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Necrotizing Enterocolitis

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Section 1: Introduction

Necrotizing enterocolitis (NEC) is the most common life threatening emergency affecting the gastrointestinal tract in infants. NEC is the inflammation of the intestine which can lead to a serious bacterial infection and necrosis of the intestine. Premature infants are most at risk for acquiring NEC which can be life threatening.

Patients diagnosed with NEC need aggressive treatment and may require surgical interventions. Early diagnosis is crucial for preventing serious complications. Treatment for NEC can be invasive and can cause growth and developmental delays. NEC can cause life-long complications that can impact the quality of life of patients and their families. It is important for nurses to be knowledgeable about NEC to promote optimal outcomes for patients. In this course, participants will learn the risk factors and stages of NEC, signs and symptoms, diagnostic criteria for NEC, and different treatment options.

Section 2: What is Necrotizing Enterocolitis and Risk Factors

References: 1, 2, 3, 6, 7, 8, 9, 10, 12, 17

Necrotizing enterocolitis (NEC) is life threatening and most commonly affects premature infants. Premature infants are defined as being born before 37 weeks gestation. If left untreated, NEC can cause intestinal perforation, peritonitis, sepsis, and death. NEC is caused by a bacterial infection in the intestine which can lead to intestinal inflammation and necrosis or the death of an organ or tissue. The bacteria can perforate the necrotic tissue and can enter the bloodstream. The bacterial infection can also cause peritonitis which is the inflammation of the tissue lining the abdomen. Any surviving intestinal tissue becomes inflamed and

can make it difficult for the body to digest food.

Peritonitis and sepsis can be life threatening without treatment. Inflammation from peritonitis can spread quickly and can cause severe organ damage. Sepsis is the body's extreme response to a bloodstream infection and needs to be recognized and treated promptly. Sepsis can also cause widespread inflammation and organ damage. Patients with peritonitis or sepsis can deteriorate rapidly. It is important for nurses to be able to identify signs and symptoms of these conditions so treatment can begin promptly.

NEC most commonly affects premature infants due to the immaturity of the gastrointestinal tract and the decreased ability to fight off infections. NEC most commonly occurs within 2 to 6 weeks after birth. There are four types of NEC:

- Classic
- Transfusion-associated
- Atypical
- Term infant

Classic NEC is the most common type and affects infants born earlier than 28 weeks gestation. Classic NEC usually occurs 3 to 6 weeks after birth and symptoms appear suddenly. These patients usually respond well to prompt treatment and have good outcomes.

Transfusion-associated NEC occurs as the result of receiving a blood transfusion. Research shows that 1 in 3 premature infants develop transfusion-associated NEC within 48 hours after receiving a blood transfusion. Research also shows that infants with transfusion-associated NEC were more likely to need surgical intervention and a longer hospitalization. Blood transfusions can increase the risk of NEC due to the potential trigger of an immune response in the gastrointestinal

tract or reperfusion injuries associated with blood transfusions.

Atypical NEC occurs when an infant develops NEC within the first week of life or before their first feeding. Atypical NEC is very rare.

Term infant NEC refers to full-term infants who develop NEC. Infants born at term usually do not have low birth weights or other risk factors of NEC. These infants usually have a birth defect such as a congenital heart defect or restricted growth that makes them more susceptible to infections.

Risk Factors

NEC almost only affects premature infants, but can also occur in full-term infants. Research shows that 70% of all cases of NEC occur in premature infants. Up to 5% of all premature infants are diagnosed with NEC and it can be attributed to 8% of all neonatal intensive care unit (NICU) admissions. The cause of NEC is often unknown, but risk factors include:

- Prematurity
- Low birth weight
- Formula feeding
- Genetics
- Infection in infants
- Infants who receive blood transfusions

Premature infants have a weaker gastrointestinal system and immune system which is thought to contribute to the risk of acquiring NEC. The weak gastrointestinal system can cause a decreased amount of oxygen-rich blood flow to the intestines which can lead to tissue damage, necrosis, and bloodstream

infections.

Research has shown that infants, especially infants with a low birth weight, have a higher risk of acquiring NEC if they are formula fed versus breastfed. It is thought that breast milk provides protection from the mother against bacteria, which can help decrease the incidence of NEC. Research shows that NEC often occurs in infants weighing less than 5 and a half pounds at birth and the greatest risk is for infants weighing less than 2 pounds at birth.

The prognosis of NEC is determined by the severity and the time treatment is started. The mortality rates of NEC are high, ranging from 10 to 50%. Research shows that 15 to 40% cases of NEC are fatal and infants that survive often have long-term health complications. Research shows that 45% of infants diagnosed with NEC have neurological impairments and are at increased risk for chronic conditions such as cerebral palsy, cognitive delays, and visual impairment. It is important for nurses to be aware of the risk factors and signs of NEC to help improve the prognosis.

Section 2 Personal Reflection

How could you as a nurse support parents whose child was just diagnosed with NEC given the high mortality rates?

Section 2 Key Words

Necrotizing enterocolitis (NEC) - A disease of the intestines commonly affecting premature infants that occurs when the intestine becomes inflamed and necrotic due to a bacterial infection.

Premature infant - An infant born before 37 weeks gestation.

Intestinal perforation - A common complication of necrotizing enterocolitis (NEC) that occurs when a hole develops in the intestine and can cause a severe infection.

Necrosis - The death of an organ or tissue due to lack of blood flow, disease, or injury.

Peritonitis - Inflammation of the tissue lining the abdomen often caused by a bacterial infection.

Sepsis - The body's extreme response to a bloodstream infection that can lead to organ failure, shock, and death.

Classic NEC - The most common type of necrotizing enterocolitis (NEC) that affects infants born earlier than 28 weeks gestation and has sudden onset.

Transfusion-associated NEC - A type of necrotizing enterocolitis (NEC) that occurs as the result of receiving a blood transfusion.

Atypical NEC - A rare type of necrotizing enterocolitis (NEC) that occurs when an infant develops NEC within the first week of life or before their first feeding.

Term infant NEC - A type of necrotizing enterocolitis (NEC) that occurs in full-term infants.

Section 3: Signs, Symptoms, and Diagnostic Criteria

References: 1, 2, 3, 5, 6, 7, 8, 9

Signs and symptoms of NEC are often nonspecific which can delay diagnosis. Symptoms can appear suddenly or over the course of a few days. Symptoms of NEC include:

- Poor feeding and decreased appetite

- Lethargy
- Vomiting
- Abdominal tenderness and distention
- Discoloration of the abdomen
- Diarrhea and bloody stools
- Change in the volume or frequency of stools
- Hypoactive bowel sounds
- Palpable abdominal mass
- Episodes of bradycardia or apnea

It is important for nurses to be aware of these symptoms when caring for patients at high risk for NEC and identify these symptoms early for prompt diagnosis and treatment. If NEC progresses without prompt treatment, more severe symptoms can occur including:

- Hypotension
- Weak pulses
- Fluid in the abdomen
- Inability to maintain a normal temperature
- Respiratory failure
- Symptoms of peritonitis and sepsis

Many of these severe symptoms can be attributed to peritonitis and sepsis. Symptoms of peritonitis include:

- Abdominal pain or tenderness
- Abdominal distention
- Fever
- Vomiting
- Decreased appetite
- Diarrhea or constipation
- Lethargy
- Decreased urine output

Symptoms of sepsis include:

- Fever
- Lethargy
- Decreased urine output
- Tachycardia
- Tachypnea
- Hypotension
- Diaphoresis

It is important for healthcare providers to be aware of these signs and symptoms as early treatment is most important for preventing severe NEC and potential lifelong complications.

Diagnostic Criteria

If healthcare providers suspect a patient has NEC, several tests can confirm the NEC diagnosis. Abdominal x-ray, ultrasound, or an abdominal CT scan are the most common tests to confirm a NEC diagnosis. These tests typically show dilated loops of bowel, pneumatosis intestinalis, or portal venous gas. Pneumatosis intestinalis is the visualization of air within the bowel wall and is a certain finding of NEC. Portal venous gas may not always be present in all cases of NEC and can indicate that intestinal perforation has occurred. Because NEC can progress in severity so quickly, it is often recommended that scans should be repeated several hours apart until treatment is initiated in order to determine if NEC is progressing rapidly.

Labs are not recommended as reliable diagnostic criteria for NEC, but may be obtained to identify symptoms and other complications related to NEC. An occult blood stool sample can determine if there is blood in the stool. Other labs can determine if the patient has an elevated white blood cell count, decreased platelet count, or lactic acidosis. NEC can cause dehydration and electrolyte imbalances so labs are often helpful in determining these imbalances.

As of now, there is not a gold standard for diagnosing NEC. The Centers for Disease Control and Prevention (CDC) define NEC as having at least one of the following:

- Symptoms of vomiting, abdominal distention, or bloody stools
- Imaging findings of pneumatosis intestinalis, portal venous gas, or the presence of gas in the abdominal cavity

NEC is often reliant on symptoms and imaging findings, but Bell's staging is a way to diagnose and classify NEC. Bell's staging was the first classification developed for NEC in 1978. At the time Bell's staging was developed, there were limited

treatment options for NEC and no agreed upon diagnostic criteria. Bell's staging was developed to classify infants into one of three stages of NEC:

- Stage I: suspected NEC
- Stage II: confirmed NEC
- Stage III: advanced NEC

Stage I is when infants have nonspecific symptoms such as lethargy, abdominal distention, vomiting, apnea, and bradycardia. Infants may have lab results that may indicate a NEC diagnosis such as blood in stool samples and low platelets.

Stage II is when infants have more severe symptoms such as decreased bowel sounds, abdominal pain, bloody stools, and pneumatosis intestinalis is noted on x-ray or ultrasound. This stage confirms the NEC diagnosis.

Stage III is when infants have more severe symptoms than stage II and show signs of hemodynamic instability such as respiratory failure, hypotension, decreased urine output, and symptoms of peritonitis or sepsis.

In 1986, Bell's staging was updated to include more stages to help guide treatment options based on the severity of NEC. Today, Bell's staging is still the most commonly used diagnostic criteria for NEC worldwide.

Section 3 Personal Reflection

How would you educate the parents of a premature infant admitted in the NICU on the importance of identifying the early signs and symptoms of NEC?

Section 3 Key Words

Pneumatosis intestinali - Gas found in the bowel wall which can be commonly

seen on radiology imaging and is diagnostic criteria for necrotizing enterocolitis.

Bell's staging - A set of characteristics used to classify the severity of necrotizing enterocolitis and used to help guide treatment plans.

Bell's stage I - The stage in which NEC is suspected and involves nonspecific symptoms such as lethargy, abdominal distention, vomiting, apnea, and bradycardia.

Bell's stage II - The stage in which NEC is confirmed and involves more severe symptoms such as decreased bowel sounds, abdominal pain, bloody stools, and pneumatosis intestinalis is noted on x-ray or ultrasound.

Bell's stage III - The stage in which NEC is considered advanced and involves signs of hemodynamic instability such as respiratory failure, hypotension, decreased urine output, and symptoms of peritonitis or sepsis.

Section 4: Treatment Options

References: 1, 2, 3, 4, 6, 7, 10, 11, 12, 13, 14

There are different treatment options for NEC depending on the severity of the disease. There is no cure for NEC, but the goal is to prevent any further damage and minimize complications as much as possible. Early diagnosis and treatment can improve patient outcomes. Initial treatment for NEC includes:

- Bowel rest
- Total parenteral nutrition (TPN)
- Intravenous (IV) antibiotics
- Abdominal decompression

One of the first interventions for a patient with NEC is to stop all enteral feeds. Enteral feeds are any method of feeding that uses the gastrointestinal tract including oral feeds and feeding through a gastrointestinal tube. Stopping feeds gives the intestines time to rest and heal. Patients receive TPN to maintain adequate nutritional status until enteral feeds can be resumed which can take several days to several weeks. While bowel rest is important in treating NEC, long-term stoppage of enteral feeds can lead to adverse conditions such as feeding intolerance, decreased growth, and a prolonged use of TPN. Healthcare providers should be cautious and continually evaluate the patient's treatment progress when stopping enteral feeds.

A nasogastric (NG) tube is often placed to help keep the stomach empty to allow for bowel rest and decompress dilated bowels. Decompressing the abdomen can help relieve swelling and abdominal discomfort.

Broad spectrum IV antibiotics help to fight the bacterial infection associated with NEC. Broad spectrum antibiotics include ampicillin, gentamicin, clindamycin, and metronidazole. Research shows that broad spectrum antibiotics are recommended because there is not a consistent bacteria found to cause NEC. IV antibiotics are usually prescribed for 10 to 14 days. IV antibiotics are also treatment recommendations for peritonitis and sepsis which can be associated with NEC.

Other interventions may include IV fluids and supplemental oxygen. IV fluids can help provide nutrition and fluid resuscitation while the patient is on bowel rest. Without enteral feeds, patients may need supplemental IV fluids to keep electrolyte and glucose levels consistent. Supplemental oxygen may be required if patients are experiencing respiratory failure. Patients should be monitored frequently with serial abdominal exams, labs, and radiology to monitor the progression of NEC. Patients will be on continuous vital sign monitoring and

admitted to an intensive care unit.

Bell's staging can be used for determining the course of treatment in patients with NEC. Bell's stage I advises stopping enteral feeds and starting TPN to promote bowel rest. Providing supportive care such as IV fluids and supplemental oxygen, and frequent monitoring to ensure NEC is not progressing are other treatment recommendations for stage I. Bell's stage II advises continuing treatment recommendations of stage I and starting IV antibiotics. Bell's stage III advises moving towards surgical intervention as treatment recommendations from stage I and stage II are often not sufficient in treating advanced NEC.

Surgical Options

Surgical interventions are necessary if NEC is severe or if the patient is not responding to initial treatment. 1 in 4 infants diagnosed with NEC need surgical intervention. A laparotomy procedure is the most common procedure for NEC treatment, but is contraindicated in patients who are too small or in critical condition. If patients are not stable enough for surgery, a peritoneal drain may be inserted to help drain fluid and gas from the abdomen. This can help preserve as much of the intestine as possible until the patient is stable enough for surgery. Other treatments such as bowel rest, IV fluids, and abdominal decompression can be started to help symptoms until the infant is strong enough for surgery.

A laparotomy procedure is often preferred as it is a more conservative approach with removal of only the necrotic intestine. This allows conservation of as much healthy intestine as possible with the goal to prevent further long-term complications. A laparotomy is when an incision is made in the abdomen to allow the surgeon to visualize the damaged intestine and remove any necrotic tissue. Because the tissue damage is often extensive in NEC, a long and deep incision is often required for a laparotomy procedure and recovery can be a long process.

Another surgical intervention for NEC is an ostomy. An ostomy is when the surgeon creates a small hole called a stoma in the abdomen and connects part of the intestine to the stoma. This allows stool to exit through the stoma into an ostomy bag. The ostomy bag is a removable pouch that is attached to the skin to collect stool. An ostomy can be a necessary intervention for NEC if the patient has a large amount of necrotic intestinal tissue that needs to be removed. It is possible that the ostomy can be reversed if the patient's condition improves, but some infants may need the ostomy long-term.

Infants with NEC need close monitoring after surgery. IV antibiotics and TPN are often recommended for at least two weeks after surgery. Patients need to be monitored for electrolyte and fluid abnormalities and may need respiratory support after surgery. Infant mortality can still be up to 50% after surgery so close monitoring is needed to ensure NEC is not still progressing.

Section 4 Personal Reflection

What support and education might parents need if their child is needing surgical interventions for progressing NEC symptoms?

Section 4 Key Words

Bowel rest - Restricting food intake to allow the bowels to heal and improve certain medical conditions such as necrotizing enterocolitis.

Abdominal decompression - A procedure allowing fluids and air to be removed from the abdomen via nasogastric tube to improve abdominal distention and discomfort.

Enteral feeds - Any method of feeding that uses the gastrointestinal tract including oral feeds and feeding through a gastrointestinal tube.

Total parenteral nutrition (TPN) - Nutrition administered intravenously when there is a contraindication to enteral feeds.

Laparotomy - A surgical procedure cutting into the abdomen to allow for visualization of damaged tissue and repair or removal if indicated.

Peritoneal drain - A drain placed in the abdomen to allow the release of built up abdominal fluid.

Ostomy - A surgical procedure that connects part of the intestine to a stoma to allow stool to exit through the abdomen into an ostomy bag.

Stoma - A surgical connection between the intestine and the external abdomen.

Section 5: Possible Complications

References: 1, 14, 15, 16

Even with successful treatment, patients may have lifelong complications from NEC. Aside from peritonitis and sepsis, complications of NEC can include:

- Prolonged hospitalization
- Prolonged use of TPN which can lead to liver failure
- Short bowel syndrome
- Intestinal strictures
- Postoperative complications
- Intestinal failure
- Nutritional deficiencies
- Growth and development delays

Short bowel syndrome is a common complication of NEC. Short bowel syndrome, or short gut syndrome, is a condition that occurs when the intestines are shortened or damaged causing a decreased ability to absorb enough nutrients. Short bowel syndrome can be a lifelong condition and require continued tube feedings or TPN.

Short bowel syndrome can cause a lot of complications due to malabsorption. Malabsorption is the body's inability to absorb enough water, vitamins, calories, and other nutrients to allow the body to grow and function normally. Malabsorption can lead to dehydration and decreased growth and development. Other complications of short bowel syndrome include chronic inflammation and bacterial overgrowth in the intestines, gallstones and kidney stones, peptic ulcers, and liver disease. Patients with short bowel syndrome need lifelong nutritional support which can include TPN or feedings through a gastric tube. Patients may need to be on medications to decrease the amount of stomach acid and to manage related symptoms such as chronic diarrhea. Patients may also need repeat surgeries to continue to repair damaged intestinal tissue.

Intestinal strictures often occur after NEC surgery and affect 1 in 3 infants. Intestinal structures are bands of scar tissue that form inside the abdominal tissue and can compress the intestines and other organs. Symptoms of intestinal structures include:

- Abdominal pain
- Abdominal distention
- Constipation
- Nausea and vomiting

Patients may need more surgery to treat the strictures if symptoms are severe. It is important to treat intestinal strictures promptly as they can cause bowel

obstructions. Bowel obstructions prevent stool and fluid from moving through intestines and can lead to decreased blood flow and necrosis.

Postoperative complications can occur with a laparotomy or ostomy procedure. Postoperative complications include:

- Injury to nearby organs
- Excessive bleeding
- Infection of the surgical incision
- Nerve damage
- Intestinal strictures
- Bowel obstruction
- Malabsorption
- Diarrhea or constipation
- Skin irritation and bleeding around the stoma site
- Stoma prolapse

Because patients often need multiple surgeries and continued treatment for NEC, these complications are often recurring throughout the patient's life.

Long-Term Impacts on Patient and Family

The long-term impact of NEC can be a lifelong burden for patients and their families. One study showed that 72% of parents reported their child having long-term complications of NEC, most commonly digestive complications. Patients reported long-term symptoms such as diarrhea, abdominal pain, bowel obstructions, and malabsorption. 86% of parents reported that their child had the

need for a long-term feeding tube or TPN. 43% of parents reported needing re-hospitalization due to complications from NEC.

Patients who suffer from complications of NEC such as short bowel syndrome report needing re-hospitalization and continued long-term symptoms. It is important that patients continue to follow up with their healthcare providers to monitor ongoing symptoms and adjust treatment plans as needed.

Long-term complications can have a negative impact on patients' mental health. Research shows that older patients with NEC reported increased anxiety, poor body image, and negative emotions related to NEC. Surgical procedures leaving large scars or ostomy bags can cause negative body image and insecurities. Children with NEC often have growth and development delays and may experience difficulties in school or other social settings.

Parents of children with NEC reported financial concerns and anxiety related to their child's diagnosis. Parents often struggle with the life altering complications of NEC such as growth and development delays or the need for continuous TPN or an ostomy. Continued hospitalizations, surgeries, and other medical expenses related to NEC can cause a significant financial burden on families. Parents of children with chronic health care needs often report feeling stressed about the financial impact as well as adjusting their work and personal lives to attend to their child's ongoing medical needs. It is important for nurses to be aware of these impacts and to be a support for patients and families throughout their treatment. The impact of chronic health conditions, especially severe conditions such as NEC, on patients and families continues throughout their lives and after they leave the hospital. Nurses must be aware of external factors impacting patients and families and provide support and resources to help throughout their care.

Section 5 Personal Reflection

How could you as the nurse support patients and families who are struggling with their changed quality of life after diagnosis and treatment of NEC?

Section 5 Key Words

Short bowel syndrome - A condition that develops when the intestine is shortened or damaged and cannot absorb enough nutrients, also known as short gut syndrome.

Malabsorption - The body's inability to absorb enough water, vitamins, calories, and other nutrients to allow the body to grow and function normally.

Intestinal structures - Bands of scar tissue that form inside the abdominal tissue and can compress the intestines and other organs.

Bowel obstruction - A blockage in the intestines that prevents fluid and stool from passing through the intestines.

Section 6: Case Study #1

The nurse is taking care of a 3-week-old infant who was born premature at 27 weeks gestation and weighed 4 pounds at birth. The infant has been admitted to the neonatal intensive care unit (NICU) for monitoring and assistance with feeding due to their low birth weight. The infant has been needing supplemental feeds through a nasogastric tube and IV fluids to encourage growth. The parents are eager to bring their child home and have a lot of questions about why their child is still in the NICU. The parents state "Our baby has gotten bigger so when can we bring them home?"

1. What factors put this infant at high risk for acquiring NEC?

2. What type of NEC would this infant be at risk for?
3. What education could the nurse provide to the parents about the risk for NEC?

Section 7: Case Study #1 Review

This section will review the case studies that were previously presented in each section. Responses will guide the clinician through a discussion of potential answers as well as encourage reflection.

1. What factors put this infant at high risk for acquiring NEC?

   NEC most commonly affects premature infants and commonly occurs within 2 to 6 weeks after birth. Because this infant was born at 27 weeks gestation and is only 3 weeks old, they are at high risk for NEC. Premature infants have a weaker gastrointestinal system and immune system which is thought to contribute to the risk of acquiring NEC. The weak gastrointestinal system can cause a decreased amount of oxygen-rich blood flow to the intestines which can lead to tissue damage, necrosis, and bloodstream infections. Low birth weight is also a risk factor for NEC. Research shows that NEC often occurs in infants weighing less than 5 and a half pounds at birth and the greatest risk is for infants weighing less than 2 pounds at birth. The infant has been receiving formula feeds to improve growth, which is another risk factor for NEC. Research has shown that infants, especially infants with a low birth weight, have a higher risk of acquiring NEC if they are formula fed versus breastfed.

2. What type of NEC would this infant be at risk for?

   Classic NEC is the most common type and affects infants born earlier than

28 weeks gestation. Classic NEC usually occurs 3 to 6 weeks after birth and symptoms appear suddenly. These patients usually respond well to prompt treatment and have good outcomes.

3. What education could the nurse provide to the parents about the risk for NEC?

   It is important to educate the parents about the severity of NEC. NEC is life threatening and most commonly affects premature infants due to the immaturity of the gastrointestinal tract and the decreased ability to fight off infections. The nurse should educate the parents on the existing risk factors such as low birth weight, formula feedings, and prematurity. NEC most commonly occurs within 2 to 6 weeks after birth so the infant should be closely monitored for signs of NEC and the ability to start treatment early. The prognosis of NEC is determined by the severity and the time treatment is started.

Section 8: Case Study #2

The nurse is caring for an 8-week-old premature infant who is admitted to the NICU for low birth weight and concerns for NEC. The patient is exhibiting the following symptoms: poor feeding, bloody stools, abdominal distention, and vomiting. The infant is scheduled for an abdominal x-ray later that day to confirm the NEC diagnosis. The parents of the patient appear anxious and do not want to leave the infant's side. The mother states "I just don't understand how this happened. My baby was fine a few days ago."

1. What would be anticipated findings on the abdominal x-ray to confirm the NEC diagnosis?

2. According to Bell's staging, what stage of NEC would the nurse suspect the

infant is in based on the current symptoms?

3. What education could the nurse provide to ease the parent's anxiety about the sudden onset of symptoms?

Section 9: Case Study #2 Review

This section will review the case studies that were previously presented in each section. Responses will guide the clinician through a discussion of potential answers as well as encourage reflection.

1. What would be anticipated findings on the abdominal x-ray to confirm the NEC diagnosis?

   Abdominal x-ray, ultrasound, or an abdominal CT scan are the most common tests to confirm a NEC diagnosis. These tests typically show dilated loops of bowel, pneumatosis intestinalis, or portal venous gas. Pneumatosis intestinalis is the visualization of air within the bowel wall and is a certain finding of NEC. Portal venous gas may not always be present in all cases of NEC and can indicate that intestinal perforation has occurred. Because NEC can progress in severity so quickly, it is often recommended that scans should be repeated several hours apart until treatment is initiated in order to determine if NEC is progressing rapidly.

2. According to Bell's staging, what stage of NEC would the nurse suspect the infant is in based on the current symptoms?

   Bell's staging is another way to diagnose NEC and was the first classification developed for NEC in 1978. Stage I is when infants have nonspecific symptoms such as lethargy, abdominal distention, vomiting, apnea, and bradycardia. Infants may have lab results that may indicate a NEC diagnosis

such as blood in stool samples and low platelets. Stage II is when infants have more severe symptoms such as decreased bowel sounds, abdominal pain, bloody stools, and pneumatosis intestinalis is noted on x-ray or ultrasound. This stage confirms the NEC diagnosis. Stage III is when infants have more severe symptoms than stage II and show signs of hemodynamic instability such as respiratory failure, hypotension, decreased urine output, and symptoms of peritonitis or sepsis. The infant would be in stage I based on the current symptoms, but could move into stage II depending on the findings of the abdominal x-ray.

3. What education could the nurse provide to ease the parent's anxiety about the sudden onset of symptoms?

   It is important to explain that symptoms of NEC can happen suddenly in premature infants. The prognosis of NEC is determined by the severity and the time treatment is started. Because the infant is already being monitored in the NICU and has stage I symptoms, treatment can be started early and improve the prognosis. Further education about the treatment plan and possible long-term effects should be provided to the parents once the diagnosis is confirmed and the healthcare providers decide what course of treatment is best for this patient.

Section 10: Case Study #3

The nurse is caring for a patient diagnosed with severe NEC. The patient is a 4-week-old infant who has been on bowel rest and TPN for two weeks with no improvement of symptoms. The infant is currently experiencing the following symptoms: hypotension, decreased urine output, bloody stool, low platelet count, and abdominal distention. The mother of the patient has been asking what other treatment options are available. The healthcare providers are planning to speak

to the parents of the infant today to discuss surgical interventions.

1. Besides bowel rest and TPN, what are some other initial interventions for NEC?

2. What surgical interventions are available to treat patients with severe NEC?

Section 11: Case Study #3 Review

This section will review the case studies that were previously presented in each section. Responses will guide the clinician through a discussion of potential answers as well as encourage reflection.

1. Besides bowel rest and TPN, what are some other initial interventions for NEC?

   There are different treatment options for NEC depending on the severity of the disease. A nasogastric (NG) tube is often placed to help keep the stomach empty to allow for bowel rest and decompress dilated bowels. Decompressing the abdomen can help relieve swelling and abdominal discomfort. Broad spectrum IV antibiotics help to fight the bacterial infection associated with NEC. Broad spectrum antibiotics include ampicillin, gentamicin, clindamycin, and metronidazole. Research shows that broad spectrum antibiotics are recommended because there is not a consistent bacteria found to cause NEC. IV antibiotics are usually prescribed for 10 to 14 days. Other interventions may include IV fluids and supplemental oxygen. IV fluids can help provide nutrition and fluid resuscitation while the patient is on bowel rest. Without enteral feeds, patients may need supplemental IV fluids to keep electrolyte and glucose levels consistent. Supplemental oxygen may be required if patients are experiencing respiratory failure. Patients should be monitored frequently

with serial abdominal exams, labs, and radiology to monitor the progression of NEC.

2. What surgical interventions are available to treat patients with severe NEC?

   Surgical interventions are necessary if NEC is severe or if the patient is not responding to initial treatment. A laparotomy procedure is most common for NEC treatment, but is contraindicated in patients who are too small or in critical condition. If patients are not stable enough for surgery, a peritoneal drain may be inserted to help drain fluid and gas from the abdomen. This can help preserve as much of the intestine as possible until the patient is stable enough for surgery.

   A laparotomy is when an incision is made in the abdomen to allow the surgeon to visualize the damaged intestine and remove any necrotic tissue. Because the tissue damage is often extensive in NEC, a long and deep incision is often required for a laparotomy procedure and recovery can be a long process.

   Another surgical intervention for NEC is an ostomy. An ostomy is when the surgeon creates a small hole called a stoma in the abdomen and connects part of the intestine to the stoma. This allows stool to exit through the stoma into an ostomy bag. The ostomy bag is a removable pouch that is attached to the skin to collect stool. An ostomy can be a necessary intervention for NEC if the patient has a large amount of necrotic intestinal tissue that needs to be removed. It is possible that the ostomy can be reversed if the patient's condition improves, but some infants may need the ostomy long-term.

Section 12: Case Study #4

The nurse is taking care of a 4-month-old infant who has short bowel syndrome. The infant was born premature and has suffered many complications from NEC requiring continuous monitoring in the NICU since birth. The patient has an ostomy and has been receiving TPN. The mother of the infant is currently at the bedside and appears visibly distressed. The mother states she is worried about losing her job due to all the time she spends with her child in the NICU. She states "I cannot lose my job. How will I keep up with my child's medical costs if I lose my job?"

1. What education could the nurse provide to the mother about short bowel syndrome?
2. What are some factors that can impact the families of patients with NEC that the nurse should be aware of?
3. What education could the nurse provide to the mother about long-term complications of NEC?

Section 13: Case Study #4 Review

This section will review the case studies that were previously presented in each section. Responses will guide the clinician through a discussion of potential answers as well as encourage reflection.

1. What education could the nurse provide to the mother about short bowel syndrome?

   Short bowel syndrome is a common complication of NEC. Short bowel syndrome, or short gut syndrome, is a condition that occurs when the intestines are shortened or damaged causing a decreased ability to absorb

enough nutrients. Short bowel syndrome can be a lifelong condition and require continued tube feedings or TPN.

Short bowel syndrome can cause a lot of complications due to malabsorption. Malabsorption is the body's inability to absorb enough water, vitamins, calories, and other nutrients to allow the body to grow and function normally. Malabsorption can lead to dehydration and decreased growth and development. Other complications of short bowel syndrome include chronic inflammation and bacterial overgrowth in the intestines, gallstones and kidney stones, peptic ulcers, and liver disease. Patients with short bowel syndrome need lifelong nutritional support which can include TPN or feedings through a gastric tube. Patients may need to be on medications to decrease the amount of stomach acid and to manage related symptoms such as chronic diarrhea. Patients may also need repeat surgeries to continue to repair damaged intestinal tissue.

2. What are some factors that can impact the families of patients with NEC that the nurse should be aware of?

   Even with successful treatment, patients may have lifelong complications from NEC. The long-term impact of NEC can be a lifelong burden for patients and their families. Many parents report long-term symptoms and continued re-hospitalizations due to complications from NEC. Surgical procedures leaving large scars or ostomy bags can cause negative body image and insecurities. Children with NEC often have growth and development delays and may experience difficulties in school or other social settings.

   Parents of children with NEC reported financial concerns and anxiety related to their child's diagnosis. Parents often struggle with the life altering complications of NEC such as growth and development delays or the need

for continuous TPN or an ostomy. Continued hospitalizations, surgeries, and other medical expenses related to NEC can cause a significant financial burden on families. Parents of children with chronic health care needs often report feeling stressed about the financial impact as well as adjusting their work and personal lives to attend to their child's ongoing medical needs. It is important for healthcare providers to be aware of these impacts and to be a support for patients and families throughout their treatment.

3. What education could the nurse provide to the mother about long-term complications of NEC?

   Even with successful treatment, patients may have lifelong complications from NEC. Complications can include: prolonged hospitalization, prolonged use of TPN which can lead to liver failure, short bowel syndrome, intestinal strictures, postoperative complications, intestinal failure, nutritional deficiencies, growth and development delays. It is important that the mother is aware of the continued medical care that the child will need throughout their lives. If the mother is aware of the long-term needs, it may help her be prepared and plan for the future.

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