Pediatric HIIT Workout: Abdominal Pain & Limping Child

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W.O.D

- Understand the causes of acute abdominal pain in childhood.
- Develop a differential diagnosis based on age and symptoms.
- Formulate a plan for evaluation and management of acute abdominal pain.
- Discuss imaging study for various diagnoses.

Green vomit is surgical

Vomiting and distention is surgical.

Vomiting and shock is surgical.

Mantra

Accessed 4.23.2020:http://pemplaybook.org/podcast/the-pediatric-surgical-abdomen



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Introduction

- Causes range from “belly aches" to an emergency requiring immediate attention.
- Differential to abdominal pain is a very long list
  - Age based approach
- Divided into the following categories:
  - SERIOUS/Common
  - LESS serious/ Common
  - SERIOUS/UNcommon
  - LESS serious/UNcommon

Background

- < 5 yo are not able to localize pain well.
- 1000 children: ages 4-18yo
  - 10% with one episode that sought medical attention
  - Constipation accounted for 48%
- Good history, physical and exam.

https://socratic.org/questions/from-the-lumen-outward-what-are-the-layers-of-the-gastrointestinal-tract

Neonate



7 day old infant "Change in feeding."

- Child is a former 36 week premature infant.
- Diagnosis of ToF a birth, awaiting surgery at 3 month of age.
- Child is feed Similac Neosure.
- Parents complain of feeding intolerance and more spit up(non-bilous) over the last 2 days and hematochezia x 1. most frequent sign of NEC is a sudden change in feeding tolerance

Physical exam

- Vitals: T: 99 F, HR: 70, RR: 30, BP: 70/40
- Physical exam:
  - Gen: neonate irritable and crying
  - CV: RRR with + murmur
  - Lungs: b/l CTA
  - Abd: +mild distended, BS hypoactive, No HSM, NTTP
  - Skin is without lesions.

KUB



Accessed3.25.2020 : www. Uptodate.com

Which of the following is the likely diagnosis in this patient?

a. Bacteremia
b. Dietary protein allergy
c. Necrotizing Enterocolitis
d. Volvulus

Necrotizing Enterocolitis (NEC)

- NEC occurrence inverse to gastrointestinal age
- Presentation:
- Diagnosis: Bell staging

Niño DF et al. Necrotizing enterocolitis: new insights into pathogenesis and mechanisms. Nature. 2016; 13:590-600.

Modified Bell staging

Modified Bell staging criteria for necrotizing enterocolitis (NEC) in neonates

Stage	Classification of NEC	Systemic signs	Abdominal signs	Radiographic signs
IA	Suspected	Temperature instability, apnea, bradycardia, lethargy	Gastric retention, abdominal distention, emesis, heme-positive stool	Normal or mild intestinal dilation, mild ileus
IB	Suspected	Same as above	Grossly bloody stool	Same as above
IIA	Definite, mildly ill	Same as above	Same as above, plus absent bowel sounds with or without abdominal tenderness	Intestinal dilation, ileus, pneumatosis intestinalis
IIB	Definite, moderately ill	Same as above, plus mild metabolic acidosis and thrombocytopenia	Same as above, plus absent bowel sounds, definite tenderness, with or without abdominal cellulitis or right lower quadrant mass	Same as IIA, plus ascites
IIIA	Advanced, severely ill, intact bowel	Same as IIB, plus hypotension, bradycardia, severe apnea, combined respiratory and metabolic acidosis, DIC, and neutropenia	Same as above, plus signs of peritonitis, marked tenderness, and abdominal distention	Same as IIA, plus ascites
IIIB	Advanced, severely ill, perforated bowel	Same as IIIA	Same as IIIA	Same as above, plus pneumoperitoneum

DIC: disseminated intravascular coagulation.

Adapted from: Neu J. Necrotizing enterocolitis: the search for a unifying pathogenic theory leading to prevention. Pediatr Clin North Am 1996; 43:409.

UpToDate®

NEC management

- Management depends upon the severity of illness
- Supportive care
  - Bowel rest with discontinuation of enteral intake
  - Gastric decompression with intermittent nasogastric suction,
  - Correction of metabolic, fluid/electrolyte,
- Broad spectrum antibiotics
- Surgical intervention
  - Intestinal perforation occurs
  - Unremitting clinical deterioration
- Prognosis: Survival rates at 70 to 80 %.

Lin PW, Stoll BJ. Necrotising enterocolitis. Lancet 2006; 368:1271.

2 week old "Has spit up after feedings."

- Child is a term infant.
- Diagnosis of ASD and hetrotaxy.
- Child is direct breast feed.
- History of poor feeding that was thought to be reflux.



Bilious?

Physical exam

- Vitals: T: 99.0 F, HR: 170, RR: 30, BP: 70/40
- Exam:
  - Gen: calm
  - CV: RRR without murmur
  - Lungs: b/l CTA
  - Abd: + distended, BS active, No HSM
  - Skin is without lesions.

Which of the following is the best exam to order in this patient?

a. Abdominal radiograph
b. Abdominal CT
c. Abdominal Ultrasound
d. Upper GI series

Volvulus & Malrotation

- Pathophysiology
- Clinical Presentation:
  - Vomiting
  - Abdominal distension
  - Abdominal tenderness
  - Hematochezia
- Imaging modalities:
  - Plain radiograph: midgut
  - Ultrasound
  - Upper GI series should be performed under fluoroscopy

Volvulus & Malrotation

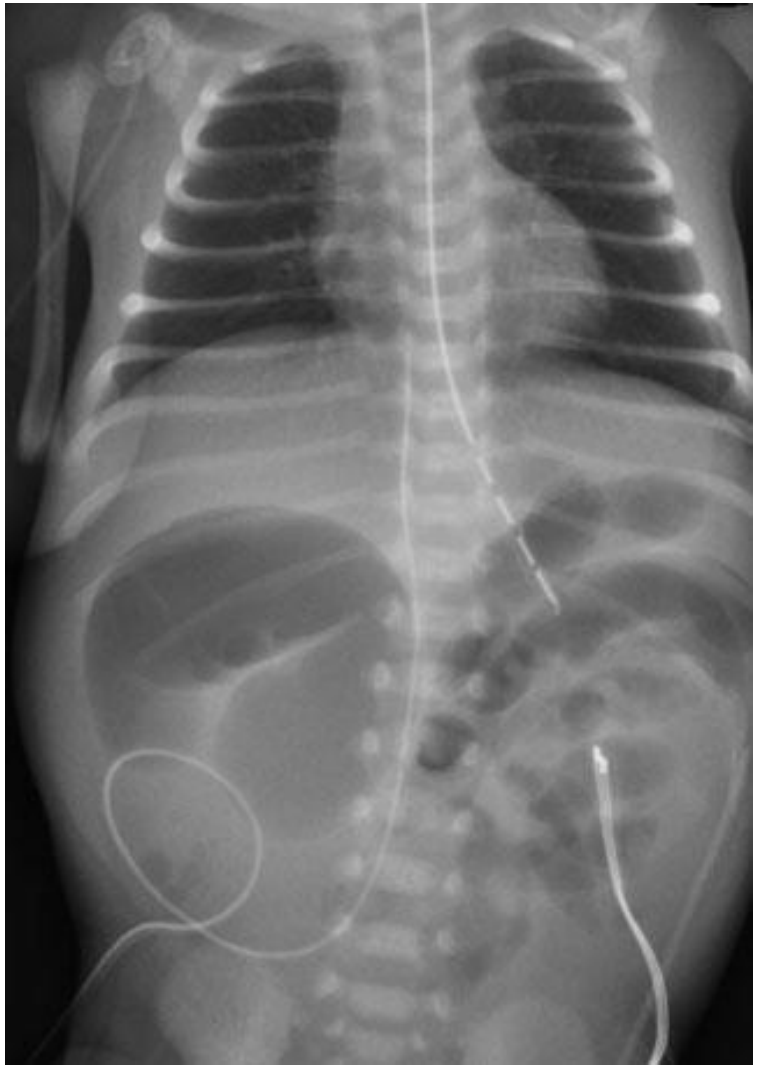
Management:

Immediate surgical intervention if decompensation.

UGI is the best study to order

Barium enema and ultrasonography can be useful adjuncts. DOES NOT exclude malrotation.

Ladd procedure : Surgical intervention



Aboagye J, Goldstein SD, Salazar JH, et al. Age at presentation of common pediatric surgical conditions: Reexamining dogma. J Pediatr Surg 2014; 49:995.

Dietary protein allergy

- Cow's milk allergy (CMA) : most common food allergy in young children.
- Non-immunoglobulin E (IgE)-mediated CMA tends to resolve by early childhood.
- Diagnosis
- Management

Luyt D, Ball H, Makwana N, et al. BSACI guideline for the diagnosis and management of cow's milk allergy. Clin Exp Allergy 2014; 44:642.

Causes of abdominal pain in the neonate.

	Serious	Less Serious
Common	NEC	Colic
Uncommon	Volvulus Testicular torsion	Dietary protein allergy



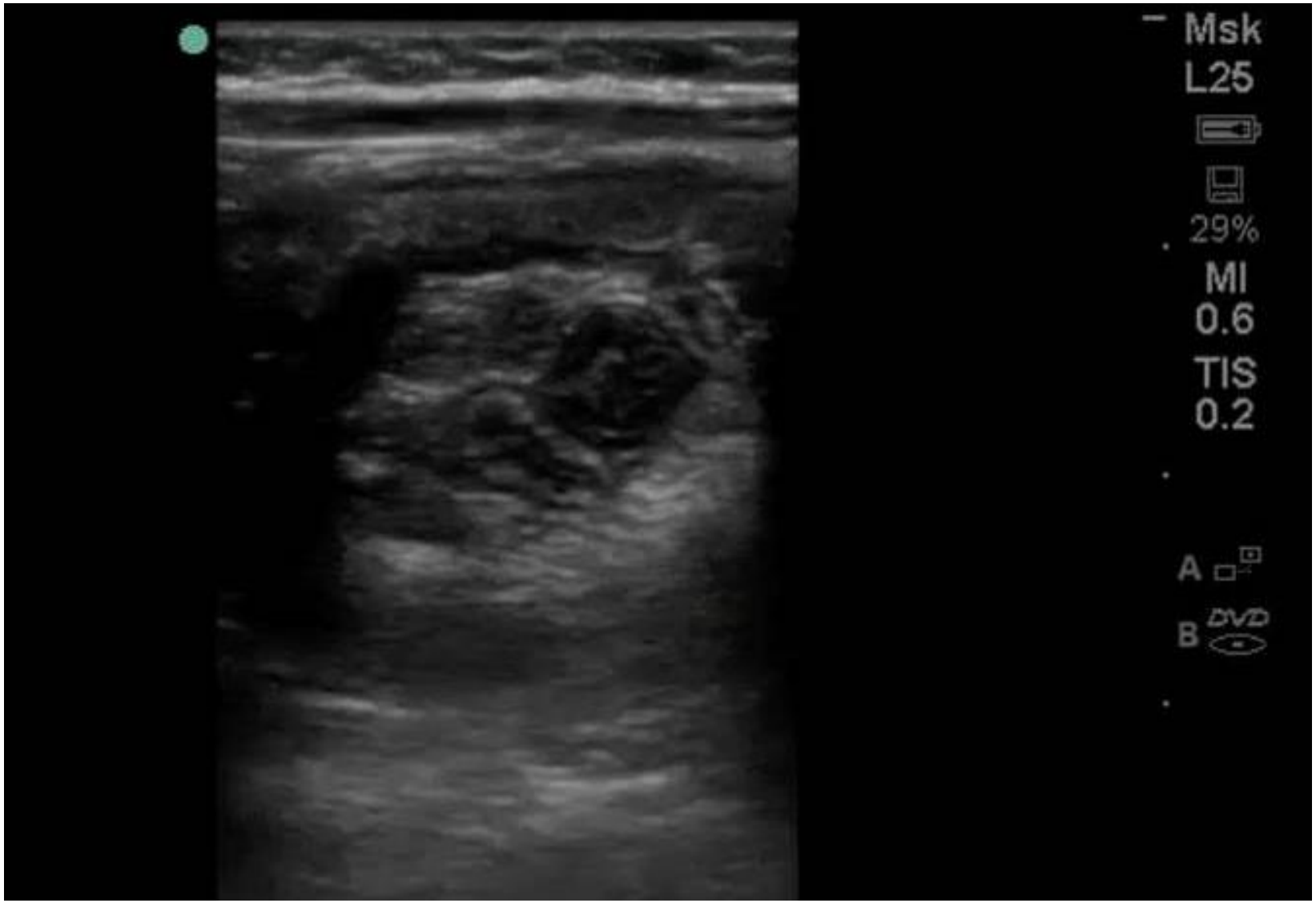
18 mo. "He has 3 days of vomiting and his belly hurts."

- Recent diagnosis of adenovirus a month ago.
- Non-bilious, non-bloody emesis
- Not responsive to laxatives and Zofran
- Episodes lasting of screaming and then seems fine.
- Denies diarrhea.

Physical exam

- Vitals: T: 99 F, HR: 120, RR: 30, BP: 90/50
- Exam:
  - Gen: asleep in mothers arms
  - CV: RRR without murmur
  - Lungs: b/l CTA
  - Abd: No hepatosplenomegaly appreciated. Bowel sounds diminished. Soft abdomen
  - Skin is without lesions.

Imaging



- https://litfl.com/ultrasound-case-064/

Which of the following is this patient's likely diagnosis?

a. Constipation
b. Gastroenteritis
c. Intussusception
d. Viral illness

Intussusception

- Ileocecal junction accounts for 90 percent < 2 yo.
- Often occurs at the ileocecal junction
- Presentation: typical vs. atypical presentation
- Classic triad found in approximately 15 percent of cases.
- Males > females 3:1
- Peaks in spring and autumn: correlated with adenovirus infections
- "Lead point" - Meckel diverticulum, intestinal polyps, lymphomas, cystic fibrosis

Imaging

Abdominal plain film

- Exclude perforation
- Sensitivity <48 % to diagnose intussusception.

Ultrasound:

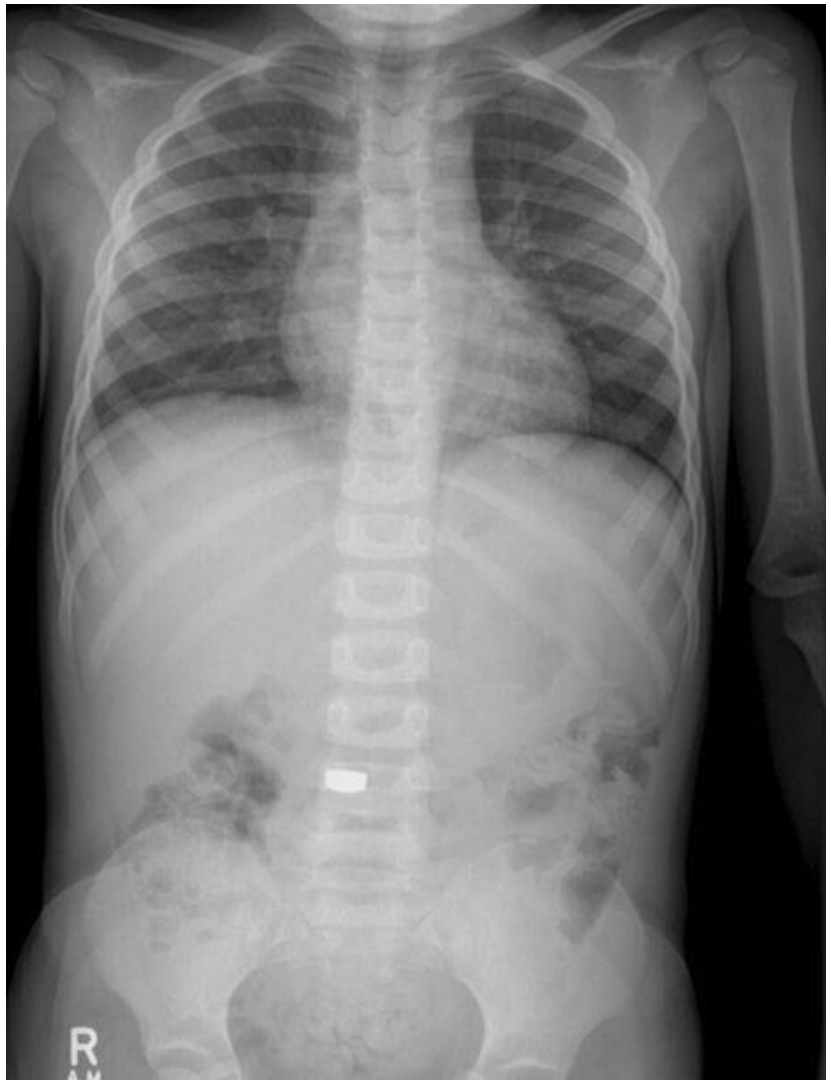
- Ultrasonography = gold standard
- Sensitivity and specificity is near 100%.
- Target sign/donut sign.

Management

- Hydrostatic enema:
  - Contrast (barium or water-soluble contrast with fluoroscopy
  - Saline (with ultrasound)
- Air-contrast enema: air or carbon dioxide
  - (with either fluoroscopy or ultrasound);
  - Higher risk for perforation than hydrostatic (1% risk)
  - Generally safer than perforation from contrast
- Consider involving surgical service early

KitagawS, Miqdady M. Intussusception in children. Uptodate.com. Accessed April 17, 2020.

14 mo.
"Sudden onset of chocking and gagging."



https://litfl.com/top-10-foreign-bodies/#jp-carousel-174423

Which of the following is an indication for referral in this patient?

a. When the patient shows signs of airway compromise
b. When there is evidence of near-complete esophageal obstruction
c. When the ingested object is sharp, long.
d. When the ingested object is a high-powered magnet or magnets.
e. When a disk battery is in the esophagus and/or stomach.
f. When there are signs or symptoms suggesting inflammation or intestinal obstruction

Foreign body ingestion management

- A battery lodged in the esophagus should be removed urgently.
- Suspected ingestion of a high-powered magnet(s) requires urgent evaluation.
- A sharp object in the esophagus or proximal gastrointestinal tract should be removed promptly.
- Patients with a food bolus impaction who are in acute distress or unable to swallow oral secretions require immediate attention.

Causes of acute abdominal pain in infants & toddlers.

	Serious	Less Serious
Common	FB ingestion	Constipation
		Gastroenteritis
		Viral Illness
		UTI
UNCommon	Adhesions	Hepatitis
	HUS	
	Hirshsprung disease	
	Intussusception	
	Sickle cell crisis	
	Incarcerated hernia	
	Tumor	



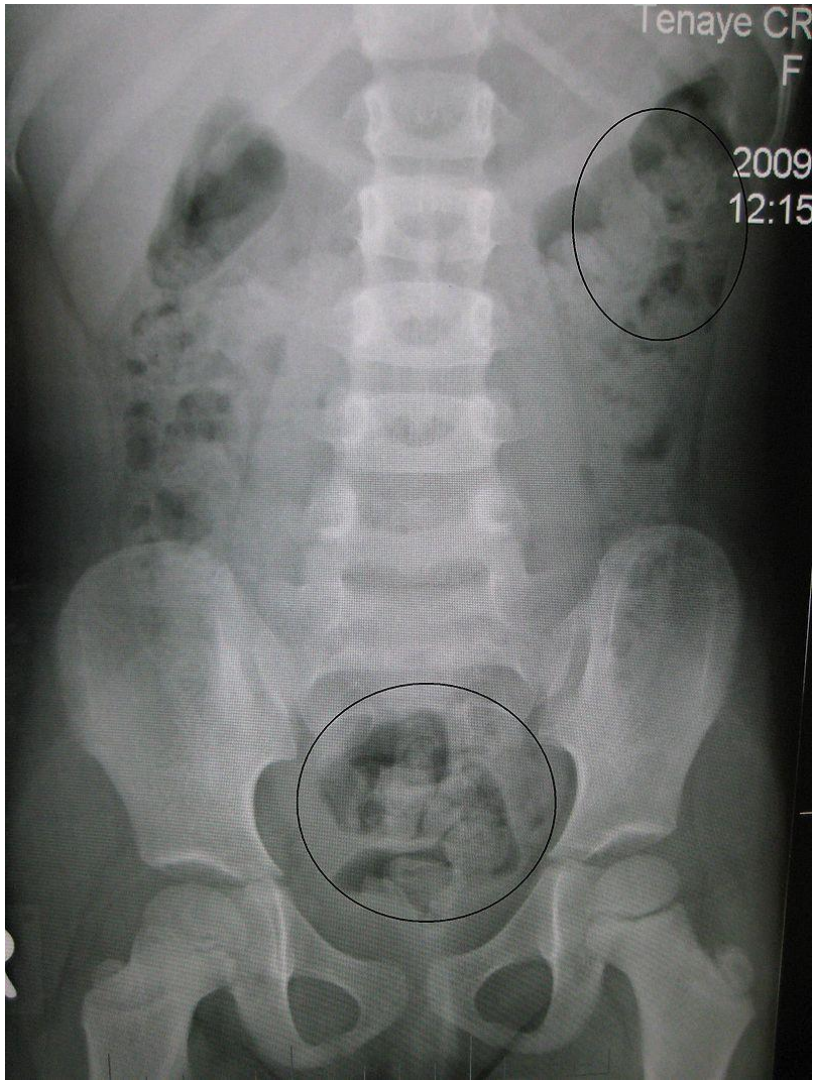
5 yo. "Intermittent abdominal pain for 2 weeks."

- Intermittent abdominal pain lasting various amounts of time.
- No vomiting, + occasional watery diarrhea
- Denies fever

Physical exam

- Vitals: T: 99.5 F, HR: 100, RR:27, BP: 90/50
- Exam:
  - Gen: Awake, active
  - HEENT: no erythema or exudate
  - CV: RRR without murmur
  - Lungs: b/l CTA
  - Abd: BS active,soft, No HSM, no masses palpated
  - Skin is without lesions.

Imaging



By James Heilman, MD - https://iasotea10.com/perdida-de-peso/iaso-tea/, CC BY 3.0, https://commons.wikimedia.org/w/index.php?curid=6876565

Which of the following is the likely diagnosis in this patient?

a. Adhesions
b. Constipation
c. Bowel obstruction
d. Pneumonia

Constipation

- Most frequently identified cause of acute abdominal pain.
- History
- Bristol stool chart
- Overflow
- Physical Exam:
- Abdominal exam
- Medical Management:

8 yo. "Abdominal pain x 2 days."

- Child with a 2 day history of anorexia, periumbilical pain, nausea and fever of 101.
- Physical Exam reveals an ill appearing child with an equivocal obturator/psoas sign who is febrile.
- You suspect appendicitis.

Which of the following would be the best first test in this patient?

a. Abdominal x ray
b. Abdominal Ultrasound
c. Abdominal CT scan
d. Abdominal MRI

Appendicitis

- Uncommon < 5 years old
- Symptoms: School age
  - Often have abdominal pain first; vomiting comes later
  - Typical migration of periumbilical pain to the right lower quadrant may not occur
- Symptoms: Adolescents: Adult like
  - Fever, anorexia, periumbilical abdominal pain that migrates to the right lower quadrant, and vomiting.
  - Involuntary guarding and rebound tenderness are present more often with perforation.
- Scoring systems: Scores vary in their performance

Pediatric Appendicitis Score

Low Risk PAS (<4) Low likelihood

The score has a higher negative predictive value (95%) in the absence of RLQ pain.

Equivocal PAS (4-6)

Surgical consults are warranted for patients with equivocal scores and imaging where the appendix cannot be visualized.

High Risk PAS (>6)

Surgical consult is warranted for these patients.

Imaging may still be pursued, but patients should only undergo ultrasound prior to a surgical consult.

Item	Score
Anorexia	1
Nausea or vomiting	1
Migration of pain	1
Fever > 100.5	1
Pain with cough or percussion	2
RLQ tenderness	2
WBC > 10,000 cells/mcl	1
Neutrophils > 75%	1
TOTAL	10

Accessed April 27, 2020:https://litfl.com/abdominal-pain-ddx/

Imaging

Ultrasound:

- Advantages: readily available, non invasive, highly specific
- US confirmed dx of appendicitis in 51% of patients
- Limited: obese and uncooperative children

CT scan

- Advantages: Most accurate study for diagnosis
- High radiation

MRI:

- May become the imaging modality of choice

A 6 yo male with 2 day history of bloody diarrhea

- Term birth
- Past medical history unremarkable.
- Denies fever, ill contacts, or recent exposure to children with diarrhea.
- Recently attended a birthday party consuming hamburgers and hotdogs.



Physical Exam

- Vitals: T: 100 F, P 150, R 28, BP 100/45, O2:100% on RA.
- Gen: Alert but fussy, pale, and non-toxic appearing.
- Eyes: conjunctiva are pale.
- HEENY: No nasal flaring or palatal petechiae. Pale tongue.
- CV: RRR + murmur
- Lungs: b/l CTA
- Abdomen: soft, NT liver edge palpable 3cm below the RCM.
- Skin: edema, rash, or petechiae

Labs

- CBC: WBC 16,000 with 56% segs, 12% bands, 27% lymphs, 3% eos, 2% basos,
- H/H:8 mg/dl/24.6, platelet count 75,000
- peripheral smear shows schistocytes, helmet cells, and polychromasia.
- BMP:Na 133, K 5.9, Cl 96, bicarbonate 16, BUN 45, creatinine 1.3, glucose 145 mg/dL, Ca 7.8, PO_4 7.1,
- Uric acid 7.3, and LDH 300.
- Coagulation studies are normal.

Which of the following is the most likely diagnosis in this patient?

a. Inflammatory bowel diseases
b. Appendicitis
c. Acute gastroenteritis
d. Hemolytic uremic syndrome

HUS

- Triad of HUS: microangiopathic hemolytic anemia, thrombocytopenia, and acute kidney injury.
- Pathogenesis
- Presentation
- Management - supportive
  - Red blood cell transfusions for anemia when the hemoglobin level reaches 6 to 7 g/dL or hematocrit <18 percent.
  - Platelet transfusion for patients who have significant clinical bleeding or if an invasive procedure is required.
  - Appropriate fluid and electrolyte management to maintain adequate intravascular volume and correct/avoid electrolyte abnormalities.
  - Stopping nephrotoxic drugs or those that are implicated in the etiology of HUS.
  - Initiation of dialysis therapy in patients with symptomatic uremia, azotemia

Accessed >https://www.uptodate.com/contents/overview-of-hemolytic-uremic-syndrome-in-children

Causes of Abdominal Pain in 6-11 yo children

	Serious	Less Serious
Common	Adhesions	Constipation
	Appendicitis	Viral illness
	DKA	Gastroenteritis
	IBD	Pharyngitis
	Trauma	UTI
		Pneumonia
Uncommon	HUS	Abdominal migraine
	Perforated Ulcer	Cholecystitis
	Peritonitis	HSP
	Intrabdominal absces	Hepatitis
	Myocarditis	
	Pancreatitis	
	Testicular torsion	
	Sickle cell crisis	
	Tumor	



17 yo. M with abdominal pain and syncope

- Playing soccer this afternoon when was elbowed in the stomach at a soccer game. Had a syncope episode on sidelines while stretching without LOC.
- ROS: Sore throat, cough and fatigue x 1 week.
- Physical Exam:
- T 98.3 °F | HR 90 | BP 129/60 | RR 16 | SpO2 100%
- Pale but comfortable and alert. CV: RRR without m/g/r Lungs: CTA
- Abdomen diffusely tender, guarding in the upper quadrants.



Which of the following is the most likely diagnosis in this patient?

a. Acute appendicitis
b. Intestinal perforation
c. Liver laceration
d. Splenic laceration

Management

- Splenic conservation through non-operative management is preferred in hemodynamically stable children and adolescents.
- >90%: no surgical intervention necessary
- <5%: need transfusion
- 1%: splenectomy
- Initial non-op management does not increase need for transfusion, length of stay or rates of splenectomy.

Causes of Abdominal Pain in Adolescents

	Serious	Less Serious
Common	Adhesions	Constipation
	Appendicitis	Viral illness
	DKA	Gastroenteritis
	IBD	Pharyngitis
	HUS	UTI
	PID	Dysmenorrhea
	Trauma	Pneumonia
Uncommon	Perforated Ulcer	Abdominal migraine
	Pertonitis	Cholecystitis
	Intraabdominal abscess	HSP
	Myocarditis	Hepatitis
	Pancreatitis	Urolitiasis
	Sickle cell disease	
	Ectopic pregnancy	
	Tumor	

Summary

Acute abdominal pain is a common occurrence. Most episodes are not emergencies.

Acute appendicitis remains the most common surgical emergency in pediatrics.

Constipation is the most frequent identified cause of acute abdominal pain in children 29%


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An 2 year old with a 1 day history of refusing to bear weight to the left leg.

- Moderate improvement after Motrin.
- Mom denies any trauma or fall.
- Afebrile, but has had a mild coryzal illness early in the week.

Physical Examination:

- T 36.9 C, pulse 120, BP 100/60, RR 22, SpO2 100%.
- No specific tenderness, swelling or redness noted
- Alert, active, lying on the bed, with his hip flexed, abducted, and in external rotation.
- No overlying erythema of the hip, knee, or ankle.
- The left hip has mild restriction in abduction in comparison the right hip
- Patient is able to bear weight but has an antalgic gait.

Which labs and imaging would you order?

a. CBC
b. ESR/CRP
c. X ray: A/P, lateral and frogleg
d. Ultraound
e. MRI
f. All the above
g. None of the above

Which is the most likely cause of his symptoms?

a. Toddler's fracture
b. Septic arthritis
c. Transient synovitis
d. Osteomyelitis
e. Limb length discrepancy

Cause of a limp in a child

S: Septic arthritis (hip>knee)

T: Toddler's fracture

O: Osteomyelitis (2% of those children presenting with limp)

P: Perthes disease

L: Limb length discrepancy

I: Inflammatory

M: Malignancy

P: Pyomyositis

I: Iliopsoas abscess

N: Neurologic

G: Gastrointestinal /Genitourinary

Accessed on April 21, 2020: https://pemplaybook.org/

Labs and Imaging

- **American College of Radiology Appropriateness Criteria**
- Traumatic – XR
- Atraumatic, no signs of infection – XR, if negative then US hip
- Atraumatic, signs of infection – US hip, if negative consider XR, if negative and still concerned for septic arthritis consider MRI
- Labs : CBC, ESR, CRP

Accessed April 27, 2020.American College of Radiology. ACR appropriateness criteria. Acutely limping child up to age 5. Revised 2018. https://acsearch.acr.org/docs/69361/Narrative).

Kocher's criteria

- Erythrocyte sedimentation rate >40
- WBC >12
- Non-weight bearing on the affected joint
- Fever >38.5 C

- 0/4 = 0%
- 1/4 = 3%
- 2/4 = 40%
- 3/4 = 93%
- 4/4 = >99%

Kocher, MS Differentiating between septic arthtisi ans transient synovitisis of the hip J Bone Joint Surg AM, 1999 Dec (12) 1662-1670.

Take Home Points

Child with a fever who presents with refusal to walk has septic arthritis or osteomyelitis until proven otherwise.

Transient synovitis is a diagnosis of exclusion!

2 or more Kocher criteria should prompt orthopedic consultation for consideration of joint aspiration.

Review

NEC

Volvulus

Intussusception

Splenic rupture

Constipation

Appendicitis

HUS

Transient Synovitis