Necrotizing Enterocolitis

Necrotizing enterocolitis (NEC) is an inflammatory disease, or necrosis, of the bowel. NEC is a serious, life-threatening gastrointestinal emergency that primarily affects premature neonates; the more preterm a neonate is, the higher the incidence of NEC. Up to 10% of NICU admissions will develop NEC (incidence varies regionally and within individual units). Full-term infants also can develop NEC. It is estimated that 20%–40% of neonates with NEC will require surgical intervention. Surgical NEC fatality rates are as high as 50%. The onset of NEC most commonly appears within the first 6 weeks of life; in more premature infants, the age of inflammatory disease onset is earlier (days 3–30). The most common areas of intestinal damage are the distal ileum and proximal colon. Spontaneous intestinal perforation (SIP), or isolated intestinal perforation, generally occurs within the first week of life. Although infants with SIP will present similarly to those with NEC, SIP is distinctly different from NEC. SIP is a focal perforation without an inflammatory component.

The exact etiology of NEC is unknown, although it is characterized by intestinal injury, inflammation, and necrosis. Prematurity is the most common risk factor. Other factors that have been found to play a role in NEC include enteral feeding with formula, decreased bowel motility, and an immature immune system allowing for bacterial invasion. The premature neonate has an immature intestinal tract and therefore has decreased intestinal motility. The intestinal barrier isn't "tight" (or strong). As the intestinal wall's mucosal barrier breaks down from the invasion of abnormal bacteria (i.e., gas-producing bacteria), intestinal injury can become severe. Other risk factors include the following:

Feeding Practices. Feeding does provide a necessary medium for the multiplying of bacteria. Feeding hyperosmolar formula or medications can damage the intestinal mucosa. Examples of osmolarity for different feeding types include

- breast milk: 257 mOsm/L
- preterm breast milk with fortifier: approximately 300 mOsm/L
- premature infant formulas (20 cal/oz): approximately 210 mOsm/L
- premature infant formulas (24 cal/oz): approximately 250 mOsm/L
- elemental formulas (20 cal/oz): approximately 250 mOsm/L–310 mOsm/L
- examples of medication osmolality include
  - Polyvisol: > 11,000 mOsm/L
  - NaCl: > 7,000 mOsm/L
  - Phenobarbital: > 7,000 mOsm/L (Jew, Owen, Kaufman, & Balmer, 1997).

Human milk has been identified to be protective against NEC, mostly due to immunologic factors. Mothers should be encouraged to provide their own breast milk. If the mother is unable to provide her own milk, use of donor milk should be considered, especially for the very-low-birthweight (< 1,500 g) population. Recent randomized, controlled trials comparing donor milk and formula demonstrated twice the incidence of NEC in the formula-fed groups (Ramani & Ambalavanan, 2013).

Gastric residuals do not necessarily indicate the presence of NEC. Gastric motility is slower in the preterm neonate. Because the motor complexes of the intestines are immature (thus slower motility), it can be normal to have light green–tinged or milky residuals in the absence of other clinical signs and symptoms. One must note the color of the residual, the amount of the residual in comparison with the amount of the feeding, and if there are any signs or symptoms.

Adopting a standardized feeding guideline may decrease the risk of NEC. There is some evidence to suggest this practice may decrease incidence of NEC, however, other studies do not show a significant difference. Some centers have noted a consistent decline in the incidence and severity of NEC following the institution of feeding guidelines.

Hypoxic/ischemic events. After a hypoxic event, intestinal ischemia may follow as blood is shunted away from the intestines. With reperfusion of the bowel, damage to the intestine may occur. Some examples of events that may impact gut perfusion include patent ductus arteriosis (diastolic steal), hypotension, hypovolemia, umbilical line(s) placement, exchange transfusion, packed red blood cell transfusion, and polycythemia. In addition, neonates with congenital heart disease have compromised bowel perfusion, which may make them susceptible to ischemic injury of the bowel.

Abnormal bacterial colonization. Abnormal bacterial colonization of the immature intestinal tract is a significant risk factor identified with NEC. Some studies have shown that neonates who were born via cesarean section, fed formula, or exposed to antibiotics have a decrease in diversity of intestinal microbiota and abnormal patterns of bacterial colonization. Probiotics are a potential mode of preventing severe NEC, but the specifics of timing and dosage are unclear (Niño, Sodhi, & Hackam, 2016).

H2 blockers. These medications (e.g., Pepcid, Zantac) alter the pH of the stomach. Histamine-2 blockers have been shown to increase the risk of sepsis and meningitis for neonates (Torrazza & Neu, 2013).

Presentation

Nonspecific symptoms of NEC may include apnea, bradycardia, temperature instability, lethargy, and hypotension. More specific symptoms may include discolored abdominal wall, visualization or palpation of bowel loops, abdominal distention, feeding residuals, bloody stools, and decreased or absent bowel sounds. Laboratory findings also can be nonspecific. These may include thrombocytopenia, neutropenia, and metabolic acidosis.

The Modified Bell's Staging Criteria chart is used to categorize NEC presentation using clinical symptoms and radiologic findings. There are three stages, and each stage is divided into two presentations.

Interventions

Lab work such as complete blood counts, blood cultures, inflammatory markers (e.g., C-reactive protein), blood gases, electrolytes, and glucose and coagulation studies should be evaluated and repeated as indicated. Frequent abdominal X rays may be taken in one or two views and may include left lateral decubitus or cross-table lateral views. Presence of the biomarker intestinal fatty acid-binding protein has been found to be an important predictor of NEC and the extent of intestinal damage (Niño et al., 2016).

Nonsurgical interventions include gastric decompression to low intermittent suction, intravenous fluids or parenteral nutrition, possible replacement of gastric output, monitoring of vital signs, antibiotics, pain management, ventilator support as needed, circulatory support as needed (e.g., for hypotension), strict intake and output, and laboratory studies (as mentioned above), including serum glucose, and frequent X rays. The pediatric surgeon should be called if Bell's Stage II or greater NEC is noted or if medical management is not successful.

Surgical intervention is necessitated if pneumoperitoneum is noted on the X ray. Other indications for surgery can include portal venous gas; fixed, dilated intestinal loops noted on the X ray; an abdominal mass; clinical deterioration; or presence of bowel necrosis on an ultrasound (Niño et al., 2016). Options for surgery include an exploratory laparotomy or placement of a peritoneal drain. The type of surgery performed will depend on the condition of the neonate as well as the progression of bowel necrosis. Peritoneal drain placement can be performed at the bedside and is a temporary measure for an unstable neonate. With an exploratory laparotomy, the bowel is examined and the necrotic segments removed. Most times, an ostomy is created with a mucus fistula. After the neonate has grown and is stable, with feedings re-established, a reanastomosis is performed, assuming there is enough viable bowel length to do so. Timing of reanastomosis may be weeks to months after the laparotomy.

Complications from NEC may include intestinal strictures, malabsorption with or without short bowel, cholestatic liver disease, recurrent NEC episode, and neurodevelopmental delay. Intestinal strictures are more often found in NEC patients managed medically, not requiring surgical intervention; infants with late onset NEC; and infants delivered via cesarean section (Zhang et al., 2017). Malabsorption is seen in infants having significant bowel length resected or those who lose their ilieo-cecal valve. A general rule of thumb is that more than 30 cm of bowel with intact ileocecal valve or more than 50 cm of bowel without the ileocecal valve is required for an infant to survive on enteral nutrition (Kastenberg & Sylvester, 2013). Recurrent NEC occurs in about 5% of cases. Cholestatic liver disease may occur due to prolonged use of total parenteral nutrition and intralipids. Neurodevelopmental delay is related to the severity of NEC as well as the presence of circulating inflammatory mediators, which may contribute to a less than favorable neurodevelopmental outcome.

References

Berseth, C. L., Bisquera, J. A., & Page, V. U. (2003). Prolonging small feeding volumes early in life decreases the incidence of necrotizing enterocolitis in very low birth weight infants. *Pediatrics, 111*(3), 529–534.

Gephart, S. M., McGrath, J. M., Effken, J. A., & Halpern, M. D. (2012). Necrotizing enterocolitis risk: State of the science. *Advances in Neonatal Care, 12*(2), 77–87.

Gregory, K. E., DeForge, C. E., Natale, K. M., Phillips, M., & Van Marter, L. J. (2011). Necrotizing enterocolitis in the premature infant: Neonatal nursing assessment, disease pathogenesis, and clinical presentation. *Advances in Neonatal Care, 11*(3), 155–164.

Jew, R. K., Owen, D., Kaufman, D., & Balmer, D. (1997). Osmolality of commonly used medications and formulas in the neonatal intensive care unit. *Nutrition in Clinical Practice, 12*, 158–163.

Kastenberg, Z. J., & Sylvester, K. G. (2013). The surgical management of necrotizing enterocolitis. *Clinics in Perinatology, 40*(1), 135–148.

Niño, D. F., Sodhi, C. P., & Hackam, D. J. (2016). Necrotizing enterocolitis: New insights into pathogenesis and mechanisms. *Nature Reviews Gastroenterology & Hepatology, 13*(10), 590–600.

Ramani, M., & Ambalavanan, N. (2013). Feeding practices and necrotizing enterocolitis. *Clinics in Perinatology, 40*(1), 1–10. doi: 10.1016/j.clp.2012.12.001

Torrazza, R. M., & Neu, J. (2013). The altered gut microbiome and necrotizing enterocolitis. *Clinics in Perinatology, 40*(1), 93–108. doi: 10.1016/j.clp.2012.12.009

Zhang, H., Chen, J., Wang, Y., Deng, C., Li, L., & Guo, C. (2017). Predictive factors and clinical practice profile for strictures post-necrotising enterocolitis. *Medicine, 96*(10), e6273.

Bibliography

Boyd, C. A., Quigley, M. A., & Brocklehurst, P. (2007). Donor breast milk versus infant formula for preterm infants: Systematic review and meta-analysis. *Archives of Disease in Childhood, Fetal and Neonatal Edition, 92*(3), F169–F175.

Cloherty, J. P., Eichenwalk, E. C., & Stark, A. R. (2008). *Manual of Neonatal Care* (6th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Gomella, T. L., Cunningham, M. D., & Eyal, F. G. (2009). *Neonatology: Management, procedures, on-call problems, diseases and drugs* (6th ed.). New York, NY: McGraw Hill.

Patel, R. M., & Denning, P. W. (2013). Therapeutic use of prebiotics, probiotics, and postbiotics to prevent necrotizing enterocolitis. *Clinics in Perinatology, 40*(1), 11–25. doi: 10.1016/j.clp.2012.12.011

Sharma, R., & Hudak, M. L. (2013). A clinical perspective of necrotizing enterocolitis. *Clinics in Perinatology, 40*(1), 27–51. doi: 10.1016/j.clp.2012.12.012

Verklan, M. T., & Walden, M. (2004). *Core curriculum for neonatal intensive care nursing* (3rd ed.). St. Louis, MO: Elsevier.

Necrotizing Enterocolitis: Information for Parents

Necrotizing enterocolitis (NEC) is a disease that affects the intestines of sick babies. NEC occurs more often in premature babies—the earlier the baby is born, the greater the risk of NEC. Up to 10% of all babies admitted to the neonatal intensive care unit (NICU) can have NEC.

NEC is an inflammatory disease of the intestine (also known as the bowel). First, the intestinal wall lining becomes damaged. Then, bacteria attack the intestine to cause swelling and infection. This can lead to a rupture, or perforation, of the intestine. If the intestine ruptures, bacteria can get into the abdomen, which can be life threatening. The exact cause of NEC is unknown, but the most consistent risk factor is related to feeding. Babies who are fed formula are more likely to have NEC than those who are fed breast milk (human breast milk has a protective effect against NEC).

It can be difficult to identify NEC because the premature infant may have other issues that appear similar to NEC. Symptoms of NEC may include feeding intolerance, a round stomach or belly with "loops of bowel" noticeable, vomiting, bloody stools, not being active (lethargy), and times of not breathing and slowing of the heartbeat (apnea and bradycardia). Your baby may need assistance with breathing, such as the use of a ventilator. The best way to diagnose NEC is with an X ray of the stomach.

NEC treatment includes allowing the bowel to rest, so feedings will be stopped. This may be for as little as 3 days but may last for several days or weeks. A tube from your baby's mouth to the stomach will be placed to remove fluid and air from the stomach. Blood sampling will be done and intravenous fluids will be started for nutrition as well as antibiotics. Abdominal X rays will be frequent.

Many infants who have NEC do not need surgery, but there are some infants who will—if surgery is needed, a pediatric surgeon will be involved. During surgery, the sick part of the intestine will be removed, but sometimes, the healthy ends of the intestine can be sewn back together. Other times, the two ends of the intestine are brought to an opening in the skin called an ostomy. Your baby will stool through the ostomy into a bag. The ostomy may last a few weeks to months before the ends of the intestines are healed enough to be reconnected. After your baby has recovered from surgery and the antibiotics are done, he or she will be able to start feedings again.

Some babies experience narrowing of the intestines and poor digestion of feedings after having had NEC. When narrowing (also called *strictures*) happens, it can cause a blockage in the intestine. Poor digestion of feedings (called *malabsorption*) also may occur. If this happens, the use of human milk or another easy-to-digest formula may help.

During the initial diagnosis of NEC, you may not be able to hold your baby because he or she is so sick. Please ask questions of the NICU staff. The staff is here to support you together as a family.