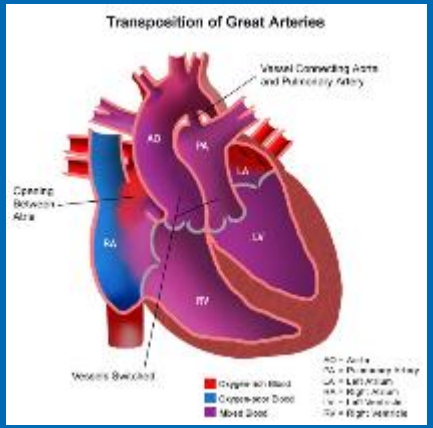
https://www.choc.org/heart/congenital-heart-defects/coarctation-of-the-aorta/

Congenital Heart Disease

- History and PE Exam that Increases Suspicion of CHD
  - Poor feeding for several days to weeks – fatigue with feeding
  - Absence of temp instability or other signs of sepsis
  - Oxygen desaturation that doesn't respond to O2 therapy – difference between pre/post ductal saturations
  - Difference between brachial and femoral pulses
  - Hepatomegaly
  - Presence of Murmur
  - Tachypnea without other signs of distress



https://www.choc.org/heart/congenital-heart-defects/hypoplastic-left-heart-syndrome/



https://www.choc.org/heart/congenital-heart-defects/transposition-of-the-great-arteries/

Congenital Heart Disease

Treatment:

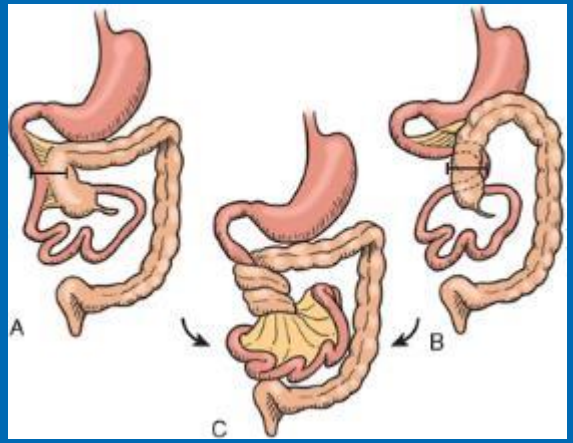
- Support Airway, Breathing, Circulation
- Check upper and lower BP’s
- Check Pre/Post Ductal Saturations
- Get ECHO to confirm diagnosis
- Prostaglandin E infusion is needed for ductal dependent lesions

GI Emergencies

GI Emergencies

Malrotation with Volvulus

- Symptoms
  - Bilious Emesis
  - Abdominal Distention
  - May present in shock if there is bowel ischemia
- Treatment
  - NPO
  - Gastric Decompression
  - Transport to a facility that can do an UGI
  - Surgery



https://basicmedicalkey.com/malrotation-volvulus-and-bowel-obstruction/

https://www.safercare.vic.gov.au/clinical-guidance/neonatal/vomiting-in-neonates

https://www.pedsurglibrary.com/apsa/view/Pediatric-Surgery-NaT/829042/all/Intestinal_Rotational_Abnormalities

Case Studies

Case Study #1

- 5-day old infant is being brought in by EMS from stand alone ED after parents brought infant in with “fast breathing” and poor feeding.
- Infant was born at a birth center. MOC had good prenatal care throughout pregnancy
- Infant’s APGARS were 7 and 9.
- No maternal risk factors, GBS status unknown

Prior to Arrival

- Outside hospital placed a PIV and gave a 20ml/kg Normal Saline Bolus
- Presumed sepsis
- Did not want to wait for CCT transport, so called 911 and had them transport the infant

What is on your differential based on the history?

- Sepsis
- Failure to Thrive
- Ductal Dependent Cardiac Lesion
- Heart Failure
- Non-Accidental Trauma

Physical Exam

Airway: Patent

Breathing: Tachypneic into the 70's with slight subcostal retractions, breath sounds are clear and equal, oxygen saturations are 88% on 1L NC.

Circulation: HR is 135 – 140 NSR, BP: 50/28 (39), capillary refill is 4-5 seconds, infant is mottled

Disability: Infant has poor tone and is minimally reactive

Exposure: Temp is 37.0, no rashes or abnormal skin conditions noted

Physical Exam

What additional things would like to know on your physical exam?

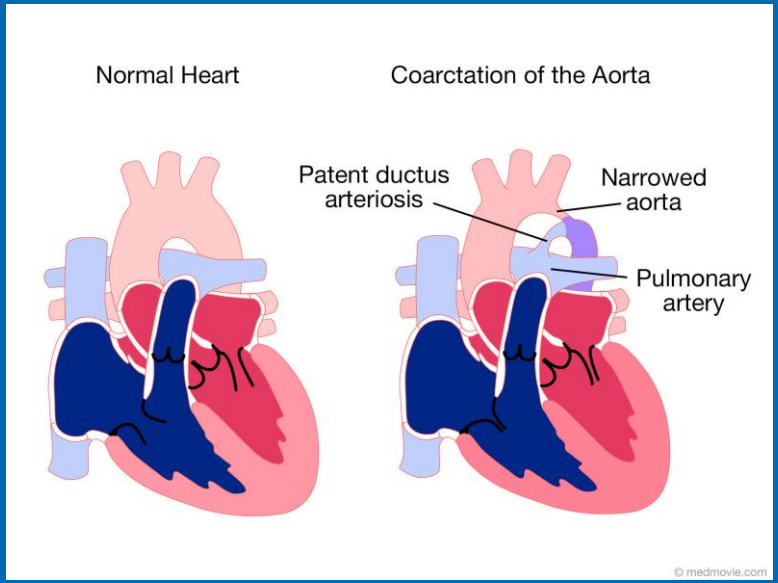
- Check Brachial vs Femoral pulses
- Check upper and lower BP’s
- Check Pre and Post-ductal saturations
- Liver Edge
- Hyperoxia Test

Physical Exam

- Brachial Pulses are 2+ / Femoral Pulses are barely palpable
- 15 - point difference between upper and lower BP systolic
- Pre-ductal saturations are 89%, post-ductal saturations are 70%
- Liver edge is 1cm below RCM
- No significant difference in arterial oxygen levels on Hyperoxia test

What do you think the diagnosis is?

- Infant had coarctation of the aorta
- Started on Prostaglandin E1 infusion at 0.0125mcg/kg/min
- Admitted to CICU



Case Study #2

- 3-week-old infant brought into EMS after patient had a breath-holding spell and became cyanotic at home.

- History:
  - Home birth 6 days in a birthing tub
  - Good prenatal care with midwife throughout pregnancy
  - Mom’s 2nd pregnancy and 2nd child
  - Uncomplicated delivery
  - Apgar's 8 and 9
  - Infant has been breast feeding well

Anything else you want to know?

Physical Exam

Airway: Patent

Breathing: Tachypneic into the 60's, no increased WOB. Breath sounds clear and equal, oxygen saturations at 95% in room air.

Circulation: HR 175, BP slightly below normal

Disability: Infant with slightly decreased tone

Exposure: Temp is 37.0, no rashes or abnormal skin conditions noted

Event

- 20 minutes after patient arrival, infant had an apneic episode with decreased level of consciousness and cyanosis
- Infant also noted to have twitching of the right arm that did not stop with pressure and eye deviation to the left.
- Infant required BVM ventilation
- No PIV in place, Intranasal Midazolam given
- Infant is minimally responsive with inadequate respiratory drive – patient intubated and placed on vent

What is the cause of the seizure?

- What labs and tests would you like at this time?

Labs and Tests

- CBC showed leukocytosis and bandemia
- Blood gas shows a metabolic acidosis
- Hgb is 7 with a HCT of 21 (PRBC's ordered)

- CXR shows clear lung fields, normal gas pattern through bowel

- Repeat physical exam is significant for oozing from IV stick sites.

- Coags sent:
  - PT: 30 (12.5 – 16)
  - PTT 58 (25 – 30)
  - PLTS 300 (150 – 350)

More Information

- Anything else you would like to ask the parents?
    - Parents state that they declined Vitamin K and Erythromycin at birth

CT Results

- Infant had extensive intraventricular hemorrhage, extensive subdural and subarachnoid hemorrhages
- Patient with poor neurological outcome

Hemorrhagic Disease of the Newborn

- Newborn infants are at risk for Vitamin K deficiencies due to:
  - Limited placental transfer
  - Poor bioavailability and absorption via breast milk and formula
- Vitamin K prophylaxis introduced in 1940's to decrease the incidence
  - Without prophylactic dose at birth the deficiency can last up to 6 months

Prevalence

A 2020 article published in Hospital Pediatrics estimated the refusal rate for intramuscular Vitamin K by parents ranged from:

- 0 – 3.2% for infants born within a US hospital
- Up to 14.5% for infants born at home
- Up to 31% for infants born in birthing centers

Types of Vitamin K Deficient Bleeding

Early Onset:

- Severe bleeding within the first 24 hours of life
- Related to maternal exposures that interfere with Vit K metabolism (ie. Warfarin)

Classic:

- Occurs within the first 1-7 days of life
- Less severe
- Presents with persistent bleeding of umbilical stump or circ site or GI bleeding

Late Onset

- Occurs 2 – 12 weeks usually
- 30-60% present with intracranial hemorrhages
- Associated mortality is 14%

Resources

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