Objectives

• Be cognizant of neonatal presentation of shock
  – Manifestations
• Be aware of neonatal etiologies that can present in shock
  – Sepsis
  – Congenital adrenal hyperplasia
  – Congenital heart malformations
  – Inherited disorders of metabolism
• Be cognizant of evaluation tools and therapies used in neonatal shock from various etiologies
  – Glucose infusions
  – Prostaglandins
  – Steroids
  – Pressers

Neonatal Shock

• Definition
  – inadequate tissue perfusion
  – variety of pathophysiology
  – result in cellular hypoxia and ultimately cell death
• Presentation
  – Cardiac
  – Respiratory
  – Signs of inadequate perfusion
    • Neurological
    • Renal
Normal heart rate


Shock:
Tachycardia most common
bradycardia uncommon/late

Normal systolic and diastolic blood pressures


Normal systolic blood pressures

Normal respiratory rate


Shock:
Acidosis compensated with increased minute ventilation
Often associated with labored breathing

Signs of inadequate perfusion

- Neurologic
  - Lethargy
- Renal
  - Oliguria
- Capillary refill and perfusion?


ED initial evaluation tool

- Airway/Breathing
  - monitor for apnea
- Circulation
  - monitor
- Dextrose
  - Blood glucose level (infants prone to hypoglycemia)
- Environment
- Cultures and antibiotics/antivirals
  - Blood, CSF, urine
- Studies
  - glucose, CMP, CBC with differential, UA, Urine culture
  - If stable CSF with cell count, protein, glucose, gram stain, culture
  - +/- Herpes studies, blood gas, lactate
  - ?Serum Amino Acids, Urine Organic acids
Shock considerations

• For infants in shock.
  – Besides ensuring airway and adequate respirations consider to improve tissue perfusion:
    • Ensure IV access (multiple and potentially central access)
    • Fluid bolus
    • Pressers
  – Antiviral, antibiotic medications
  – +/- evaluation of DIC

Goal in shock resuscitation

• resolution tissue ischemia
• normalized vital signs
• normalized pH
• lactate levels

Fluids and Vasopressors

• Fluids and vasopressor therapy
  – 10-20 ml/kg fluid bolus over 10-20 minutes depending on severity of symptoms and presence of myocardial disease

• Vasopressors
  – Dopamine (5-20 micrograms/kg/minute)
  – Dobutamine
  – Epinephrine (0.04 to 4 micrograms/kg/minute)
  – Norepinephrine

Subhedar NV, Dopamine versus dobutamine for hypotensive preterm infants. Cochrane Database of Systematic Reviews 2003
Havel, C. Vasopressors for hypotensive shock. Cochrane Database of Systematic Reviews 2011
**Evaluation of Hyponatremic Dehydration**

- Intravascularly depletion excludes SIADH and Renal/liver failure
- Hypovolemic dehydration breakdown: renal and extrarenal losses (or lack of intake). These can be differentiated by urine Na levels.
  - Na < 20mEq/L: kidneys functioning as expected
  - Na > 20mEq/L: altered renal function

**Fluids for Hyponatremic Dehydration**

- 20 ml/kg NS or LR bolus for hypotension
- Followed initially by D10/NS at 150/kg/day
  - What is the goal correction rate of sodium replenishment?
    - (0.5/hour)
  - What is the concern of hyponatremia?
    - Seizures (treatment 3% NS 2ml/kg/hour until Na> 120)
  - What is the concern of over-rapid correction?
    - Central pontine myelinolysis

**Congenital Adrenal Hyperplasia**

- Named after the deficient enzyme
- 21-hydroxilase deficiency most common
- Na loss/ dehydration/ acidosis
- Females may present with virilization
- Males enlarged penis or pigmentation
- Glucocorticoid (hydrocortisone)
- Mineralocorticoid (fludrocortisone/Florinef)
- +/- Na supplementation

http://www.hopkinschildrens.org/cah/printable.html

Medium Chain Acyl-Coenzyme A Dehydrogenase Deficiency (MCAD)

- More common inherited metabolic disorders
- Northern European descent
- Usually autosomal recessive inheritance
  – May have family history of presumed SIDS cases
- Enzyme responsible for cleaving triglycerides in times of fasting
  – Lack thereof leads to non-ketotic hypoglycemia with resultant neurological deficiency, acidosis, and shock.

Gordon B. Congenital Adrenal Hyperplasia Due to 21-Hydroxylase Deficiency
Metabolic disorders

- Securing airway
- IV access (central if possible)
- Avoid catabolism
- IV D10 bolus of 2ml/kg followed by glucose infusion 10-12 mg/kg/minute
  - D10 near 150 ml/kg/day
- NPO (avoid substrates that can exacerbate the problem)
- Frequent monitoring of glucose, acid base, and electrolyte labs
- Obtain UOA, Serum AA
- Cortisol, B-hydroxybuterate, Growth hormone, and insulin (hypoglycemia protocol)
  - Watch neurological status for seizures

Signs and treatment of CHD

- Respiratory distress and cardiomegaly on CXR
- Securing an airway
- IV access (central if possible)
- Diuretics
- Ionotropic medications (dopamine/Epinephrine)
- Echo
- Prostaglandins for likely ductal dependent cardiac lesion

CHD

[Image of CHD]

[Image source: http://www.crkirk.com/thumbnail/common/coarct.htm]
**CHD**

- Prostaglandin
- Known ductal dependent lesions with open ductus 0.0125 to 0.025mcg/kg/minute.
- Constricted ductus arteriosus 0.05 can titrate to 0.1 mcg/kg per minute.
- Complications
  - flushing, hyperpyrexia
  - hypotension, tachycardia, and apnea (especially with higher doses)

**CCHD Screening**

- Designed to identify critical congenital heart disease prior to decompensation
- Truncus Arteriosus
- Transposition of the Great Vessels
- Tricuspid Atresia
- Tetralogy of Fallot
- Total Anomalous Pulmonary Venous Return
- Hypoplastic Left Heart
- Pulmonary Atresia
Objectives Review

- Be cognizant of neonatal presentation of shock
  - Tachycardia, Tachypnea/labored breathing, lethargy, oliguria
- Be aware of neonatal etiologies that can present in shock
  - Sepsis Herpes
  - Congenital heart malformations
  - Congenital Adrenal Hyperplasia
  - Inherited disorders of metabolism
- Be cognizant of evaluation tools and therapies used in neonatal shock from various etiologies
  - Glucose infusions
  - Prostaglandins
  - Steroids
  - Pressers

Shock in the neonate

- Variety of etiologies
  - Broad Differential Diagnosis, but remember the top 3 are:
    - Sepsis
    - Sepsis
    - Sepsis
    - Congenital heart defects
    - Inherited disorders of metabolism
    - Endocrinopathies