SHOCK IN THE NEONATE

Developed by -
Lisa Fikac, MSN, RNC-NIC

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- Completion of the entire activity
- Submission of a completed evaluation form
- Completion of a post-test with a grade of at least 85%.

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Microsoft Office Clip Art and Creative Memories are the sources for all graphics unless otherwise noted.

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Objectives

- Identify the types and causes of shock in the neonate.
- Discuss the clinical presentation, clinical management, and outcomes of neonatal shock.
Inadequate perfusion, oxygenation, and delivery of nutrients to the vital organs which may lead to multi-system organ failure and even possibly death.

- There is inadequate removal of cellular wastes due to diminished perfusion.
- Shock is NOT hypotension.
  - Hypotension is usually a late sign of shock, NOT the initial presentation.
  - Central nervous system (CNS) reflexes may maintain BP despite the patient being in severe shock.
- Shock is a serious, life-threatening medical emergency requiring prompt recognition and aggressive, appropriate intervention.

Although shock may be due to varying causes and present differently in different newborns, the end result is the same -

- The longer shock persists the greater the chances the infant will sustain renal and/or brain damage.
- Although renal damage may be reversible, brain damage is irreversible.
- Failure to recognize and treat shock may result in multi-system organ failure and even death in the newborn.

There are three main types of shock seen in the neonate -

- Hypovolemic
- Cardiogenic
- Septic
Hypovolemic shock occurs because the circulating blood volume is insufficient and leads to inadequate tissue perfusion.

- The normal neonatal circulating blood volume is ~ 80-100 mL/kg.
- Hypovolemic shock occurs with ≥ 10% acute blood loss.
  - This leads to a decrease in cardiac output.

**Etiology**

Hypovolemic shock is the most common type of shock seen in the newborn.

- This may already be present at birth.

Hypovolemic shock may have the following origins -

- Acute and/or chronic blood loss
  - Placental abruption or previa
  - Placental laceration
  - Uterine rupture
  - Difficult delivery leading to trauma and/or hypoxia
  - Umbilical cord rupture
  - Maternal-fetal transfusion
  - Twin-to-twin transfusion
  - Sequestered blood
    - Intraventricular (IVH)
    - Gastrointestinal (GI)
    - Pulmonary
  - Accidental or incorrect removal of arterial lines
  - Iatrogenic causes such as lab draws
- Plasma or fluid losses
  - Effusions (erythroblastosis fetalis, non-immune hydrops)
  - Break in skin integrity
- Myelomeningocele, gastroschisis
- Dehydration
  - Occurs over time
  - May be due to emesis or diarrhea
  - Can occur as a result of insensible water loss
  - May be due to repeated discarding of GI residuals and/or stomach contents without replacement of fluid/electrolytes
Cardiogenic shock is primary pump failure that is characterized by insufficient cardiac output despite sufficient blood volume in the ventricles at the end of diastole and prior to systole.

**Etiology**

Cardiogenic shock occurs when the heart muscle functions poorly.

Cardiogenic shock may have the following origins -

- Intrapartum or postpartum asphyxia
- Hypoxia
- Metabolic acidosis
- Bacterial or viral infection
- Severe respiratory distress
- Severe metabolic or electrolyte imbalance
  - Severe hypoglycemia can interfere with myocardial function
  - Inborn errors of metabolism
- Arrhythmias
  - Can potentially decrease oxygenation and perfusion
- Congenital heart defects
  - Can interrupt normal blood flow patterns and lead to decreased oxygenation and perfusion
Septic shock can occur as a result of a severe infection.

- Toxins are released from the replication of the responsible organism, causing impaired peripheral arterial resistance.
- The loss of vascular integrity allows fluid leakage from the blood vessels into the tissue.
- Hypotension can be severe and usually requires a combination of hypovolemic and cardiogenic shock therapies.

**Etiology**

Either bacterial or viral infections may be responsible for septic shock.

Common organisms responsible for septic shock include -

- Gram negative cocci
  - *E. coli*
  - *H. influenzae*
  - *Neisseria gonorrhoea*
  - *Pseudomonas aeruginosa*
- Gram positive cocci
  - *Group B Streptococcus*
  - *Staphylococcus aureus*
  - *Staphylococcus epidermitis*
- Virus
  - Congenital herpes simplex virus (HSV) can be very significant

Pinpointing when the infection began can help in determining the etiology as well as the organism that is the likely culprit.
The initial presentation of shock in the neonate may be vague with non-specific signs and symptoms that could be attributed to other pharmacologic or physiologic processes.

**Shock occurs in three phases -**

- Compensated
- Uncompensated
- Irreversible

**Signs of the compensated phase of shock include -**

- Increased HR
- Decreased urine output
- No change in blood pressure

**Signs of the uncompensated phase of shock include -**

- Increased HR
- Decreased urine output
- Decreased blood pressure
- Blood flow to the major organs becomes compromised

During the **irreversible phase of shock**, cellular damage occurs and leads to cellular death.
• Infants who have reached this phase of shock incur severe organ damage.

When assessing the overall picture of the neonate, symptoms of shock include -

• **Respiratory effort** changes occur in an attempt to compensate for the body's need for oxygen and to eliminate CO₂. The following may be seen -
  - Tachypnea
  - Increased work of breathing
    - Retractions
    - Nasal flaring
  - Gasping is an ominous sign and may be a sign of impending cardiac arrest.

• **Hypotension + weak peripheral pulses** may occur as blood vessels vasoconstrict and shunt blood away from non-vital organs to preserve the central BP.
  - BP may be normal or low.
  - Pulses feel diminished or are not palpable.
  - By the time BP drops and hypotension is obvious, the infant is already in an advanced state of shock.

• **Poor peripheral perfusion**
  - The peripheral blood vessels vasoconstrict to increase cardiac return.
  - Prolonged capillary refill time > 3 seconds
  - The infant in shock may have a normal core temperature with cool extremities.
  - The skin may also be mottled, pale, or cyanotic.

• **Tachycardia** of > 180 bpm at rest
  - With decreased perfusion, the body compensates by increasing the heart rate to circulate the blood volume to perfuse and oxygenate itself.
  - As shock persists, bradycardia of < 100 bpm with very poor perfusion may occur.
    - This is an ominous sign and may be a sign of impending cardiac arrest.

• **Acidosis** may be respiratory, metabolic, or a mixture of the two
  - Metabolic acidosis is due to lactic acid buildup from anaerobic metabolism in poorly perfused, poorly oxygenated tissues.
  - Hypoventilation causes carbon dioxide levels to rise and pH levels to fall resulting in respiratory acidosis.
  - pH < 7.25 is troubling, especially if the infant has poor perfusion, tachycardia, and/or hypotension.
  - pH < 7.20 is extremely troubling.
  - pH < 7.10 indicates that the infant is in severe crisis.
- **Hypoglycemia** may occur because of increased glucose consumption.
- **Lethargy + CNS depression** may occur because of decreased perfusion and glucose availability.
  - This may also result in decreased muscle tone.
- **Decreased urine output** may occur because of decreased perfusion to the kidneys.
  - Normal urine output is 2-3 mL/kg/hr.

These symptoms may be suggestive of many other neonatal diagnoses, but determination of the underlying cause is the number one priority so that appropriate treatment may be initiated.
The most important step in treating shock is to identify its cause and treat it appropriately.

The next step is to identify any problems that may impair cardiac function and correct them.

Improvement of cardiac function will increase cardiac output and this leads to...

- Improved tissue perfusion and oxygenation, which leads to...
- A decrease in anaerobic metabolism which will...
- Decrease the buildup of lactic acid accumulation and will...
- Improve pH

No matter what the cause of neonatal shock, care of the neonate includes -

- **Standard nursing care**
  - Monitor vital signs and oxygen saturation
  - Provide a neutral thermal environment
  - Monitor the infant's blood glucose
    - Provision of maintenance glucose infusion is important.
      - A good starting place is D\textsubscript{10}W at 80 mL/kg/day.
      - Treat hypoglycemia as needed.
        - D\textsubscript{10}W 2 mL/kg bolus
  - Monitor intake and output.
- **Respiratory support** should be given at whatever level the infant requires in order to maintain adequate oxygenation and ventilation.
- **Cardiovascular support** may require the use of inotropic agents such as dopamine, dobutamine, or epinephrine.
  - Dopamine is usually the first choice.
  - Corticosteroids may be an option for infants who -
- Experience vasopressor resistant shock
  OR
- Who have adrenal insufficiency

- **Correction of acidosis** is key!
  - Treat the underlying cause of the acidosis!
  - NaHCO₃ 4.2% solution (0.5 mEq/mL) may be used to treat severe metabolic acidosis.
    - Consider if the pH < 7.15
    - The infant must be adequately ventilated.

- **Diagnostic studies** may include -
  - Lab work
    - CBC and blood culture
    - C-reactive protein (CRP)
    - Electrolytes
    - ABGs
  - X-rays
    - Chest
    - Abdominal
  - Other possible studies
    - Echocardiogram (ECHO)
    - Head ultrasound
    - Lumbar puncture

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**Hypovolemic Shock**

When treating hypovolemic shock, the goal is to improve the circulating blood volume by providing crystalloids or blood products.

Dosing for volume replacement is -

- 10 mL/kg per dose IV
- Given over 15-30 minutes
- When there is **not** an acute loss of blood, normal saline and lactated ringers are appropriate volume expanders.
- When there is an acute loss of blood, normal saline may be used for volume expansion until packed red blood cells (PRBCs) or whole blood is available.
Cardiogenic Shock

Again, when treating cardiogenic shock, the focus of treatment is the underlying cause that is affecting the functioning of the heart.

Remember that some of the conditions that may affect the functioning of the heart include -

- Hypoxia
- Hypoglycemia
- Hypothermia
- Hypotension
- Acidosis
- Arrhythmias
- Infection
- Electrolyte imbalances
- Inborn errors of metabolism

Septic Shock

Treatment of septic shock may involve a combination of hypovolemic and cardiogenic shock treatments.

- Fluid boluses may be needed as the infant's fluid shifts from the intravascular space to the extravascular space.
- Inotropic support may also be needed.

The infection must also be treated with antibiotics. Broad spectrum antibiotics such as ampicillin and gentamicin are most frequently used.
Shock is a serious, life-threatening medical emergency that requires prompt recognition and appropriate interventions.

Individual outcomes are related to the type of shock and aggressive treatment of the underlying cause of shock.

For all types of shock, outcomes are ultimately linked to the -

- Underlying cause
- Infant's response to treatment
- Promptness in initiating treatment

Shock that goes unrecognized or is inappropriately treated may exacerbate cellular death in one or more organ systems and may result in multisystem organ failure and death.
References


