Sepsis, Neonatal: Identifying and Managing

What Is Identifying and Managing Neonatal Sepsis?

- Neonatal sepsis is a life-threatening systemic infection that occurs during the first month of life. Successful management of sepsis requires prompt identification of signs and symptoms and early treatment with intravenous (I.V.) antimicrobial therapy. (For more information about neonatal sepsis, see Quick Lesson About ... Neonatal Sepsis)
  - What: Early identification of sepsis in neonates can be a challenge because signs of systemic infection in the neonate are often nonspecific. A continuum of signs and symptoms of sepsis exists that ranges from systemic inflammatory response syndrome (SIRS) to septic shock. Although bacteremia is always presumed to be the cause of sepsis, sepsis is clinically defined as the presence of both SIRS and presumed bacteremia because treatment is often initiated before laboratory culture confirms bacteremia. At minimum, the presence of risk factors for neonatal sepsis can be sufficient to trigger a strong clinical suspicion for sepsis and prompt a sepsis screening protocol that includes a series of laboratory and diagnostic screening tests
  - How: The nurse clinician can contribute to identification and management of sepsis by detecting and reporting early signs of SIRS (e.g., abnormal temperature, bradycardia) and other nonspecific signs of illness (e.g., vomiting, poor feeding), and by facilitating completion of laboratory and diagnostic tests. Treatment is initiated prior to culture results that prove the diagnosis of sepsis and includes antimicrobial therapy and supportive measures (e.g., mechanical ventilation, fluid resuscitation)
  - Where: Sepsis can develop in neonates who are being cared for in the newborn nursery, neonatal intensive care unit (NICU), or at home. When diagnosed with sepsis in the newborn nursery or at home, neonates are moved to the NICU for intensive monitoring and treatment
  - Who: Identifying and managing the neonate with sepsis is the responsibility of nurses, respiratory therapists, physicians, and advanced practice clinicians who have experience in neonatal intensive care

What Is the Desired Outcome of Identifying and Managing Neonatal Sepsis?

- Neonatal sepsis is identified and managed with the goal of eliminating the infection, ameliorating signs and symptoms, and promoting full recovery

Why Is Identifying and Managing Neonatal Sepsis Important?

- Neonates are particularly susceptible to sepsis because of physiologic immaturity. The neonate’s skin does not provide an adequate barrier to infection for the first several months of life, and the gastrointestinal, respiratory, and genitourinary tracts are prone to microbial colonization
- Potential complications of sepsis include pneumonia, meningitis, disseminated intravascular coagulation (DIC), multiple organ dysfunction, and septic shock. Without treatment, neonatal sepsis has a very high rate of mortality. Identification of the early signs of sepsis, including those that are subtle or nonspecific, can trigger screening and initiation of treatment that will greatly improve the neonate’s chance of survival
Facts and Figures

› Neonatal sepsis is classified according to the timing of manifestations as early-onset sepsis (EOS; i.e., sepsis that develops within 72 hours of birth, though 85% of cases of EOS occur within 24 hours of birth) or late-onset sepsis (LOS; i.e., sepsis that develops > 72 hours to 30 days after birth). The timing of infection is determined by how the infection is acquired; infections transmitted vertically (i.e., transmission from the mother prior to or during birth) result in EOS, and infections that are acquired shortly after birth from in-hospital or community sources result in LOS (Stoll et al., 2011)

› Neonatal sepsis can be bacterial, viral, or fungal in origin, but bacterial infection acquired from a contaminated birth canal is most common. The most frequent bacterial sources are Group B streptococcus (GBS) in term neonates and Escherichia coli in preterm neonates. Protocols for intrapartum antibiotic prophylaxis yield reduced rates of neonatal GBS infection, but E. coli infection remains difficult to prevent and treat in preterm neonates (Stoll et al., 2011)

› Indwelling central venous catheterization is associated with the development of coagulase-negative staphylococcal sepsis in preterm neonates. Paradoxically, central venous catheter (CVC) removal has been related to increased risk of catheter-related sepsis. Findings from one research study support the administration of an anti-staphylococcal agent (e.g., cefazolin) during catheter removal as an effective method of preventing catheter-related sepsis in neonates (Hemels et al., 2011)

› Guidelines for the management of pediatric and neonatal septic shock have been published by the American College of Critical Care Medicine (ACCM)

› Development of multidrug-resistant pathogens in neonates is a serious concern in NICUs worldwide that is associated within appropriate use of broad-spectrum antibiotics and prolonged antibiotic treatment. It is recommended that blood culture and sensitivity be performed immediately in all neonates suspected of having sepsis, and that pathogen-specific antibiotic therapy be begun as soon as possible to avoid excessive use of broad-spectrum antibiotics (Bedford Russell & Kumar, 2015; Dong & Speer, 2015)

› Heart rate variability has been noted in many patient populations to be a useful adjunct in sepsis detection (Bohanon et al., 2015)

What You Need to Know Before Assisting in the Identification and Management of Neonatal Sepsis

› Knowledge of the definition of sepsis and familiarity with signs and symptoms that can occur with neonatal sepsis is important

• Sepsis is clinically defined as the presence of both SIRS and suspected or proven bacteremia

• SIRS is defined by the presence of at least 2 of the following 4 criteria, one of which must be either abnormal temperature or leukocyte count:
  - Abnormal temperature defined as > 38 °C/100.4 °F or < 36 °C/96.8 °F by rectal, oral, bladder, or central catheter probe. Hypothermia is more common than hyperthermia in neonates with sepsis
  - Abnormal heart rate (e.g., tachycardia or bradycardia)
    - Tachycardia is defined in neonates as a mean heart rate greater than 2 standard deviations over normal for age for at least 30 minutes in the absence of a stimulus (e.g., pain, medication)
    - Bradycardia is defined as a mean heart rate less than the 10th percentile for 30 minutes in the absence of triggers (e.g., vagal stimulus, medication)
  - Respiratory distress (e.g., apnea, respiratory rate greater than 2 standard deviations above normal for age and/or distress that requires mechanical ventilation)
  - Abnormal leukocyte count defined as any deviation from normal for age, or > 10% immature neutrophils in the absence of a clear cause (e.g., chemotherapy)

• Research is currently being performed regarding whether or not certain biomarkers (e.g., interleuken-6 [IL-6], procalcitonin [PCT]) in umbilical cord blood or maternal serum may be useful in providing early diagnostic information for identification of EOS in the neonate. Results of an early study indicate that PCT and IL-6 in umbilical cord blood and IL-6 in maternal serum may be useful for diagnosis. Further research is needed to determine if this information can be used to modify clinical outcomes (Su et al., 2014)

• Specific signs and symptoms are not always necessary prior to initiating a sepsis screening protocol in neonates. The presence of one or more of the following risk factors or nonspecific signs and symptoms may be sufficient to trigger clinical suspicion for sepsis:
  - Risk factors include
    - intrapartum fever
    - difficult delivery, low Apgar score, or resuscitation in delivery room
- premature rupture of membranes
- male gender
- African American descent
- birth asphyxia
- premature labor
- meconium-stained or foul-smelling amniotic fluid
- prolonged internal monitoring
- prematurity
- congenital anomalies of the spine or abdomen
- low birthweight (e.g., < 2,500 g)
- invasive treatment (e.g., central venous catheterization, mechanical ventilation)
- multiple birth
- maternal infection (e.g., GBS)

Nonspecific signs and symptoms include
- hypotonia
- hypotension
- apnea
- vomiting, diarrhea, or distended abdomen
- hyper- or hypoglycemia
- feeding intolerance/lack of weight gain
- respiratory distress
- irritability
- pallor
- lethargy
- seizures
- jaundice
- petechiae
- bruising
- bleeding
- bulging fontanels
- hepatosplenomegaly
- temperature instability (hypothermia is more common than fever)
- resting tachycardia
- cyanosis
- having the appearance of being unwell

Competence in physical assessment of the neonate and pediatric critical care skills are important

- In caring for the neonate with sepsis, the neonatal nurse clinician will provide assistance with invasive laboratory and diagnostic studies (e.g., blood culture, lumbar puncture for cerebrospinal fluid [CSF] culture, endotracheal aspiration), administer I.V. antimicrobial therapy, and institute supportive measures (e.g., mechanical ventilation, parenteral nutrition, fluid resuscitation, and invasive monitoring).

The following preliminary steps should be performed prior to implementing strategies to identify and manage neonatal sepsis:

- Review facility protocol for management of neonatal sepsis, if one is available
- Review the treating clinician’s orders for management of neonatal sepsis, including laboratory and diagnostic testing, medications, and monitoring methods and parameters
- Review the instructions for all equipment to be used and verify that the equipment is in good working order
- Verify parental completion of facility informed consent documents. If the initiation of neonatal sepsis is performed under emergency conditions and it is not possible to obtain written consent, the universally accepted standards of care for neonatal sepsis offer implied consent
- Review the patient’s medical history/medical record for information about allergies (e.g., to latex, medications, or other substances); use alternative materials as appropriate
- Review medical history for risk factors for sepsis
  - Identify both neonatal and maternal risk factors
Review perinatal history and laboratory and diagnostic study results for abnormalities (e.g., birth complications, maternal infection, resuscitation)

Gather supplies appropriate for the procedure, which will vary based on the child’s clinical condition and the specific procedures ordered but typically include the following:

- Personal protective equipment (PPE; e.g., nonsterile gloves, sterile gloves, gown, mask)
- Facility-approved, developmentally-appropriate pain assessment tool
- Vital sign equipment (e.g., stethoscope, thermometer, BP machine)
- Cardiopulmonary monitoring equipment with pulse oximeter and temperature probe
- Supplies for CVC insertion and blood sampling
- Supplies for urine sampling (e.g. by suprapubic aspiration)
- Supplies for lumbar puncture if indicated
- Supplies for endotracheal intubation and mechanical ventilation
- Supplies for supplemental oxygen administration
- Supplies for I.V. administration of fluids, blood products, and medications, including I.V. pump, pole, and tubing/filtration systems
- Prescribed medications (e.g., analgesics, antimicrobial agents), I.V. fluids, and parenteral nutrition as appropriate
- Resuscitation cart
- Written information, if available, to reinforce verbal education

How To Assist in the Identification and Management of Neonatal Sepsis

- Perform hand hygiene
- Don PPE as appropriate to avoid transfer of microorganisms
- Identify the patient according to facility protocol
- Introduce yourself to the parents, if present, and explain your clinical role in identifying and managing neonatal sepsis and providing care for their neonate
  - Evaluate whether the parents require special considerations regarding communication (e.g., due to illiteracy, language barriers, or deafness); make arrangements to meet these needs, if present
  - Assess the parents for knowledge deficits and anxiety regarding neonatal sepsis
    - Determine if the parents require special considerations regarding communication (e.g., due to illiteracy, language barriers, or deafness); make arrangements to meet those needs if they are present
    - Follow facility protocols for using a professional certified medical interpreter, either in person or via phone, when a language barrier exists
    - Explain details of all assessment procedures and interventions you will be performing, including their purpose; answer questions and provide emotional support as needed
- Identify current risk factors for sepsis, including invasive monitoring and treatments
- Perform a complete physical assessment of the neonate, and report abnormalities to the treating clinician
  - Assess the neonate’s baseline temperature and other vital signs according to facility protocol and evaluate for signs and symptoms of hypothermia
  - Evaluate the neonate’s intake and output, Apgar score, and response to stimuli
  - Assess all body systems for abnormalities that could indicate increased risk of sepsis (e.g., impaired skin integrity, hypothermia)
- Monitor for and report nonspecific signs and symptoms to the treating clinician
  - Inspect the neonate for visible signs of distress (e.g., lethargy, hypotonia, pallor), including subtle symptoms (e.g., having an unwell appearance)
  - Some neonates with sepsis are asymptomatic
- According to the treating clinician’s orders and/or facility protocol, initiate the sepsis screening protocol to rule out sepsis (for details, see Red Flags, below)
  - Identify SIRS by the presence of 2 or more of the following signs:
    - Abnormal heart rate
    - Respiratory distress
    - Abnormal leukocyte count
    - Abnormal temperature
  - Assist with completion of laboratory and diagnostic tests, as ordered, which may include
- blood culture to confirm bacteremia and identify the source organism. Results might take up to 36 hours
- blood chemistry tests (e.g., glucose, calcium, pH, electrolytes) and arterial blood gases to identify electrolyte abnormalities, hyper- or hypoglycemia, and metabolic acidosis
- CBC to identify total WBC count, neutrophil count, and ratio of immature to total polymorphonuclear leukocytes (PMNs)
  - Absolute neutrophil count < 1,000/mL is abnormal
  - Total WBC count < 7,500/mm$^3$ or > 40,000/mm$^3$ is abnormal
- Gram stain and culture of endotracheal aspiration, if intubated
- polymerase chain reaction (PCR) test to identify bacterial cause of infection
- urine culture to confirm bacteremia and identify the source organism
- lumbar puncture for CSF culture to rule out or confirm meningitis
- chest X-ray to identify pneumonia by the presence of infiltrates or pleural effusion
- abdominal X-ray to identify necrotizing enterocolitis
- C-reactive protein (CRP) level, which can be used to rule out sepsis if results are normal (< 1 mg/dL), but is not necessarily diagnostic if elevated (≥ 1 mg/dL)
- procalcitonin level, which is considered diagnostic of sepsis if elevated (e.g., > 0.55 ng/mL at birth or > 1.7 ng/mL at 3 days old)
- urine culture obtained by suprapubic aspiration
- Administer I.V. broad-spectrum antibiotic (e.g., gentamicin, ampicillin, cefotaxime) as prescribed, after blood, urine, and/or CSF specimen have been obtained for culture
- Assess for signs of pain (e.g., indicated by tachycardia, bradycardia, periods of apnea, irritability, inconsolability) that may be caused by illness or invasive tests and treatments. Administer analgesia, as prescribed
- Institute supportive care measures, as ordered
  • Assist with placement of a CVC, if ordered
  • Administer supplemental oxygen, assist with intubation as needed, and provide prescribed respiratory support
  • Initiate incubator therapy, as ordered. (For details, see Nursing Practice & Skill ... Newborn Care: Incubators -- Management of the Preterm Infant)
  • Administer I.V. fluids as prescribed to promote hemodynamic stability
  • Initiate cardiopulmonary monitoring according to the treating clinician’s orders and/or facility protocol
  • Initiate parenteral nutrition, as prescribed, to reduce risk of aspiration
  • Administer blood products, as ordered, as treatment for anemia, coagulopathy, or shock
- Institute isolation precautions as necessary to prevent transmission of microorganisms
- Monitor for complications, initiate strategies to reduce risk for complications, and/or manage complications that develop
  • Monitor for signs of infection related to invasive medical interventions
  • Adhere to facility protocols for hand hygiene and infection control
  • Monitor for hypothermia related to I.V. fluids/nutrition
  • Monitor for signs and symptoms of sepsis-related complications, including pneumonia, meningitis (e.g., bulging fontanels, loss of consciousness), DIC (e.g., abnormal bleeding times), multiple organ dysfunction, and septic shock. Administer prescribed treatment
- Keep the parents informed about the neonate’s condition using simple, nonmedical terminology they can understand
- Dispose of used equipment in the appropriate receptacles
- Remove and discard gloves and other PPE; perform hand hygiene
- Clean and disinfect the stethoscope using a disinfectant wipe and perform hand hygiene
- Update the patient’s plan of care, if appropriate, and document the following information in the patient’s medical record:
  • Time and date the strategies for identifying and managing neonatal sepsis were performed, including
    – physical assessment findings, including vital signs
    – laboratory and diagnostic test results, including when and how findings were communicated to the treating clinician
    – nursing interventions performed and patient outcome
    – medication, I.V. fluid, and volume expander administration
    – pain assessment findings and analgesia administered
    – The neonate’s response to all interventions
  • Laboratory specimens collected and sent for analysis
  • Any unexpected patient events, interventions performed, whether or not the treating clinician was notified, and patient outcome
What to Expect After Identifying and Managing Neonatal Sepsis

› Neonatal sepsis is identified and optimally managed, and the neonate experiences resolution of signs and symptoms and full recovery

Red Flags

› Sepsis screening protocols that include combinations of multiple laboratory tests can be useful in ruling out sepsis, but are of limited value in diagnosing sepsis because individual tests have poor sensitivity with the exception of procalcitonin
› Clinical signs are given greater weight than blood culture results because neonatal blood specimens may not be sufficient to yield accurate laboratory test results. A negative blood culture does not necessarily indicate that bacteremia does not exist
› To decrease the risk of necrotizing enterocolitis, enteral feedings should not be initiated for 24–72 hours for a neonate who is recovering from septic shock

What Do I Need to Tell the Patient/Patient’s Family?

› Assess parent anxiety level and coping ability; provide emotional support, educate, and encourage discussion about neonatal sepsis pathophysiology, risk factors, treatment risks and benefits, management strategies, and individualized prognosis
› If laboratory testing or other diagnostic procedures are ordered, explain how these tests and/or procedures are performed and when the results will likely become available
› Encourage parental visitation and bonding with the neonate, as appropriate to facility protocols. Reinforce education on proper hand hygiene prior to and during visits

References


