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Acute Abdominal Pain

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Objectives After completing this article, readers should be able to:

1. Understand the principal causes of acute abdominal pain in children.
2. Describe the characteristics of visceral versus somatic abdominal pain.
3. Be familiar with the differential diagnosis of abdominal pain based on symptoms and location of pain.
4. Discuss the evaluation of acute abdominal pain.
5. Distinguish surgical from medical abdominal pain.

The Problem

“Hello, Doctor Jones, Billy has an awful tummy ache!” For such a simple statement, so many possible outcomes exist. Is this an emergency? Does he have appendicitis? Does he need a surgeon? Is this something trivial? Has Billy eaten something harmful? Is he constipated? Acute abdominal pain can be caused by myriad conditions whose outcomes vary from rapid improvement to surgery, posing a diagnostic Gordian Knot. However, through evaluation of the patient’s history and symptoms and the use of technology, a pediatrician usually can arrive at a reasonable conclusion about the care of the patient, even if the diagnosis still is undetermined.

Acute abdominal pain can be classified according to its location and nature, history, or associated signs (Table 1).

Location and Nature

Some conditions can cause pain in different regions, and it may be difficult to associate the disease with the location of the pain. Localization of the source of abdominal pain is confounded by the nature of the pain receptors involved. Further, the type of pain associated with a particular disease may change as the disease process progresses, as in appendicitis. Abdominal pain may be classified as visceral, somatoparietal, and referred pain. Most abdominal pain is associated with visceral pain receptors.

Visceral pain receptors are located in the muscles and mucosa of hollow organs, in the mesentery, and on serosal surfaces. These pain receptors typically respond to stretch, such as when the bowel is distended or mesentery is stretched or torsed. Visceral pain response is not well localized because the afferent nerves associated with this pain have fewer nerve endings in the gut, are not myelinated, are bilateral, and enter the spinal cord at several levels. However, there are three broad areas of association. Visceral pain in the stomach, lower esophagus, and duodenum is perceived in the epigastric area. Pain emanating from the small intestine is felt in the umbilical area. Colonic visceral pain is felt in the lower abdomen. The pain can be described as dull, diffuse, cramping, or burning and may prompt the child to move in an attempt to decrease the pain. Because autonomic nerves may be involved secondarily in the same pathologic process, patients also may exhibit sweating, nausea, vomiting, pallor, and anxiety.

Somatoparietal pain receptors are located principally in the parietal peritoneum, muscle, and skin. These pain receptors typically respond to stretching, tearing, or inflammation. The nerves that convey somatoparietal pain travel within specific spinal nerves that are myelinated and numerous and that transmit to specific dorsal root ganglia. The pain is more localized, associated with one side or the other, more intense, and more often is

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Table 1. Differential Diagnosis Mapped to Location of Abdominal Pain

Epigastric	Right Upper Quadrant	Left Upper Quadrant
Gastroesophageal reflux	Hepatitis	Splenomegaly
Esophagitis	Cholecystitis	Splenic infarction
Gastritis	Cholelithiasis	Traumatic spleen injury
Gastric ulcer	Biliary colic	Lower left lobe pneumonia
Duodenal ulcer	Cholangitis	Kidney disease
Pancreatitis	Right lower lobe pneumonia	Urinary tract disease
Gastric volvulus	Kidney disease	
Small bowel volvulus	Urinary tract disease	
Erythromycin induced		
Non-steroidal inflammatory medication-induced		
Hypogastric	Left Lower Quadrant	Right Lower Quadrant
Constipation	Constipation	Constipation
Colon spasm	Colon spasm	Mesenteric adenitis
Colitis	Colitis	Crohn disease
Bladder disease	Ovarian torsion	Acute obstruction
Uterine conditions	Ectopic pregnancy	Localized perforation
Pelvic inflammatory disease	Testicular torsion	Appendicitis
	Hernia	Intussusception
	Sigmoid volvulus	Ovarian torsion
		Ectopic pregnancy
		Testicular torsion
		Hernia
Periumbilical	"All Over"	"All Over"
Functional disease	Gastroenteritis	Porphyria
Constipation	Perforation	Sickle cell crisis
Gastroenteritis	Constipation	Volvulus
Early appendicitis	Functional disease	Abdominal migraine
Pancreatitis	Colic	Cyclic vomiting syndrome
Small bowel volvulus	Streptococcal pharyngitis	Lead poisoning
Henoch-Schönlein purpura	Intussusception	Iron ingestion
Incarcerated umbilical hernia	Inflammatory bowel disease	Familial Mediterranean fever
	Henoch-Schönlein purpura	Angioneurotic edema
	Diabetic ketoacidosis	Venomous bite
		Location Varies
		Trauma
		Infarction
		Gluten-sensitive enteropathy

described as having a sharp quality. Movement usually intensifies parietal pain so the child will stay still or splint when walking.

Referred pain arises when visceral pain fibers affect somatic nerve fibers in the spinal cord or central nervous system. This pain generally is well localized but distant from the affected site. For example, any inflammatory process that affects the diaphragm can be perceived as pain in the shoulder or lower neck because of convergence of the nerve pathways of these two regions.

History and Symptoms

Often, the most important component needed for diagnosis is a history. The order of onset of symptoms, their progress, characteristics of emesis (Table 2) and stools (Table 3), and application of knowledge of the nature of pain are important. For example, the pain of appendicitis may have started a day or two before presentation, gradually increasing in severity and changing location. That pain generally begins as poorly localized and vague (ie, visceral receptors are affected), but as the inflammation

Table 2. Differential Diagnosis Based on the Color of the Vomitus

Emesis	Suggested Diagnosis
Bile-colored	Obstruction Midgut volvulus
Coffee ground-colored	Esophagitis Gastritis Gastric ulcer Trauma from forceful vomiting
Bright red blood, small volume	Esophagitis Gastritis
Bright red blood, large volume	Esophageal tear (Mallory Weiss tear) Gastric ulcer Duodenal ulcer Esophageal varices
Food or gastric contents	Infectious gastroenteritis Obstruction
Fecal appearance	Obstruction

continues and the appendix swells, pain fibers in the parietal peritoneum are stretched, and the pain becomes more localized toward the right lower quadrant. The classic pattern in intussusception is intermittent crampy pain.

Besides location, associated signs and symptoms can help determine the cause of the pain. The color of emesis can be a useful clue, as can the appearance of the stool.

Table 3. Appearance of Stool

Stool	Suggested Diagnosis
Watery diarrhea	Infection Bacterial Viral Parasitic Appendicitis with perirectal abscess
Hard or large stool	Constipation
Decrease in stool frequency	Constipation Obstruction
Mucus-containing	Colitis (can be normal)
Bright red blood, small volume	Constipation Fissure Hemorrhoid, suggesting constipation Colitis Henoch-Schönlein purpura Polyp
Bright red blood, large volume	Colitis Polyp
"Currant jelly stool"	Intussusception
Melena	Gastric ulcer Duodenal ulcer
Pale, acholic stools	Biliary or hepatic disease

Laboratory Diagnosis

In perplexing cases, laboratory studies frequently are requested and, with notable exceptions, are remarkably unhelpful. Studies generally include a complete blood count, erythrocyte sedimentation rate, and urinalysis. Adolescent females should have a pregnancy test (regardless of whether they have experienced menarche).

The white blood cell count can be misleading and only can confirm the examiner's suspicions; it cannot be relied on to exclude serious illness. The sedimentation rate, when elevated, can indicate the presence of an inflammatory process. However, like the white blood cell count, it cannot be diagnostic.

The urinalysis is relatively easy to obtain and can reveal the presence of a urinary tract infection, diabetes, nephritis, and sometimes, chronic kidney disease.

Other specific laboratory studies may be appropriate based on the conditions being considered, but generally they are not helpful in the immediate acute setting.

General Symptoms and Assessment of Severity

Acute abdominal pain can be caused by an easily remediable problem or by a serious condition that requires surgery. Confounding the presentation is the variety of patient responses to pain, from the stoic to the hysterical. Some of the loudest patients have functional pain. Unfortunately, no signs of illness are absolute, but certain warning signs can suggest more serious illness.

First, does the patient look ill? If the child is bouncing around the room, it is easier to provide reassurance and avoid excessive testing. When the patient appears ill, it is important to distinguish whether the child is improving or worsening. Observing the patient in the office or emergency department for several hours allows serial examinations. A rapid revisit or even admission may be prudent until serious disease is excluded. History of abdominal trauma, pain worsening with movement, involuntary guarding, rebound tenderness, and tenderness with percussion are indications for prompt surgical evaluation. Are there signs of bleeding or significant volume loss or dehydration? These clues may not lead to surgery but need to be addressed to restore well-being. When in doubt, the pediatrician should detain the patient, perform serial examinations, and ask the surgeon for help.

Gastroenteritis

Probably the most common cause of acute abdominal pain is infectious gastroenteritis. Obtaining a history of recent travel, ill contacts, and diet (food-borne pathogens) is important. Viruses are the more common cul-

prits, but bacteria and parasites also can produce acute illness. Clinical findings vary, based on the infectious organism, but many of these agents cause fever, vomiting, and diarrhea along with pain. The pain usually is nonspecific in location, and the child also can have diffuse tenderness, although “guarding” is unlikely. If bloody diarrhea is present, stool cultures and stool examination for parasites should be requested. Antibiotics can worsen serious illness such as hemolytic-uremic syndrome and should not be used without clear indication. An acute presentation with blood in the stool is more likely a sign of infectious colitis but may be the initial presentation of inflammatory bowel disease. Positive bacterial cultures must be reported to appropriate authorities.

Most causes of acute abdominal pain that require surgery do not present in this manner. Generally, fever, vomiting, and diarrhea indicate acute-onset infection rather than surgical disease. In some cases, particularly when the child looks ill, making the distinction can be difficult.

Rehydration is beneficial. Oral rehydration is preferred, but intravenous fluids may be used until oral therapy can be started. Rehydration during acute gastroenteritis usually makes the child feel much better. Improving appearance with rehydration is reassuring.

Acute Appendicitis

Inflammation of the appendix results in distention leading to ischemia. Necrosis, perforation, and peritonitis or abscess may ensue. It is not known why the appendix becomes inflamed, but a fecalith or lymphoid tissue

obstructing the lumen may be the precipitating cause. Acute appendicitis is the most common reason for emergent abdominal surgery in children.

Unfortunately, it still is difficult to be certain of a diagnosis of acute appendicitis. Timely diagnosis is critical, but it can be extremely challenging, especially in young children. As the inflammation starts, the visceral nerves send a message of general unease, which may manifest as pain referred to the umbilical region, then anorexia, typically followed by nausea. A young child has a hard time explaining this feeling and may show only anorexia and decreased activity.

Vomiting, fever, guarding, and abdominal pain with any movement (especially walking) are important signs when present. Requesting the patient to hop off of the examination table or hop up and down usually is refused or elicits a dramatic increase in abdominal pain.

As inflammation increases and the parietal peritoneum becomes irritated, the somatic nerves begin to signal that something is wrong. This pain usually is appreciated in the area two thirds of the distance from the umbilicus to the anterior superior iliac spine (McBurney point). Pain and tenderness in this location are sensitive signs for appendicitis but, unfortunately, are not specific for appendicitis (Table 4).

If the appendix ruptures, a child can show clinical improvement as the pressure in the organ is released, thus decreasing pain. Over the next day, the child may worsen due to peritonitis; sometimes, a localized abscess forms instead. With abscess formation, the right lower quad-

Table 4. Signs of Appendicitis

Tenderness at McBurney point	Percussion or palpation in the right lower quadrant results in pain in an area approximately two thirds of the distance from the umbilicus to the anterior superior iliac spine
Involuntary guarding	Abdominal wall muscle spasm to protect inflamed abdominal organs from motion
Pain on movement	Significant increase in pain with walking, hopping off of the table, or jumping up and down
Rovsing sign	Pressure in the left lower quadrant results in pain in the right lower quadrant
Rebound tenderness	Sudden release of deep palpation of the abdomen results in a large increase in pain. (Save this test for the end of the examination to stay in the child's good graces.)
Psoas sign	With the patient on his or her left side, extend the right thigh while applying stabilizing resistance to the right hip. This maneuver should cause an increase in pain due to the location of the appendix over the iliopsoas muscle.
Obturator sign	Increased pain with passive flexion and internal rotation of the right thigh
Anorexia	
Nausea	
Vomiting	
Fever	
Bent knees	The child is most comfortable while lying with knees bent

rant pain can continue, and a tender mass becomes palpable.

Many maneuvers can elicit pain associated with appendicitis, and the clinician should be familiar with at least some of them (Table 4).

Diagnostic laboratory tests for appendicitis include the white blood cell count, which typically is mildly elevated and may have a shift toward neutrophils but is not a reliable diagnostic test. Radiologic studies have become more helpful in determining the presence of appendicitis and can help define an abscess and demonstrate other causes of pain such as a renal stone, Crohn disease, or gynecologic problems. Right lower quadrant ultrasonography often can show enlargement of the appendix as well as changes in the wall, presence of increased fluid around the appendix, or an abscess if the appendix has ruptured. Because ultrasonography does not expose a child to radiation or contrast, it is preferred to computed tomography (CT) scan, although CT scan may be necessary when the physical findings are uncertain and an experienced ultrasonographer is not available.

Because there is no perfect test for appendicitis other than the pathology report, the best diagnostic instrument is the examiner. Appendectomy is the appropriate treatment.

Small Bowel Volvulus

Volvulus is a surgical emergency; delay in surgical intervention can cause short gut or death. Incomplete rotation of the embryonic bowel results in the vascular supply of the small intestine flowing through a narrow pedicle of mesentery, which can twist about its base, cutting off blood flow. Dull, aching abdominal pain may be the first symptom, but more dramatic pain also may be the presentation. Obstructive symptoms are followed by an acutely inflamed abdomen.

Volvulus typically presents early, before 1 year of age, but it can occur at any age. The obstruction results in bile-stained emesis and pain, although the pain can be hard to detect in infants. Bile-stained emesis signals a surgical emergency. Rectal bleeding is a late sign indicating vascular compromise to the mucosa.

A plain radiograph may show a dilated stomach and proximal duodenum, but the primary test for a volvulus is a contrast upper gastrointestinal study. Recently, Doppler ultrasonography has been used to detect volvulus and malrotation.

The bowel must be untwisted before vascular necrosis occurs. An appendectomy typically is performed because the appendix would be left in an abnormal loca-

tion, which would make diagnosing appendicitis more difficult.

Intussusception

Probably the most frequent cause of intestinal obstruction in children is an intussusception. This condition occurs when part of the intestine is pulled antegrade into the adjacent part of intestine, trapping the more proximal bowel in the distal segment. The most common site is the junction of the ileum and colon, where the ileum is pulled into the colon. In some cases, a lead point such as a polyp, tumor, or Meckel diverticulum is pulled downstream. The cause in infants typically is unknown. Some have suggested hypertrophy of mesenteric lymph nodes caused by a viral infection.

Like a volvulus, intussusception occurs more commonly in infants than in older children. The signs and symptoms include abdominal pain, lethargy, vomiting, pallor, and if the obstruction is prolonged, abdominal distention and rectal bleeding. The bloody bowel movement in this illness often is described as looking like red currant jelly. Such a stool, however, is not seen commonly, but when seen, it suggests vascular compromise.

The child may show signs of crampy pain when peristalsis occurs and causes additional stretching and squeezing of the trapped intestine. The child may lie quietly between the peristaltic waves.

Older children often localize the pain to the periumbilical region, but it can be in the right lower quadrant. Appendicitis may be suspected, but the pain often is intermittent in intussusception rather than continuous.

In the most common form of intussusception, ileocolic, a sausage-shaped mass may be palpable on the right side or in the right upper quadrant of the abdomen. Abdominal radiographs may show obstruction, and a mass also may be visible. Ultrasonography demonstrates bowel within bowel or a “target.” Ultrasonography is very accurate in detecting intussusceptions and is considered the test of choice.

Treatment (and confirmation of the intussusception) is with an air contrast enema. Air is safer and cleaner than liquid and is more effective. If the enema fails, surgery must be performed to reduce the intussusception.

Henoch-Schönlein Purpura

Because the rash of Henoch-Schönlein purpura (HSP) may present after the onset of abdominal pain, severe acute pain can be the initial sign of the condition. HSP is a vasculitis that can be triggered by infection, medications, or even insect bites. The rash begins on the buttocks or extensor surfaces of the legs and may spread

peripherally. It can start as urticaria but progresses to “palpable purpura.”

The intestine also shows purpuric lesions, and the edema and inflammation result in colicky pain. Children also may vomit with HSP, and the abdomen can be tender to palpation. The lesions can lead to gastrointestinal bleeding or complications of intussusception or perforation. HSP usually affects children younger than 10 years of age, but it is rare in infants. HSP recurs in about one third of cases.

Arthralgias or arthritis are seen in most cases, with the lower extremity large joints affected most often. HSP also can lead to nephropathy in up to 50% of the children. The renal involvement usually is mild and may present weeks after the abdominal pain.

If the typical rash is seen, no testing is indicated. Ultrasonography or contrast radiographs of the intestines show the edematous lesions in the gut. Endoscopy demonstrates purpuric lesions. The white blood cell count can be increased, and markers of inflammation such as the sedimentation rate usually are elevated. Occasionally, there are no other signs of HSP apart from the abdominal pain, and the diagnosis may be made after observing purpuric lesions of the gastrointestinal tract on endoscopy.

Treatment is supportive. In the case of severe joint or abdominal pain, prednisone can be used to decrease symptoms.

Pancreatitis

Upper abdominal pain and tenderness, especially when associated with vomiting, are typical features of pancreatitis as well as many other diseases. To determine if pancreatitis is present, serum amylase or lipase must be measured. If concentrations of these enzymes are greater than three times the upper limit of normal, pancreatitis most likely is the cause of the symptoms. Normal values do not exclude the diagnosis.

Pancreatitis arises from many different infections, medications, or trauma. Other causes include gallstones, abnormal ductular anatomy, systemic illness, and metabolic problems. The cause in any specific patient can be hard to determine, and finding the cause can be expensive. Therefore, in an isolated case, an exhaustive search is not necessary. Most children who experience acute pancreatitis do not suffer additional episodes.

CT scan or ultrasonography can help diagnose pancreatitis as well as look for anatomic causes or gallstones. In recurrent episodes of acute pancreatitis, pancreatic-sufficient cystic fibrosis should be excluded, along with genetic forms of pancreatitis. Magnetic resonance chol-

angiopancreatography or endoscopic retrograde cholangiopancreatography should be considered.

Treatment is supportive. The patient may eat if food does not cause pain. Narcotics should be used for severe pain. Intravenous fluids and intravenous acid suppression are used. If vomiting continues with gut “rest,” a nasogastric tube can be used to decompress the stomach. In severe cases, patients require intensive care due to the fluid shifts and hypotension accompanying necrotic pancreatitis.

Ulcer Disease

Epigastric or right upper quadrant pain can signify a peptic ulcer. These lesions usually occur in the distal stomach or proximal duodenum. In severe cases, bleeding or perforation can occur. Ulcer symptoms are common because many children have nonulcer dyspepsia, in which there is pain similar to that caused by an ulcer, but no ulcer is present.

Nonsteroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen are an important cause of ulcers and dyspepsia in children. Some ulcers are caused by infection with *Helicobacter pylori*. *H pylori* ulcers are less common in children than in adults, and more ulcers fall into the idiopathic category. Eosinophilic gastroenteritis, Crohn disease, and any severe illness can be associated with ulcer disease as well.

Ulcers are diagnosed with upper gastrointestinal endoscopy. Biopsies should be taken to look for *H pylori* as well as other causes of ulcers.

Treatment is with acid suppression, typically with proton pump inhibitors (PPIs). Histamine-2 receptor antagonists (H_2 RAs) also are used but are not as effective as PPIs at suppressing acid production. Antacid preparations can help with symptoms and provide additional buffering. If *H pylori* is found, antibiotics also are necessary.

Bleeding ulcers can be treated endoscopically with cautery, injection, and mechanical methods. Surgery is used when endoscopic therapy and medications fail or when there is a perforation.

Gastritis

Gastritis can feel the same as an ulcer, and diagnosis is made by endoscopy. Gastritis has many different causes, with acute infectious gastritis and NSAID therapy being two of the more frequent. Treatment is to remove any precipitating agent, provide acid suppression, and give supportive care.

NSAID-induced Dyspepsia

Patients who must be treated with NSAIDs are at risk of developing NSAID-related gastrointestinal dyspepsia, which may be a manifestation of gastritis or gastric ulcer. The risk of NSAID-related complications is increased by a history of ulcer disease or bleeding or by use of corticosteroids. In patients receiving NSAIDs, complications can be lessened by providing adequate acid suppression. Standard doses of H₂RAs do not prevent most NSAID-related gastric ulcers. Doubling the dose may be effective, but single daily doses of a PPI are superior to H₂RAs and other treatments (including misoprostol) in reducing ulcers and NSAID-associated dyspepsia.

Esophagitis

Gastroesophageal reflux disease (GERD) and esophagitis can present acutely as epigastric abdominal pain. GERD is present when gastric contents move into the esophagus and produce symptoms or damage. Esophagitis can result from GERD or from other inflammation such as eosinophilic esophagitis or from infections such as herpes or *Candida*.

Treatment is with antacids and acid suppression for the pain and ongoing therapy for reflux. If the child does not improve, endoscopy to look for inflammation, infection, or possibly even a foreign body should be performed.

Hepatitis

Inflammation of the liver can cause right upper quadrant pain. Anorexia, nausea, and vomiting also are common in hepatitis. The liver can be inflamed due to infection, reactions to medications or chemicals, or autoimmune hepatitis. Clues to hepatitis being the source of the acute pain include jaundice, hepatomegaly, and liver tenderness.

Liver enzyme concentrations are elevated in acute hepatitis. The child also should have direct hyperbilirubinemia. Urinalysis can be a screening test for liver disease by detecting bilirubin and urobilinogen.

Acute infectious hepatitis is treated with supportive care and is prevented best by immunization for hepatitis A and B and avoiding behaviors that can lead to hepatitis C or E infection.

Biliary Tract Disease

Cholelithiasis and Cholecystitis

Right upper quadrant abdominal pain can result from gallstones and cholecystitis. Pain, fever, vomiting, and jaundice often are present. The pain occasionally radiates

to the back. A positive Murphy sign is strongly suggestive of gall bladder disease. The examiner palpates the right upper quadrant at the costal margin while the patient breathes in. The sign is considered to be positive if the patient feels pain. Gallstones are seen more frequently with hemolytic disorders, such as sickle cell disease, and in infants and children who have received peripheral alimentation. Acalculous cholecystitis typically occurs during a significant systemic illness such as sepsis or an illness requiring a stay in the intensive care unit.

Ultrasonography can show the presence of stones and a thickened gall bladder wall with possible gall bladder dilatation. The ultrasonographer can produce a positive Murphy sign with the transducer, which helps to diagnose cholecystitis.

Laboratory tests should show an elevation in liver enzymes, especially gamma-glutamyltranspeptidase (GGTP) and alkaline phosphatase. The white blood cell count is elevated, and direct bilirubin is increased. The amylase value can be elevated, making it harder to know if the problem is cholecystitis or pancreatitis.

Treatment consists of bowel rest, intravenous pain control, and intravenous fluids. If fever is present or the child looks ill or unstable, antibiotics are needed for enteric bacteria. The timing of curative cholecystectomy is determined best with the surgeon. Complications of cholecystitis include perforation of the gall bladder, with peritonitis or abscess formation.

Acute hydrops of the gall bladder can look like acalculous cholecystitis, but the gall bladder wall is not inflamed. The symptoms usually are the same, but ultrasonography shows an enlarged gall bladder without wall thickening. Treatment is supportive rather than surgical, but perforation can result, which requires surgery.

Stones in the Bile Duct

Choledocholithiasis, or bile duct stones, can present much like cholecystitis, but jaundice is more likely to be present. Right upper quadrant pain, fever, and tenderness are consistent with impacted stones.

GGTP, alkaline phosphatase, and conjugated bilirubin concentrations are elevated, as might be aminotransferase values. Because duct obstruction can cause pancreatitis, amylase and lipase values should be assessed.

Ultrasonography usually demonstrates the stone, but sometimes stones can be hard to see. A dilated duct also may be present.

If fever is present, antibiotics should be started. The child is given nothing by mouth but should receive intravenous fluids and narcotic analgesics.

The gastroenterologist and surgeon should be consulted if the stone does not pass spontaneously because either surgery or an endoscopic retrograde cholangiopancreatography with stone removal may be necessary.

Constipation

One of the more common treatable causes of acute abdominal pain is constipation, which can cause severe pain in some children and raise concerns about more serious illness. Constipation can follow a social change such as toilet training, starting school, changing the diet, or taking a trip. The child frequently does not know that his or her pattern of stooling has become abnormal, and the parent is not aware of a change. Nausea can accompany constipation, but other symptoms are rare.

Examination may show distention, a mass in the left lower quadrant or low mid-abdomen, and mild tenderness when the mass is palpated. The rectal examination usually demonstrates a full rectal vault in contrast to Hirschsprung disease, in which the rectum contains little stool. Guarding is not typical. An abdominal radiograph should show a full rectal vault and fecal loading, but signs of obstruction are absent.

Treatment varies, depending on the age of the child and the degree of constipation.

Incarcerated Inguinal Hernia

Signs of intestinal obstruction with abdominal pain accompany an incarcerated inguinal hernia. Examination should reveal a groin mass that may be tender and sometimes can be red due to the underlying inflammation. An abdominal radiograph may show obstruction or an air bubble in the groin.

The best therapy is early repair. Therefore, health supervision examinations should include an evaluation for hernias. Emergent surgery is required to treat an incarcerated hernia.

Urinary Tract Disease

Urinary tract infections and renal stones can present as abdominal pain. Vomiting may be present and mask the diagnosis, especially in small children. A urinalysis is necessary, and if results are suggestive of infection, urine can be sent for a culture. Acute pyelonephritis often is accompanied by costovertebral angle tenderness; suprapubic tenderness may be elicited in a child who has localized cystitis.

Reproductive Tract Diseases

Disorders of the reproductive system can cause abdominal pain. Ovarian or testicular torsion and ectopic preg-

nancy are not rare events. Ovarian cysts and sexually transmitted infections can cause abdominal pain.

Testicular torsion manifests as a tender scrotum with an enlarged testis. Pain radiates into the abdomen. Nausea may accompany the pain and sometimes progresses to vomiting. Adolescent boys may be embarrassed to describe testicular pain and instead report hip or abdominal pain. This condition reinforces the importance of the physical examination when evaluating a child for acute abdominal pain. If in doubt, ultrasonography can evaluate blood flow to the testicle. Emergent surgery is necessary to save the affected testicle.

Ovarian torsion is harder to differentiate from other causes of acute abdominal pain due to the location of the ovaries. The pain is in the lower abdomen. Besides pain, nausea and vomiting can be present. As with many other conditions, infants who have this problem simply may be fussy, feed poorly, and vomit. The torsed organ swells, resulting in a palpable mass. Ultrasonography is needed for this diagnosis. As with testicular torsion, emergent surgery is necessary to preserve the organ.

Ovarian cysts are common in postmenarchal adolescents and usually cause acute pain only if there is hemorrhage into the cyst or the cyst ruptures and releases blood into the abdomen. Analgesics and time may be appropriate treatment. In cases of complicated cysts, surgery sometimes is required. A pregnancy test should be performed.

An ectopic pregnancy must be considered in any postmenarchal female presenting with lower abdominal pain. Because adolescents sometimes are confused or untruthful about their sexual histories, every female adolescent presenting with acute abdominal pain should undergo a pregnancy test.

Pelvic inflammatory disease can produce acute abdominal pain with rebound tenderness that can be difficult to distinguish from a surgical abdomen. The pain usually is in the lower abdomen, but sexually transmitted infections also can cause a perihepatitis that leads to pain in the right upper quadrant. Fever may be present. If pelvic inflammatory disease is suspected, gynecologic evaluation by appropriate colleagues may be critical, along with assuring appropriate follow-up and protection of the child where necessary.

Pneumonia

Because of visceral innervation, a lower lobe pneumonia can present as abdominal pain. In the febrile child who has abdominal pain, the lung fields must be auscultated and a chest radiograph considered if the findings are suspicious.

Streptococcal Pharyngitis

Many children who have streptococcal pharyngitis experience abdominal pain due to the pharyngitis. The pain can mimic appendicitis. Some surgeons require a rapid streptococcal screen as part of the evaluation for appendicitis. Why streptococcal pharyngitis causes abdominal pain is not known.

Diabetic Ketoacidosis

Acute abdominal pain can be the initial presentation of diabetes mellitus as a feature of diabetic ketoacidosis (DKA). The review of systems should be positive for polyuria or the parent may relate increased urinary frequency, which should prompt a urinalysis that can lead to the correct diagnosis. Weight loss and thirst (polydipsia) also are common complaints in those who have diabetes. The serum amylase value can be elevated, but true pancreatitis is rare.

The pain resolves with appropriate treatment for DKA. Therefore, if the pain remains despite improvement in the ketoacidosis, the child should be evaluated for other causes of abdominal pain. On occasion, DKA is precipitated by the stress of another condition that may account for the abdominal pain (such as a urinary tract infection.)

Sickle Cell Crisis

The vascular occlusion of sickle cell crisis can result in a surgical abdomen due to infarction as well as to gallstone formation. In the child who has sickle cell disease, the diagnosis may be difficult. The venous occlusive disease in affected patients is more likely to be accompanied by chest pain or limb pain due to the same sludging in blood vessels that causes the abdominal pain. The pain in sickle cell crisis improves with oxygen and hydration.

Functional Disease

Although functional abdominal pain more often is chronic, the initial presentation can be the complaint of acute pain. Objective signs of pain are less likely to be present.

Functional pain usually is felt at the umbilicus, but it can be epigastric, as in nonulcer dyspepsia. Either diarrhea or constipation can be present. The child can have derangements in the autonomic nervous system, with flushing or pallor. The gait more often is normal compared with the stooped, guarded posture of a patient who has a surgical abdomen.

Functional disease results from complex biopsychosocial features that are beyond the scope of this article.

Malingering

Malingering must be differentiated from organic and functional pain. The child does not necessarily consciously seek secondary gain from the abdominal pain. Malingering is a complex and potentially serious condition that requires evaluation by a team of specialists, including an expert in child behavior.

Summary

- Although acute abdominal pain usually is self-limited, there are serious consequences to overlooking conditions that require surgery.
- The pediatrician should use the examination to decide if the child is likely to have appendicitis or other surgically treated disease, and when suspicious, consult a surgeon early in the process.
- Vomiting bile is a sign that requires consultation with a surgeon.
- If in doubt about the seriousness of the illness, detain the child and perform serial examinations. Ask another physician to provide an opinion because experience is one of the most sensitive tools available for evaluating acute abdominal pain.

Suggested Reading

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PIR Quiz

Quiz also available online at <http://pedsinreview.aappublications.org>.

1. What is the correct approach to an 8-week-old infant who has bile-colored (bilious) vomiting?
 - A. Admit for observation.
 - B. Obtain surgical consultation immediately.
 - C. Perform an urgent upper gastrointestinal endoscopy.
 - D. Provide intravenous fluids to maintain hydration.
 - E. Provide reassurance as long as there is no blood.
2. Inflammation of the abdomen that involves the diaphragm may be referred to the:
 - A. Inguinal region.
 - B. Lower back.
 - C. Shoulder.
 - D. Sternum.
 - E. Testicle.
3. Which of the following conditions should be excluded in a child who has recurrent episodes of acute pancreatitis?
 - A. Cow milk protein allergy.
 - B. Crohn disease.
 - C. Cystic fibrosis.
 - D. *Helicobacter pylori* infection.
 - E. Malrotation of the intestine.
4. The diagnostic test of choice for peptic ulcer disease is:
 - A. Abdominal ultrasonography.
 - B. Computed tomography scan of the abdomen.
 - C. Upper gastrointestinal endoscopy.
 - D. Upper gastrointestinal series (barium radiograph).
 - E. Urea breath test for *Helicobacter pylori*.
5. A 15-year-old girl presents with a 36-hour history of worsening right lower quadrant pain. Her last menstrual period was 2 weeks ago. She has tenderness to palpation. Which of the following conditions is the *most* likely cause of her pain?
 - A. Cholelithiasis.
 - B. Ovarian torsion.
 - C. Pyelonephritis.
 - D. Right lower lobe pneumonia.
 - E. Small bowel volvulus.

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