

Neonatal Sepsis: Assessment and Care

2 Contact Hours

First Published: November 30, 2011

Updated: July 23, 2015

Course Expires: July 31, 2018

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Acknowledgments

RN.com acknowledges the valuable contributions of...

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Purpose and Objectives

The purpose of this course is to examine the risk of developing sepsis and infections in the neonatal period. This course will review factors that contribute to neonatal sepsis and immune responses that occur. Assessment data, treatment and interventions for neonatal sepsis will be discussed.

After successful completion of this course, you will be able to:

1. Describe at least two principle sources of newborn infection
2. List at least five factors that increase neonatal risk of infection
3. Identify two types of host defenses
4. List signs and symptoms of neonatal sepsis
5. Describe at least three common pathogens in the NICU
6. Discuss diagnostic tests used in diagnosis of sepsis
7. Describe nursing interventions for a septic infant

Introduction

There have been many advances in prevention, assessment and treatment of neonatal sepsis in the past few decades. However, the morbidity and mortality associated with sepsis remains high for susceptible neonates.

Discussion of Sepsis

Sepsis defined

Sepsis is a toxic condition caused by the spread of invading organisms, or their by-products, through the bloodstream or in other tissue in the body. It is also known as septicemia. The definition of sepsis has evolved beyond that of an infection. There is now a spectrum of symptoms of systemic inflammatory response syndrome (SIRS) to septic shock (Anderson, 2014; Caple, 2011). Causes of sepsis include viral, fungal, bacterial or parasitic in nature.

Neonatal sepsis differs from adult sepsis in terms of symptoms, diagnosis and treatment, and continues to have a high rate of morbidity and mortality for infants.

Neonatal sepsis **occurs within the first 30 days of life**, although some late-onset sepsis has been described within the first 90 days of life, particularly when related to prematurity (Gardner, Carter, Enzman-Hines, & Hernandez, 2015).

Incidence of Sepsis

Neonatal sepsis is a significant cause of morbidity and mortality of hospitalized newborns and premature infants. Worldwide, sepsis accounts for 15% of neonatal deaths (Unicef, 2015). In the United States sepsis is still the seventh lead cause of neonatal death (Centers for Disease Control and Prevention, 2013)

The Centers for Disease Control and Prevention (CDC) estimates that one in every 141 babies born in the United States each year dies of infection in the first year of life, with approximately 20,000 deaths in the neonatal period (2010). The incidence of neonatal infection is higher for infants with lower gestational age, with premature infants having a three to five times greater risk of developing sepsis. Although the incidence of sepsis is relatively low, the associated morbidity and mortality is high (Gardner et al., 2015).

In the United States, 1 to 5 of every 1000 live births results in neonatal infection.

Early-onset of sepsis versus late-onset

Approximately one to eight out of every 1000 births results in early-onset sepsis. The causes of infection for early-onset sepsis occur from maternal transmission during pregnancy or delivery, or immediately following delivery. Symptoms may be present at birth, but many infants demonstrate symptoms in the first 24 hours of life (Gardner et al., 2015; Shrestha, Subedi, & Rai, 2011).

Late-onset sepsis is seen in infants after 72 hours of life. The infections causing late-onset sepsis are from a variety of sources, and are usually hospital-acquired infections (Gardner et al., 20015; Shrestha, Subedi, & Rai, 2011).

Prevention of late-onset sepsis is the key strategy. Infection control policies and practices, including the use of bundles for invasive procedures (such as central lines and intubations), hand hygiene, and use of chlorhexidine can avert development of late-onset sepsis (Dong & Speer, 2014).

Early-onset sepsis is classified as occurring in newborns less than 72 hours of age.

Knowledge Check 1

Early-onset sepsis is classified as occurring in newborns less than ____ hours of age.

Type your answer and then press the space bar.

CORRECT

Yes, that's right. Early-onset sepsis is classified as occurring in newborns less than **72 hours of age.**

Sources of Sepsis: Bacterial

- **Group B Strep (GBS):** Most common cause of **early-onset** sepsis in North America
- **Staphylococcus aureus:** Most common organism for **late-onset** and **nosocomial** infections
- **Escheria coli:** Most common incidence worldwide (25-45% infections)
- **Coagulase-negative staphylococcus**
- **Klebsiella**
- **Hemophilus influenza**
- **Listeria monocytogenes**
- **Neisseria meningitides**
- **Streptococcus pneumonia**
- **Pseudomonas**
- **Enterobacter**
- **Serratia marcescens**
- **Anaerobic species, such as clostridium**
- **Salmonella**
- **Citrobacter**
- **Proteus**

Group B Strep is the most common cause of **early-onset** sepsis in North America.

Sources of Sepsis: Viral and Fungal

Sources of sepsis: Viral

- **TORCH**
 - Toxoplasmosis
 - O** "Other" such as HIV, Syphilis
 - Rubella
 - Cytomegalovirus (CMV)
 - Herpes

- **Varicella**

Sources of sepsis: Fungal

- **Candida**

- **Malassezia furfur**
(American Academy of Pediatrics, 2015; Gardner et al., 2015)

Bacterial Classifications

The common causes of neonatal infections are from bacteremia.

Most bacteria can be divided into four groups on the basis of shape and gram stain:

- **Gram positive bacilli:** This is the least common cause of human infection. Gram positive bacilli include the human pathogens - *C diphtheriae*, *C tetani*, *C botulinum*, *C difficile*, *B anthracis* and *Listeria*.
- **Gram negative cocci:** Include the important genus *Neisseria* (in this category are the human pathogens - *Neisseria meningitis* and *Neisseria gonorrhoea*).
- **Gram negative bacilli (rods):** Include the enteric bacteria (*E coli*, *Salmonellae*, *Shigellae*, *Vibrio*, *Campylobacter*, and *Helicobacter* are in this group) and the genus *Pseudomonas*. *Haemophilus*, *Bordetella*, *Brucella* and *Legionella* are classified as small gram negative rods.
- **Gram positive cocci:** These are the most common causes of human infection. Gram positive cocci include the genera *Streptococci* and *Staphylococci* (in this category are the human pathogens *haemolytic streptococci* and *Staphylococcus aureus*).

Gram positive bacteria have thicker peptidoglycans in the cell walls and are susceptible to penicillins (American Academy of Pediatrics, 2015).

Bacterial Classifications Group B Strep

In North America, Group B Strep (GBS) is the most serious cause of neonatal sepsis and associated mortality.

GBS is a normal flora found in the vagina and gastrointestinal tract in up to 20% of women. It does not normally cause any problems for the mothers who are colonized with GBS, but can cause critical health problems for infants.

Because of the high risk and associated mortality with GBS infection in the newborn, prevention and treatment guidelines have been established by the CDC and American Academy of Pediatrics (AAP).

The main focus of the guidelines is to promote GBS screening of all pregnant women in their third trimester of pregnancy. This is partially because approximately 25% of GBS infections occur in term infants who are born to mothers without any identified risk factors. When the pregnant woman is tested and is positive for colonization of GBS, she should be treated with antibiotics during labor (AAP, 2011).

Group B Strep

GBS infections can either be an early or late onset infection, but has the highest incidence of early-onset sepsis in the United States. The early onset infection is a consequence of transmission of GBS bacteria from the mother to the fetus, usually during delivery. The infant will begin to present symptoms during the first 48 hours of life. At first, the symptoms may be very subtle and nonspecific. GBS infections are rapidly progressive and the symptoms worsen if treatment is not initiated. Within hours, an infant can deteriorate to septic shock and death. The mortality rate can be 30-50% in infants less than 37 weeks gestation (AAP, 2011).

Late onset GBS may be less severe than early onset but still involves a 25% mortality rate. Infants with this late form of infection generally present with meningitis as the key symptom (Caple, 2011).

Late onset GBS infections can occur up to 2 months of age, and are acquired by nosocomial transmission in hospital rather than from a maternal source.

Group B Strep Prophylaxis

The Centers for Disease Control and Prevention (CDC), in collaboration with the American Academy of Pediatrics (AAP) and the American College of Obstetricians and Gynecologists (ACOG) revised recommendations in 2010 for preventing perinatal Group B strep (CDC et al., 2010). Some **key points** include:

- **Universal screening of maternal GBS**; if there has been a GBS culture within the five weeks prior to onset of labor, then that culture can be used to guide practice
- **Intrapartum GBS prophylaxis is indicated with:**
 - a) a previous infant with invasive GBS
 - b) GBS bacteriuria at any time during current pregnancy
 - c) positive GBS culture during last trimester of current pregnancy
 - d) unknown GBS status with onset of labor and pre-term, ROM >18hours, maternal temperature >100°F, rapid GBS test positive
- **Penicillin G is preferred antibiotic** for intrapartum prophylaxis, with ampicillin as acceptable alternative. If there is a history of allergy, cefazolin, clindamycin or erythromycin may be used
- For neonates, **a revised algorithm is created**, which includes a minimum of observation up to full clinical evaluation/diagnostic work-up and antibiotic therapy (CDC et al., 2010)

Staphylococcal Infections

Staphylococcal pathogens such as staphylococcal aureus can cause a range from mild infections to severe sepsis. The majority of the transmissions are nosocomial in nature, caused by lack of hand hygiene, improper sterile technique or invasive procedures.

Colonization of the staphylococcal pathogen has been seen in 40%-90% of infants within the first five days of life. It is also the most common cause of late-onset infections (American Academy of Pediatrics, 2015; Gardner et al., 2015).

Escherichia Coli

Escherichia coli (E-coli) is the pathogen with the highest incidence of neonatal infection worldwide, particularly in developing countries.

The bacteria can be transmitted to the neonate through labor and delivery via the maternal genital tract. It can also be acquired through nosocomial means such as poor hand hygiene (American Academy of Pediatrics, 2015; Gardner et al., 2015).

In the United States, E-coli is the most common cause of gram negative neonatal infection.

Knowledge Check 2

Which is the most common cause of early-onset sepsis in North America?

E-coli

Staph Aureus

Group B Strep

CORRECT

Yes, that's right. The correct answer is Group B Strep.

Risk Factors

Maternal

Click the mouse icon to view a list of known maternal risk factors contributing to neonatal sepsis:

- No prenatal care
- Malnutrition
- Low socioeconomic status
- Substance abuse
- Fever
- Active urinary tract infection (UTI)
- Chorioamnionitis
- Positive or unknown Group B Strep
- Premature rupture of membranes (ROM) or premature labor <37 weeks
- Prolonged ROM >24 hours
- Prolonged or difficult labor
- Multiple pregnancies

(Caple, 2011; Gardner et al., 2015)

Neonatal

Click the mouse icon to view a list of known neonatal risk factors contributing to neonatal sepsis.

- Prematurity
- Low birth weight
- Congenital anomalies (especially ones that disrupt first line of defense, such as gastroschisis)
- Male gender
- Newborn errors of metabolism
- Asphyxia/fetal distress
- Meconium aspiration

(Caple, 2011; Gardner et al., 2015)

Environmental Risk Factors

Click the mouse icon to view a list of known environmental risk factors associated with neonatal sepsis.

- Resuscitation
- Invasive procedures
- Length of hospitalization
- Use of antibiotics

(Caple, 2011; Gardner et al., 2015)

Knowledge Check 3

Risk factors for developing neonatal sepsis include all of the following except:

Premature labor

Resuscitation

Female gender

CORRECT

Yes, that's right. Female gender is not a neonatal risk factor; male gender is a known neonatal risk factor.

Immunity in the Body: Defense Mechanisms

The body has many ways to prevent and cope with infections, called defense mechanisms or innate immunity.

- **Barriers** are one defense mechanism, considered the first line of defense. Barriers include the skin and mucous membranes.
- **Mechanical clearance** is another mechanism, where the body attempts to rid itself of foreign substances. These attempts include coughing and vomiting.
- Other defense mechanisms consist of an inflammatory response and immunity response. **Inflammatory and immune responses are considered a “complement system,” which may trigger and interact with each other** (Todar, 2012).

Immunity in the Body: Inflammatory Response

Localized or systemic infection triggers the body to move nutrients, and inflammatory/immunity cells to the site, to prevent foreign invasion. Inflammation occurs when tissues are injured by trauma, bacteria, toxins, or other causes. The injured cells then release chemicals that cause vessels to leak fluid into the tissues; producing swelling (these chemicals include prostaglandins, histamine, and bradykinin). The swelling assists in isolating the foreign substance from further contact with body tissues (Todar, 2012).

Premature and compromised infants develop a systemic inflammation, because they cannot localize the source. This can cause a diffuse reaction. **Click the mouse** to view some common reactions.

- **Hypotension**
- **Third spacing** - Third spacing produces edema
- **Microthrombi** - Microthrombi can obstruct the blood flow to an area, producing further coagulation, which can in turn lead to DIC
- **Further cellular activation**
- **Disseminated intravascular coagulation (DIC)** - DIC occurs when the blood clotting mechanisms are activated throughout the body instead of being localized to an area of injury. Small blood clots form throughout the body, and eventually the blood clotting factors are used up and not available to form clots at sites of tissue injury. Clot dissolving mechanisms are also increased. This disorder is variable in its clinical effects, and can result in either clotting symptoms or, more often, bleeding. Bleeding can be severe (Gardner et al., 2015).

Immunity in the Body: Immune Response

The chemicals released in response to damaged cells also attract the white blood cells, phagocytes, that "eat" microorganisms and dead or damaged cells. This process is called phagocytosis. The immune response is specific to the type of micro-organism, and is affected by type of serum protein (immunoglobulin) and blood cell (lymphocyte) (Todar, 2012).

Types of immunity include **natural** and **acquired** immunity.

Natural immunity refers to the susceptibility of a species to specific infections.

Acquired immunity can be through **active** or **passive** means. **Active** immunity occurs with antibody formation and response to an antigen. This occurs from exposure to infection or immunizations, but it may take time to create functional antibodies.

Passive immunity is acquired when antibodies are produced by one person, and passed to another. For neonates, passive immunity is from a maternal source which has short-term effects but immediate function (Gardner et al., 2015; Todar, 2012).

The immune response is the last line of defense, and occurs more slowly than the inflammatory response.

Immunity in the Body: Immunoglobins

Immunoglobulins (Ig) are glycoprotein molecules that are generated by plasma cells in response to an immunogen and which function as antibodies. Immunoglobulins can also be given to neonates as a form of passive immunity. Types of immunoglobulins include:

IgG

This is the major serum Ig, and **the only one that crosses the placenta.**

The half-life is about 24 days, and it is capable of carrying out all of the functions of immunoglobulin molecules.

(Gardner et al., 2015; Todar, 2012).

IgA

This is the second highest in the serum, and found in secretions mainly in gastrointestinal and respiratory systems.

The main source of IgA for newborns is breast milk.

(Gardner et al., 2015; Todar, 2012).

IgM

This is the first to respond to all infections, but only the third highest Ig in serum. It protects from *blood-borne* infections.

High levels indicate congenital infection.

(Gardner et al., 2015; Todar, 2012).

IgD

This Ig performs antigen binding receptor on B cells. High levels indicate chronic infections

(Gardner et al., 2015; Todar, 2012).

IgE

This Ig has small quantities in serum, and has a role with allergic reactions.

(Gardner et al., 2015; Todar, 2012).

Knowledge Check 4

The “complement system” of defense mechanisms consists of:

Barriers and mechanical clearance

Inflammatory response and immune response

Barriers and immune response

CORRECT

Inflammatory and immune responses are considered a “complement system,” which may trigger and interact with each other.

Signs and Symptoms

The clinical signs and symptoms of sepsis and SIRS in the neonate are very different from the adult. These are divided into early and late signs and symptoms. Often, symptoms in the early stage are non-specific, making it difficult to diagnose (Gardner et al., 2015).

The **early stage** of sepsis development is also known as “warm shock.” The main symptoms are from a decrease in systemic vascular resistance due to vasodilation.

The **late stage** of sepsis development is caused from the body being unable to meet the oxygen demands of tissues. Tissue damage and lactic acidosis can occur, and this is now a hypovolemic state.

(Gardner et al., 2015)

Signs and Symptoms	Early	Late
Gastrointestinal	Feeding intolerance, abdominal distention	
Respiratory	Tachypnea, apnea, grunting, nasal flaring, retractions, increased oxygen requirements	
Cardiovascular	Widened pulse pressure (the difference between systolic and diastolic pressure), bradycardia or tachycardia, pink flushing, mottling, full pulses	Further decrease in systemic vascular resistance produces a significant decrease in systolic pressure, causing a narrowed pulse pressure
Neurologic	Lethargy, hypotonia, temperature instability (hypothermic or hyperthermic), behavioral changes	Seizures
Metabolic	Acidosis, glucose instability (hypoglycemia or hyperglycemia)	Decreased perfusion to kidneys (increased BUN, creatinine, renal failure), acidosis, enlarged spleen/liver)
Multiple organ dysfunction syndrome		Death
Complete blood count (CBC) changes	Increase or decrease in white blood cells (WBC), more immature WBC (increased I:T ratio), decreased platelets	Increase or decrease in white blood cells (WBC), more immature WBC (increased I:T ratio), decreased platelets

Knowledge Check 5

Drag each term on the left to the correct box on the right to indicate whether it is an early or late sign.

Narrowed pulse pressure

Widened pulse pressure

Tachypnea

Decrease kidney perfusion

CORRECT

LATE

EARLY

EARLY

LATE

Diagnostic Tests

Diagnostic workup is required with suspected sepsis, or infants at risk.

Not one specific test can definitively rule out or confirm sepsis with 100% certainty. Therefore, it can take a combination of laboratory tests, imaging, and clinical symptoms to diagnose neonatal sepsis

(Caple, 2011; Gardner et al., 2015).

Test	Description
CBC	(to be discussed in more detail later in course)
Blood culture	Used to identify the organism, and the susceptibility or resistance to specific antibiotics. Cultures may be falsely negative, such as if baby was exposed to antibiotics through maternal treatment. Blood cultures should be drawn prior to initiating antibiotics.
Arterial blood gas (ABG)	ABG is drawn to determine if acidosis or alkalosis is present and accurate oxygen saturation levels.
C-reactive protein (CRP)	CRP is a non-specific indicator of inflammation. CRP responds within six to eight hours of an inflammatory reaction; over 0.2mg/dL is considered elevated. Many studies have been done of the usefulness of CRP in diagnosing sepsis with contradictory results.
Lumbar puncture (LP)	Examination of cerebral spinal fluid (CSF) can show values indicative of meningitis, and a culture should be done. Suspicious CSF includes elevated leukocytes, presence of protein, and low glucose (<50% of serum level), with the presence of micro-organisms. Taking a blood glucose just prior to an LP can be a useful comparison.
Suprapubic tap/urinalysis	Sterile urine sample from a bladder tap is preferred. The urine sample can show if there is a urinary tract infection (UTI), or abnormalities in protein, or glucose. An UTI is not common with early-onset infection, but if the infant is more than 72 hours old, this can be suspect.
X-rays	Chest x-ray (CXR) and/or abdominal x-ray (AXR) can show pleural effusions, pulmonary edema, necrotizing enterocolitis, etc.

Knowledge Check 6

Which of the following statements is **TRUE**?

Symptoms of sepsis are the same with adults and neonates

A negative blood culture means that the neonate does not have an infection

A combination of clinical symptoms and tests are needed to diagnose sepsis

CORRECT

Yes, that's right. Not one specific test can definitively rule out or confirm sepsis with 100% certainty. Therefore, it can take a combination of laboratory tests, imaging, and clinical symptoms to diagnose neonatal sepsis

In-depth Look at a Complete Blood Count

Components of CBC

Platelets

Platelets range from 130-400 K/uL.

Low platelets may be indicative of infection, as microorganisms lead to platelet destruction

Hematocrit (Hct)

Hct is the percent of RBC when a sample is spun down.

Hgb

Hgb ranges from 13.5-21.5 g/dL. Hgb is manufactured to carry oxygen, but other substances may bind.

Red blood cells (RBC)

Values for RBC range from 3.5-6.5 M/uL

White blood cells (WBC)

WBC count can be falsely elevated by nucleated RBC, or if the baby was stressed during labor and delivery. Some laboratories may provide an “adjusted” WBC value.

Normal WBC count varies in the neonate. Generally, in the first week of life, the values are 5,000-30,000 (or 5-30 K/uL). Leukopenia (<5000) is sign of infection **in first week of life**. Leukocytosis (>30000) is indicative **after** the first week.

- **Monocytes:** These enter tissues and become macrophages to help destroy foreign bodies
- **Lymphocytes:** Functions in immune response, and antibody production; consists of B and T cells
- **Granulocytes:** Also phagocytosis functions; consists of eosinophils, basophils, and neutrophils
- **Neutrophils:** Fight infections
- **Eosinophils:** Less killing ability, release mediators to control inflammatory processes, increased in allergic disorders and parasitic infections
- **Basophils:** Granules contain histamine and heparin; inflammation mediators

Neutrophils

Neutrophil counts are only seen as abnormal in 66% of infants. Neutropenia is seen with pregnancy induced hypertension (PIH), asphyxia, and intraventricular hemorrhage (IVH). The neutrophils, in their attempt to fight infection, release cells into the bloodstream, starting with mature cells.

From immature to mature forms of neutrophils:

myeloblast → promyelocyte → myelocyte → metamyelocyte → bands → segs

When the mature cells have been released to fight infection, the immature forms will then be released. This is the body's attempt to fight infection, even though these cells are ineffective. **This release of immature cells is seen as a “left shift”** (Caple, 2011; Gardner et al., 2015).

Calculating the I:T Ratio

The immature to total (I:T) ratio is the relationship between immature and total neutrophils. It is calculated using the bands, segs, and metas, if available; **metas may not always be given in a differential.**

$$\text{I:T} = \frac{\text{immature neutrophils}}{\text{Total (mature + immature)}}$$

$$\text{I:T} = \frac{\# \text{ of bands } (+ \text{ metas})}{\# \text{ of segs } + \# \text{ of bands } (+ \text{ metas})}$$

Another way to look at it: bands / (segs+bands)

An I:T ratio >0.2 is considered a “left shift” and can indicate infection.

Knowledge Check 7

Which of the following CBC results may indicate infection in the neonate in the first week of life?

A high platelet count of 540 K/uL

A high WBC count of 35,000 (35 K/uL)

An I:T ratio of 0.3

CORRECT

Yes, that's right. An I:T ratio >0.2 is considered a "left shift", and can indicate infection.

Interactive Activity

Calculate the I:T ratio for the following results:

WBC 9.2

RBC 3.6

Hgb 12.1

Hct 39.5

Plt 236

Segs 36

Bands 12

Type answer here and then press the spacebar.

CORRECT

The correct answer is .25.

I:T = bands / (segs + bands)

I:T = 12 / (36 + 12) = 0.25

Nursing Management

Nurses and caregivers are essential in identifying symptoms of sepsis and in the treatment of the neonate with suspected or confirmed infection. Click each intervention technique on the left to view more information.

Parental Support

Parents and caregivers require emotional support through this time of crisis, but each situation is unique.

Assess the anxiety level and ability to cope for each family member anxiety level and coping ability.

Appropriate education on neonatal sepsis pathophysiology, risk factors, treatments, prognosis, proper hand hygiene and any isolation precautions are needed.

Encourage participation in care and bonding with the infant. (Anderson, 2014; Caple, 2011; Gardner et al., 2015).

Additional Therapy

Many times infants with sepsis require transfusions of blood products, including packed red blood cells (PRBCs), platelets, and fresh frozen plasma (FFP).

For infants who may require prolonged antibiotic therapy, central line placement is warranted.

Studies have been conducted to investigate other treatments of neonatal sepsis, including granulocyte transfusion, IV immune globulin (IVIg) infusion, exchange transfusion, and the use of recombinant cytokines.

Monitoring of Lab Results

Lab results including CBC, blood cultures, electrolytes and arterial blood gases are important to determine progress of the infant's condition.

Hypoglycemia is another complication of sepsis and blood glucose monitoring is required.

Monitoring and Treatment of Seizures

Seizures are another potential complication of sepsis.

Monitor the infant's behavior for focal seizures (movement of one limb or "freezing" stare, for example).

Medication and seizure precautions may be needed in severe cases.

Maintain Perfusion

Hypovolemic and septic shock are complications of sepsis.

Monitoring blood pressure is vital, and use of volume expanders or inotropes to maintain blood pressure may be required.

Provide Adequate Oxygenation and Ventilation

Hypoxemia is a common problem with sepsis.

Continuous pulse oximetry is required and supplemental oxygen may be needed to keep oxygen saturations within range.

Severely septic, premature, or neonates with other complications may require continuous positive airway pressure (CPAP) or mechanical ventilation.

Maintain Fluids and Electrolytes

A balance of fluid and nutrition is required for the septic neonate.

They should be placed NPO due to increased risk of aspiration, paralytic ileus, and necrotizing enterocolitis.

An intravenous access is required.

Maintain Neutral Thermal Environment

Temperature instability is common with sepsis and diverts much needed energy away from growth and the body's ability to fight the infection.

The infant may need to be placed in a warmer or incubator, and temperature must be regularly monitored.

Hand Hygiene and Aseptic Technique

Adherence to hand hygiene, use of personal protective equipment and aseptic technique is essential to prevent further infections or spread the organism to another.

Depending on the organism, infection control practices may involve isolation.

Assessment

Continuous physical assessment is vital to identify subtle changes in the infant's condition or behavior.

Often times, the neonate may look "unwell" or a parent can voice concerns about behavioral changes.

Neonatal Sepsis: Assessment and Care

Inspect the infant for visible signs of distress, such as poor tone, lethargy, and pallor or a change in response to stimuli.

Watch trends in the infant's vital signs from baseline, including temperature and pulse pressure.

Remember to include pain assessment. Intake and output should also be monitored.

Fluid & Electrolyte Maintenance

Infants characteristically have 80% water make up in their bodies. Preterm neonates may have as high as 85-90% total body water. Therefore, fluid requirements are high, due to this high proportion of body water. When the infant is further compromised by sepsis, the balance of fluids and electrolytes is vital. Fluid requirements can vary between 80-120mL/kg/day in the first week of life (Gardner et al., 2015).

Electrolytes must also be monitored carefully. Here are some key points about the major electrolytes:

- **Sodium (Na⁺):** Major component of extracellular fluid (ECF). Normal values are 136-145 mmol/L; preterm infants may require higher levels due to immature renal system. Na⁺ is essential for retention of body water and takes part in regulation of acid-base balance, tissue osmolality and enzyme activity (Gardner et al., 2015)
- **Potassium (K⁺):** Major component of intracellular fluid (ICF). Normal values are 3.5-5 mmol/L. K⁺ is essential for cardiac function, participates in enzyme activity, CNS function, tissue osmolality and glycogen use (Gardner et al., 2015)
- **Chloride (Cl⁻):** Component of ECF. Normal values are 99-111 mmol/L. Cl⁻ is necessary for K⁺ retention, transport of carbon dioxide, formation of hydrochloric acid in the gastrointestinal tract, and participates in tissue and cell osmolality (Gardner et al., 2015)
- **Calcium (Ca²⁺):** Component of ECF. Normal values are 7-12 mg/dL. Calcium is essential for blood coagulation and neuromuscular function (Gardner et al., 2015)

Anti-infective: Bacterial Anti-infective Therapy

Antibiotic therapy is dependent on the type of organism that is causing the infection. After laboratory work up, broad spectrum antibiotics should be immediately started. The most common empiric antibiotics are ampicillin along with an aminoglycoside, usually gentamicin.

After identifying the causative organism (bacterial) then the antibiotic combinations with the most sensitivity and least toxicity should be started, and continued for the recommended course of treatment. Antivirals are required if sepsis is suspected or confirmed from a virus, and antifungals are used to treat fungal infections.

Sources of sepsis: Bacterial

- **Group B Strep (GBS):** Ampicillin and gentamicin most common antibiotic therapy.
- **Staphylococcus aureus:** Ampicillin, gentamicin, and clindamycin most common antibiotic therapy; if MRSA, vancomycin is used and then blood cultures are essential to identify sensitivity for antibiotic therapy.
- **Escheria coli:** Treated with third-generation cephalosporins such as ceftriaxone.
- **Coagulase-negative staphylococcus:** Vancomycin or flucloxacillin commonly used.
- **Klebsiella:** Blood cultures essential to identify sensitivity; third-generation cephalosporins such as ceftriaxone.
- **Hemophilus influenza:** Main treatment is third-generation cephalosporins.
- **Streptococcus pneumonia:** Main treatment is third-generation cephalosporins.
- **Pseudomonas:** Generally treated with aminoglycoside such as gentamicin and a quinolone.
- **Anaerobic species, such as clostridium:** Vancomycin common treatment.

Sources of sepsis: Viral and Fungal

Sources of sepsis: Viral

- **TORCH:**
 - **Toxoplasmosis:** Treated with pyrimethamine and sulfadiazine.
 - **Other:** HIV, antiretroviral therapy such as zidovudine; Syphilis, main treatment is penicillin G.
 - **Rubella:** Supportive care
 - **Cytomegalovirus (CMV):** Treated with ganciclovir.
 - **Herpes:** Treated with acyclovir.
- **Varicella:** Zoster immune globulin used with supportive care.

Sources of sepsis: Fungal

- **Candida:** Amphotericin B and flucytosine main therapies.
- **Malassezia furfur:** Fluconazole, amphotericin B and flucytosine main therapies.

(Caple, 2011; Devlin, 2006; Gardner, 2009).

Considerations for Common Antibiotics

As discussed, there are common antibiotics used in the treatment of neonatal sepsis. Click each therapy on the left to view considerations that nurses should be familiar with.

Vancomycin

Should be infused via pump over a minimum of 60 minutes.

Dosing is dependent on gestational age and serum concentration, including peak and trough levels.

Aminoglycosides are associated with neurotoxicity, ototoxicity, and nephrotoxicity. These risks increase with patients with poor renal function, high doses, or prolonged therapy.

Other side effects can include rash, hypotension, and phlebitis. Neutropenia can occur with prolonged therapy.

Vancomycin is incompatible with cephalosporins, dexamethasone, and most penicillins (Anderson, 2014).

Ceftriaxone

Should be infused via pump over 30 minutes. Dosing is usually every 24 hours.

Ceftriaxone should not be administered in neonates with hyperbilirubinemia as it displaces bilirubin from binding sites.

Other side effects may include diarrhea, increased BUN and creatinine, skin rash, nausea and vomiting.

It is incompatible with calcium (Anderson, 2014).

Gentamicin

Should be administered via a syringe pump for a minimum of 30 minutes. Dosing is based on serum concentration.

Serum levels, including peak and trough levels, should be measured if therapy is more than 48 hours.

Aminoglycosides are associated with neurotoxicity, ototoxicity, and nephrotoxicity. These risks increase with patients with poor renal function, high doses, or prolonged therapy.

Gentamicin should not be administered with penicillins, and is incompatible with ampicillin, amphotericin B, furosemide, and heparin (Anderson, 2014).

Ampicillin

Can be administered by slow IV push or intramuscular (IM).

Dosing is usually done every 8-12 hours for neonates. Very large doses can cause CNS excitation or seizures.

There may be moderately prolonged bleeding times with repeated doses.

Clearance is mainly by the renal route.

Reconstituted ampicillin must be used within an hour of mixing, and is not compatible with amino acid solutions/total parenteral nutrition (TPN) (Anderson, 2014).

Putting it Together: Case Study

Baby George was born at 31 weeks gestation. His birthweight was 1345g, and APGARS were 3 at one minute, and 7 at five minutes after resuscitation efforts. Maternal history includes a 22 year old mother, gravida 2, para 1 (now 2), with no prenatal care. Maternal temperature in labor, with periods of fetal tachycardia. Delivery was precipitous but one maternal dose of penicillin was given. Baby George is admitted to the NICU. A rapid GBS test was done with inconclusive results.

Which of the following risk factors for sepsis does Baby George have?

Prematurity, no prenatal care, unknown maternal GBS.

Male gender, maternal fever.

Low birthweight, resuscitation.

All of the above.

CORRECT

Yes, that's right. All of these are risk factors.

Maternal risk factors include GBS status, no prenatal care, and maternal fever. Neonatal risk factors include male gender, prematurity, and low birthweight. Environmental risk factor includes resuscitation.

Putting it Together: Case Study

Upon admission to the NICU, Baby George is hypotonic, hypothermic, grunting, and not responding to stimuli as expected. He is on a warmer with a cardiorespiratory monitor. His oxygen saturations are 91%. An umbilical venous catheter (UVC) is successfully inserted and intravenous fluids started. George's father is at the bedside.

Which of the following priority interventions are anticipated?

Moving to an incubator for neutral thermal environment.

Increasing intravenous fluids and monitoring vital signs.

Prepare for drawing blood for labs, supplemental oxygen and possible respiratory support (CPAP).

CORRECT

The correct intervention is to prepare for drawing blood for labs, supplemental oxygen and possible respiratory support (CPAP). Blood work is an immediate priority, as is the respiratory support based on George's current condition.

Putting it Together: Case Study

Baby George's initial CBC returns with the following results:

WBC	8.4
RBC	3.47
Hgb	13.4
Hct	40.0
Plt	228
Segs	47
Bands	24

The interpretation of this CBC is:

WBC and RBC/Hgb/Hct within range, low platelets, I:T ratio 0.03

WBC within range, slightly low RBC/Hgb/Hct, platelets within range, I:T ratio 0.34

High WBC, high RBC/Hgb/Hct, high platelets, I:T ratio 0.04

CORRECT

The correct answer is WBC within range, slightly low RBC/Hgb/Hct, platelets within range, I:T ratio 0.34.

Values for RBC range from 3.5-6.5 M/uL; Hgb ranges from 13.5-21.5 g/dL; Hct ranges 40-65%; Platelets range from 130-400 K/uL; "Normal" WBC count varies in the neonate. Generally, in the first week of life, the values are 5,000-30,000 (or 5-30 K/uL); I:T ratio calculated at 0.34.

Putting it Together: Case Study

While awaiting confirmation from the blood cultures on Baby George, the neonatologist diagnoses him with suspected sepsis. The organism suspected is Group B Strep.

Which of the following orders do you anticipate?

Monitor blood pressure and blood glucose every 4 hours

NPO, IV fluids at 80mL/kg/day

Start ampicillin and gentamicin IV

All of the above

CORRECT

All of the answers are correct.

Treatment includes keeping NPO with IV fluids. Monitoring blood pressure and blood glucose is important for any changes in condition. Ampicillin and gentamicin are antibiotics used to treat Group B Strep.

Conclusion

In this course, you learned:

Neonatal sepsis has a high risk of morbidity and mortality, particularly with lower gestations and birthweights. It is vital to recognize risk factors and early signs and symptoms in order to initiate prompt diagnosis and treatment.

Nurses and caregivers are integral in identifying behavioral changes that may eventually cascade into symptoms of severe sepsis.

Assessment, hand hygiene and monitoring of the neonate's condition are just as crucial as other medical therapies in prevention, detection, and treatment of neonatal sepsis.

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