Neonatal Emergencies

"Big Problems for Our Small Patients"

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

Objectives

Discuss Fetal Transition from Intrauterine to Extrauterine Life

Review Neonatal Resuscitation

Discuss Post-Resuscitation Stabilization

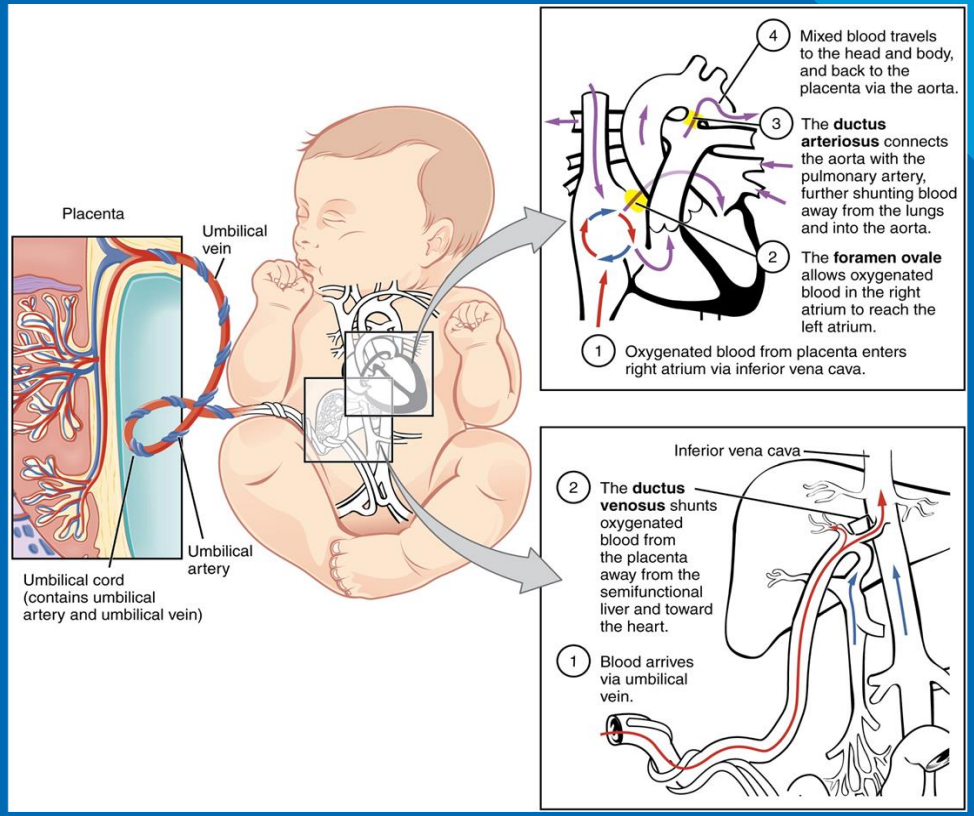
Discuss Types of Neonatal Emergencies

Life in the Uterus

Key Points:

- Umbilical vein brings oxygenated blood from the placenta to the fetus
- Enters fetus through the liver and into right side of the heart
- Fetal shunt 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
- Oxygen saturation of a the fetus is approximately 50-60%

(AHA, 2022)



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

Physiological Changes at Birth

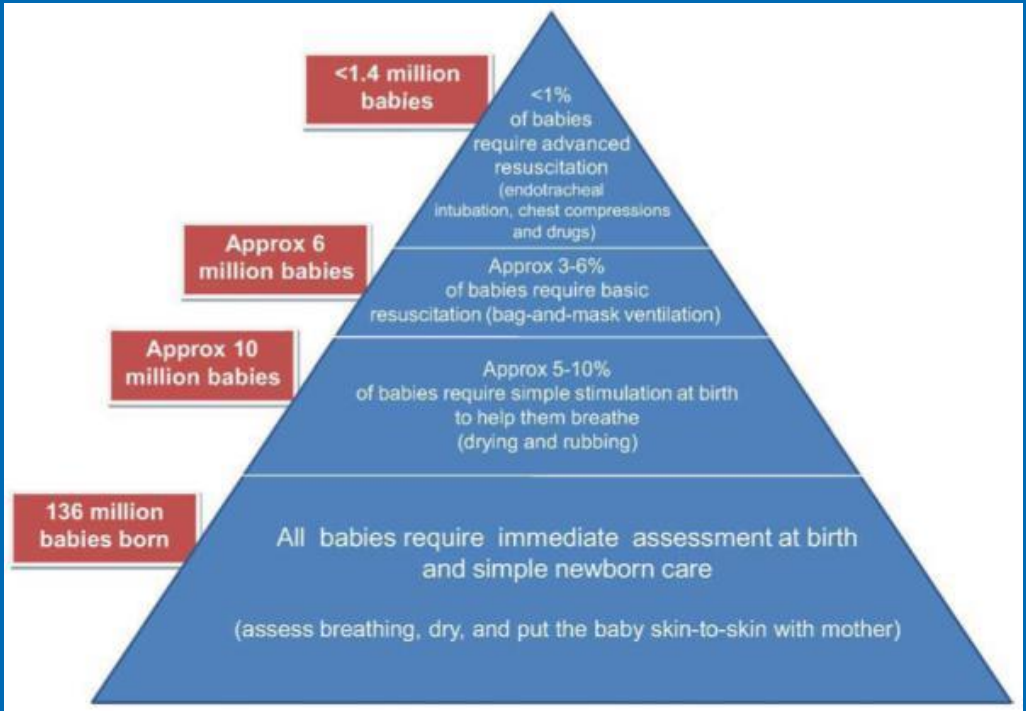
Changes at Birth	Result
Newborn takes their first breath and cries	Fluid is absorbed from the alveoli and the lungs fill with air
Increased O2 levels in the lungs causes dilation of the blood vessels	Pulmonary vascular resistance decreases
Umbilical Cord Clamped ideally after at least 30-60 seconds	Systemic BP increases

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

(Weiner & Zaichkin, 2021)

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)

Neonatal Resuscitation

Questions to ask

- What is the expected gestational age?
- Is the amniotic fluid clear?
- Are there any additional risk factors?
- What is the umbilical cord management plan?

(Weiner & Zaichkin, 2021)

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) (Yang 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)

Steps for Resuscitation

1. Infant is born – Ask 3 questions
    - Is the infant term?
    - How is the infant's tone?
    - Is the infant breathing/crying?

2. Warm, Dry, Stimulate
    - Vigorously dry and stimulate at the same time (unless <32 weeks)
    - Remove wet linens
    - Suction only if you see secretions in the airway
        - Mouth 1st then nose

https://www.independent.co.uk/life-style/health-and-families/giving-birth-midwife-guide-child-labour-baby-mother-don-t-tell-you-a7484886.html

(Weiner & Zaichkin, 2021)

3. Assess for Apnea/Gasping OR HR <100

- If Infant is apneic/gasping, or HR <100
  - Provide Positive Pressure Ventilation (PPV)

Positive-Pressure Ventilation | Textbook of Neonatal Resuscitation | AAP Books | American Academy of Pediatrics

(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

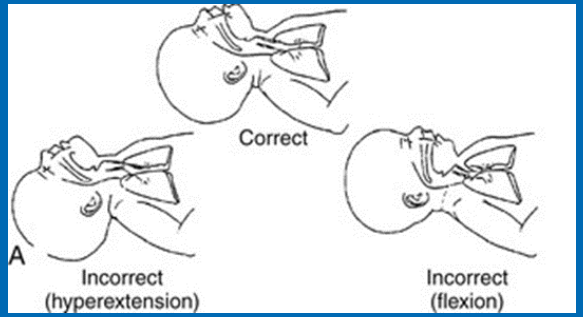
Rate is 40 – 60 Breaths per minute

(Weiner & Zaichkin, 2021)

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

PPV and Advanced Airway

- Open airway by placing infant in the sniffing position



https://clinicalgate.com/pulmonology/

- Make sure it's the right size mask
- When creating a seal with the mask ensure that you are not occluding the soft tissue of the neck

https://www.myheart.org.sg/wp-content/uploads/2019/07/6.-Neonatal-Resuscitation-by-Dr-Selina-Ho-Kah-Ying-Dr-Ereno-Imelda-Lustestica-and-Dr-Vina-Tagamolila-Canlas.pdf

(Weiner & Zaichkin, 2021)

5. After 30 seconds of PPV recheck HR
   - If HR < 60 start chest compression
   - Compression to Ventilation ratio is 3:1
   - 90 compressions and 30 breaths in 1 minute

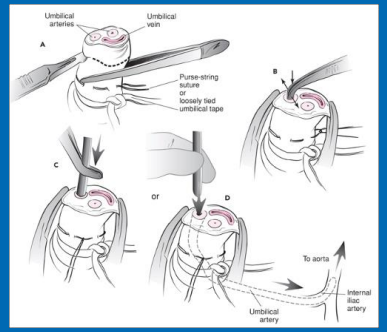
SDM College of Medical Sciences and Hospital (sdmmedicalcollege.org)

6. After 1 minute of compression and PPV – Recheck HR
   - HR < 60 - check for good chest rise and effective compressions
   - Obtain Access and give Epinephrine
     - Epinephrine Dose (1mg/10ml):
       - ETT 0.1mg/kg
       - IV 0.02mg/kg
     - NS Bolus/PRBCS (signs of hemorrhage or shock)
       - 10ml/kg
       - Over 5-10 minutes

(Weiner & Zaichkin, 2021)

Access

- Umbilical Venous Access
  - If you are certified to place



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

- Peripheral IV
  - 24 or 22G catheter
  - Can place anywhere you see a vessel – 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

Supraglottic Devices

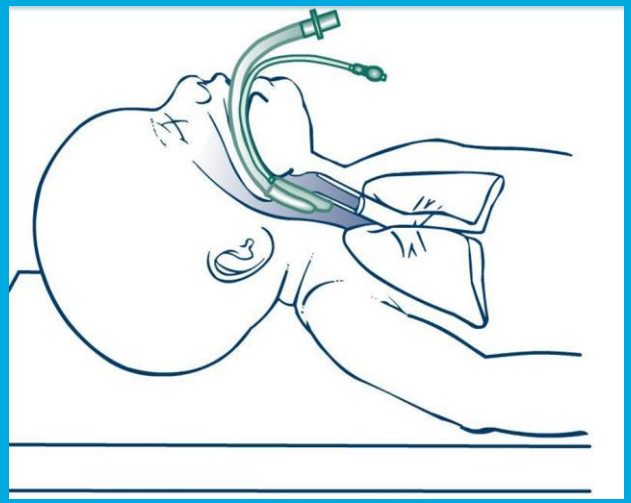
IGEL Size 1

(Weight 2kg - 5kg)

https://www.flemingmedical.ie/airways/

LMA Size 1

(Weight < 5kg)



https://www.tomwademd.net/neonatal-resuscitation-program-use-of-the-laryngeal-mask-airway/

https://www.researchgate.net/figure/Infant-in-polyurethane-bag-parental-consent-obtained-for-use-of-photograph_fig1_7877401

Premature Delivery

For infants less than 32 weeks

- Increase the room temp to 74 – 77 degrees
- Place in a plastic bag from the neck down
- Use a thermal mattress if available

Post-Resuscitation Care

Hypothermia

- **Hypothermia increases the chances of morbidity and mortality in infants**

- At birth infants go from an approximate intrauterine temp of 37 degrees Celsius to a temp of approximately 25 degrees Celsius

- **The neonate can lose heat at a rate of 0.1 – 0.3 degrees Celsius per minute. Up to 0.2 – 1 degrees Celsius per minute.**

https://www.healthynewbornnetwork.org/hnn-content/uploads/MSF_Advanced-Neonatal-Care_2015.pdf

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

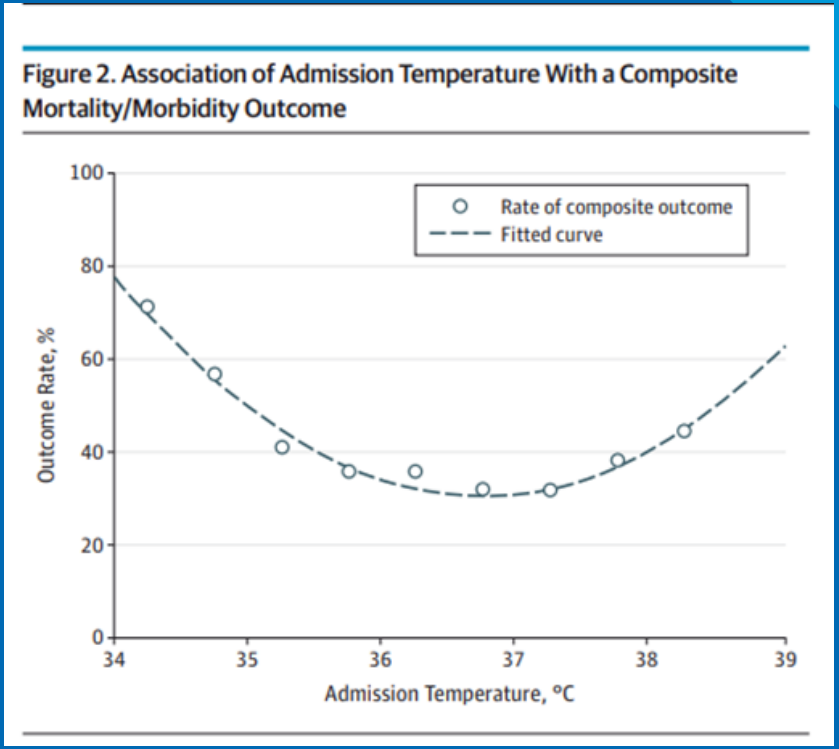
- Detrimental Effects of Hypothermia
  - Bradycardia
  - Apnea
  - Lethargy
  - Acrocyanosis
  - Metabolic acidosis
  - Impaired Immune function
  - Impaired surfactant production
  - Impaired coagulation
  - Hypoglycemia

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 temp of the DR or ambulance
  - Provide warm blankets
  - Place hat on newborns shortly after birth
  - Put newborns born at 32 weeks or less in a plastic bag
  - If infant is stable – place skin to skin with mom

Post-Resuscitation Care

Hypoxia

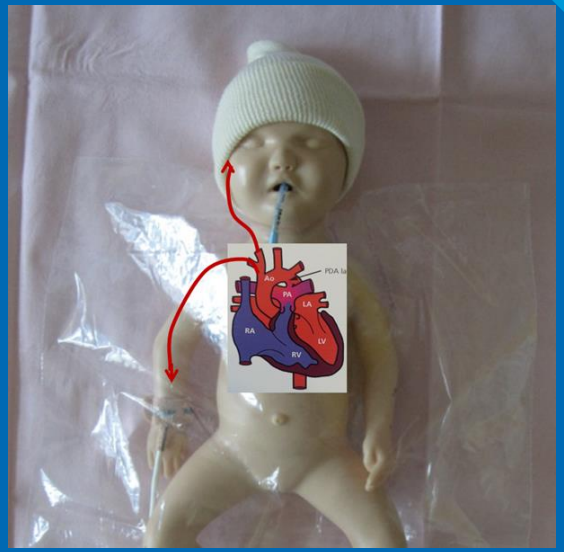
- Neonates are very sensitive to hypoxia – it's the number one cause for bradycardia in this population

- Place oxygen saturation on the infant's right hand
  - Measures pre-ductal oxygen saturation
  - Target Oxygen Saturations

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/



https://www.neoresus.org.au/learning-resources/key-concepts/first-response/breathing/

Post-Resuscitation Care

Hypoglycemia:

- Usually Defined as a blood glucose <50mg/dl

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

https://www.lucieslist.com/week-24-gestational-diabetes/#gref

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

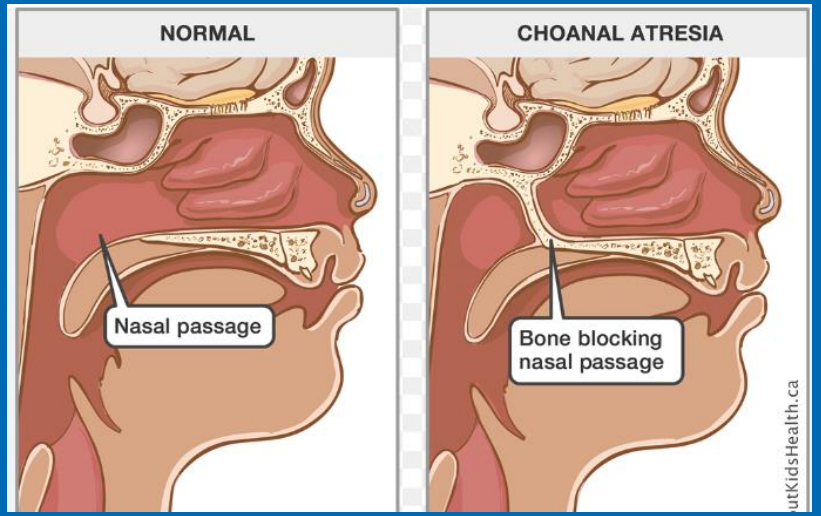
https://www.gmvemsc.org/vdb-dextrose.html

(Karlsen, 2012)

Congenital Defects

Choanal Atresia

- Occlusion of one or both nasal passages
- Symptoms
  - Infant will become cyanotic when quiet
  - Pinks up with crying
  - Unable to Pass suction cathether
- Treatment
  - Oral airway for frequent desaturations
  - Pacifier with opening



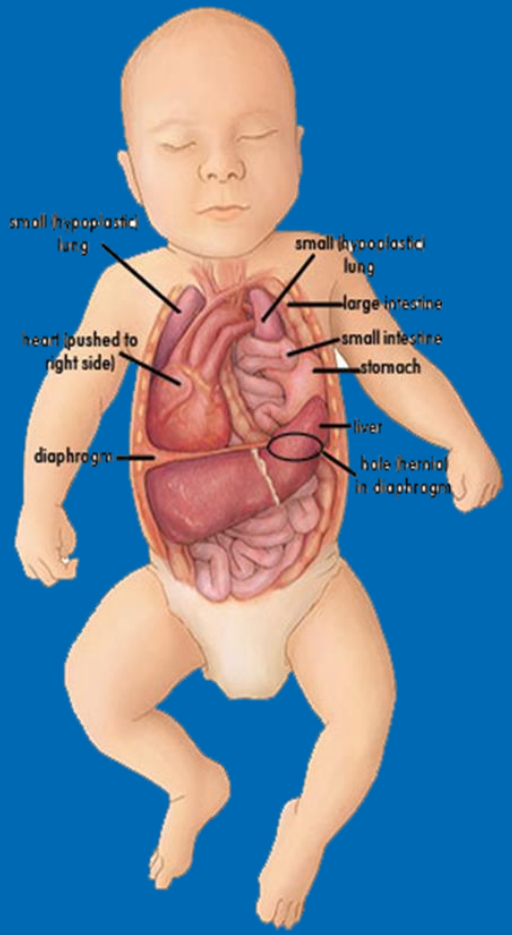
Abdominal Wall Defects

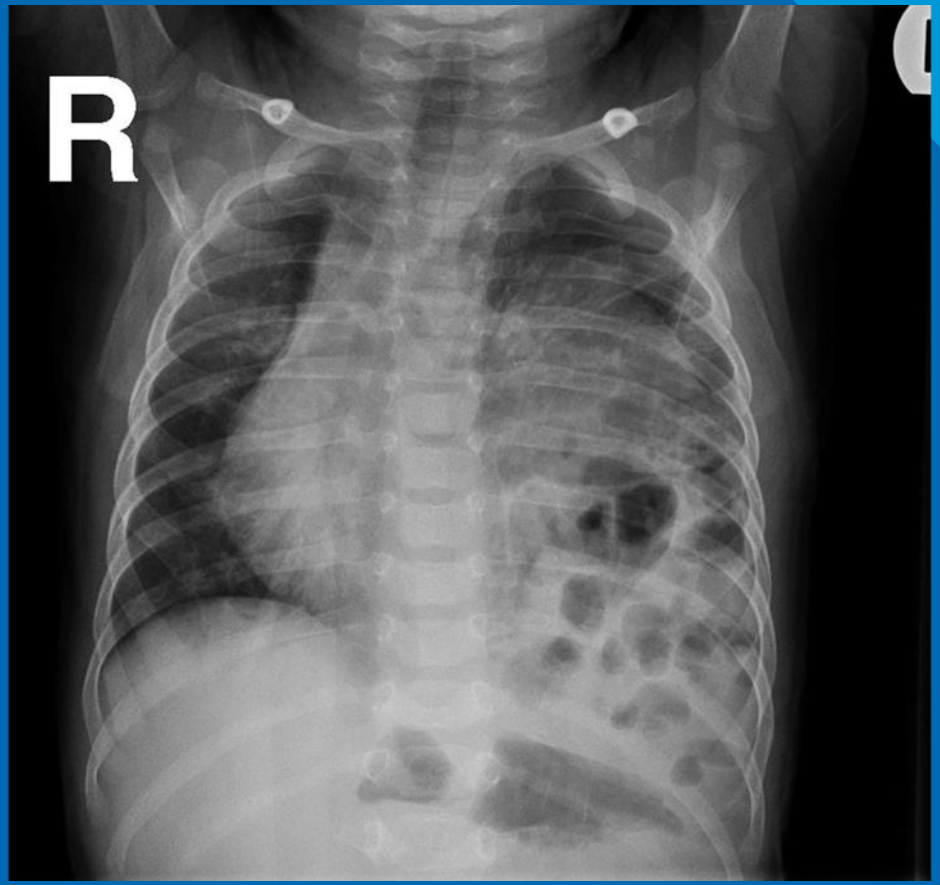
Gastroschises or Omphalocele

- Abdominal contents herniate through the abdominal wall
- Treatment
  - Place infant in sterile bag
  - Keep infant warm
  - Prevent hypovolemia
  - Position infant on side – monitor color of abdominal contents
  - Reposition if you notice the bowel looking dusky

Diaphragmatic Hernia

- Abdominal contents herniate through the opening in the diaphragm into the thoracic cavity
- The defect usually occurs on the left side
- Symptoms
  - Respiratory Distress
  - Bowel sounds heard on effected side of chest – no breath sounds
  - Barrel chest and scaphoid abdomen
- Treatment
  - Decompress the stomach with suction
  - Intubate
  - These infants are usually severely ill


small (hypoplastic) lung
small (hypoplastic) lung
large intestine
small intestine
heart (pushed to right side)
stomach
liver
diaphragm
hole (hernia) in diaphragm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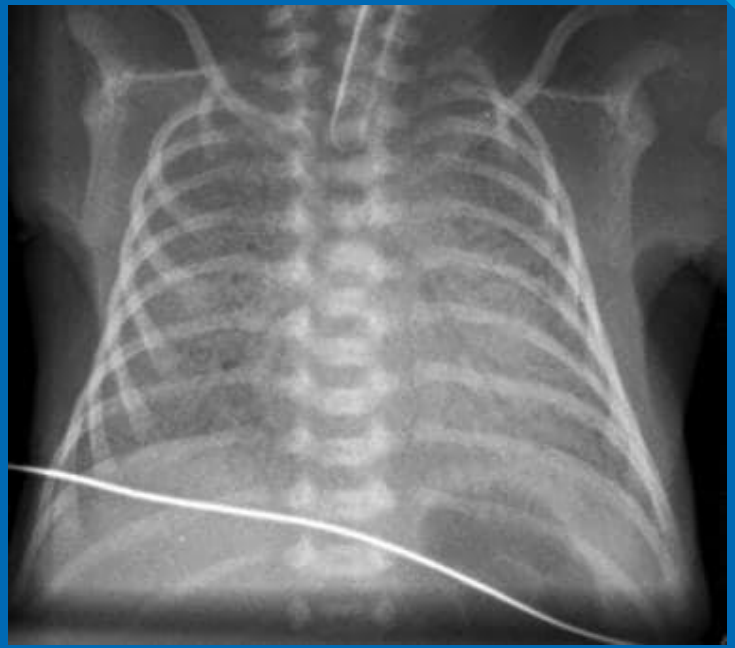
Respiratory Emergencies

Respiratory Distress Syndrome

- Caused by immature lungs and surfactant deficiency
- Usually preterm or late preterm infants
- 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



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

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

Pneumothorax

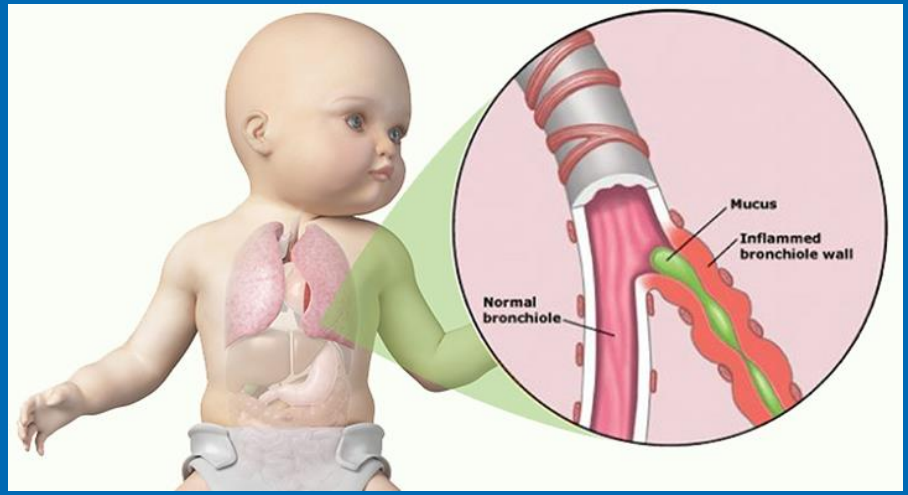
- Can occur in any infant, but more common in infants that received PPV or CPAP or infant with meconium aspiration

- 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

Bronchiolitis

- Usually caused by RSV
- Symptoms:
  - 1-3 days of cough, nasal discharge/congestion
  - Apnea
  - Tachypnea
  - Course breath sounds
  - Retractions
  - May have hypoxia
  - Decreased PO intake
- Treatment:
  - Suction if needed
  - Respiratory support if needed
  - NS Bolus and fluids if hypovolemic



https://www.researchgate.net/figure/The-figure-shows-Bronchiolitis-disease-20_fig5_319208257

https://www.babypromv.com/product/nosefrida-hygiene-filters/

https://mms.mckesson.com/product/853981/Philips-Healthcare-989805606951

https://www.neotechproducts.com/product/little-sucker-nasal-tip/

https://axiommedicals.com/products/amsino-international-suction-catheter-amsure-whistle-cap-style-16-fr-control-valve-vent-m-483573-4853-each

Neonatal Shock

Shock

Definition: Inadequate oxygen delivery to the tissues

Compensated vs Uncompensated Shock

https://personcenteredtech.com/2016/06/06/electronic-records-revelations-jay-ostrowski/baby_shocked_featuredsize/

Karlsen, 2013

Shock Physical Exam

Breathing:

- Tachypnea
- Increased WOB
- Apnea

Circulation

- Tachycardia (HR > 180)
- Pale or cyanotic
- Mottled
- Poor perfusion
    - Delayed capillary refill
    - Mottled and/or cool skin
- Chest X-ray
    - Heart Size
- Urine output

https://www.paediatricemergencies.com/collapsed-neonate/

Types of Neonatal Shock

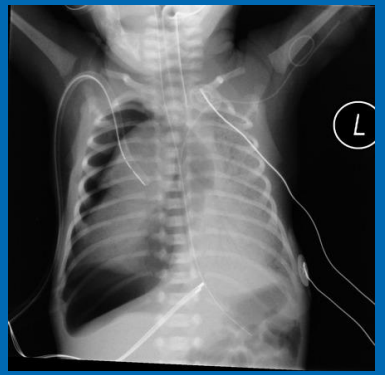
Hypovolemic

↓ Circulating Blood Volume

Causes:

- Intrapartum Blood Loss
- Postanal Blood Loss
- Obstruction
- Dehydration

https://doctorlib.info/pediatric/visual-diagnosis-treatment-pediatrics/2.html



https://radiopaedia.org/articles/neonatal-pneumothorax

Treatment:

- Volume
  - NS 10ml/kg/dose
  - PRBC 10 ml/kg/dose

Karlsen, 2013
Bhat & Plakkal, 2015

Types of Neonatal Shock
Cardiogenic

Myocardial Dysfunction / Heart Failure

Causes:
- Birth Asphyxia
- Infection
- Hypoglycemia
- Infection
- Arrythmias
- Congenital defect

Treatment:
- Treat underlying cause
- Consider Inotropes

https://radiopaedia.org/cases/neonatal-cardiomyopathy

Karlsen, 2013
Bhat & Plakkal, 2015

https://hellodoctor.com.ph/parenting/baby/premature-babies/neonatal-sepsis/

Types of Neonatal Shock

Septic

Loss of vascular integrity and profound hypotension

Causes:

- Infection

Treatment:

- Antibiotics
- Volume replacement – NS Bolus
- Vasopressors

Karlsen, 2013
Bhat & Plakkal, 2015

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 PGE1.**
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/fospheny, phenobarbital, keppra (all 20mg/kg except Keppra, which is 20-60mg/kg).

Created by Ellen 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 (0.05mg/kg – 0.1mg/kg)
  - Check Glucose

https://neovideos.aappublications.org/detail/videos/neurology/video/6196597125001/myoclonus---neonatal-seizures?autoStart=true

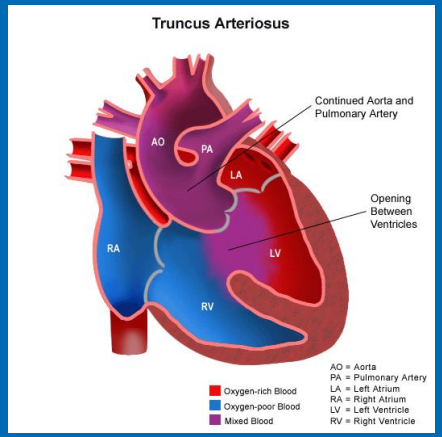
BRUE – Brief Resolved Unexplained Event

- Occurs in infant < 1
- Symptoms:
  - 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
- Exam
- CHECK GLUCOSE
- Rule out other causes
- Infant should be monitored with EKG and pulse ox

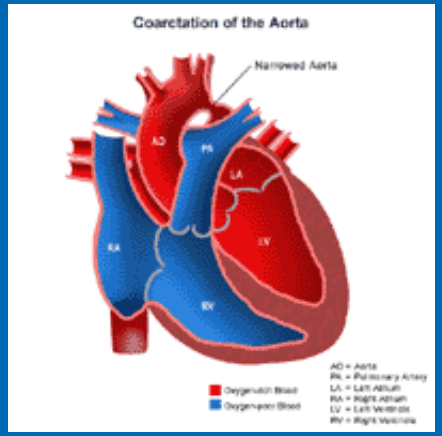
Cardiac Emergencies

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 or pulmonary blood flow – the neonate will present very ill in the first few weeks of life when their ductus closes.



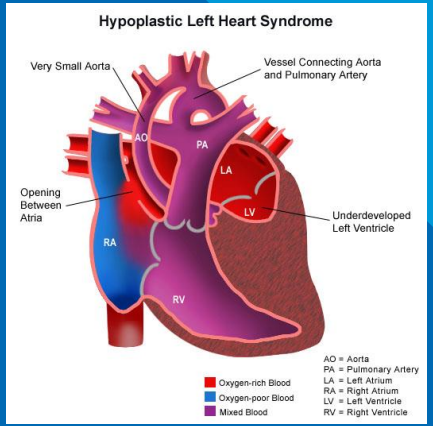
https://www.choc.org/heart/congenital-heart-defects/truncus-arteriosus/



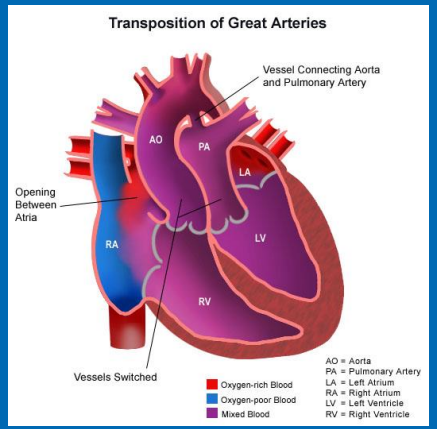
https://www.choc.org/heart/congenital-heart-defects/coarctation-of-the-aorta/

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
  - Oxygen desaturation that doesn't respond to O2 therapy – difference between pre/post ductal saturations
  - Difference between brachial and femoral pulses
  - Signs of CHD – Hepatomegaly, Pulmonary edema
  - Present 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

Transport:

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

Infection

Infection

- Risk Factors
  - Prolonged Rupture of Membranes
  - Maternal Infection
  - Chorioamnionitis
  - Procedures (prior or after birth)
- Symptoms:
  - Poor thermoregulation
  - Any fever in an infant <3 months is concerning
  - Lethargy, irritability, seizures, poor tone
  - Respiratory distress
  - Tachycardia, hypotension, mottled, poor perfusion
  - Poor feeding
  - Rashes
  - Glucose instability
  - Omphalitis
  - Monitor for signs of Septic Shock

https://starship.org.nz/health-professionals/infective-lesions-in-the-newborn/

Infection

Treatment:

- Provide oxygen to maintain saturations
- Treat hypotension with volume
- Treat hypoglycemia
- Stabilize Temperature
- Monitor for signs of septic shock
- Transport to facility for antibiotic treatment

Causes:

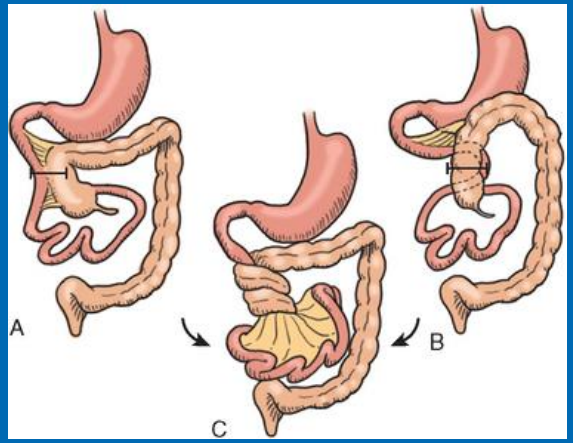
- Bacterial, Viral, Fungal

GI Emergencies

GI Emergencies

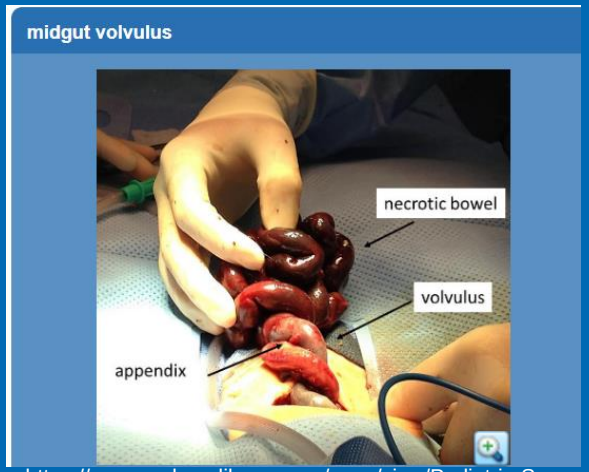
Malrotation with Volvulus

- 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

Key Points

- Neonates are infants <28 days
- Ventilation is the most important intervention for the apneic and bradycardic neonate.
- Know what a normal newborn exam consists of so you can recognize abnormal findings
- Airway, Breathing, Circulation
- Hypothermia increases the morbidity and mortality in neonates
- Most deliveries are uncomplicated and require routine resuscitation

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