Necrotizing Enterocolitis: A Surgical Emergency

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Objectives

A. Understand the pathophysiology of necrotizing enterocolitis (NEC)

B. Be able to explain and identify the signs and symptoms of NEC

C. Discuss medical treatment options for NEC

D. Identify the surgical patient

E. Understand the complications of NEC
Case Presentation

• Ex 32 weeker, spent 2 weeks in OSH NICU for feeding and growing

• Presented to EC at 4 weeks with non-bloody diarrhea ~ 10 episodes x 4 days with decreased PO intake

• Admitted for fluid resuscitation, monitoring electrolytes and ad lib feeding
Initial Physical Exam

Vitals:
- BP 100/59
- HR 141
- T 98.5F (36.9C) – rectal
- RR 44
- SpO2 100% on RA

Physical Exam:
- General: thin, tired
- Head: fontanelles slightly sunken
- CV/Pulm: no respiratory distress, CTAB, RRR, good cap refill
- Abdomen: BS appreciated, soft, non-distended, non-tender
- Neuro: tired, but wakes to cry
Two days after admission

• Bedside nurse concerned with appearance of infant and that he had not eaten in ~ 4 hours

• MD to bedside: exam was unremarkable besides child appearing pale with BG 275

• (9/3) “Approximately 20 minutes after I left the room, RN noted blood in his diaper with a rectal temp of 93F. On exam, belly distended. Grunting with respirations which was new. KUB ordered. BCx ordered. Called NICU MD on call ... She came to evaluate immediately. KUB c/w NEC. Transferred to NICU.”
FINDINGS:

Catheters/tubes/postoperative changes: None.

Lungs, pleura and airways: Normal.

Cardi mediastinal structures: Normal.

Abdomen: There is widespread pneumatosis throughout multiple loops of bowel and extensive portal venous air within the liver. There is a large lucent area overlying the left upper abdomen and it is unclear if this is intraperitoneal free air or the stomach bubble.

Bones: Normal.

IMPRESSION:

Radiographic findings consistent with necrotizing enterocolitis. Recommend left lateral decubitus abdominal radiograph to exclude pneumoperitoneum. Findings discussed with the referring clinician at the time of dictation.

The lungs are clear.
Defining Necrotizing Enterocolitis

“...result of mucosal compromise in the presence of pathogenic bacteria ... in a susceptible host. This leads to bowel injury and an inflammatory cascade.”

– Pediatric Surgery NaT
Pathophysiology of NEC

• Genetic predisposition

• Intestinal immaturity
  - Motility
  - Absorption, digestion, and circulatory regulation
  - Mucosal physical barriers (i.e. decreased gastric acid production)

• Abnormal microbial colonization or dysbiosis
  - E.coli, Klebsiella, Enterobacter sp., Staphylococcus sp., Clostridium sp.

• Exaggerated inflammatory response
  - Factors such as: TLR4, PAF, interleukin-8, COX-2, PGE2
Pathophysiology continued

Open | Closed

[Pathogen image]
Risk Factors

*Necrotizing enterocolitis is primarily a disease of prematurity*

**Prematurity**
- Enteral feedings in preterm infants
- Maternal eclampsia
- Hypothermia
- Hypoxia (congenital heart and lung disease)
- Use of indomethacin and steroids
- Neonatal sepsis
- Gastrointestinal disease (i.e. gastroschisis)
Benefits of Breastfeeding

- Human breast milk includes antimicrobial and anti-inflammatory factors:
  - Secretory immunoglobulins
  - Cytokines
  - Lactoferrin
  - Lysozymes
  - Growth factors
Just for fun

Is any one brave enough to shout out signs and symptoms that come to mind when you hear necrotizing enterocolitis?
Signs and symptoms

• Vital signs:
  • Temperature instability
  • Bradycardia
  • Apnea
  • Hypotension
Signs and Symptoms continued

• Physical Exam:
  - Lethargy, and irritability
  - Abdominal distention and tenderness
  - Abdominal wall erythema/bruising
  - +/- Rectal bleeding
  - Feeding intolerance
    • Increased gastric residuals
# Priority Nursing Assessment for the Prevention of NEC

<table>
<thead>
<tr>
<th>Physiologic System</th>
<th>Generalized</th>
<th>Cardiovascular and Respiratory</th>
<th>Gastrointestinal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nursing assessments and clinical signs associated with NEC</strong></td>
<td>Temperature</td>
<td>Vital signs</td>
<td>Feeding intolerance</td>
</tr>
<tr>
<td>Behavior</td>
<td>• Temperature instability</td>
<td>• Apnea</td>
<td>• Emesis</td>
</tr>
<tr>
<td></td>
<td>• Additional radiant heat requirements</td>
<td>• Bradycardia</td>
<td>• Increasing pregaage residuals</td>
</tr>
<tr>
<td></td>
<td>• Lethargy</td>
<td>• Oxygen desaturations with increased respiratory support needs</td>
<td>• Bilious aspirates</td>
</tr>
<tr>
<td></td>
<td>• Irritability</td>
<td>• Hypotension</td>
<td></td>
</tr>
</tbody>
</table>

**Abdominal exam**

- Diminished or absent bowel sounds
- Increased abdominal girth
- Distention, presence of bowel loops
- Abdominal masses, especially in right lower quadrant

**Stool frequency and characteristics**

- Change in stool frequency and/or characteristic
- Guaiac-positive stool
Just for fun

What diagnosis should you think of first in an infant experiencing bilious emesis?

A. Duodenal atresia  
B. Necrotizing enterocolitis  
C. Malrotation with volvulus
Just for fun

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Lab findings

- Abnormally high or low WBC with left shift
- Elevated CRP
- Thrombocytopenia - Important to be trended
- High or low blood glucose
- Electrolyte imbalances
- Evidence of DIC
- Metabolic acidosis
- +/- Gram negative blood cultures
Radiologic findings

- Non-specific bowel dilatation
- Thickening of bowel wall
- Fixed, dilated loop (unchanged on > 1 radiograph)
- Pneumatosis intestinalis
- Portal venous gas
- Pneumoperitoneum
Just for fun

Which radiologic finding is pathognomonic for necrotizing enterocolitis?

A. Fixed, dilated loop of bowel

B. Pneumatosis intestinalis

C. Pneumoperitoneum
Just for fun

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Fixed Loop of Bowel
Pneumatosis Intestinalis
Portal Venous Gas

Pneumoperitoneum
## Modified Bell’s Criteria

<table>
<thead>
<tr>
<th>Stage</th>
<th>Classification</th>
<th>Systemic Signs</th>
<th>Abdominal Signs</th>
<th>Radiographic Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA</td>
<td>Suspected</td>
<td>Temp instability, apnea, bradycardia, lethargy</td>
<td>Gastric retention, abdominal distention, emesis, heme-positive stool</td>
<td>Normal vs intestinal dilation, mild ileus</td>
</tr>
<tr>
<td>IB</td>
<td>Suspected</td>
<td>Same as above</td>
<td>Grossly bloody stool</td>
<td>Same as above</td>
</tr>
<tr>
<td>IIA</td>
<td>Definite, mildly ill</td>
<td>Same as above</td>
<td>Same as above plus absent bowel sounds, possible abdominal tenderness</td>
<td>Intestinal dilation, ileus, <strong>pneumatosis intestinalis</strong></td>
</tr>
<tr>
<td>IIB</td>
<td>Definite, moderately ill</td>
<td>Same as above, plus mild metabolic acidosis and thrombocytopenia</td>
<td>Same as above, plus absent bowel sounds, abdominal tenderness, possible abdominal cellulitis or RLQ mass</td>
<td>Same as IIA, plus ascites</td>
</tr>
<tr>
<td>IIIA</td>
<td>Advanced, severely ill, intact bowel</td>
<td>Same as IIB, plus hypotension, bradycardia, severe apnea, combined respiratory and metabolic acidosis, DIC, neutropenia</td>
<td>Same as above, plus peritonitis, marked tenderness, abdominal distention</td>
<td>Same as IIA plus ascites</td>
</tr>
<tr>
<td>IIIB</td>
<td>Advanced, severely ill, perforated bowel</td>
<td>Same as IIIA</td>
<td>Same as IIIA</td>
<td>Same as above plus <strong>pneumoperitoneum</strong></td>
</tr>
</tbody>
</table>
Medical Treatment

• Bowel rest

• Sump orogastric decompression

• IV fluid resuscitation

• TPN/IL

• Broad spectrum antibiotics (triple antibiotic therapy)
  - Antibiotic therapy 10-14 days
Indications for Surgery

• Absolute indication: pneumoperitoneum

• Relative indications:
  1. Abdominal wall cellulitis and edema
  2. Persistent dilated, fixed loop of bowel on x-ray
  3. Clinical deterioration
     i.e. hemodynamic instability, increasing ventilatory support, worsening laboratory abnormalities
Surgery

First Surgery

1a. Diseased part of bowel removed

1b. Ostomy created

Second Surgery

Cut ends of bowel joined
Just for fun

What is the most common location of intestine to be affected by NEC?

A. Duodenum
B. Ileocecum
C. Sigmoid colon
Just for fun

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A. Duodenum
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For Comparison
Complications

• Wound separation or dehiscence

• Stoma complications (stricture, necrosis, prolapse, and retraction)

• Intestinal strictures

• Intestinal failure associated liver disease

• Short bowel syndrome
Wound Separation or dehiscence

- Definitions of the vocabulary
- Diagnosed: Clinically
- Treatment: depends (medical vs. surgical)
Stoma Complications

• Stricture
  - Diagnosed: clinically +/- imaging
  - Treatment: typically surgery is indicated

• Necrosis
  - Diagnosed: Clinically
  - Treatment: depends on the depth of the necrosis
    • Typically will slough off
Stoma Complications

• Prolapse
  - Diagnosed: clinically
  - Treatment: Depends on the severity of the prolapse

• Retraction
  - Diagnosed: clinically
  - Treatment: Depends on the severity of the retraction
Intestinal stricture

• Cause: result of fibrotic healing and scarring of an ischemic area

• Diagnosed: UGI with small bowel follow through

• Treatment: Surgical
Intestinal failure associated liver disease

• Diagnosed: trending bilirubin levels (> 2.0 mg/dL x 2 weeks)

• Causes:
  - Prolonged exposure to total parental nutrition
  - Extensive small bowel resections
  - Lack of enteral feeding, which leads to reduced gut hormone secretion; reduction of bile flow and biliary stasis

• Treatment
  - Limit lipid use in TPN by using fish oil (Omegaven)
  - If able to start a feeding regimen, this has shown to decrease the rate by 40%
Short Bowel Syndrome

• Consequence of a large bowel resection

• Historically: if > 40 cm of bowel remaining, then can have eventual transition to oral feeds

• Actuality: depends on the health, function, and location, versus the absolute length of the remaining bowel

• Intestinal rehabilitation
Case presentation continued
Case presentation continued

(9/5) – Exploratory Laparotomy
“Findings: Patchy necrotic bowel from ligament of Trietz to last 15cm of terminal ileum. Colon not involved.”
Case presentation continued

(9/7) – Second look exploratory laparotomy
“Findings: Multiple areas of necrotic bowel. No perforation. 56 cm resected, 59 cm remaining.”
Case Conclusion

• Patient is 2 years old today
  - Consumes a regular diet and **NOT ON TPN**
    • lactose intolerance
  - Speech delay
  - Flagyl for 2 weeks/month
Future Considerations

• Use of probiotics
  - Mechanism:
    • Alter the composition of gut microbiota
    • Decrease the pro-inflammatory response
    • Decrease the permeability of the mucosa
    • Effects bacterial metabolites
Pathophysiology continued

Open

Closed

[Image of bacteria]

[Image of person with mouth open]
Future considerations

• Use of probiotics
  * Not currently FDA approved in the US
  - Goal: promote the formation of a beneficial and protective intestinal microbiome
  - Concern: introducing live bacteria into a preemie gut could potentially cause bacteremia
  - Problems: since probiotics are not FDA regulated, finding standards to implement this regimen are difficult
References


References


• UCSF Children’s Hospital (2004). *Necrotizing Enterocolitis, Intensive Care Nursery House Staff Manual*. San Francisco, CA: UCSF Children’s Hospital at UCSF Medical Center
Questions