

Pediatric acute abdomen and emergent Surgical conditions

Done By; Zeina Fasfous, Muhammad Abu Zahra, Eyab Habashneh, Ayah Al Neurat , Mahmoud Al Athamneh, Abdulrahman Al Nadi, Safa Al Shelbi, Kareem Swan



Table of contents

01

Introduction

02

History & Physical
Examination

03

Common causes of
acute abdomen in
pediatrics

04

Gastrointestinal
obstruction in
pediatrics

05

Inflammatory and
infectious cause in
pediatrics

06

Trauma-Related
Acute Abdomen

07

Metabolic and
vascular causes in
pediatrics

08

Special
considerations in
pediatrics

Introduction

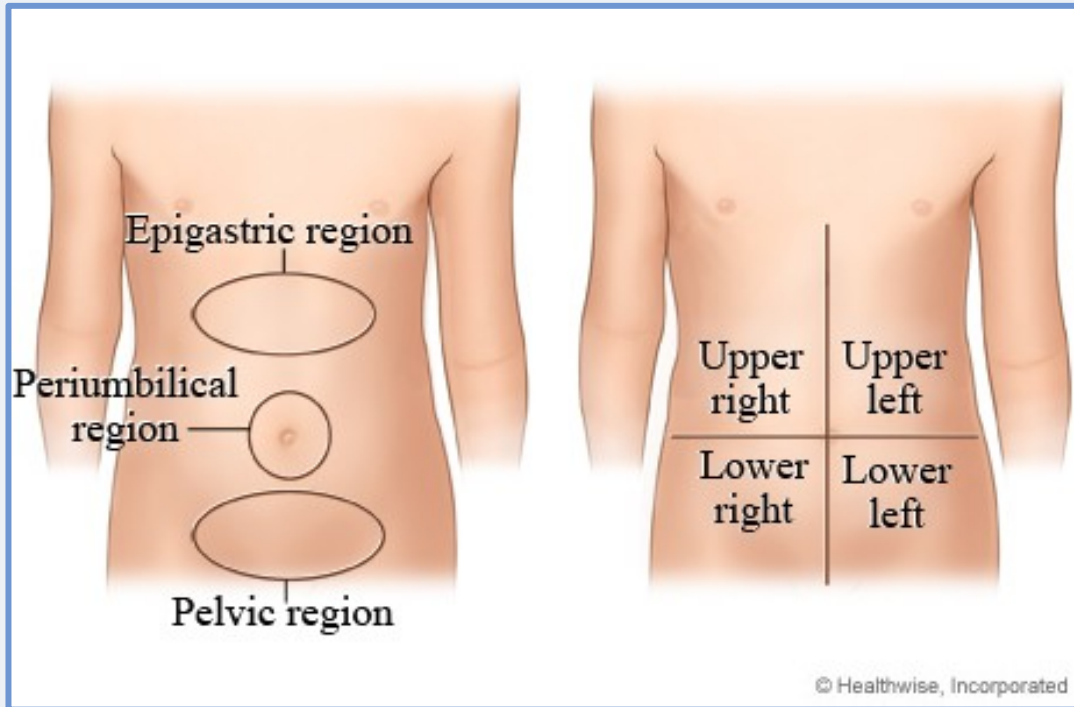


TABLE 32-4 **Etiologies of Pediatric Abdominal Pain**

Very Common Causes	Less Common Causes	Rare Causes
Acute appendicitis	Intussusception	Henoch–Schönlein purpura
Viral infection	Lower lobe pneumonia	Nephrotic syndromes
Gastroenteritis	Intestinal obstruction	Pancreatitis
Constipation	Urinary tract obstruction	Hepatitis
Genitourinary tract infection	Inguinal hernia	Diabetic ketoacidosis
Trauma	Meckel diverticulum Cholecystitis Intra-abdominal mass	Lead poisoning Acute porphyria Herpes zoster Sickle cell anemia

when what you didn't think was
important, ends up being on the
exam.



CLINICAL EVALUATION

In the evaluation of a child with acute abdominal pain, the most important components are careful history taking and repeated physical examinations, Selective use of appropriate laboratory and radiological investigations may be necessary to establish a specific diagnosis.

The diagnosis may remain uncertain despite initial evaluation process.

Children with acute abdominal pain should be detained in an emergency department with serial physical examinations to clarify any diagnostic uncertainty.

History Taking

Important details of the history include:

Symptom onset, pattern, progression, location, intensity, character, precipitating and relieving factors of abdominal pain, and associated symptoms. Age of the patient is a key factor in the evaluation of acute abdominal pain as listed in the Table below.

Differential Diagnosis of Acute Abdominal Pain by Predominant Age:

Neonates and Infants	Children	Adolescents
Infantile colic	Gastroenteritis	Appendicitis
Gastroenteritis	Appendicitis	Gastroenteritis
Constipation	Constipation	Constipation
Hirschsprung's disease	Functional pain	Dysmenorrhea
Incarcerated hernia	Diabetic ketoacidosis	Pelvic inflammatory disease
Intussusception	Urinary tract infection	Ectopic pregnancy
Volvulus	Trauma	Ovarian/testicular torsion
Urinary tract infection	Pharyngitis	Cholecystitis
	Pneumonia	Inflammatory bowel disease
	Henoch-Schölein purpura	Pancreatitis
	Mesenteric lymphadenitis	

History Taking

Other important historical variables include recent abdominal trauma, previous abdominal surgery, and a thorough review of systems.

- Pain relief after a bowel movement suggests a colonic condition, and improvement in pain after vomiting may occur with conditions localized to the small bowel.
- In surgical abdomen, abdominal pain generally precedes vomiting, and vomiting precedes abdominal pain in medical conditions.
- Any infants and children presenting with bilious vomiting should be presumed to have bowel obstruction, Important associated symptoms are bilious vomiting (bowel obstruction), bloody stool (bowel ischemia), and fever, Fever at the onset of acute illness is less likely to indicate a surgical abdomen, whereas fever after the onset of vomiting or pain is consistent with developing peritonitis.
- Chronic intermittent acute abdominal pain is less likely to be related to a surgical cause than a first episode of acute pain.

History Taking

It is important to ask about other associated symptoms because a variety of etiologies cause abdominal pain in children:

Table 2. Clinical Features of Selected Causes of Acute Abdominal Pain in Children

Condition	Clinical findings	Age	Comments
Abdominal migraine	Anorexia, nausea, vomiting, headache, photophobia	3 to 10 years	Boys and girls equally affected ⁸
Colic	Persistent crying without apparent cause	Younger than 3 months	Nonacute abdominal examination
Constipation	Hard, infrequent stooling	All age groups	May be most common cause of abdominal pain ⁹
Gastroenteritis or colitis	Diarrhea, with vomiting or fever	All age groups	<i>Campylobacter</i> , <i>Cryptosporidium</i> , <i>Escherichia coli</i> , <i>Salmonella</i> , <i>Shigella</i> , rotavirus
Hirschsprung disease	Constipation, severe diarrhea, bowel obstruction, perforation, sepsis	Infant	Delayed passage of meconium (more than 24 hours) in about 57% of cases ⁹
Inflammatory bowel disease	Bloody diarrhea	Primarily adolescents	Childhood prevalence of Crohn disease is 43 per 100,000; of ulcerative colitis, 28 per 100,000 ¹⁰
Omental infarction	Lower abdominal pain, vomiting, diarrhea	School-aged, overweight males ¹¹	Self-limiting, diagnosed on computed tomography ¹²
Ovarian cyst	Lower abdominal pain	Adolescent females	Types include hemorrhagic, ruptured, and ovulatory, and torsion of a cyst
Pneumonia	Cough, shortness of breath, fever, tachypnea	All age groups	Lower lobe pneumonia
Pyelonephritis	Flank tenderness, fever, nausea and vomiting	All age groups	Oral antibiotics for 10 to 14 days as effective as intravenous antibiotics ¹³
Sexually transmitted infection	Vaginal or penile discharge, fever	Adolescent	<i>Chlamydia trachomatis</i> , <i>Neisseria gonorrhoeae</i>
Streptococcal pharyngitis	Sore throat, fever	Older than 3 years	Rapid strep test or culture
Urinary tract infection	Dysuria, urinary frequency, urinary urgency, hematuria	All age groups, primarily females and uncircumcised infants	Point prevalence in children older than one year is 7.8% ¹⁴

Physical Examination

- **General appearance:** Children with peritoneal irritation remain still or resist movement, while patients with visceral pain change position frequently, often writhing with discomfort.
- **Vital signs:** Vital signs are useful in assessing hypovolemia and provide useful clues for diagnosis. Fever indicates an underlying infection or inflammation including acute gastroenteritis, pneumonia, pyelonephritis, or intra-abdominal abscess. Tachypnoea may indicate pneumonia. Tachycardia and hypotension suggest hypovolemia or third-space volume loss.
- **Abdominal examination:** The evaluating physician should gently palpate the abdomen moving toward the area of maximal tenderness. The physician has to make efforts to determine the degree of abdominal tenderness, location, rebound tenderness, rigidity, distension, masses, or organomegaly.
 - A rectal examination provides useful information about sphincter tone, presence of masses, stool nature, haematochezia, or melena, pelvic abscess.
 - Pelvic examination is required in pubertal girls to evaluate for pregnancy complications and sexually transmitted infections; scrotal examination is indicated in boys.
 - Auscultation of bowel sounds can help a clinician understand where the abdomen is painful because the child may try to block the stethoscope from that area. Absent bowel sounds can indicate ileus or peritonitis, whereas hyperactive bowel sounds may indicate obstruction.

General Investigations

- **Laboratory:**

Initial laboratory tests should include a complete blood count, erythrocyte sedimentation rate or C-reactive protein, a pregnancy test, if indicated, and urinalysis.

- **Imaging:**

- Radiation exposure is an important consideration before imaging in children. Radiation dose is dependent on the child's size. The cumulative effect of exposure over a lifetime of imaging needs to be assessed. Computed tomography (CT) of the abdomen and pelvis exposes a child to the equivalent of more than 100 chest radiographs.
- Ultrasonography is relatively inexpensive and does not expose the patient to radiation. It is the first-line imaging choice for undifferentiated acute abdominal pain, unless history or physical examination identifies a specific diagnosis
- Abdominal radiography is more likely to be diagnostic in patients with previous abdominal surgery, abnormal bowel sounds, abdominal distension, or peritoneal signs. Radiography may identify a renal or ureteric calculus, abdominal mass, ingested foreign body (including bezoars), bowel perforation with free air, and constipation.
- CT of the abdomen may be required to diagnose complications such as necrosis from pancreatitis or abscess formation in appendicitis and may be used for the diagnosis of omental torsion or mesenteric lymphadenitis.

Common Causes of Acute Abdomen in Pediatrics



Acute
appendicitis

Intussusception

Midgut
malrotation

ACUTE APPENDICITIS

What is it?

It is the inflammation of the appendix, which frequently manifests as lower right abdominal pain that begins around the umbilicus. In order to avoid complications like perforation or the formation of an abscess, early diagnosis and surgical intervention are essential.

Incidence

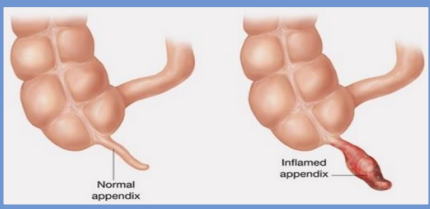
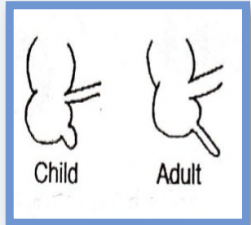
The incidence rate of acute appendicitis in children is approximately 7 to 9 cases per 1,000 children per year. It typically peaks between the ages of 10 and 14, with a higher prevalence in boys than in girls. It rarely occurs in children below the age of 5 due to the short wide lumen of the appendix where obstruction and stasis can not occur.

Etiology

It primary involves the obstruction of the appendiceal lumen.

Here are the main causes: (where all of these factors will leads to an increased pressure, reduced blood flow, bacterial growth and thus the inflammation of the appendix).

- Fecaliths: Hard stools that obstruct the appendix are the most common cause.
- Lymphoid Hyperplasia: Increased lymphoid tissue in the appendix can occur due to infections (like viral gastroenteritis) and can block the lumen.
- Foreign Bodies: Ingested items can lead to obstruction in rare cases.
- Tumors: Although less common in children, both benign and malignant tumors can obstruct the appendix.
- Infections: Viral or bacterial infections may cause inflammation and subsequent blockage.



ACUTE APPENDICITIS

Complications

- **Perforation:** If the inflamed appendix ruptures, it can lead to peritonitis, a serious abdominal infection.
- **Abscess Formation:** Pockets of pus can develop around the appendix or in the abdominal cavity, requiring drainage.
- **Ileus:** Temporary cessation of bowel movement can occur post-surgery, leading to abdominal distension and discomfort.
- **Sepsis:** A severe systemic infection can develop if bacteria spread from a perforated appendix.

Clinical Picture

1. **Abdominal Pain:** Initially periumbilical (around the belly button) before migrating to the right lower quadrant. Where the pain often worsens with movement, coughing, or palpation.
2. **Nausea and Vomiting**
3. **Loss of appetite:** (children may refuse to eat or drink.)
4. **Fever:** Low-grade fever may develop, indicating inflammation or infection.
5. **Changes in bowel habits:** Some children may experience constipation or diarrhea.

Symptoms can be atypical in younger children or in cases where the appendix is located in unusual positions (behind the cecum).

Physical Examination

1. **Tenderness:** in the right lower quadrant tenderness is a classic finding. Rebound tenderness and guarding may be present.
2. **Psoas sign:** pain with extension of the right hip.
3. **Obturator sign:** pain with internal rotation of the right hip
4. **Abdominal rigidity:** in cases of advanced inflammation or perforation, the abdomen may be tense.
5. **Vital Signs:** increased heart rate and mild fever

ACUTE APPENDICITIS

Investigations

Laboratory Tests:

- Complete Blood Count (CBC): Often shows leukocytosis (elevated white blood cell count) indicating infection or inflammation.
- C-reactive Protein (CRP): May be elevated, indicating inflammation.

Imaging Studies:

- Ultrasound: First-line imaging in children; non-invasive and avoids radiation. Can help identify an inflamed appendix or abscess.
- Computed Tomography (CT): More sensitive than ultrasound, but involves radiation. Used if the diagnosis is uncertain and the clinical picture is atypical.

Treatment

Appendectomy: The definitive treatment is surgical removal of the appendix. This can be done through:

- Open Appendectomy: Traditional method involving a larger incision.
- Laparoscopic Appendectomy: Minimally invasive with smaller incisions; associated with quicker recovery and less postoperative pain.

Preoperative Management:

- Intravenous Fluids: To maintain hydration.
- Antibiotics: Administered preoperatively to cover possible infections; commonly used are broad-spectrum antibiotics.

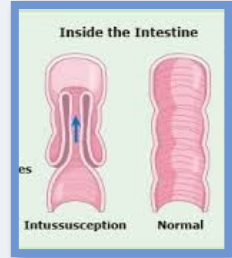
Postoperative Care:

- Monitoring for complications such as infection or abscess formation.
- Pain management and gradual return to normal activities, typically within a few weeks.

INTUSSUSCEPTION

What is it ?

When a part of the intestine folds into an adjacent segment, much like a telescope. This can cause an obstruction, leading to reduced blood flow, inflammation, and potentially ischemia or perforation of the affected bowel.

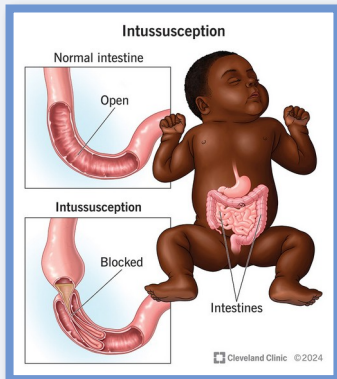


Incidence

The incidence of intussusception in pediatrics is approximately 1 to 4 cases per 1,000 children per year. It most commonly occurs in children aged 6 months to 3 years, with a peak incidence around 12 to 18 months. Intussusception is relatively rare in infants younger than 6 months and in older children.

Etiology

1. **Idiopathic Causes:** In many cases, the exact cause is unknown. Idiopathic intussusception is most common in children.
2. **Lead Points:** These are specific lesions that can precipitate intussusception, including:
 - Lymphoid Hyperplasia: Common in children, especially after viral infections, can create a lead point.
 - Meckel's Diverticulum: A congenital abnormality that can cause intussusception.
3. **Post-Surgical Changes:** Previous abdominal surgeries may lead to adhesions that can contribute to intussusception.
4. **Cystic Fibrosis:** Increased intestinal mobility and thickened secretions can be a contributing factor.
5. **Viral Infections:** Recent gastrointestinal infections, particularly with certain viruses (like rotavirus), may precede intussusception.



INTUSSUSCEPTION

Clinical Picture

1. **Abdominal pain:** sudden onset, often intermittent and severe. Where some children may draw their knees to their chest during episodes of pain.
2. **"Currant Jelly" Stools:** mucus and blood in stool, giving a jelly-like appearance.
3. **Vomiting:** may be bilious if there is significant obstruction.
4. **Lethargy:** decreased activity or responsiveness due to pain or discomfort.
5. **Abdominal Distension:** swelling of the abdomen may occur.
6. **Palpable Mass:** a sausage-shaped mass may be felt in the abdomen during examination.

Investigations

•Ultrasound:

•First-line imaging in children; non-invasive and highly effective for detecting intussusception. It can show a target sign or doughnut sign on cross-section.

•CT Scan:

•More sensitive and specific; can confirm intussusception and identify lead points, but involves radiation, so it's used when ultrasound is inconclusive or in older children.

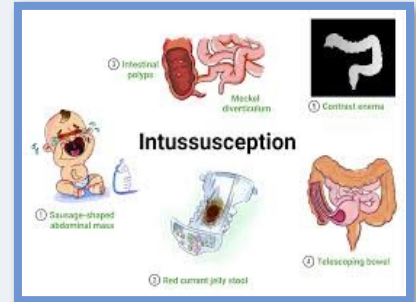
Treatment

1. Non-Surgical Management:

Air Contrast Enema: often used as both a diagnostic tool and therapeutic intervention. It can reduce the intussusception in many cases and is typically the first-line treatment.

2. Surgical Intervention:

- If non-surgical methods are unsuccessful, or if there are signs of bowel perforation, necrosis, or if the patient is unstable, surgery may be required.
- Surgical Reduction: The intussusception is manually reduced, and any damaged bowel may be resected.



MIDGUT MALROTATION

What is it ?

is a congenital condition where the intestines do not rotate properly during fetal development, leading to an abnormal positioning of the bowel. This can result in volvulus, which is a twisting of the intestine that can cause obstruction and ischemia.

Incidence

It is more commonly diagnosed in infants, particularly those under one year of age, with a peak incidence occurring in the first few months of life.

Etiology

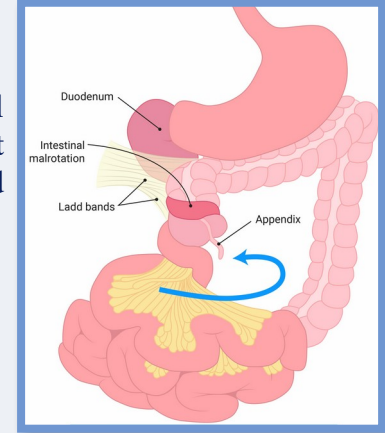
1. Embryological Factors:

- **Incomplete Rotation:** During fetal development, the intestines normally undergo a 270-degree counterclockwise rotation. If this process is incomplete or abnormal, it can lead to malrotation.
- **Failure of Fixation:** Normally, the intestines become fixed to the posterior abdominal wall, which helps maintain their position. In malrotation, this fixation may be inadequate, allowing the bowel to twist (volvulus).

2. **Genetic Factors:** Some studies suggest a potential genetic component, as midgut malrotation can occur in families or be associated with other congenital anomalies.

3. **Associated Conditions:** malrotation is sometimes seen in conjunction with other congenital conditions, such as:

- **Gastroschisis:** A defect in the abdominal wall.
- **Omphalocele:** An abdominal wall defect where organs protrude outside the body.



MIDGUT MALROTATION

Clinical Picture

1. **Severe Abdominal Pain:** Sudden onset, often severe and persistent.
2. **Vomiting:** May be bilious (green or yellow, indicating obstruction).
3. **Abdominal Distension:** Swelling of the abdomen due to obstruction.
4. **Lethargy:** Reduced activity or responsiveness.
5. **Blood in Stool:** May occur if there is bowel ischemia.

Investigations

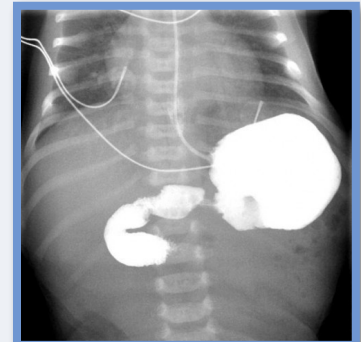
Abdominal X-ray: May show signs of intestinal obstruction or air-fluid levels.
Ultrasound: Can help identify volvulus and assess bowel perfusion.
CT Scan: Most sensitive for diagnosing malrotation and volvulus; can provide detailed images of the bowel.

Treatment

Emergency Surgery: Required to untwist the volvulus and assess the viability of the affected bowel.
Ladd's Procedure: Often performed to correct malrotation and prevent future volvulus by dividing adhesions and placing the bowel in a more stable position.

Complications

1. **Ischemia or Necrosis:** Due to prolonged volvulus.
2. **Short Bowel Syndrome:** If significant bowel resection is necessary.
3. **Recurrent Volvulus:** Can occur if the malrotation is not adequately corrected.



Gastrointestinal Obstruction in Pediatrics

```
graph TD; A((Hernia in children)); B((Intestinal atresia and stenosis)); C((Pyloric stenosis)); D((Hirschsprung's disease));
```

Hernia in
children

Intestinal
atresia and
stenosis

Pyloric
stenosis

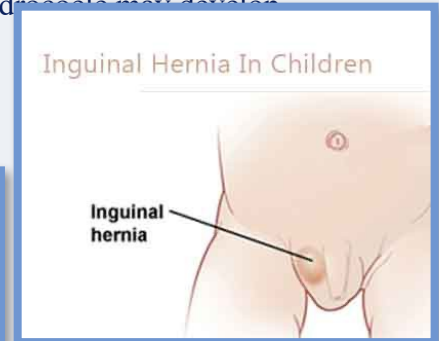
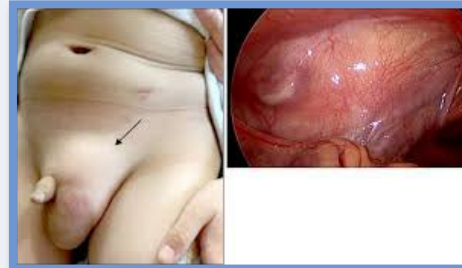
Hirschsprung's
disease

Hernias in children

Hernia is the protrusion of a viscus or part of a viscus through an abnormal opening in the walls of its containing cavity.

Indirect inguinal hernias:

- Over 99% of inguinal hernias in children are indirect. During development, an outpouching of the peritoneum (processus vaginalis) forms with the testicular descent into the scrotum in boys or in the formation of the labia in girls.
- If this subsequently fails to obliterate, it is a patent processus vaginalis (PPV). This lies within the inguinal canal, together with the spermatic cord in boys and the round ligament in girls. An indirect hernia occurs when intra-abdominal content herniates through the internal (deep) inguinal ring into the inguinal canal following the path of testicular descent. These contents then exit through the external (superficial) inguinal ring and enter the scrotum. As an indirect hernia enters the canal through the deep ring, it arises lateral to the inferior epigastric vessels. If the PPV is narrow, a hydrocoele may develop.
- Indirect inguinal hernias affect approximately 1% to 5% of children.
- Boys are affected more than girls, with an 8:1 ratio. Prematurity increases the incidence of inguinal hernia to between 7% and 30%. The incidence of bilateral hernias ranges from 10% to 40%. Bilateral hernias occur more frequently in premature infants and girls.



Hernias in children

- **Diagnosis:**

- Made by a history and physical examination. A groin bulge is noted which extends toward the scrotum or vulva either by history or observation. This is sometimes reproduced only when the child laughs, cries, or stands. Boys may have a thickened spermatic cord.

- **Management:**

- a) Reducible hernias are repaired with high ligation of the sac through a low abdominal incision. The hernia sac is anterior and medial to the spermatic cord in boys and more difficult to locate among the muscle fibers running through the external ring in girls. The sac can contain small bowel, omentum, or ovary.
- b) Incarcerated hernias can often be reduced with gentle direct pressure on the hernia. Simultaneously applying caudal traction on the testicle in addition to direct pressure on the hernia may be necessary in some cases.
- c) Strangulated hernias require emergent operative repair. Even if a severely incarcerated/strangulated hernia is reduced, the child should be admitted and scheduled for urgent herniorrhaphy. If viability of sac contents is in question, the bowel must be examined before abdominal closure.

Pyloric stenosis

Pyloric stenosis is a condition that affects infant's pylorus, the muscle at the end of the stomach leading to the small intestine. When their pylorus thickens and narrows, food can't pass through.

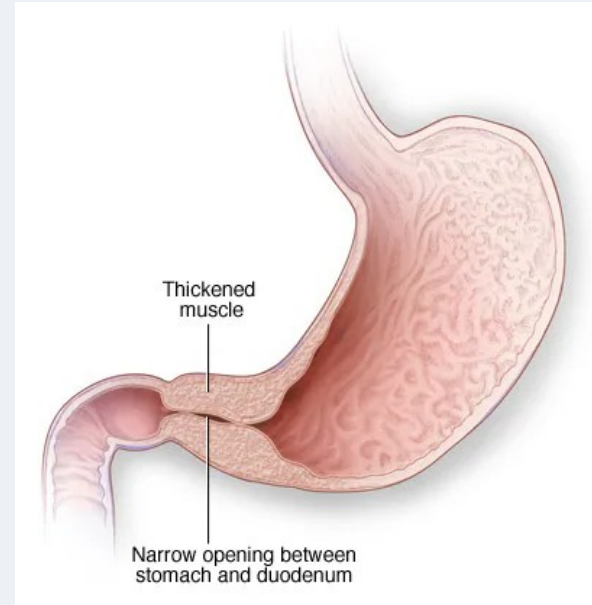
- **Symptoms:** include forceful vomiting, which may cause dehydration and malnourishment. It is the most common surgical cause of non-bilious vomiting in infants. Neonate presenting with projectile, non bilious vomiting, associated with hunger and constipation.
- **Incidence:**
 - 8:1000
 - M/F ratio=4:1
 - More in first born babies
 - More in infants born to a mother who had suffered pyloric stenosis

- **Etiology:**

Unknown, but appears to be polygenic (environmental, and genetic)
Drugs taken during pregnancy may be associated with the development of pyloric stenosis

- **Pathology:**

Progressive hypertrophy of circular pyloric muscles
Persistent vomiting leads to development of hypochloremic hypokalemic alkalosis and dehydration



Pyloric stenosis

- **Clinical presentation;**

- Neonate suffers from projectile, progressive, non bilious vomiting after which the baby is hungry and ready to suckle again.
- Classically the symptoms between 3-12 weeks after birth.

- **Signs:**

- Signs of dehydration which may be severe and life threatening.
- Visible peristalsis in the upper abdomen can usually be seen after the baby is given a test feed followed by projectile vomiting.
- The "olive" mass refers to a thickened pylorus which can be palpated to the right and superior to the umbilicus. It is approximately 2 cm in diameter, firm, and mobile.

- **Investigations:**

- Ultrasound is mainly used for diagnosis in addition to contrast xray
Shows an increase in pyloric channel length (greater than 18mm), pyloric muscle length (greater than 21mm),
pyloric muscular wall thickness(greater than 5mm), and pyloric diameter (greater than 15 mm)
- Laboratory tests may detect electrolyte and metabolic disturbances

First treated by correcting and metabolic disturbances and dehydration for persistent vomiting, then pyloromyotomy surgery

Hirschsprung's Disease

(congenital aganglionic megacolon)

It is caused due to congenital absence of ganglion cells in the submucosal and myenteric plexus of intestine.

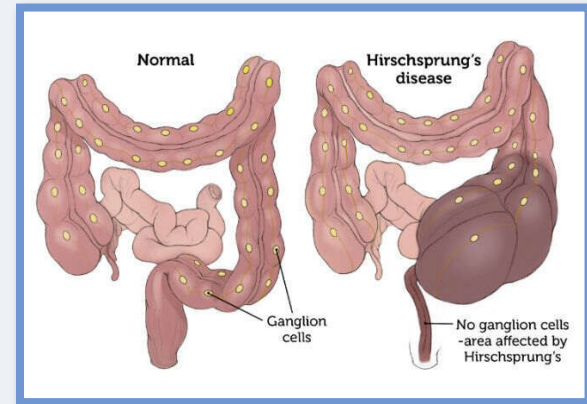
- **Pathophysiology:**

Absence of ganglionic cells -> Lack of peristalsis in the affected portion -> Functional obstruction of Colon ->

Accumulation of gas & feces proximal to the defect -> Enlargement of the Colon (Megacolon).

- **Clinical Picture:**

- In neonates and infants,
 - *Failure to pass meconium
 - *Abdominal distension
 - *Bile-stained vomiting
 - *Shock
 - *Episodes of diarrhea & constipation
- In older children,
 - *Constipation with abdominal distension
 - *Foul smelling and watery stool
 - *Malnourished and Anemic



Hirschsprung's Disease

- **Diagnostic Evaluation:**

- Hirschsprung's disease is suspected in a baby who has not passed meconium within 48 hours of birth.

- *Rectal examination

- *Palpation

- *Anorectal manometry

- *Barium enema & Rectal biopsy

- **Management:**

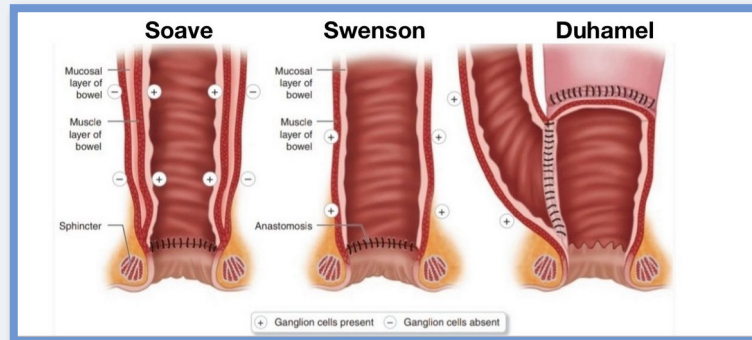
- 1. Medical management:

- Administration of Isotonic enema > Administration of stool softeners > Low residue diet.

- 2. Surgical management:

- Removing aganglionic colon and pulling down healthy colon and sewing it to the anus

- Surgical options:



Intestinal Atresia and Stenosis

Intestinal atresia: is a broad term used to describe a complete blockage or obstruction anywhere in the intestine.

Stenosis: refers to a partial obstruction that results in a narrowing of the opening (lumen) of the intestine.

- **Types;**

- *Duodenal

- *Jejunioileal

- **Mechanism:**

- Failure of vacuolation process where duodenum does not recanalize properly leading to stenosis or atresia of duodenum.

- **Presentation:**

- Bilious vomiting and abdominal distension within first 1-2 days of life.

- **3 Ds in Duodenal Atresia :**

- Distension of Duodenum and stomach.

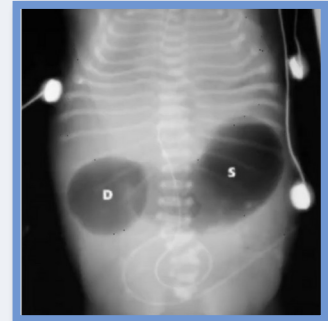
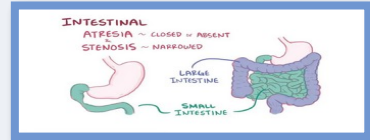
- Double bubble appearance on X-ray.

- Associated with Down syndrome

- Duodenal Atresia is associated with increased Amniotic Fluid in the uterus which is called Polyhydramnios.

- This increase in amniotic fluid is caused by the inability of the fetus to swallow the amniotic fluid and absorb it in their digestive tract.

- This can be detected by prenatal ultrasound.



Double bubble appearance

Intestinal Atresia and Stenosis

- **Jejunal and Ileal Atresia:**

- Mechanism: Results from ischemic injury (lack of blood flow to developing gut).

- *Disruption of superior mesenteric artery

- *Decrease perfusion

- *Necrosis of ischemic area

- *Segmental resorption (tripple bubble appearance)

- Presentation: Bilious vomiting and abdominal distension within first 1-2 days of life.

- **Treatment:**

- 1. Early treatment:

- Gastric decompression (removal of fluid from stomach via nasogastric tube)

- Intravenous fluids

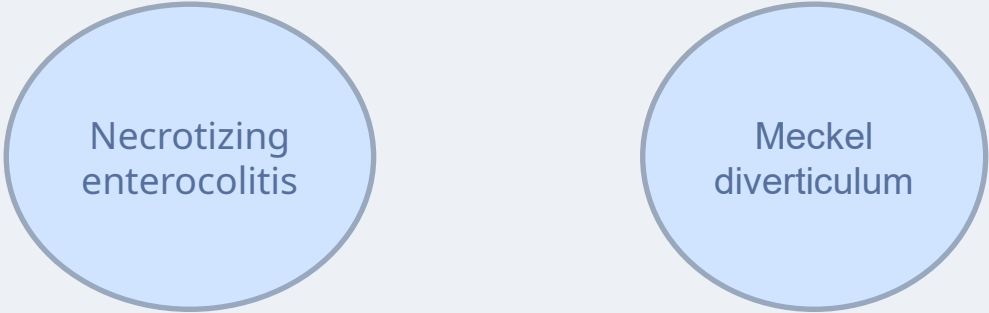
- 2. Definitive treatment:

- Surgery (Duodenoduodenostomy or Duodenojejunosomy), which may be performed openly or laparoscopically.



Tripple bubble appearance

Inflammatory and infectious cause in pediatrics



Necrotizing
enterocolitis

Meckel
diverticulum

Inflammatory and infectious cause in pediatrics

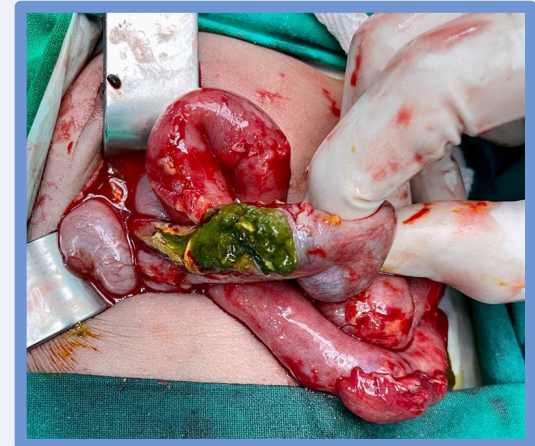
Necrotizing Enterocolitis (NEC):

NEC is the most common neonatal gastrointestinal emergency; It is characterized by an acute inflammatory disease of the intestine associated with ulceration and necrosis of the gastrointestinal tract most frequently affecting the small bowel.

The pathogenesis is believed to be multifactorial:

- involving prematurity: an immature gut barrier defense
- bacteria
- enteral feeding
- hypoxia/ischemia or low-flow states

The incidence of NEC is 1 to 3 per 1,000 live births, with **prematurity being the single most prominent risk factor.**



Inflammatory and infectious cause in pediatrics

Clinical presentation:

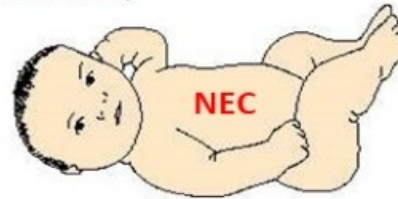
Pathogenesis of NEC in the early preterm infant: Physiological, socio-cultural, developmental mediating factors

Extrinsic factors

- NICU standards for blood transfusions
- Feedings (formula vs breast milk; route, frequency)
- Incubator environmental temperature
- Blood transfusion (temperature, route, duration)
- Nursing care during transfusion

Intrinsic factors

- Gestational age
- Sex/Ethnicity/Race
- Infant body temperature
- Presence of Anemia
- Comorbidities



Signs and symptoms

- Bells' Criteria
- Feeding intolerance
 - Emesis
 - Bloody stools
 - Abdomen distension
- Changes in physiological stability
 - Vital signs (HR, central-peripheral temperature)
 - Glucose, blood counts

Inflammatory and infectious cause in pediatrics

Diagnosis:

requires a high clinical suspicion. NEC is unusual within the first few days of life, but approximately 80% of cases occur within the first month of life.

-Clinical examination: may demonstrate a lethargic or irritable patient with abdominal distention, feeding intolerance, or passage of bloody stools, Advanced cases may show signs of peritonitis including erythema of the abdominal wall.

Temperature instability is common, as well as increasing incidence of apneic or bradycardic episodes.

-Laboratory studies: may reveal increasing leukocytosis or leukopenia as well as metabolic acidosis and thrombocytopenia.

-Plain radiographs: often reveal dilated loops of bowel with evidence of ischemia including pneumatosis intestinalis, portal venous gas, or pneumoperitoneum.



Inflammatory and infectious cause in pediatrics

-Based on clinical examination and laboratory and imaging data, patients and their expectant management can be guided by **Bell staging**:

Bell's stages	Clinical signs	Radiologic signs
I (suspected NEC)	Apnoea Lethargy Emesis Mild abdominal distention Bloody stool	Normal or intestinal dilation Mild ileus
II (proven NEC)	Stage I signs, plus: Mild metabolic acidosis/thrombocytopenia Absent bowel sounds with or without abdominal tenderness	Intestinal dilation Ileus Pneumatosis intestinalis Portal venous gas
III (advanced NEC)	Stage II signs, plus: Severe apnoea Hypotension Disseminated intravascular coagulation Neutropenia Generalised peritonitis Abdominal distention	Stage II signs, plus: Definite ascites Pneumoperitoneum

Modified Bell's staging criteria for necrotising enterocolitis, adapted from (Ref. 10).

Expert Reviews in Molecular Medicine © 2016 Cambridge University Press

Inflammatory and infectious cause in pediatrics

Management:

-Initial management of the hemodynamically stable patient should focus on bowel rest, nasogastric decompression, parenteral nutrition,

-broad-spectrum antibiotics.

-Serial abdominal examinations, laboratory studies including CBC and blood gas, and plain radiographs are valuable studies to determine the success of nonoperative management.

“Fifty percent patients will experience improvement and resolution of signs of NEC with non-operative management”.

-Operative management:

-is indicated for intestinal perforation, as indicated by free air on abdominal radiograph.

Relative indications for operative management include: overall clinical deterioration, abdominal wall cellulitis, worsening acidosis, falling white blood cell or platelet count, a palpable abdominal mass, or a persistent fixed loop on repeated abdominal radiographs.

Improvement of clinical status can be achieved with **laparotomy**, including resection of nonviable bowel and anastomoses or stomas as necessary, or with peritoneal drainage.



**Me setting up my bed to
study thinking I'll be more
efficient when I'm warm
and comfortable**



Me 2 minutes later

Inflammatory and infectious cause in pediatrics

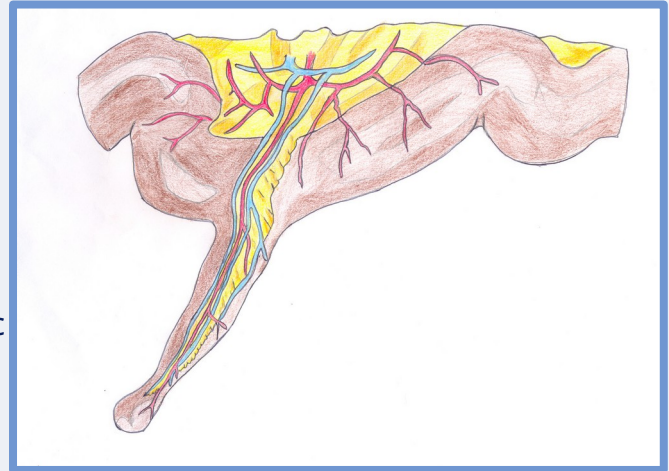
-Meckel diverticulum:

is the most common congenital anomaly of the GI tract and occurs from failure of the vitelline (omphalo-mesenteric duct) to obliterate by the sixth week of fetal development.

It is a true diverticulum: containing all layers of the bowel wall and located on the antimesenteric border of the ileum

-**"rule of twos"** for these diverticula including a:

- 2% incidence
- 2:1 male: female ratio
- 2 inch in length
- usually 2 feet from the ileocecal valve
- typically presenting before 2 years of age
- often containing two types of mucosa: intestinal and heterotopic (commonly gastric or pancreatic)



Inflammatory and infectious cause in pediatrics

Presentation:

- The vast majority are asymptomatic: Painless

- episodic bleeding is the **most common presenting symptom**: The source is typically a peptic ulcer of adjacent normal ileum on the mesenteric border of the bowel caused by acid secretion from gastric mucosa within the diverticulum.

- Intussusception or incarcerated hernia (Littre hernia) causing **intestinal obstruction is the second most common presentation**, Obstruction can also occur due to volvulus of small bowel around a fibrous band connecting the diverticulum to the anterior abdominal wall.

- "Meckel diverticulitis occurs in 20% of symptomatic patients and is often mistaken for acute appendicitis"**

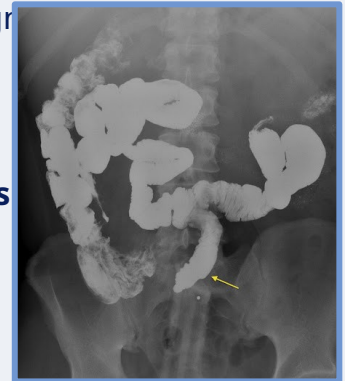
Inflammatory and infectious cause in pediatrics

Diagnosis:

A Meckel scan is a radionucleotide study based on the uptake of Tc-99m pertechnetate by ectopic gastric mucosa.

- In children, this test is the most accurate (90%) for diagnosing a Meckel
- In the presence of bleeding, a tagged red blood cell scan can also be useful.
- Contrast studies, such as small bowel follow through (SBFT) and enteroclysis, are diagnostic in some patients.

CT and sonography are typically of little value because distinguishing between a diverticulum and intestinal loops can be very difficult unless Meckel diverticulitis is



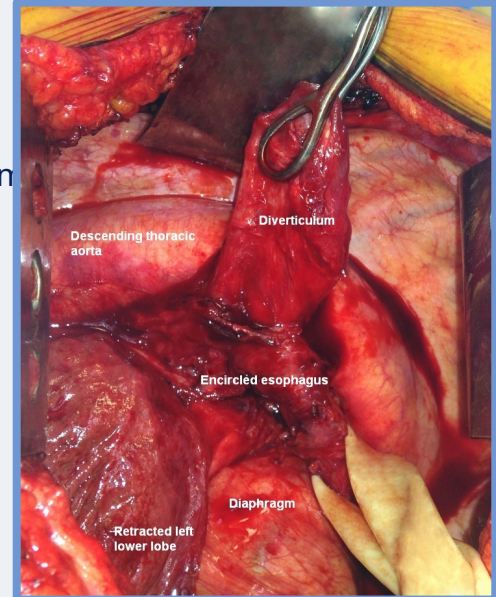
Inflammatory and infectious cause in pediatrics

Treatment:

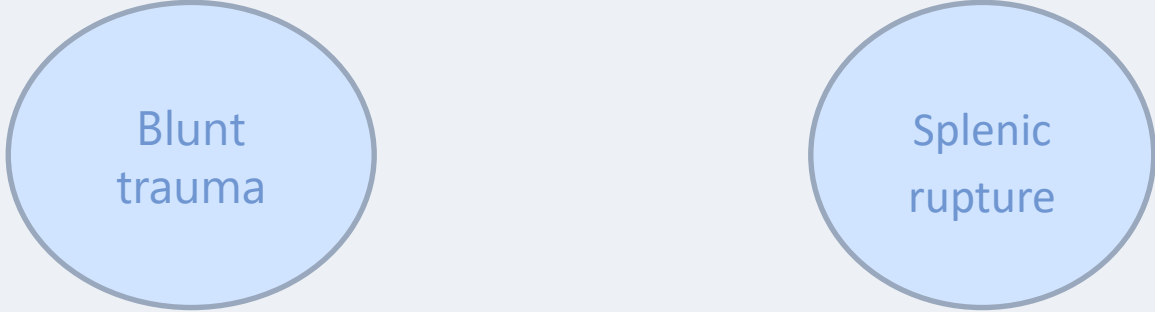
Resection is indicated in symptomatic patients:

- For patients who present with obstruction, simple diverticulectomy can be performed
- Segmental small-bowel resections should be performed for acute diverticulitis,
- Incidental diverticulectomy during surgery for other abdominal pathology is not indicated.

Lifelong morbidity associated with the presence of a Meckel diverticulum is extremely low.



Trauma-Related Acute Abdomen



Blunt
trauma

Splenic
rupture

Trauma-Related Acute Abdomen

Trauma is the leading cause of morbidity and mortality in the pediatric population. The abdomen is the third most commonly injured anatomic region in children, after the head and the extremities.

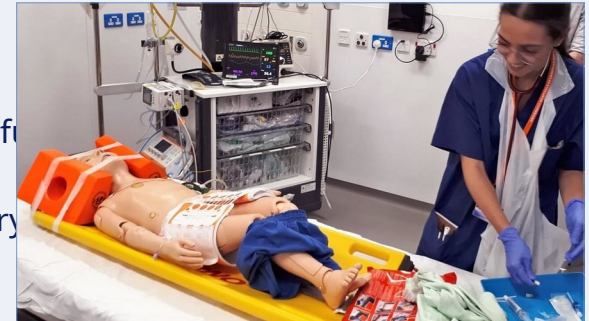
Etiology:

More than 80% of traumatic abdominal injuries in children result from blunt mechanisms; most commonly, they are related to motor vehicle accidents (MVAs). Abdominal injuries may also result from falls or direct blows to the abdominal wall

Prognosis:

Nonoperative treatment of children with blunt abdominal trauma is successful in more than 95% cases .

Out of all forms of pediatric abdominal trauma, abdominal trauma secondary to abuse is associated with the highest mortality.



Trauma-Related Acute Abdomen

Investigations:

-History: it is frequently difficult to obtain the history from young children, who may be stressed as a result of the pain and the unfamiliar hospital environment and staff. The possibility of inflicted abdominal injury should be considered in a child with unexplained or unusual clinical history or physical findings.

-Physical examination:

primary survey
secondary survey

-Laboratory studies:

- 1-CBC provides a baseline blood count. Overall, CBCs should be performed only as often as is necessary for adequate assessment of the patient's clinical condition.
- 2-Urinanalysis has proven useful in screening for injury to the urinary tract. (Detection of blood should prompt further evaluation because even microscopic hematuria can be associated with significant renal trauma.)
- 3-LFTs and pancreatic enzyme tests: findings from LFTs or pancreatic enzyme tests may be useful for monitoring the course of a liver or pancreatic injury.

Trauma-Related Acute Abdomen

Imaging studies:

- 1-CT
- 2-Angiography
- 3-ultrasonography (FAST)

Management (Based on Injury Severity):

Non-Operative Management:

For stable patients with minor injuries (e.g., grade I or II liver or spleen lacerations), non-operative management is often preferred.

Includes:

Observation in a monitored setting.

IV fluids for hydration.

Pain management.

Serial abdominal examinations to monitor for changes.

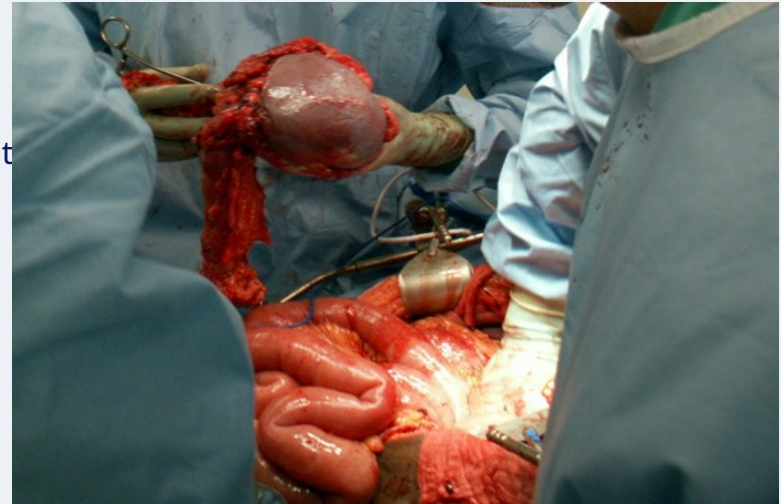
Trauma-Related Acute Abdomen

Operative Management:

Indicated for: Significant organ lacerations or vascular injuries leading to hemorrhage. Evidence of intra-abdominal free fluid or hematoma that is expanding. Hollow organ injuries (e.g., perforation).

Surgical options may include:

- Laparotomy for exploration and repair
- Laparoscopic techniques for less invasive management

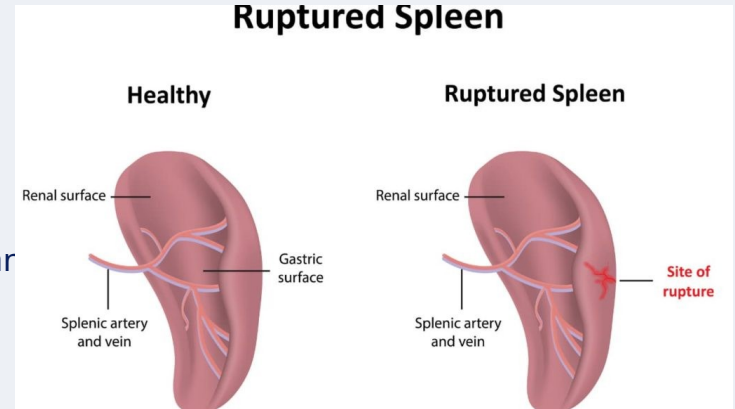


Trauma-Related Acute Abdomen

Splenic rupture in pediatrics: is a serious condition that can occur as a result of blunt abdominal trauma. It is essential to recognize, diagnose, and manage this injury promptly to prevent complications such as hemorrhagic shock.

Clinical Presentation:

- Signs & Symptoms
- Abdominal pain (often left-sided)
- Tenderness on examination, especially in the left upper quadrant
- Signs of peritonitis (e.g., rigidity, rebound tenderness)
- Possible referred pain to the left shoulder (Kehr's sign)
- Nausea and vomiting
- Signs of hypovolemic shock (tachycardia, hypotension, pallor, altered mental status)



Trauma-Related Acute Abdomen

Diagnosis:

History and Physical Exam: Detailed history of the mechanism of injury.

Thorough abdominal examination to assess for tenderness and signs of internal bleeding.

Imaging:

Ultrasound (FAST): Quick assessment for free fluid, which may indicate splenic rupture.

CT Scan: Provides a more detailed evaluation of the spleen and surrounding structures, often used in stable patients.

Trauma-Related Acute Abdomen

Spleen injury scale:

Grade	Injury	Description
I	Laceration	Capsular tear, < 1 cm parenchymal depth
II	Haematoma	Subcapsular, 10–50%, surface area Intraparenchymal, < 5 cm in diameter
	Laceration	1–3 cm parenchymal depth, which does not involve a trabecular vessel
III	Haematoma	Subcapsular, > 50% surface area or expanding; ruptured subcapsular or parenchymal haematoma Intraparenchymal haematoma > 5 cm or expanding
	Laceration	> 3 cm parenchymal depth or involving trabecular vessels
IV	Laceration	Laceration involving segmental or hilar vessels producing major devascularization (> 25% of spleen)
V	Laceration	Completely shattered spleen
	Vascular	Hilar vascular injury which devascularizes spleen

Trauma-Related Acute Abdomen

Management:

Non-Operative Management: Appropriate for hemodynamically stable patients with minor to moderate injuries (Grades I and II). Includes:

- Hospital admission for observation.
- Bed rest and pain management.
- IV fluids to maintain hydration.
- Serial abdominal exams to monitor for changes.

Operative Management:

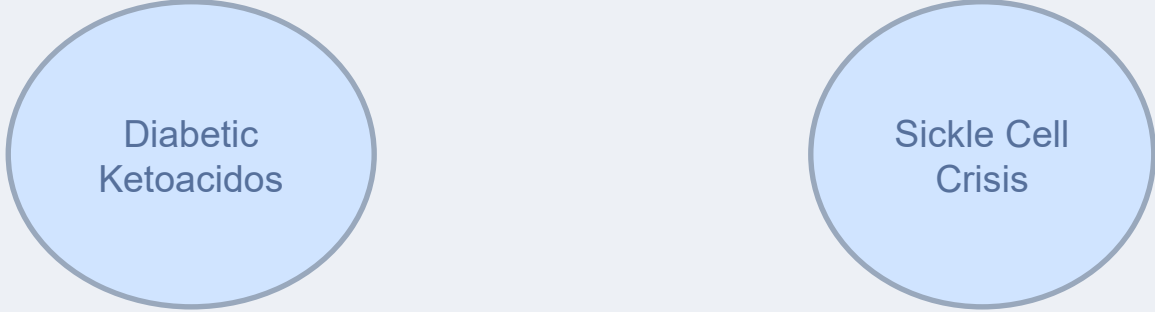
Indicated for:

- Hemodynamically unstable patients.
- Major splenic lacerations or complete ruptures (Grades III and above).
- Significant intra-abdominal bleeding or signs of peritonitis.

Surgical options:

- Laparotomy: Direct exploration and possible splenectomy (removal of the spleen) or splenorrhaphy (repair of the spleen).
- Laparoscopic surgery: Less invasive approach for some cases.

Metabolic and Vascular Cause in Pediatrics



Diabetic
Ketoacidosis

Sickle Cell
Crisis

Metabolic and Vascular Cause in Pediatrics

Diabetic Ketoacidosis (DKA):

It is a serious, life-threatening complication primarily associated with Type 1 diabetes but can also occur in those with Type 2 diabetes. It results from a combination of insulin deficiency and increased counter-regulatory hormones, leading to hyperglycemia, ketonemia, and metabolic acidosis.

- **Pathophysiology:**

- Insulin Deficiency: Lack of insulin results in high blood sugar levels (hyperglycemia) and prevents glucose uptake into cells.

- Ketone Production: With insulin deficiency, the body uses fat as an energy source, producing ketones as a byproduct. This results in ketonemia and metabolic acidosis.

- Electrolyte Imbalances: Insulin deficiency and acidosis disrupt electrolyte balance, affecting potassium, sodium, and chloride.

Metabolic and Vascular Cause in Pediatrics

Diabetic Ketoacidosis (DKA):

- **Clinical Presentation:**

- Polyuria
- Polyphagia with weight loss
- Vomiting and abdominal pain (can mimic appendicitis or other acute abdominal conditions)
- Fatigue or confusion; in severe cases, altered mental status or coma
- Kussmaul respirations: Deep breathing as the body tries to compensate for metabolic acidosis.
- Signs of dehydration: Dry mucous membranes, sunken eyes.

- **Diagnostic Criteria For DKA:**

- Hyperglycemia: Blood glucose >200 mg/dL (11 mmol/L).
- Acidosis: pH <7.3 or bicarbonate <15
- Ketosis: Presence of ketones in blood or urine.

Metabolic and Vascular Cause in Pediatrics

Sickle Cell Crisis:

It is a painful episode caused by the abnormal shape and behavior of red blood cells in people with sickle cell disease. These crises occur when sickle-shaped red blood cells block blood flow through blood vessels, leading to tissue damage and intense pain. There are several types of crises, each affecting different parts of the body.

- Types of Sickle Cell Crisis:

1) Acute Splenic Sequestration:

- * Definition: This is a sudden, painful condition where a large volume of blood pools in the spleen. The spleen becomes enlarged, leading to a drop in blood circulation throughout the body.
- * Symptoms: Rapid onset of anemia (low blood count), fatigue, rapid heart rate, abdominal pain (especially in the upper left side), and possibly shock if left untreated.
- * Treatment: This is a medical emergency. It may involve blood transfusions and, in severe cases, may lead to splenectomy.

2) Mesenteric Crisis:

- * Definition: this crisis involves painful episodes caused by the blockage of blood vessels in the mesentery, which is the tissue that attaches the intestines to the abdominal wall.
- * Symptoms: Severe abdominal pain, which can mimic conditions like appendicitis or intestinal obstruction. There may also be nausea, vomiting, and bowel disturbances.
- * Treatment: Pain management, hydration, oxygen therapy, and in severe cases, hospitalization to prevent complications like infection or tissue damage.

Metabolic and Vascular Cause in Pediatrics

Sickle Cell Crisis:

- **Clinical History:**

- Pain: Assess for sudden, severe pain often in the abdomen, bones, joints or chest.
- Fatigue or Weakness.
- Fever and Respiratory Symptoms: Fever, cough, chest pain, or difficulty breathing may suggest acute chest syndrome, which is a serious complication.
- Paleness or Yellowing of Skin/Eyes: Jaundice may indicate hemolysis.

- **Laboratory Tests:**

- Complete Blood Count (CBC): To assess for anemia, low hemoglobin, or changes in white blood cells and platelets.
- Reticulocyte Count: A low reticulocyte count may indicate aplastic crisis, while a high count can show active red blood cell production due to anemia.
- Liver Function Tests: To check for signs of hemolysis and monitor for jaundice.

Special Consideration in Pediatric



Wilms' Tumor

Gastroenteritis

Ovarian torsion

Special Consideration in Pediatric

Wilms' tumor "Nephroblastoma" :

Wilms' Tumor is the Cancer of the kidney; occurs to kids younger than 5 years old, with a 90% chance of survival .

- **Etiology :** Genetics, chromosomal deletion of WT-1 , located at chromosome 11.
- **Clinical presentation:**
 - Painless palpable abdominal mass
 - Hematuria
 - HTN
 - Most common place of metastasis is the lung, so respiratory symptoms might be present
 - 10% of cases develop WAGR syndrome
 - W:** wilms tumor
 - A:** aniridia (absence of iris)
 - G:** genitourinary abnormalities
 - R:** retardation
- **Diagnosis:**
 - Laboratory: CBC , chemistry profile(kidney function test , routine measurements of electrolytes) , urinalysis
 - Imaging : Ultrasound , abdomen and chest CT
 - Biopsy : used for confirmation, mixed pattern with blastema, stroma and single epithelial structures
- **Management and Treatment:**
 - The usual approach is surgery (nephrectomy) followed by chemotherapy , with or without radiotherapy.

Special Consideration in Pediatric

Wilms' tumor "Nephroblastoma" :

TABLE 32-6 Wilms Tumor Staging System

Stage	Characteristics
1	Tumor confined to the kidney and completely removed by surgery
2	Tumor grew beyond the kidney (e.g., nearby fatty tissue or into blood vessels) but the kidney and affected tissue were completely removed surgically
3	Tumor is not completely removed. Tumor remaining after surgery is limited to the abdomen (e.g., abdominal lymph nodes, positive margin, peritoneal implants)
4	Tumor has spread through the bloodstream to other organs far away from the kidneys (e.g., lungs, liver, bone or distant lymph nodes)
5	Tumors are in both kidneys at the time of diagnosis

Special Consideration in Pediatric

Wilms' tumor "Nephroblastoma" :

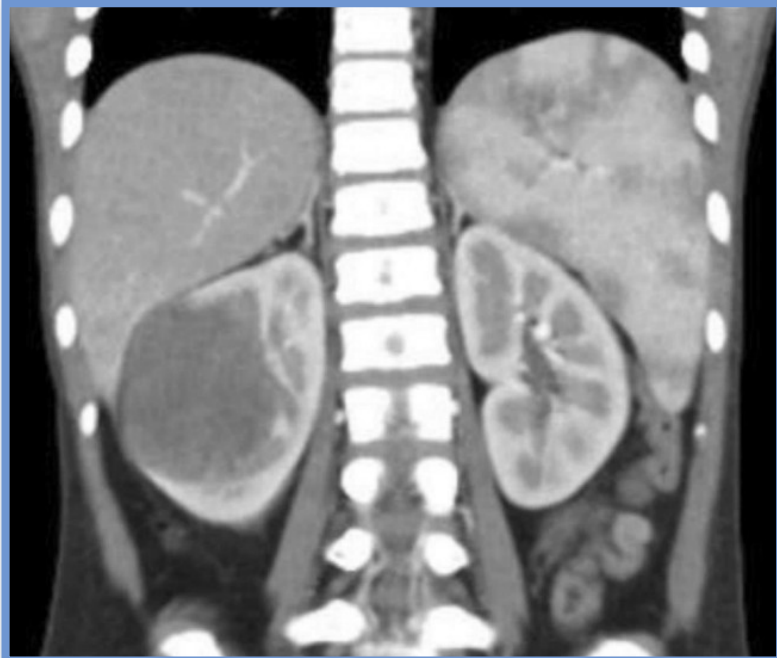


Figure 76.23 Wilms' tumour.

Special Consideration in Pediatric

Ovarian torsion:

A process that occurs when the ovary twists over the ligaments that support it, causing reduced blood supply, considered as an emergency that can occur in females of all ages.

- **Anatomy:**

- Ligaments that supports ovaries:

- 1- suspensory ligament (where ovarian vessels pass through)
- 2 - ovarian ligament (where uterine vessels pass through)

- Blood supply:

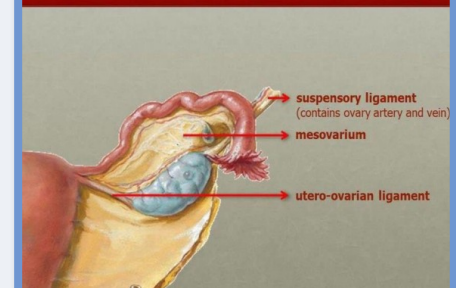
- the ovarian vessels
 - the uterine vessels, anastomosing with the ovarian vessels.

- **Pathophysiology:**

- Ovary rotates (twists) which lead to compromised the blood flow, leading to inadequate oxygen and nutrients reaching the ovary → ischemia → infarction → necrosis.
 - Most common causes of twisting in female children
 - 1- weight and size of the ovary (cysts)
 - 2- congenitally malformed and elongated fallopian tubes



Normal Ovary – Anatomy



Special Consideration in Pediatric

Ovarian torsion:

- **Clinical presentation:**

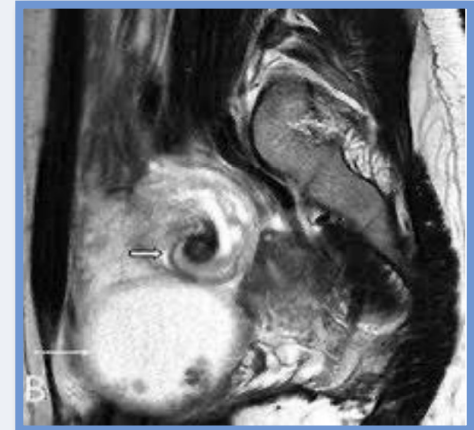
- 1- lower abdominal pain characterized by: Sudden and onset / severe/unilateral/ sharp-stabbing (like often radiating to the back, pelvis and thigh)
- 2- nausea/ vomiting
- 3- low-grade fever

- **Diagnosis:**

- Ultrasound is the first option to diagnose an ovarian torsion
- Findings : the affected ovary is enlarged, with multiple immature follicles in its periphery and snail shell sign(whirlpool)

- **Treatment (surgical):**

- Laparoscopy: is needed to gather information:
 - 1- if detected early: detorsion , usually accompanied with ovarian cystectomy when a cyst had caused the torsion
 - 2- if detected late (necrotic ovary) : oophorectomy



Special Consideration in Pediatric

Gastroenteritis:

Gastroenteritis is a short term illness (1 week - 2 weeks) triggered by the infection and inflammation of the digestive system.

- **Etiology:**

- 1- viral: most common cause of gastroenteritis in children, most importantly “Rotavirus”
- 2- bacterial : Campylobacter, salmonella, shigella , E coli.
- 3- parasitic

- **Pathophysiology:**

- Diarrhea is caused due to an increase in the intestinal fluid output in comparison to absorption.
- What causes malabsorption?
 - 1- causative damaging the villous brush border of the intestine
 - 2- causative releasing toxins that binds to enterocyte receptors causing an increase in chloride ions leading to secretory diarrhea.

- **Clinical presentation:**

- The triad of gastroenteritis is: Fever , diarrhea, and vomiting (leads to dehydration)

- **Diagnosis:**

- Usually gastroenteritis is diagnosed by its symptoms, but a stool test is done to identify the causative of the case
- # assessment of dehydration is needed in diagnosis (follows...)

Special Consideration in Pediatric

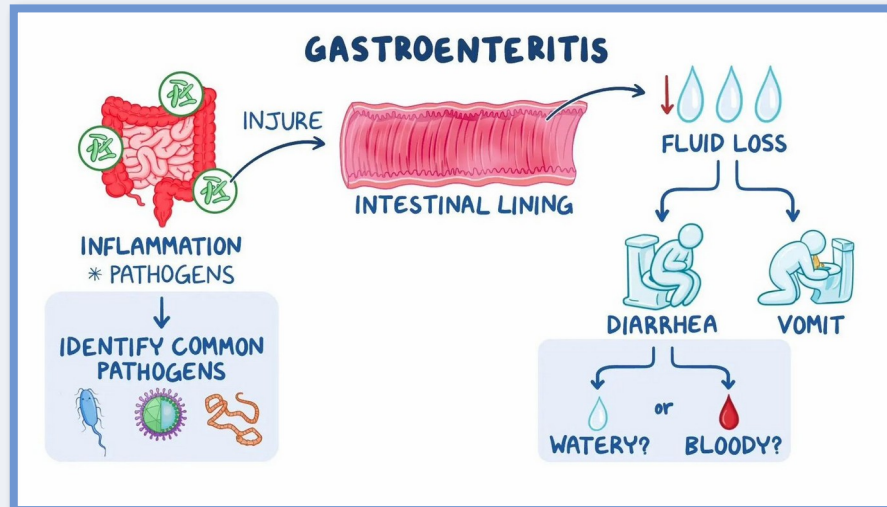
Gastroenteritis:

Level of dehydration	Total body water loss %	Signs
No dehydration	Less than 3%	Not enough of the above signs to classify as mild/moderate or severe dehydration
Mild	3%-6%	Two of the following signs: Restless, irritable Sunken eyes Thirsty, drinks eagerly Skin pinch goes back slowly
Moderate	6%-9%	
Severe	More than 10%	Two of the following signs: Lethargic or unconscious Sunken eyes Not able to drink or drinking poorly Skin pinch goes back very slowly

Special Consideration in Pediatric

Gastroenteritis:

- **Treatment** (main focus is to replace the lost amount of fluid):
 - Minimal/ no dehydration: treated by increasing fluid intake.
 - Mild / moderate : is treated by taking oral rehydration solution ORS.
 - Severe dehydration is considered an emergency, treated by taking IV fluids (normal saline or lactated ringer)



References:

- The Washington manual of surgery textbook
- bailey and love's textbook
- Medscape
- <https://pubmed.ncbi.nlm.nih.gov/29196510/>
- <https://pmc.ncbi.nlm.nih.gov/articles/PMC3915729>
- <https://www.aafp.org/pubs/afp/issues/2016/0515/p830.html#afp20160515p830-t2>
- <https://jenci.springeropen.com/articles/10.1186/s43046-020-00043-3>
- Medscape (ovarian (adnexal) torsion) article
- ChatGPT

Thank you