Big Lessons: Tiny Patients

Neonatal Emergencies

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Objectives

- Describe the latest updates to neonatal resuscitation protocols and transport guidelines
- Identify key physical exam considerations and necessary tests for emergencies
- Discuss some of the most common neonatal emergencies seen in the first 28 days of life.

Case Study 1: Rural ED Birth

- A pregnant woman arrives at a small rural stand-alone emergency department in labor
- She is Gravida: 3 Para: 2
- No prenatal care. Thinks she might be 35 weeks pregnant.
- Her amniotic fluid has ruptured and is clear

Equipment

What equipment would you prepare?

- Towels and blankets
- Warmer (turned on)
- Hat
- Cord Clamp
- Bulb Syringe
- Suction Equipment
- BVM and appropriately sized masks
- Cardiac Monitor and Leads
- Supraglottic Airway or Intubation Supplies
- Plastic Bag

Infant is born!

Should the cord be immediately clamped so baby can be moved to the warmer?

Cord was clamped and cut 15 seconds after birth.

Infant is floppy with no respiratory effort. What would your first intervention be?

Infant was dried and stimulated

Heart Rate checked and found to be approximately 40 with no respiratory effort. What is your next intervention?

CPR was started at a rate of 15:2

What would your next steps be?

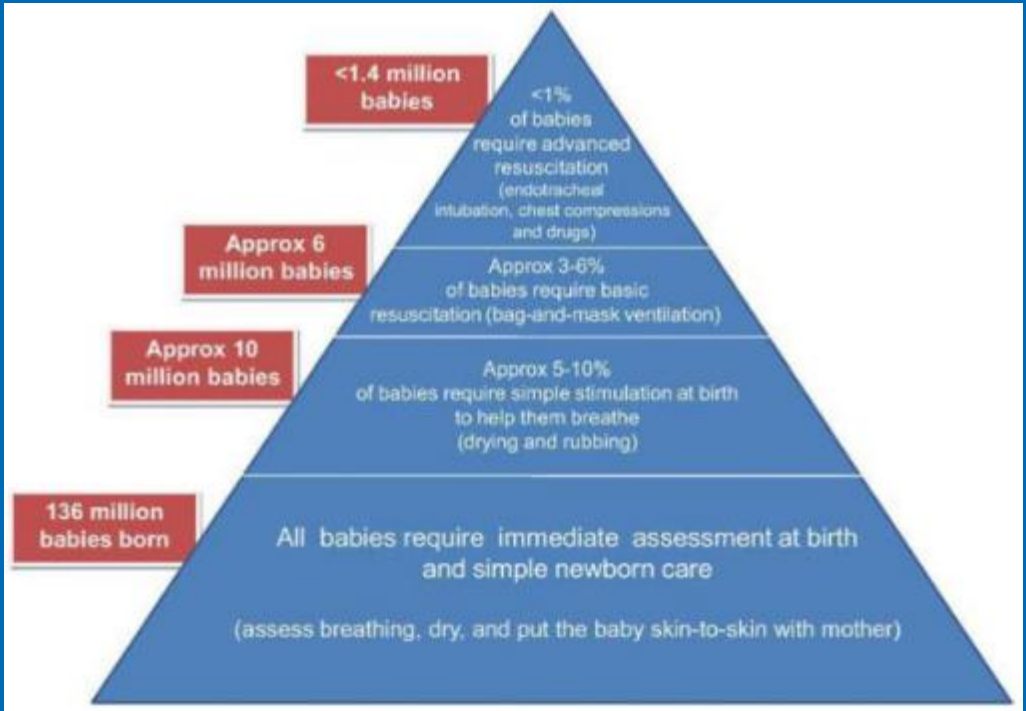
CPR was continued for 11 minutes.
At 11 minutes a supraglottic airway was placed

Once supraglottic airway was placed, HR increased >100 after 30 seconds

How could thing have been be done differently?

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/

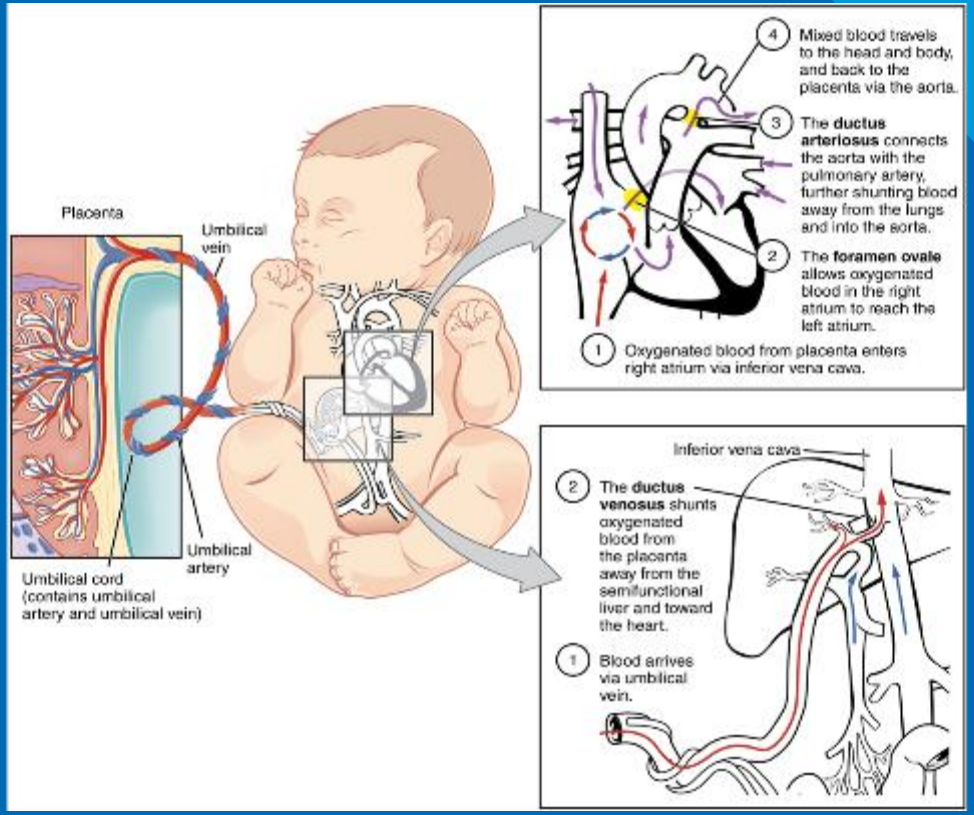
(Wall et al., 2009)

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)

- 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

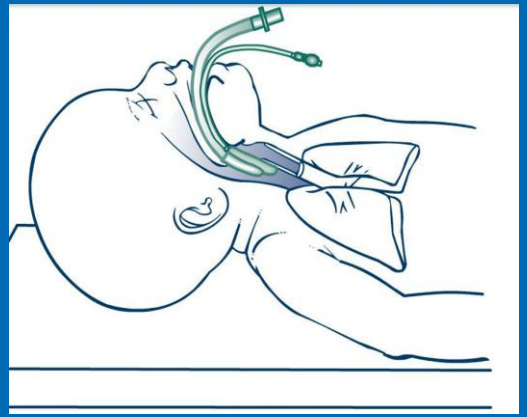
Updated PPV Guidance from AAP

- "Use of supraglottic airway may be considered as the primary interface to administer PPV instead of a face mask for newborn infants delivered at ≥34 weeks' gestation."

IGEL Size 1
2-5 kilograms (4.5 – 11lbs)

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

LMA Size 1
2.5 -5 kilograms (5 – 11lbs)



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

Air-Q3® Supraglottic Airway
Size 0: < 2kg (< 4.5 lbs)
Size 0.5: 2 - 4kg (4.5 lbs – 9 lbs)

https://myairlife.com/product/air-q3-intubatinglaryngeal-airway/

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/

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)

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

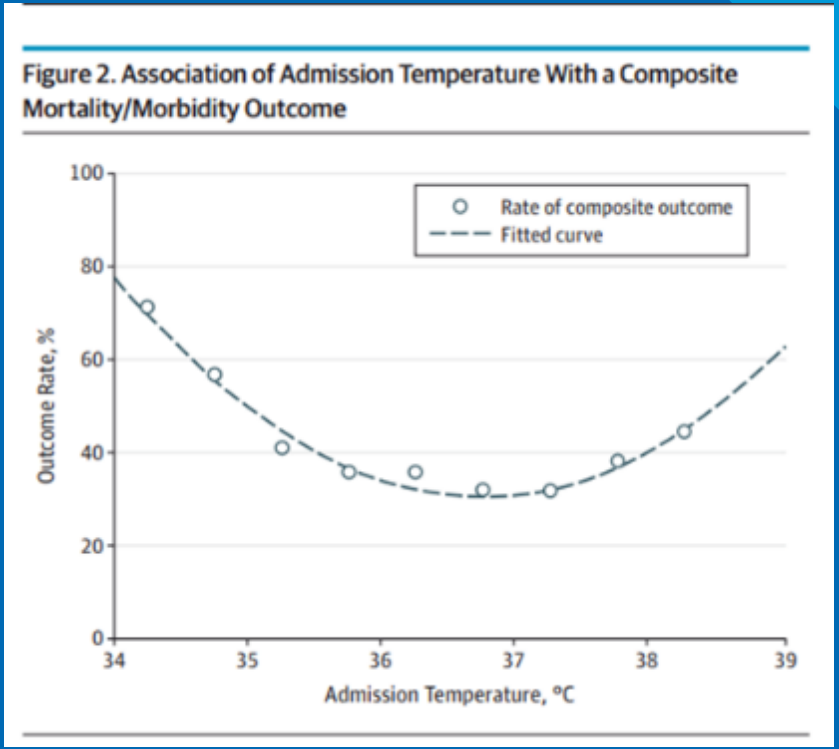
  Impaired Immune function
  Impaired surfactant production
  Impaired coagulation

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

Premature Delivery

Infant less then 32 weeks

Extra Supplies:

- Plastic Bag
- Thermal mattress

Case Study #2

- 5-day old infant is being brought in by EMS from an urgent care after the parents brought the infant in for “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 at birth.
- No maternal risk factors, GBS status unknown

Prior to Arrival

- The urgent care placed a PIV and gave 20ml/kg Normal Saline Bolus
- Presumed sepsis
- Infant is now being transported by EMS to the ED

What is on your differential?

Respiratory Disease
Pneumonia
Pneumothorax
Bronchiolitis

Cardiac Defects
Ductal Dependent Cardiac Defect
Arrythmia (SVT)

Central Nervous System
Intraventricular Hemorrhage
Meningitis
Seizures

Other
Sepsis
Midgut volvulus
Metabolic Disorder
NAT

Physical Exam

Airway: Patent

Breathing:
Tachypneic into the 80's with slight subcostal retractions, breath sounds are clear and equal. Oxygen saturations on right hand are 89% on Room Air.

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

Disability:
Infant is irritable with poor tone.

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?

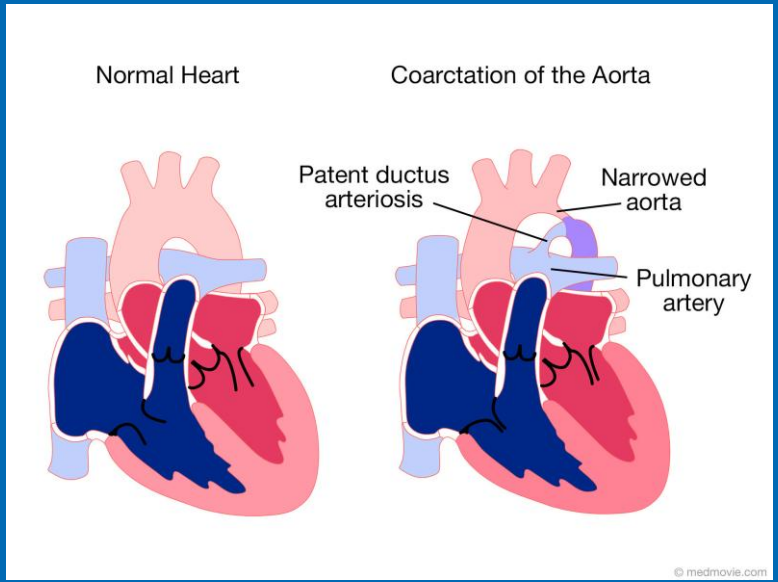
- Check a Glucose
- Check brachial vs femoral pulses
- Check upper and lower BP’s
- Check Pre- and Post-ductal saturations
- Blood Gas

Physical Exam

- Brachial Pulses are 2+ / Femoral Pulses are barely palpable
- 15-point difference between upper and lower BP systolic
- Pre-ductal saturations are 90%, post-ductal saturations are 79%
- Arterial Blood Gas showed a metabolic acidosis - Glucose 85

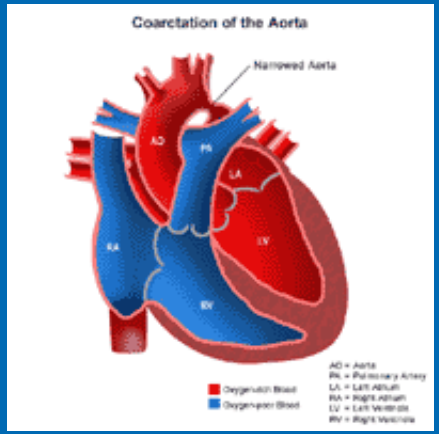
What is the diagnosis?

- Infant had Coarctation of the Aorta
- Started on Prostaglandin E1 infusion at in the Emergency Department
- Admitted to CICU



Congenital Heart Disease

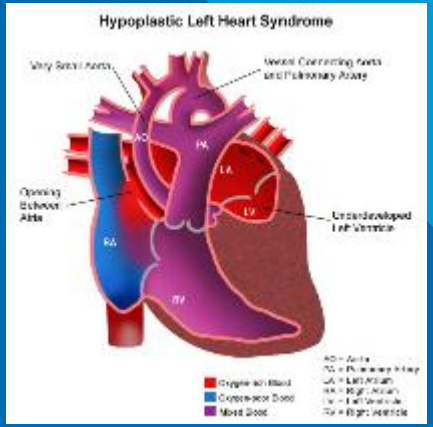
- Universal Screening for Cardiac Defects
- Congenital heart disease can be cardiac structural anomalies or anomalies of the vessels.
- When the cardiac defect is dependent on the ductus to maintain their systemic blood flow, known as obstructive left side lesions, the infant can present in significant 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.



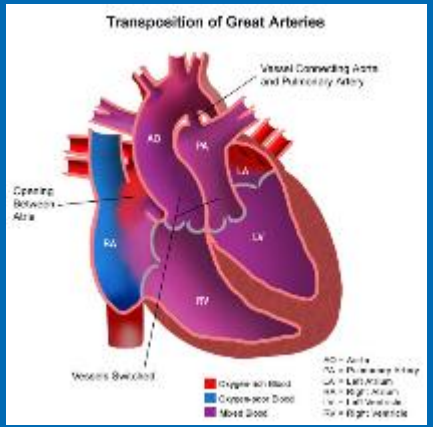
https://www.choc.org/heart/congenital-heart-defects/coarctation-of-the-aorta/

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
  - 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/

Case Study #3

- Parents called 911 after their 3-week-old infant had a breath holding spell and became cyanotic at home.

- History:
  - Home birth 6 days ago
  - 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 95% on 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

- 10 minutes out from the hospital the 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
- Upon arrival in ED infant is minimally responsive with inadequate respiratory drive – patient intubated and placed on vent

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

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

Labs and Tests

- CBC showed slightly increased WBC
- Blood gas shows a metabolic acidosis
- Hgb is 7 with a HCT of 21 (PRBC's ordered)
- Glucose: 80

- 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

- What else would you like to know?

- History:

    - Vaginal birth with no complications
    - No maternal risk factors
    - GBS status unknown
    - Parents declined Vitamin K and Erythromycin at birth

CT Results

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

Vitamin K Deficient Bleeding

- 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

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 2-7 days of life
- Less severe
- Presents with persistent bruising, bleeding of umbilical stump, circ site or GI bleeding

Late Onset

- Occurs 1 week to 6 months after birth (Most commonly 2-8 weeks after birth
- 30-60% present with intracranial hemorrhages
- Associated mortality is 14%
- Higher incidence in breastfed infants who did not receive Vitamin K at birth

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

Key Points

- Ventilation is the most important intervention for the apneic and bradycardic neonate.
- Airway, Breathing, Circulation
- Most deliveries are uncomplicated and require routine resuscitation
- Assessment should include birth history and maternal complications

Resources

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