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American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Acute (Nonlocalized) Abdominal Pain and Fever or Suspected Abdominal Abscess**

Variant 1: **Postoperative patient with fever.**

Radiologic Procedure	Rating	Comments	RRL*
CT abdomen and pelvis with IV contrast	8		☢☢☢☢
CT abdomen and pelvis without IV contrast	7		☢☢☢☢
US abdomen	6		O
MRI abdomen and pelvis without and with IV contrast	6		O
X-ray abdomen	5	To evaluate for bowel perforation.	☢☢
MRI abdomen and pelvis without IV contrast	5		O
X-ray contrast enema	4		☢☢☢
Ga-67 scan abdomen	4		☢☢☢☢
X-ray upper GI series with small bowel follow-through	4	Helpful when anastomotic leak is suspected.	☢☢☢
CT abdomen and pelvis without and with IV contrast	3	May be helpful in select cases but should be used with caution because of increased radiation dose.	☢☢☢☢
Tc-99m WBC scan abdomen and pelvis	3		☢☢☢☢
In-111 WBC scan abdomen and pelvis	3		☢☢☢☢
Rating Scale: **1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate**			***Relative Radiation Level**

Clinical Condition: **Acute (Nonlocalized) Abdominal Pain and Fever or Suspected Abdominal Abscess**

Variant 2: **Postoperative patient with persistent fever and no abscess seen on CT scan within the last 7 days.**

Radiologic Procedure	Rating	Comments	RRL*
CT abdomen and pelvis with IV contrast	8		☢☢☢☢
CT abdomen and pelvis without IV contrast	6		☢☢☢☢
US abdomen	6		O
Tc-99m WBC scan abdomen and pelvis	6		☢☢☢☢
In-111 WBC scan abdomen and pelvis	6		☢☢☢☢
X-ray abdomen	5	To evaluate for bowel perforation.	☢☢
X-ray upper GI series with small bowel follow-through	5		☢☢☢
Ga-67 scan abdomen	5		☢☢☢☢
MRI abdomen and pelvis without IV contrast	5		O
MRI abdomen and pelvis without and with IV contrast	5		O
X-ray contrast enema	4		☢☢☢
CT abdomen and pelvis without and with IV contrast	3	May be helpful in select cases but should be used with caution because of increased radiation dose.	☢☢☢☢
Rating Scale: **1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate**			***Relative Radiation Level**

Clinical Condition: **Acute (Nonlocalized) Abdominal Pain and Fever or Suspected Abdominal Abscess**

Variant 3: **Patient presenting with fever and no recent operation.**

Radiologic Procedure	Rating	Comments	RRL*
CT abdomen and pelvis with IV contrast	8		☢☢☢☢
CT abdomen and pelvis without IV contrast	6		☢☢☢☢
US abdomen	6		O
X-ray abdomen	6	To evaluate for bowel perforation.	☢☢
MRI abdomen and pelvis without IV contrast	5		O
MRI abdomen and pelvis without and with IV contrast	5		O
X-ray upper GI series with small bowel follow-through	4		☢☢☢
X-ray contrast enema	4		☢☢☢
CT abdomen and pelvis without and with IV contrast	3	May be helpful in select cases but should be used with caution because of increased radiation dose.	☢☢☢☢
Ga-67 scan abdomen	3		☢☢☢☢
Tc-99m WBC scan abdomen and pelvis	3		☢☢☢☢
In-111 WBC scan abdomen and pelvis	3		☢☢☢☢
Rating Scale: **1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate**			***Relative Radiation Level**

Clinical Condition: Acute (Nonlocalized) Abdominal Pain and Fever or Suspected Abdominal Abscess

Variant 4: Pregnant patient.

Radiologic Procedure	Rating	Comments	RRL*
US abdomen	8		O
MRI abdomen and pelvis without IV contrast	7		O
CT abdomen and pelvis with IV contrast	5	Only after other studies without ionizing radiation have been used.	☢☢☢☢
CT abdomen and pelvis without IV contrast	5		☢☢☢☢
X-ray abdomen	4	To evaluate for bowel perforation.	☢☢
CT abdomen and pelvis without and with IV contrast	2	May be helpful in select cases but should be used with caution because of increased radiation dose.	☢☢☢☢
MRI abdomen and pelvis without and with IV contrast	2	Because it is unclear how gadolinium-based contrast agents will affect the fetus, these agents should be administered only with extreme caution. Gadolinium-based contrast agents are only recommended for use during pregnancy when there are no alternatives and benefit outweighs risk.	O
X-ray upper GI series with small bowel follow-through	2		☢☢☢
X-ray contrast enema	2		☢☢☢
Ga-67 scan abdomen	2		☢☢☢☢
Tc-99m WBC scan abdomen and pelvis	2		☢☢☢☢
In-111 WBC scan abdomen and pelvis	2		☢☢☢☢
Rating Scale: **1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate**			***Relative Radiation Level**

ACUTE (NONLOCALIZED) ABDOMINAL PAIN AND FEVER OR SUSPECTED ABDOMINAL ABSCESS

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Summary of Literature Review

Introduction/Background

Acute abdominal pain with fever raises clinical suspicion of an intra-abdominal abscess or other condition that may need immediate surgical or medical attention. Infection or other inflammatory conditions are the usual cause. In these circumstances, emergency imaging plays an important role, in conjunction with other clinical information, to make a quick and accurate diagnosis. This is crucial, as proper diagnosis facilitates expeditious and appropriate therapy, thus improving patient outcome. This discussion is limited to illnesses affecting the abdomen and pelvis and excludes the gynecologic and urinary tracts. Pediatric patients are not considered.

The range of pathology that can produce abdominal pain and fever with or without abscess is very broad. It includes pneumonia, hepatobiliary disease, complicated pancreatic processes, gastrointestinal (GI) perforation or inflammation, bowel obstruction or infarction, abscesses anywhere in the abdomen, and tumor — among others. Of all patients who present to the emergency department with abdominal pain, about one-third never have a diagnosis established, one-third have appendicitis, and one-third have some other documented pathology. In the "other" category, the most common causes include (in order of frequency): acute cholecystitis, small-bowel obstruction, pancreatitis, renal colic, perforated peptic ulcer, cancer, and diverticulitis [1]. When fever is also present, the need for quick, definitive diagnosis is considerably heightened. Imaging may be especially helpful in the elderly with acute abdominal pain. In this population, many laboratory tests are nonspecific and may be normal despite serious infection [2,3].

Clinical Presentations

A variety of clinical presentations occur in patients with acute abdominal pain accompanied by fever. This review concentrates on the evaluation of patients with acute diffuse abdominal pain, immunocompromised patients with acute abdominal pain, and patients with suspected abdominal abscess. Other Appropriateness Criteria® topics address acute right upper quadrant pain, acute right lower quadrant pain, and acute left lower quadrant pain. Imaging evaluation varies among patients with different clinical presentations.

Acute diffuse abdominal pain with fever can be caused by conditions that ordinarily instigate more localized pain. These conditions include: complicated appendicitis, intestinal obstruction, complicated acute calculous or acalculous cholecystitis, bile duct obstruction with infectious cholangitis, hepatitis, hepatic abscess, pancreatitis with or without infection, pyelonephritis or renal infarction, renal stones, omental infarction, epiploic appendagitis, mesenteric adenitis, and diverticulitis [4]. Other conditions that typically present with diffuse abdominal pain and fever include bowel ischemia or infarction, bowel perforation from ulcer or tumor, diffuse colitis, typhlitis and other GI infections, peritonitis, small-bowel inflammatory disease, abdominal abscess,

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intraperitoneal or retroperitoneal hemorrhage, vasculitis, pelvic inflammatory disease (PID), and diffuse malignancy [5-10].

In patients with intestinal ischemia, CT is helpful for detecting vessel thrombosis, intramural or portal gas, and lack of bowel wall enhancement. A meta-analysis of the diagnostic accuracy of multidetector computed tomography (MDCT) for acute mesenteric ischemia has shown a pooled sensitivity of 93.3% and a pooled specificity of 95.9% [11]. Reduced segmental bowel-wall enhancement has been shown to be 100% specific for segmental bowel ischemia [12], stressing the importance of intravenous (IV) contrast material administration in this setting. For intestinal infarction, CT (sensitivity 82%) considerably outperforms radiography plus ultrasound (US) (sensitivity 28%) [13]. In bowel perforation, while radiographs are sensitive to small volumes of free air, CT is more sensitive to even smaller volumes and can detect additional loculated air or air in the mesenteric root [14].

In patients with Crohn disease or inflammatory colitis, the presence of fever raises the possibility of associated abscess or phlegmon, although CT is the procedure of choice for diagnosing abscess, regardless of cause. Please refer to the ACR Appropriateness Criteria® on "Crohn Disease" for further discussion. Pseudomembranous (ie, clostridium difficile) colitis may be accompanied with fever; CT findings are present in the colon in 88% of cases [15]. Rarely, diffuse tumors such as lymphomas or metastases may present with abdominal pain and fever; again, CT is the procedure of choice due to its depiction of all abdominal organs and lymph node chains.

Neutropenic Patients

In neutropenic patients, abdominal pain remains a diagnostic challenge due to the lack of classic clinical and laboratory signs of intra-abdominal disease [16]. Therefore, the diagnosis of acute abdomen may be delayed in these patients [17]. Neutropenia is being encountered more commonly in clinical practice and may be due to cytotoxic chemotherapy or immunosuppressive therapy. Abdominal complications of neutropenia include clostridium difficile colitis, cytomegalovirus (CMV) colitis, graft-versus-host disease, neutropenic enterocolitis, and bowel ischemia and perforation [16,18]. Furthermore, acute abdomen may be due to the toxicity of chemotherapeutic agents [19]. The liver and biliary tree may be involved with HIV-related cholangiopathy, hepatic abscesses, or hepatic bacillary angiomatosis, a peliosis-like condition. The spleen is subject to focal infarction or abscess [20]. Bowel mucosal disease may include GI tuberculosis, CMV colitis, clostridium difficile colitis, histoplasmosis, candida, mycobacterium avium complex-related enteritis, and other opportunistic bowel infection (cryptosporidiosis, giardia, isospora, and strongyloides). Tumors with adenopathy and bowel involvement include Kaposi's sarcoma and lymphoma of bowel, either of which may lead to bowel obstruction, pneumatosis intestinalis, perforation, or intussusception.

CT is the imaging procedure of choice to diagnose GI complications in immunocompromised patients. CT with oral, IV, and (frequently) rectal contrast is almost always the procedure of choice in an HIV-positive patient with acute abdominal pain and fever [21,22]. Supplemental barium studies of the mucosa of the stomach, small bowel, and colon may add additional information to that obtained from CT, particularly when mucosal lesions are small and fine. If there is any chance of bowel perforation, barium should not be used.

Occasionally, US of the biliary tree and gallbladder may be useful in evaluating HIV-related cholangiopathy. If CT is performed, radiographs have little incremental value. The utility of radionuclide scanning in this subgroup has not been validated in large prospective studies.

Abdominal Radiography

Conventional radiography may be performed in the setting of acute abdominal pain. Abdominal radiography, however, has a limited role in the evaluation of nontraumatic abdominal pain in adults [23-26]. While it has been shown to have high sensitivity (90%) for detecting intra-abdominal foreign bodies and moderate sensitivity for detecting bowel obstruction (49%), its low sensitivity for sources of abdominal pain and fever or abscess limit its role in this setting [27]. In a study of 874 patients who underwent abdominal radiography in a nontrauma emergency department, abdominal radiography was helpful in changing clinical management in only 4% of patients [24].

X-ray Upper Gastrointestinal Series with Small-Bowel Follow-Through and Contrast Enema

X-ray contrast studies of the GI tract have a limited role in the initial evaluation of adult patients without a history of recent surgery and with nonlocalized abdominal pain and fever. They may, however, be helpful in evaluating intestinal anastomotic leak, particularly when CT cannot be obtained or when there are equivocal findings on CT [28]. The sensitivity of upper GI contrast examination for detecting leak after bariatric surgery varies among reports between 22%-75% [29-31]. Endoscopy is the preferred initial examination of the stomach and colon in patients suspected of having inflammatory bowel disease (IBD).

Ultrasound

US may be useful in selected conditions, including cholecystitis, cholangitis, liver abscess, diverticulitis, appendicitis, and small-bowel inflammation, where it may be used to assess activity of Crohn disease [32-34]. While US may be able to depict portions of an abscess or malignancy (such as lymphoma), it is blind to many areas of the abdomen, particularly in the presence of increased bowel gas or free air. The shortcomings of US are partially offset by its lack of ionizing radiation, particularly in younger patients [35].

Computed Tomography

In general, CT is the most important modality in evaluating nonpregnant patients with abdominal pain, more so in those with fever. Several studies have shown that CT improves the final diagnosis and management of patients who present with abdominal pain [2,36-41]. Two reports have found CT to be superior to clinical evaluation for finding the cause of abdominal pain. CT interpretation was correct in 90%-96% of cases, while clinical evaluation was correct in 60%-76% of cases [42-44]. Additionally, the use of CT in patients with acute abdominal pain increases the emergency department clinician's level of certainty and reduces hospital admissions by 24% [45].

In a study of 584 emergency department patients presenting with nontraumatic abdominal pain, CT was shown to change the diagnosis, improve diagnostic certainty, and affect potential patient management decisions [41]. In this study, CT was used to alter the leading diagnosis in 49% of the patients ($P<0.00001$) and increased mean physician diagnostic certainty from 70.5% (pre-CT) to 92.2% (post-CT) ($P<0.001$). The management plan was changed by CT in 42% of the patients ($P<0.0001$). In a study of 93 emergency department patients, abdominal-pelvic CT with z-axis restriction based on patients symptoms was shown to reduce radiation but included all acute pathology in only 33% of abnormal cases [46].

Abdominal CT has been shown to have an excellent interobserver agreement for specific urgent diagnoses such as diverticulitis (kappa value of 0.90), appendicitis (kappa value of 0.84), and bowel obstruction (kappa value of 0.81) [47]. The presence of an elevated white blood count (WBC) >11.5 correlated with a positive abdominal CT, and the combination of WBC >11.5, male sex, and age <25 years correlated with a diagnosis of appendicitis [48]. Conversely, in a study of 522 young adult patients presenting to the emergency department with abdominal pain, no laboratory test was sufficient to offer reassurance that a CT is not necessary [49]. Abdominal CT without the use of oral or IV contrast has been advocated as an alternative to abdominal radiographs for evaluating appendicitis [23,38]. However, the use of contrast agents increases the spectrum of detectable pathology [45,50]. Advances in CT technology have resulted in isotropic image acquisition. Multiplanar reformations have been shown to improve diagnostic confidence in patients with abdominal pain [51-53]. Again, abdominal radiographs may provide useful information about bowel gas pattern or free air, but they offer no incremental information if CT is performed [35,42].

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) offers imaging without ionizing radiation. It has been shown to provide clinically useful information for rapid diagnosis of acute bowel pathology [54-57] and the following gynecological emergencies: ovarian hemorrhage, ectopic pregnancy, tumor rupture, torsion, hemorrhage, infarction, and PID [58-60].

Nuclear Medicine

The role of nuclear medicine is limited in the evaluation of acute nonlocalized abdominal pain. While Tc-99m HMPAO white-cell-labeled scanning has a high sensitivity for IBD (91%-98%) and may have some role in diagnosing appendicitis in older patients [61,62], it does not do as well as CT in depicting the complications of abscess and fistula [63].

Suspected Abdominal Abscess

Patients suspected of having abdominal abscesses may present in a number of ways: with fever, with diffuse or localized abdominal pain, or with a history of a condition that may predispose to abdominal abscesses, such as recent surgery and IBD, pancreatitis, etc. Imaging studies that have been used to detect abdominal abscesses include radiographs (supine and upright, and occasionally decubitus views); nuclear medicine studies such as gallium-, indium-, or technetium-tagged leukocyte or florine-18-2-fluoro-2-deoxy-D-glucose positron emission tomography (FDG-PET) studies; US; CT; and more recently MRI.

To our knowledge, there is little current information on radiography's role in detecting abdominal abscesses. Some reports suggest that radiographs may be useful, but this is far from proven. CT of the abdomen has been shown to be the first and best test for diagnosing intra-abdominal abscess in patients who have recently had abdominal surgery, and in patients with localizing signs for abscess [64,65]. Among intensive care unit (ICU) patients with sepsis of unknown origin, CT of the abdomen and pelvis revealed the source of sepsis in seven of 45 patients [66]. The CT can be very helpful in determining whether a patient with pancreatitis has developed a pancreatic abscess, and it can be useful in detecting abscess formation in patients with diverticulitis or Crohn disease [67-71]. Although CT can be quite accurate in detecting abnormalities of the psoas, the differentiation of psoas abscesses from other psoas lesions is difficult when only imaging criteria are used [72]. In select cases, delayed CT images after the initial acquisition may help in differentiating an abscess from unopacified bowel loops or bladder or establishing extravasation of oral or IV contrast material.

US is often useful in specific cases, but when compared with CT its results are usually of lower sensitivity and specificity [73-75]. Gallium scan and indium and technetium leukocyte scans are often useful when the CT scan is negative or equivocal [74,76,77]. Nuclear scintigraphy permits whole-body imaging and the detection of sites of infection beyond the abdominal region. The literature on technetium-labeled leukocytes suggests a very high sensitivity and specificity for abdominal abscesses as well, although there are no adequate recent comparisons with CT [78]. Although gallium is excreted in the GI tract, making it a poor choice for the primary imaging of abdominal abscesses, among patients with persistent fever following colorectal surgery the diagnostic accuracy for Ga-67 in detecting occult abscesses has been reported to be as high as 91.2% (compared to 97.1% for CT among the same patients) [79].

FDG-PET and FDG-PET/CT are currently under investigation for evaluating infection and inflammation. They potentially could replace nuclear medicine studies such as gallium-, indium-, or technetium-tagged leukocyte studies [80]. FDG-PET has several advantages over conventional nuclear medicine techniques, particularly in neutropenic patients [81], but its relative benefit in detection of abdominal abscess remains to be studied. MRI is an accurate examination for detecting abdominal and pelvic abscesses when the image acquisition is optimized for this purpose [57]. Patients without previous surgery or with a low clinical suspicion of abscess are effectively evaluated with CT, and may also be studied with indium- or technetium-labeled leukocytes to search for infection or inflammation [82].

Recent literature has focused on the role of US and CT in percutaneous drainage of abdominal abscesses [83-86]. Minimally invasive image-guided drainage of abdominal abscesses can produce excellent results [85-88]. Endoscopic US has been proposed as an alternative approach for drainage of abdominal [89] and pelvic abscess [90] and infected necrosis [89]; however, there are limited data to our knowledge comparing its performance with other modalities.

Abdominal Pain and Fever in Pregnant Patients

For discussion regarding evaluation of pregnant patients with right lower quadrant abdominal pain, see the ACR Appropriateness Criteria® on "Right Lower Quadrant Pain — Suspected Appendicitis." Diagnosing the source of abdominal pain in pregnancy is difficult for several reasons. Physiologic and anatomic changes that take place during pregnancy may lead to abdominal or pelvic symptoms that can mimic disease. These symptoms may accompany physiologic leukocytosis of pregnancy, further complicating accurate diagnosis. In pregnant patients with abdominal or pelvic pain, US should be the initial imaging modality because of its availability, portability, and lack of ionizing radiation [91].

MRI is being used more frequently in the evaluation of pregnant patients with abdominal pain who have had an inconclusive US examination. A survey of academic centers in the United States has shown that MRI is the preferred imaging modality for diagnosing appendicitis and abscess in pregnant patients in their first trimester [92]. However, this survey showed that CT is more frequently used in the second and third trimesters of pregnancy to evaluate abdominal pain [92]. In pregnant patients presenting with acute abdominal or pelvic pain, MRI has been shown to have excellent sensitivity and specificity for diagnosing appendicitis or other causes of abdominal and pelvic pain [60,93,94].

When CT is used to diagnose appendicitis, it has been shown to have a sensitivity of 88%-100% for diagnosing appendicitis in pregnancy versus 33%-46.1% for US [91,95]. In a study of pregnant women with nontraumatic abdominal pain, CT established the diagnosis in 30% of these patients when US or clinical methods had failed, and had a 99% negative predictive value for appendicitis [96].

Summary

- In nonpregnant patients with acute nonlocalized abdominal pain and fever, CT with IV contrast is the imaging modality of choice.
- In pregnant patients, US and MRI are the initial imaging modalities of choice for evaluating nonlocalized abdominal pain and fever.
- A variety of clinical presentations occur in patients with acute abdominal pain accompanied by fever. In neutropenic patients, abdominal pain remains a diagnostic challenge due to the lack of classic clinical and laboratory signs.

Safety Considerations in Pregnant Patients

Imaging of the pregnant patient can be challenging, particularly with respect to minimizing radiation exposure and risk. For further information and guidance, see the following ACR documents:

- ACR Practice Guideline for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation
- ACR-ACOG-AIUM Practice Guideline for the Performance of Obstetrical Ultrasound
- ACR Manual on Contrast Media
- ACR Guidance Document for Safe MR Practices

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies".

Supporting Documents

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

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