

Children's
HOSPITAL & MEDICAL CENTER
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Necrotizing Enterocolitis: Diagnosis, Management, and Surgical Decision Making

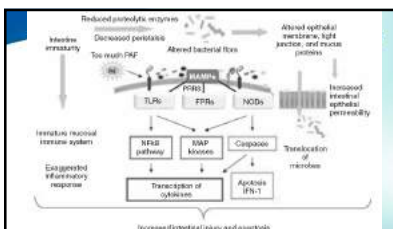
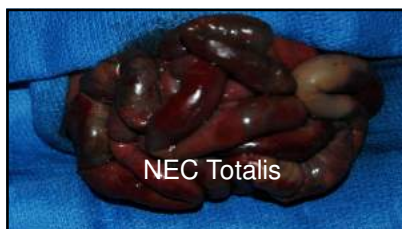
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Disclosures

Consultant/ Speakers bureaus	No Disclosures
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Off-label uses	No Disclosures

Case Presentation

- A 3 week old, former 28 week gestation male had been doing "well" in the NICU
- On CPAP for first 48 hours
- PDA appreciated on ECHO on DOL #2
- Feedings started on DOL #7 with gradual increase to full feeds by DOL #14
- Emesis noted in am of DOL #21 followed shortly by "bloody stool"
- Hypotension and respiratory distress over next 12 hours requiring intubation and placement on dopamine and dobutamine along with massive fluid and blood product resuscitation
- Taken to the OR for exploratory laparotomy



WAKE UP!!!!

Purpose

- Brief overview of what is currently known about NEC with respect to the diagnosis, the work up, and medical treatment
- Acute surgical management
 - When/what can/does a surgeon have to offer?
- Surgical management of long term complications, namely stricture

The Problem

- Although first described nearly 60 years ago, and despite significant advances in neonatal intensive care, we still do not have an effective treatment for NEC or a rational strategy to prevent NEC
- Incidence of NEC is increasing
- Medical treatment is largely supportive
- Once an operation is required, the "battle is lost"

Necrotizing Enterocolitis

- NEC is the most common life-threatening emergency of the gastrointestinal tract in the newborn period
- Now is the leading cause of death in premature infants
- Incidence is 1–5% of infants in neonatal intensive care units with 5000-7000 new cases reported annually in the U.S.
- Both incidence and case fatality rates increase with decreasing birth weight and gestational age

Pathogenesis

- Initial mucosal injury ⇒ loss of mucosal integrity ⇒ feeding provides luminal substrate for pathogenic bacterial overgrowth ⇒ invasion of damaged mucosa ⇒ inflammation ⇒ arteriolar vasospasm ⇒ coagulative necrosis

Risk Factors

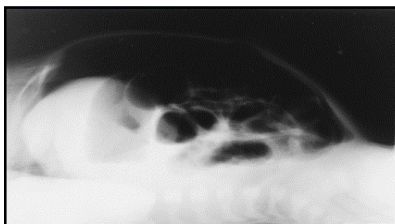
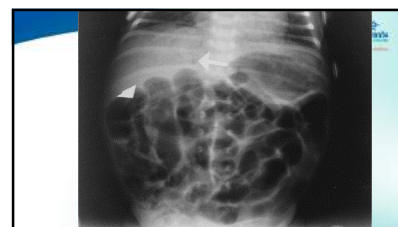
- Prematurity**
 - Full term infants with other stressors (congenital heart disease)
- Feeding**
 - If not fed then usually smaller (<700 gm) and more premature (<26 weeks)
 - Delaying of feeding though increases the incidence of NEC
 - Human milk decreases the incidence of NEC
 - Growth factors, "good" bacteria, anti-inflammatory Interleukins, better bile clearance
 - Rapid increases in feeding (> 20 ml/kg/day) are associated with increased incidence of NEC
- Blood transfusion**
- Infectious etiology ?**
 - Epidemic reports in NICU's

Symptoms

- Occult/gross blood in stool
- Change in stool pattern/diarrhea
- Glucose instability
- Abdominal mass
- Poor perfusion/shock
- Erythema of abdominal wall
- Disseminated intravascular coagulopathy
- Positive results of blood cultures
- Acidosis (metabolic and/or respiratory)
- Lethargy
- Abdominal tenderness
- Apnea/respiratory distress
- Feeding intolerance
- Temperature instability
- Delayed gastric emptying
- "Not right"
- Vomiting

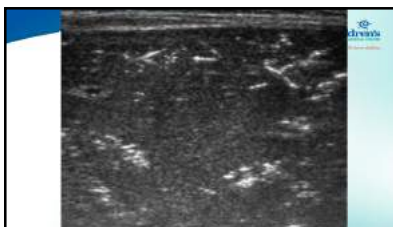
Radiology

- Plain x-rays (flat/decub) are obtained when NEC suspected and used to follow disease progression



Radiology

- What happens when plain x-rays are inconclusive or the patient's clinical picture does not match the plain x-ray findings?
- Also known that up to 50% of perforated patients will not have "free air"



Ultrasound

- Useful if diagnosis is in question and a reason is needed to stop feedings and start antibiotics
 - Not known whether starting therapy "earlier" has impact on outcome
 - Not known whether operating before perforation occurs will have impact on outcome
- Useful if patient not improving despite medical management to look for abscess
- Useful in a "gasless" abdomen on plain x-ray with a distended abdomen
- Prospective study needed

Classification

- Most commonly used is Bell's modified classification system

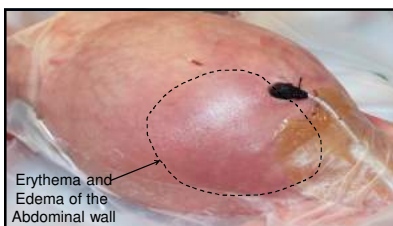
Stage	Systemic Signs	Abdominal Signs	Rectal/Peritoneal Signs
IA (Stable)	Temperature instability, apnea, bradycardia, lethargy	Distur. mentation, abdominal distention, emesis, hemipositive stool	Normal or abdominal distention, mild fuss
IB (Subacute)	Same as above	Same as above, plus bloody stool	Same as above
IIA (Critical, needs IV)	Same as above	Same as above, plus absent bowel sounds, diffuse abdominal tenderness	Intestinal distention, fluid, pneumotosis intestinalis
IIB (Critical, needs IV)	Same as above, plus mild metabolic acidosis and thrombocytopenia	Same as above, plus absent bowel sounds, diffuse tenderness, with or without abdominal cellulitis or right lower quadrant mass	Same as IIA, plus ascites
IIIA (Advanced, severely ill, needs blood)	Same as IIB, plus hypotension, bradycardia, severe apnea, combined respiratory and metabolic acidosis, DIC, and multi-organ failure	Same as above, plus signs of peritonitis, marked tenderness, and abdominal distention	Same as IIA, plus ascites
IIIB (Advanced, severely ill, peritoneal signs)	Same as IIIA	Same as IIIA	Same as above, plus pneumoperitoneum

Treatment

- Medical
 - Cessation of feedings
 - OG decompression
 - IV fluids/TPN
 - Broad spectrum antibiotics
 - Ventilator support
 - Blood pressure support
 - Blood product administration

Surgical Treatment

- Does operative intervention alter the disease progression???
- Goal of operation is to remove necrotic bowel and preserve intestinal length
- Only absolute indication for operative intervention is perforation
- Relative indications include a positive paracentesis, palpable abdominal mass, abdominal wall erythema, portal venous gas, fixed intestinal loop, and clinical deterioration despite maximal medical therapy
- Drain versus exploration
- Data is confusing because most studies are small (<20 patients), non-randomized, occurring in different time periods, and include patients that have NEC and Spontaneous Intestinal Perforation (SIP)



SIP vs NEC

<ul style="list-style-type: none"> SIP <ul style="list-style-type: none"> Occurs 0-3 weeks of age Average size 750 gm Clinically stable Lack peritonitis early on Indomethacin exposure Free air or gasless abdomen on x-ray Terminal ileum only site of involvement Pathology is hemorrhagic necrosis Drain placement as only therapy in 25-50% 	<ul style="list-style-type: none"> NEC <ul style="list-style-type: none"> Occurs 2-12 weeks of age Average size 1000 gm Clinically unstable Focal or diffuse peritonitis early on Pneumatosis, portal venous gas, fixed loop on x-ray Entire bowel can be affected Pathology is coagulative necrosis Drain placement as only therapy in 10-20%
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Treatment

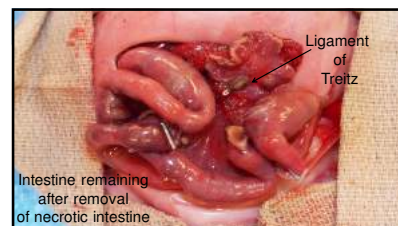
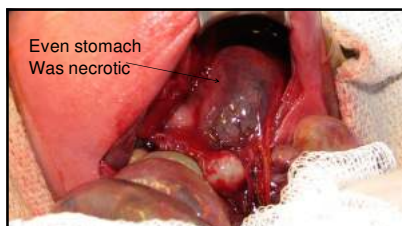
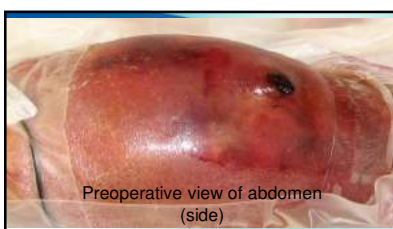
- Only prospective, randomized trial to date regarding drain vs laparotomy
 - "randomly" assigned 117 patients less than 34 weeks gestation and weighing less than 1500 gm with evidence of "perforation"
 - Concluded no difference in 90 day survival if treated initially with either drain or laparotomy (34.5% vs 35.5% mortality, respectively)
- Problems
 - Choosing to randomize left up to the surgeon
 - Cross-over allowed after initial therapy
 - Included NEC and SIP
 - Difficulty accruing population
- More than 75% of patients who were initially drained eventually required laparotomy

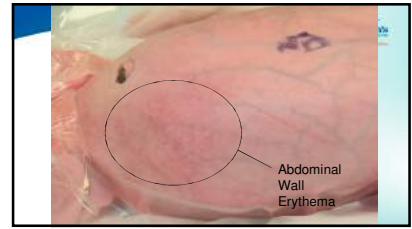
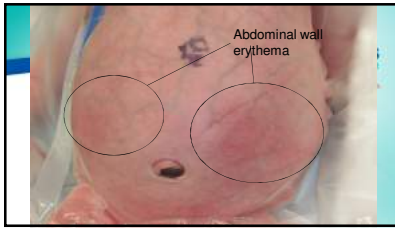
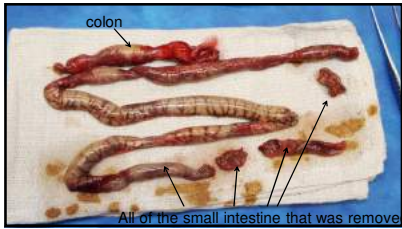


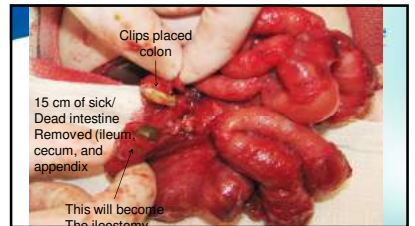
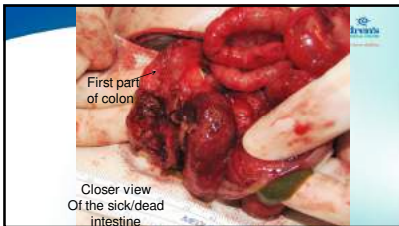
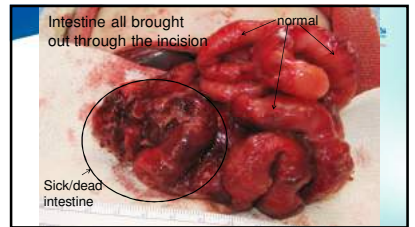
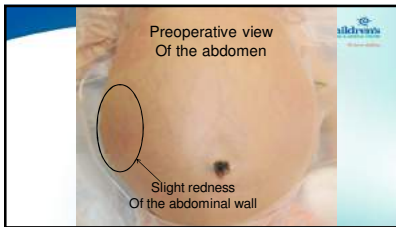
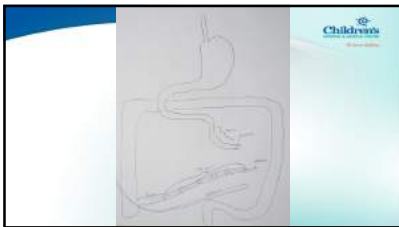
Treatment

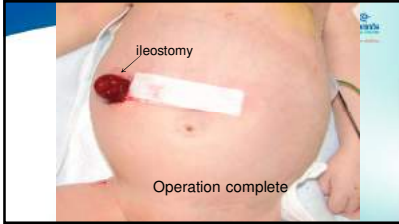
- Drain thus useful in management of perforation
 - if very small infant (<1000 gm) if clinically stable
 - In infant that is in extremis as temporizing measure
- Follow-up radiological contrast studies necessary if post-drain feeding difficulties to rule out stricture

• And now onto some cases



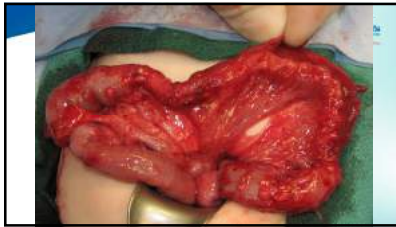
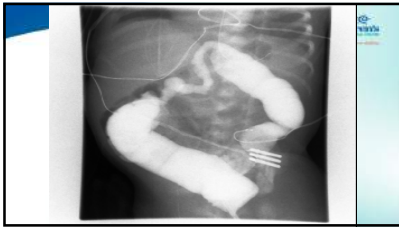


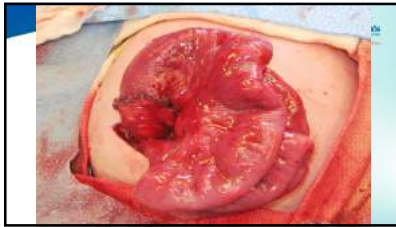




Surgical Management of post NEC Strictures

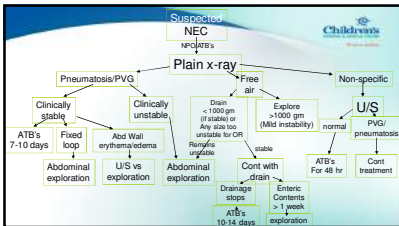
- Result from fibrotic healing and scarring in an area of ischemia
- Incidence varies widely from 9-57%
- Up to ¼ of strictures identified early will resolve spontaneously
- Diagnosis with contrast enema since most will be colonic (80%) or distal ileum (15%)
- Debate about prophylactically screening all post NEC babies or just the symptomatic ones





Prevention

- Early human breast milk feeding with standardized advancement
- Minimize unnecessary antibiotic exposure
- Minimize acid blockade
- Enteral nutrition fortification with human milk based fortifiers or elemental formula
- Avoid "elective" transfusions and extreme anemia
- Use of probiotics



1100 gram infant has newly diagnosed pneumatosis intestinalis, and gas in the liver parenchyma. No signs of pneumoperitoneum. What is the treatment?

- A: Emergent liver and small bowel transplant
- B: Antibiotics for NEC
- C: Laparotomy to remove the affected intestine
- D: Placement of Penrose drain at bedside
- E: Changes in ventilator settings

After 2 days of antibiotic treatment, 15 day old former 26 week GA infant (700gr) with NEC has decreased abdominal distension and now pneumoperitoneum on today's x-ray. What is the treatment?

- A: change antibiotic regimen to include antifungal therapy
- B: laparotomy, resection of perforation and ileostomy
- C: placement of abdominal drain at the bedside
- D: continue current care as abdominal distension is improving
- E: Repeat x-ray to follow the pneumoperitoneum

