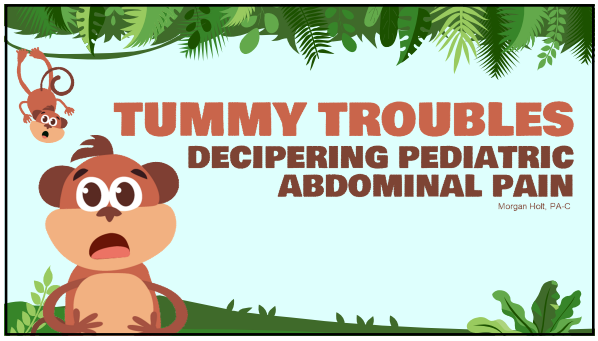
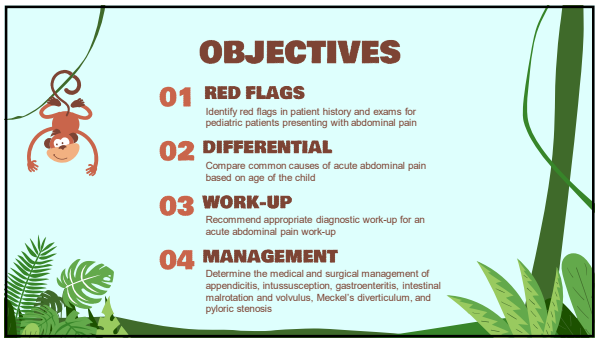
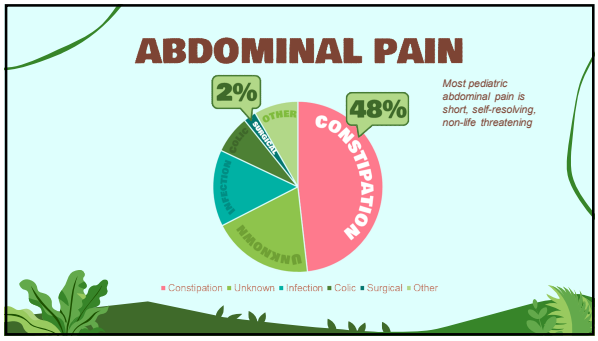

TUMMY TROUBLES
DECIPERING PEDIATRIC ABDOMINAL PAIN
Morgan Holt, PA-C


OBJECTIVES
01 RED FLAGS
Identify red flags in patient history and exams for pediatric patients presenting with abdominal pain
02 DIFFERENTIAL
Compare common causes of acute abdominal pain based on age of the child
03 WORK-UP
Recommend appropriate diagnostic work-up for an acute abdominal pain work-up
04 MANAGEMENT
Determine the medical and surgical management of appendicitis, intussusception, gastroenteritis, intestinal malrotation and volvulus, Meckel's diverticulum, and pyloric stenosis

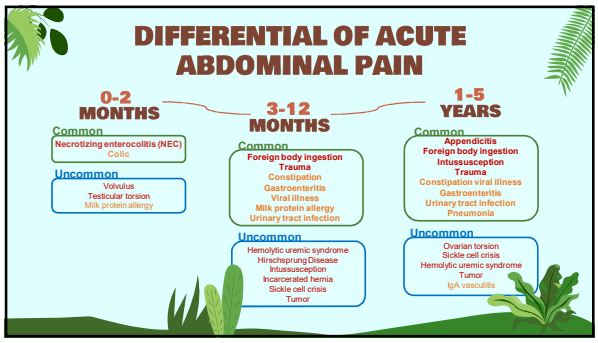

ABDOMINAL PAIN
Abdominal pain is perceived via mucosal or serosal receptors
Serosal receptors respond to mechanical and chemical stimuli (poorly localized); stretch is the principal mechanical stimulus (also contraction, compression, torsion)
Mucosal receptors respond to chemical stimuli
Pain receptors are located on serosal surfaces, the mesentery, and intestinal wall
Abdominal pain is often poorly localized (perceived as midline) until a serosal surface becomes involved)
Children <5 years old do not localize pain well

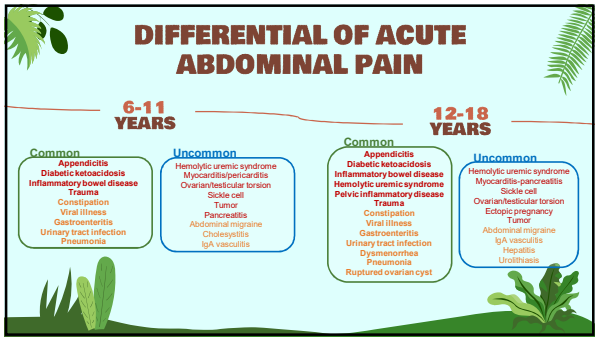

ABDOMINAL PAIN
2%
48%
CONSTIPATION
OTHER
SURGICAL
INFECTION
UNKNOWN
Most pediatric abdominal pain is short, self-resolving, non-life threatening
Constipation Unknown Infection Colic Surgical Other


01
RED FLAGS

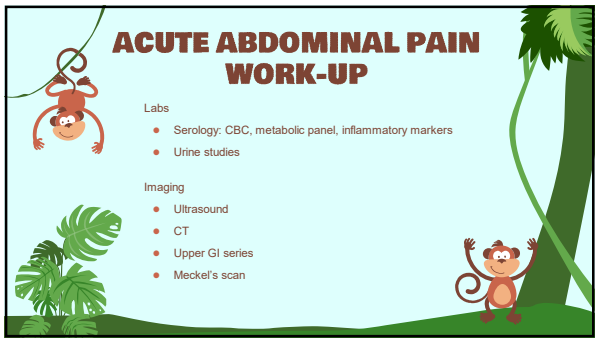

RED FLAGS
<5 years old
Fever
Weight loss
Bile or blood stained emesis
Jaundice
Hepatosplenomegaly
Pain in location other than umbilicus
Awakening from sleep in pain
Referred pain to shoulder groin or back
Family history of inflammatory bowel disease
Elevated inflammatory markers
Anemia
Edema
Hematochezia


02
DIFFERENTIAL


DIFFERENTIAL OF ACUTE ABDOMINAL PAIN
0-2 MONTHS
Common
Necrotizing enterocolitis (NEC)
Colic
Uncommon
Volvulus
Testicular torsion
Milk protein allergy
3-12 MONTHS
Common
Foreign body ingestion
Trauma
Constipation
Gastroenteritis
Viral illness
Milk protein allergy
Urinary tract infection
Uncommon
Hemolytic uremic syndrome
Hirschsprung Disease
Intussusception
Incarcerated hernia
Sickle cell crisis
Tumor
1-5 YEARS
Common
Appendicitis
Foreign body ingestion
Intussusception
Trauma
Constipation viral illness
Gastroenteritis
Urinary tract infection
Pneumonia
Uncommon
Ovarian torsion
Sickle cell crisis
Hemolytic uremic syndrome
Tumor
IgA vasculitis

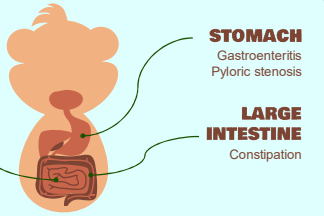

DIFFERENTIAL OF ACUTE ABDOMINAL PAIN
6-11 YEARS
Common
Appendicitis
Diabetic ketoacidosis
Inflammatory bowel disease
Trauma
Constipation
Viral illness
Gastroenteritis
Urinary tract infection
Pneumonia
Uncommon
Hemolytic uremic syndrome
Myocarditis/pericarditis
Ovarian/testicular torsion
Sickle cell
Tumor
Pancreatitis
Abdominal migraine
Cholesystitis
IgA vasculitis
12-18 YEARS
Common
Appendicitis
Diabetic ketoacidosis
Inflammatory bowel disease
Hemolytic uremic syndrome
Pelvic inflammatory disease
Trauma
Constipation
Viral illness
Gastroenteritis
Urinary tract infection
Dysmenorrhea
Pneumonia
Ruptured ovarian cyst
Uncommon
Hemolytic uremic syndrome
Myocarditis-pancreatitis
Sickle cell
Ovarian/testicular torsion
Ectopic pregnancy
Tumor
Abdominal migraine
IgA vasculitis
Hepatitis
Urolithiasis


03
WORK-UP


ACUTE ABDOMINAL PAIN WORK-UP
Labs
Serology: CBC, metabolic panel, inflammatory markers
Urine studies
Imaging
Ultrasound
CT
Upper GI series
Meckel's scan


04
MANAGEMENT

DIFFERENTIAL DIAGNOSIS



STOMACH
Gastroenteritis
Pyloric stenosis

SMALL INTESTINE
Intussusception
Volvulus
Meckel's
Appendicitis

LARGE INTESTINE
Constipation

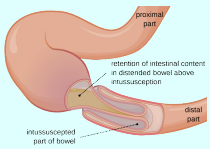
INTUSSUSCEPTION

Top cause of small bowel obstruction in infants and children

Ages 6 months - 3 years

Invagination of one portion of the intestine "intussusceptum" into the lumen of adjacent intestine "intussuscipiens"

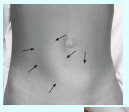
Causes
- **Idiopathic (most common)**
- **Lead point (10%)**
  - Peyer's patches (enlarged lymh node)
  - Meckel's diverticulum
  - Polyps
  - Intestinal duplication
  - Lymphoma
  - Tumors
  - IgA vasculitis



INTUSSUSCEPTION

Locations of intussusception
- Most common: **ileocolic**
- Pathologic lead point: typically entero-enteric

Presentation:
- **Sudden episodes of transient, severe abdominal pain**
  - **Drawing legs up** toward abdomen
  - After pain episode, suddenly pain-free but **may be very tired**
- May have nausea and vomiting
- **Sausage-shaped mass of RUQ** (concave towards umbilicus)
- **Dance sign** (when ileocolic): emptiness on palpation of RLQ
- LATE FINDING: **Currant jelly (bloody) stool,** from blood clots and sloughing of mucosa indicating ***imminent bowel ischemia***



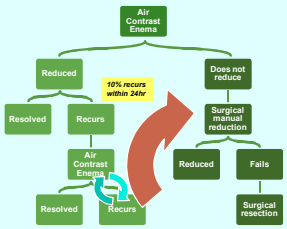
INTUSSUSCEPTION

Diagnosis
- **ULTRASOUND: target sign,** donut lesion, pseudokidney sign

Treatment (and diagnostic):
- **AIR OR CONTRAST ENEMA**
  - Maximum pressure of 120mmHg delivered 3 times in attempt to reduce intussusception
  - ***Reduction is confirmed by reflux of air (or contrast) into the small bowel***
  - **Perforation is rare** <1%
  - Pediatric surgeon should be available
- No need to administer antibiotics prior to enema (no benefit, can delay treatment)

IS IT SUCCESSFUL?
WILL IT RECUR?

INTUSSUSCEPTION



INTUSSUSCEPTION

Successes in modern management of intussusception
- Less radiation needed
- No need for antibiotics prior to reduction
- Laparoscopic surgery (if indicated) has smaller scars, earlier discharge

Additional considerations
- IgA vasculitis
- Rotavirus vaccine

MECKEL'S DIVERTICULUM

The most common congenital malformation of the GI tract

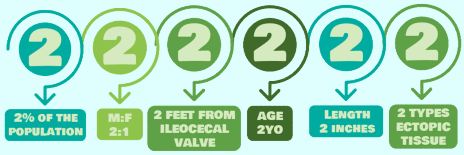
Congenital persistence of omphalomesenteric duct (vitelline duct, yolk stalk), which is the connection between the fetal yolk sac and developing midgut

At 5-7 weeks gestation, the connection (omphalomesenteric duct) regresses as the placenta grows to become the main source of nutrition

Incomplete regression leads to multiple malformations, the most common being Meckel's diverticulum.

Ectopic tissues is trapped within the diverticulum; this is what produces ssymptoms
- Gastric tissue
- Pancreatic tissue

MECKEL'S RULE OF 2'S



MECKEL'S PRESENTATION

Asymptomatic
- Most often Meckel's is an incidental finding

Symptomatic due to…
- Bleeding (1-3 years old)
  - Ectopic tissue within diverticulum causing ulceration to adjacent ileal mucosa
  - Painless, episodic bright red blood per rectum (can be profound blood loss)
- Obstruction (0-1 years old)
  - The diverticulum becomes a lead point causing intussusception
  - Nausea, vomiting, intermittent abdominal pain, bloody stool
- Inflammation (7-9 years old)
  - Secretion of acid and enzymes from the heterotopic tissue
  - Vague abdominal pain that becomes localized, fever, chills, anorexia, nausea

MECKEL'S MANAGEMENT

Bleeding (1-3 years old)
- Diagnosed via Meckel's technetium-99m nuclear medicine scan
- Laparoscopic surgical resection of diverticulum and any adjacent ulcerated tissue

Obstruction (0-1 years old)
- Discovered in operating room after intussusception algorithm unsuccessful
- Laparoscopic surgical reduction

Inflammation (7-9 years old)
- Mimics appendicitis on history, exam, and imaging, often discovered in operating room
- Diverticulectomy versus resection if there is perforation with peritonitis

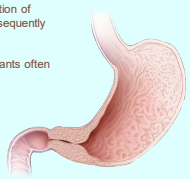
Incidental finding, asymptomatic (most common)
- Removal not indicated

PYLORIC STENOSIS

Thickening of the circular smooth muscle layer of the pylorus, eventually leading to gastric outlet obstruction

The enteric nervous system, gastrointestinal hormones, and interstitial cells of Cajal are all affected, which leads to failure of relaxation of pylorus muscle, increased production of growth factors, subsequently leading to muscle hypertrophy

>90% diagnosed before 10 weeks old (though premature infants often diagnosed 2 weeks later than term infants)



PYLORIC STENOSIS

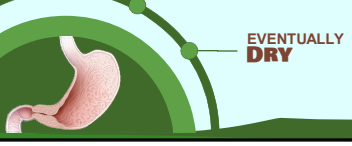
NON-BLOODY
NON-BILIOUS
EMESIS
Becomes increasingly frequent
Becomes more forceful "projectile

NON-ILL APPEARING

HUNGRY AFTER EMESIS

OLIVE SIGN

EVENTUALLY DRY



PYLORIC STENOSIS

VOLUME DEPLETTION

LOSE Na | LOSE Cl | LOSE H^+ | LOSE K

HYPOCHLOREMIC HYPOKALEMIIC METABOLIC ACIDOSIS

KIDNEYS ATTEMPT MAINTAIN pH *By excreting excess bicarb*

PYLORIC STENOSIS

PYLORIC STENOSIS IS NOT A SURGICAL EMERGENCY
Infants are often dehydrated and need to have proper resuscitation in preparation for anesthesia and surgery

Obtain BMP (Na, Cl, bicarb, K)

Abdominal ultrasound
Pyloric muscle >3-4mm thickness and >15-18mm length

Ultrasound not available?
Upper GI with barium "string sign" (elongated pyloric channel)

Risk of alkalosis-induced apnea in the postop period. Correct electrolyte derangement prior to procedure!

PYLORIC STENOSIS

Dextrose-containing IV fluids with potassium added
May require normal saline boluses to normalize urine output

No need for NG decompression; this would worsen electrolyte abnormalities

Pyloromyotomy is curative

Okay to resume regular infant diet post-op
Infant may have emesis post-op; this is anticipated
Okay to discharge after tolerating multiple consecutive feedings without emesis, without need for IV fluids

Risk of alkalosis-induced apnea in the postop period. Correct electrolyte derangement prior to procedure!

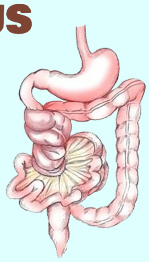
VOLVULUS

Intestinal malrotation is usually asymptomatic; however, the associated narrow mesenteric pedicle increases risk of life-threatening mid-gut volvulus.

Complete volvulus causes vascular cutoff at base of SMA, leading to ischemia from duodenum to the proximal transverse colon.

Any infant with bilious emesis must be suspected of having malrotation and possibly volvulus

PROMPT DIAGNOSIS is necessary to prevent intestinal loss due to ischemia



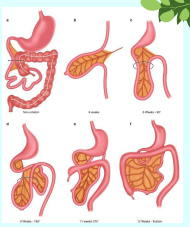
VOLVULUS

ELONGATION: Normal intestinal rotation begins at 4 weeks gestation. This is when the straight tube begins to rapidly elongate.

HERNIATION: During elongation, the GI tract herniates through a widened umbilical defect completing a 90 degree counterclockwise rotation

ROTATION: By 10th week gestation, the GI tract returns to the abdomen, making another 180 degree counterclockwise turn for a total of 270 degree turn

RETURN: At 11th week gestation and on, fixation of the bowel in the abdomen occurs



VOLVULUS

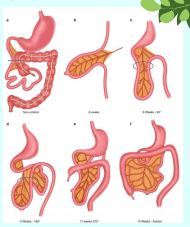
Any process that interferes with normal **elongation, herniation, rotation, and return of bowel** in the abdomen will result in some degree of incomplete intestinal rotation.

Malrotation = failure to complete the full 270 degree rotation

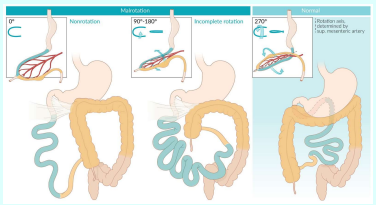
The SMA runs alongside the duodenum (instead of crossing anterior to it), so it is now within a narrow mesenteric pedicle that connects the duodenaljejunal junction with the cecum.

Abnormal tissue referred to as **Ladd's bands** attaches the cecum to the duodenum (beginning of small intestine) and may create a blockage in the duodenum.

Blood supply to the intestine is channeled through very narrow mesentery, and because the intestine is not properly fixated, the bowel can twist on its own blood supply, which is **volvulus**



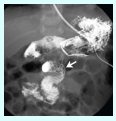
VOLVULUS



VOLVULUS

Presentation: **Bilious emesis** (50%), scaphoid abdomen (if obstruction is proximal)

Intestinal ischemia signs:
- Abdominal distention (due to bowel edema)
- Bloody stools (from mucosal sloughing from ischemia)
- Peritonitis/rigid abdomen
- Sepsis (tachycardia, hypotension, oliguria)



Management:
- STAT Abdominal ultrasound
- **STAT Upper GI study: "corkscrew" appearance**
- X-ray would show nonspecific bowel gas pattern, may see "double bubble" sign
- **Surgery: Ladd procedure**

APPENDICITIS

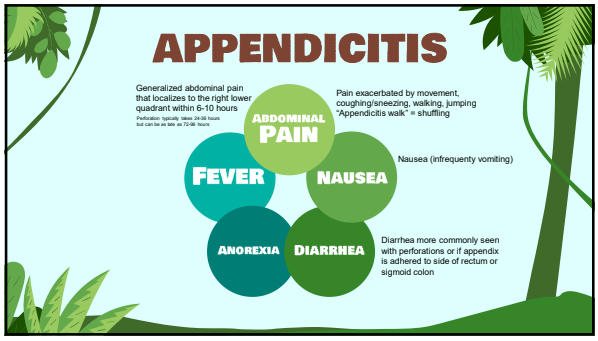
Most common pediatric acute surgical condition
7% of USA population undergoes appendectomy

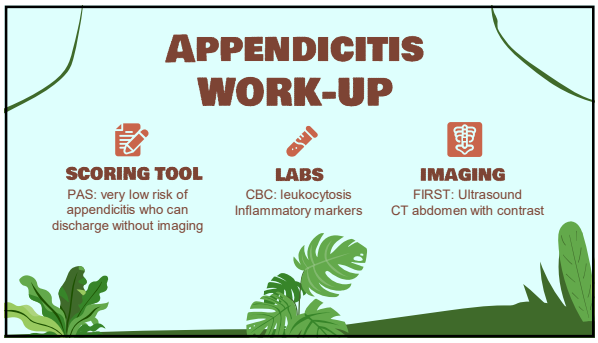
Typically ages 8-18 years old

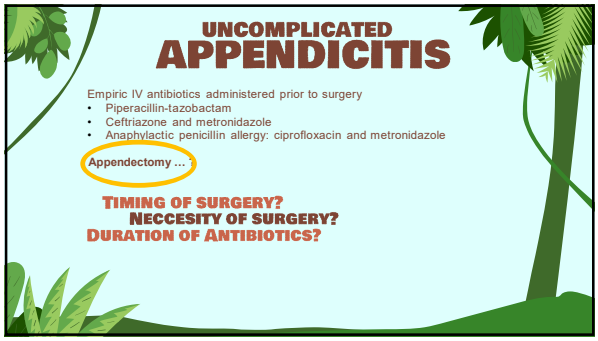
Fecalith (most common) or lymphoid hyperplasia leads to escalating pressure within the appendiceal lumen, eventually blocking venous and lymphatic drainage, and eventually blocking flow from the appendiceal artery

Once circulation is impaired in the appendiceal wall, bacteria infiltrate

Bacteria infiltrate the mucosa → *Inflammatory reaction* → *Ulceration* → *Infection of appendiceal tissue* → *Gangrene and perforation*


APPENDICITIS
Generalized abdominal pain that localizes to the right lower quadrant within 6-10 hours
Perforation typically takes 24-48 hours but can be as late as 72-96 hours
ABDOMINAL PAIN
Pain exacerbated by movement, coughing/sneezing, walking, jumping
"Appendicitis walk" = shuffling
FEVER
NAUSEA
Nausea (infrequenty vomiting)
ANOREXIA
DIARRHEA
Diarrhea more commonly seen with perforations or if appendix is adhered to side of rectum or sigmoid colon


APPENDICITIS WORK-UP
SCORING TOOL
PAS: very low risk of appendicitis who can discharge without imaging
LABS
CBC: leukocytosis
Inflammatory markers
IMAGING
FIRST: Ultrasound
CT abdomen with contrast


UNCOMPLICATED APPENDICITIS
Empiric IV antibiotics administered prior to surgery
• Piperacillin-tazobactam
• Ceftriazone and metronidazole
• Anaphylactic penicillin allergy: ciprofloxacin and metronidazole
Appendectomy ... ?
TIMING OF SURGERY?
NECCESITY OF SURGERY?
DURATION OF ANTIBIOTICS?

COMPLICATED APPENDICITIS

Empiric IV antibiotics prior to procedure and after
- Piperacillin-tazobactam
- Ceftriaxone and metronidazole
- Anaphylactic penicillin allergy: ciprofloxacin and metronidazole

Types of complicated appendicitis:
- **Perforated appendicitis:** appendectomy and IV antibiotics
- **Appendicitis WITH intra-abdominal abscess:** percutaneous drain placement and IV antibiotics

COMPLICATED APPENDICITIS

Perforated appendicitis has **risk of developing intra-abdominal abscess** within 5-7 days of presentation
- Signs: Fever, dysuria, worsening abdominal pain, worsening diarrhea, decline in oral intake
- If persistent signs of intra-abdominal abscess, obtain CT abdomen on POD 5

Discharge criteria
- Tolerating regular diet
- Pain controlled without IV medications
- 24hr free of symptoms that would otherwise suggest abscess

Once tolerating oral intake, transition to oral antibiotics to complete total of 10-14 day course of antibiotics
- Amoxicillin-clavulanate
- Anaphylactic allergy to penicillin: ciprofloxacin and metronidazole

GASTROENTERITIS

Inflammation of gastrointestinal tract due to infectious agent (virus, bacteria, parasitic)

Viruses are most common: norovirus, enterovirus, astrovirus, adenovirus, rotaviru

Presentation
- Vomiting (non-bilious)
- Diarrhea (can be watery, can be bloody)
- Fever
- Decreased oral intake
- May have signs of dehydration: decreased urine output, dry mucous membranes, no tear production when crying, sunken fontanelle

LABS NECESSARY?
ANTIBIOTICS NECESSARY?

GASTROENTERITIS

Clinical diagnosis

Value based care: Does a GI pathogen panel or stool culture alter your management?

AVOID antibiotics (rarely indicated)

Risk of hemolytic-uremic syndrome, which is leading cause of acquired renal failure due to antibiotic treatment of Shiga toxin-producing E. Coli (STEC) infections
- Thrombocytopenia
- Microangiopathic hemolytic anemia
- Renal insufficiency

When is antibiotic treatment necessary in gastroenteritis?
- ***Salmonella infections in certain populations: Less than 3 months of age and immunocompromised including sickle cell disease***

GASTROENTERITIS

Oral rehydration versus IV fluids

Symptomatic care: ondansetron (avoid in congenital long QTc syndrome)

Avoid anti-diarrheals such as loperamide

Potential complications of gastroenteritis
- Intussusception
- Bacteremia (immunocompromised)
- Meningitis
- Osteomyelitis (particularly Salmonella in those with sickle cell disease)
- Hemolytic-uremic syndrome
- Guillain-Barre (after Campylobacter infection)
- Reactive arthritis

SUMMARY

Intussusception: Episodes of severe pain; currant jelly (bloody) stool is late finding warning of imminent ischemia; ultrasound is first line and air/contrast enema is diagnostic and first line treatment

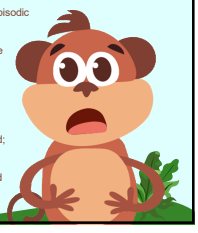
Meckel's Diverticulum: Most common symptomatic presentation is episodic bleeding and typical age of presentation is 2 years old or less

Pyloric stenosis: Frequent, forceful non-bilious emesis that can cause hypochloremic hypokalemic metabolic acidosis; manage electrolytes and hypovolemia first; not a surgical emergency

Volvulus: Often presents as bilious emesis and can quickly lead to bowel ischemia

Appendicitis: Risk of developing intra-abdominal abscess if perforated; Antibiotics required post-op if perforated or abscess present

Gastroenteritis: Usually self-limiting; treat Salmonella if <3 months old or immunocompromised




THANK
YOU
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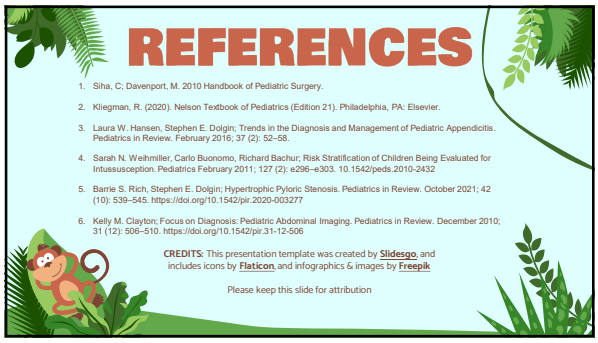
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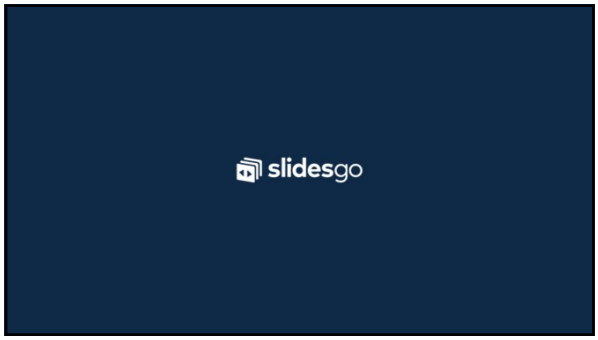
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