American College of Radiology
ACR Appropriateness Criteria®
Acute Nonlocalized Abdominal Pain

Variant 1: **Acute nonlocalized abdominal pain and fever. No recent surgery. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate	O
US abdomen	May Be Appropriate	O
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
MRI abdomen and pelvis without IV contrast	May Be Appropriate	O
CT abdomen and pelvis without and with IV contrast	May Be Appropriate	☢☢☢☢
Radiography abdomen	May Be Appropriate	☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢
WBC scan abdomen and pelvis	Usually Not Appropriate	☢☢☢☢
Nuclear medicine scan gallbladder	Usually Not Appropriate	☢☢
Fluoroscopy contrast enema	Usually Not Appropriate	☢☢☢
Fluoroscopy upper GI series with small bowel follow-through	Usually Not Appropriate	☢☢☢

Variant 2: **Acute nonlocalized abdominal pain and fever. Postoperative patient. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate	O
US abdomen	May Be Appropriate	O
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
MRI abdomen and pelvis without IV contrast	May Be Appropriate	O
CT abdomen and pelvis without and with IV contrast	May Be Appropriate	☢☢☢☢
Radiography abdomen	May Be Appropriate	☢☢
Fluoroscopy contrast enema	May Be Appropriate	☢☢☢
Fluoroscopy upper GI series with small bowel follow-through	May Be Appropriate	☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢
WBC scan abdomen and pelvis	Usually Not Appropriate	☢☢☢☢
Nuclear medicine scan gallbladder	Usually Not Appropriate	☢☢

Variant 3: **Acute nonlocalized abdominal pain. Neutropenic patient. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate	O
US abdomen	May Be Appropriate	O
MRI abdomen and pelvis without IV contrast	May Be Appropriate	O
CT abdomen and pelvis without and with IV contrast	May Be Appropriate	☢☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢
WBC scan abdomen and pelvis	Usually Not Appropriate	☢☢☢☢
Radiography abdomen	Usually Not Appropriate	☢☢
Nuclear medicine scan gallbladder	Usually Not Appropriate	☢☢
Fluoroscopy contrast enema	Usually Not Appropriate	☢☢☢
Fluoroscopy upper GI series with small bowel follow-through	Usually Not Appropriate	☢☢☢

Variant 4: **Acute nonlocalized abdominal pain. Not otherwise specified. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
CT abdomen and pelvis without IV contrast	Usually Appropriate	☢☢☢
MRI abdomen and pelvis without and with IV contrast	Usually Appropriate	O
US abdomen	May Be Appropriate	O
MRI abdomen and pelvis without IV contrast	May Be Appropriate	O
CT abdomen and pelvis without and with IV contrast	May Be Appropriate	☢☢☢☢
Radiography abdomen	May Be Appropriate	☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢
WBC scan abdomen and pelvis	Usually Not Appropriate	☢☢☢☢
Nuclear medicine scan gallbladder	Usually Not Appropriate	☢☢
Fluoroscopy upper GI series with small bowel follow-through	Usually Not Appropriate	☢☢☢
Fluoroscopy contrast enema	Usually Not Appropriate	☢☢☢

ACUTE NONLOCALIZED ABDOMINAL PAIN

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Summary of Literature Review

Introduction/Background

The range of pathology that can produce abdominal pain is broad and necessitates an imaging approach that can identify pathology in many different organ systems. Common pathologies include pneumonia, hepatobiliary disease, complicated pancreatic processes, nephrolithiasis, gastrointestinal (GI) perforation or inflammation, bowel obstruction or infarction, abscesses anywhere in the abdomen, and tumor—among numerous other causes. Of all patients who present to the emergency department (ED) 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 of abdominal pain include: acute cholecystitis, small-bowel obstruction (SBO), pancreatitis, renal colic, perforated peptic ulcer, cancer, and diverticulitis [1]. Imaging plays an essential role in narrowing the differential diagnosis and directing management. In a retrospective study of 8,710 visits to the ED at a tertiary cancer center, 1,035 abdominopelvic CT scans were performed, with the most common indications including nononcologic emergencies in 26.7%, postoperative complications in 19.2%, oncologic emergencies in 14.3%, and intestinal obstruction in 12.2% of patients presenting with an acute complaint [2]. From a sample of the patients scanned for abdominopelvic indications, 36.6% were negative, 40% were positive for clinical suspicion, and 14.5% had an incidental positive result. The authors suggested that CT played an essential role in determining management, especially in instances where the positive result was not concordant with the initial diagnostic consideration (14.5% incidental positive). In a separate retrospective study, Pandharipande et al [3] found that the leading diagnosis changed in 51% of patients and the decision to admit changed in 25% of patients with abdominal pain following the results of a CT examination in the ED. The impact of imaging underscores the difficulty in making an accurate clinical diagnosis when patients present with nonlocalizing abdominal pain.

Associated fever with abdominal pain constitutes an even more challenging clinical situation. Fever raises clinical suspicion of an intra-abdominal infection, abscess, or other condition that may need immediate surgical or medical attention. When fever is present, the need for quick, definitive diagnosis is considerably heightened. Imaging is especially helpful in the elderly with acute abdominal pain and fever. In this population, many laboratory tests are nonspecific and may be normal despite serious infection [4-6]. The neutropenic patient is a diagnostic challenge as typical signs of abdominal sepsis may be masked, diagnosis may be delayed [7], and it is associated with a high mortality rate [8].

It is important to note that this overview of imaging focuses on the evaluation of patients with nonspecific abdominal pain, with or without fever, abdominal pain in the setting of recent surgery, and immunocompromised patients with acute abdominal pain. In addition, unless otherwise stated, the ratings and recommendations for this document specifically relate to the adult nonpregnant patient, although the narrative briefly discusses some imaging approaches for younger and pregnant patients in Variant 4. Refer to other Appropriateness Criteria topics

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in patients with more localized signs or symptoms, including the ACR Appropriateness Criteria® topic on "Right Upper Quadrant Pain" [9], the ACR Appropriateness Criteria® topic on "Left Lower Quadrant Pain–Suspected Diverticulitis" [10], the ACR Appropriateness Criteria® topic on "Crohn Disease" [11], the ACR Appropriateness Criteria® topic on "Right Lower Quadrant Pain–Suspected Appendicitis" [12], the ACR Appropriateness Criteria® topic on "Suspected Small-Bowel Obstruction" [13], or the ACR Appropriateness Criteria® topic on "Acute Pelvic Pain in the Reproductive Age Group" [14] for further discussion.

Discussion of Procedures by Variant

Variant 1: Acute nonlocalized abdominal pain and fever. No recent surgery. Initial imaging.

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 appendicitis, diverticulitis, inflammatory bowel disease, pancreatitis, etc. In addition, some malignant conditions (including lymphoma and necrotizing masses), as well as masses producing secondary infections, such as cholangitis in the setting of a pancreatic malignancy, could all present with abdominal pain and fever.

Radiography Abdomen

Although the use of radiographs has shown 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 [15]. Radiography demonstrates low overall sensitivity in the detection of colitidies and enteritidies, and even low-dose CT demonstrates superior diagnostic yield in comparison with abdominal radiography [16]. Many authors suggest that they have a limited role in the evaluation of nontraumatic abdominal pain in adults [17-22].

Fluoroscopy Contrast Enema

No current literature supports the use of contrast enema for evaluating patients with nontraumatic abdominal pain and fever in the absence of recent surgery.

Fluoroscopy Upper GI with SBFT

No current literature supports the use of an upper GI series with small bowel follow-through (SBFT) for evaluating patients with abdominal pain and fever in the absence of recent surgery.

CT Abdomen and Pelvis

With a generally broad differential and need for fast imaging because of clinical acuity, CT is a preferred imaging option [23]. CT can be performed without and/or with intravenous (IV) contrast and with or without positive oral contrast. Most commonly, in the setting of nonlocalized, nontraumatic abdominal pain, a routine CT of the abdomen and pelvis is performed with IV contrast and a single postcontrast phase. In this setting, precontrast and postcontrast images are not required for diagnosis. Abdominal CT without the use of oral or IV contrast has been advocated as an alternative to abdominal radiographs for evaluating appendicitis [17,24]. However, the use of IV contrast increases the spectrum of detectable pathology in patients with nonlocalized pain [25,26]. Many institutions do not routinely use oral contrast because of the associated delay in scan acquisition and departmental throughput balanced against questionable diagnostic advantage [27-30]. Contraindications are not considered in the appropriateness assessment.

Although sensitivity and specificity ranges are not routinely reported because of the wide spectrum of pathology encountered, there are sufficient data to suggest that CT with IV contrast adds diagnostic value and helps direct management. In a prospective study assessing impact of CT on management decisions in the ED, a total of 584 patients presented with nontraumatic abdominal complaints and CT changed leading diagnosis in 49%, changed admission status in 24%, and altered surgical plans in 25% [31]. In the same study, with concerns to etiologies associated with fever, the diagnosis of abscess decreased by 19% following CT, colitis and inflammatory bowel disease decreased by 12%, diagnosis of cholecystitis and cholangitis increased by 100%, and diagnosis of pelvic inflammatory disease increased by 280% following CT. Among intensive care unit patients with sepsis of unknown origin, CT of the abdomen and pelvis revealed the source of sepsis in 7 of 45 patients [32]. Pseudomembranous (ie, clostridium difficile) colitis is frequently encountered in the inpatient setting and is a common diagnostic consideration in a patient with fever; CT findings are present in the colon in 88% of cases [33]. Rarely, diffuse tumors such as lymphomas or metastases may present with abdominal pain and fever; CT with contrast will depict all abdominal organs and lymph node chains in the evaluation of potential malignancy.

In addition to detection of an abscess, CT can also be used as guidance for percutaneous drainage. Percutaneous drainage is feasible and effective for the treatment of abdominopelvic abscess [34].

In adult patients with Crohn disease or inflammatory colitis, the presence of fever raises the possibility of associated abscess or phlegmon. Refer to the ACR Appropriateness Criteria® topic on "Crohn Disease" for further discussion [11].

MRI Abdomen and Pelvis

MRI is often performed with specific indications in mind, using tailored protocols. However, when optimized for the acute setting, MRI can be an accurate examination for detecting abdominal and pelvic abscesses [35]. A prospective study of consecutive patients presenting with acute abdominal pain investigated the use of a rapid acquisition noncontrast MRI protocol for determining the source of abdominal pathology [36]. The MRI was positive in 116 of 349 cases and indeterminate in 3 cases. Overall accuracy was 99% and only 3 cases with negative MRIs later required appendectomies. A range of pathologies were detected, including SBO, diverticulitis, pelvic inflammatory disease, pyelonephritis, renal abscess, pseudomembranous colitis, and diverticular abscess. A rapid MRI protocol may be beneficial in this setting. In a separate retrospective study of MRI with IV contrast in patients with pelvic pain, MRI depicted acute appendicitis with 100% sensitivity and 92% positive predictive value and ovarian torsion with a sensitivity of 86% and specificity of 100% [37]. Given its accuracy for a range of intra-abdominal pathologies [36,37], as well as the feasibility of distinguishing infected from noninfected fluid [38], MRI may be used as an alternative to CT. It should be noted that, in practice, the feasibility of MRI for acute abdominal pain will rely on institutional expertise, availability, and adoption of protocols that are aimed at rapid acquisition and multiorgan assessment, such as that used in the study by Byott and Harris [36].

US Abdomen

Ultrasound (US) in general is less sensitive and specific than CT for nonlocalized abdominal pain workup. One retrospective review of 92 patients who underwent multiple studies to specifically evaluate for an intra-abdominal abscess demonstrated a sensitivity and specificity for US of 75% and 91%, respectively, compared to 88% and 93%, respectively, for CT [39]. A smaller retrospective study evaluating the performance of US in patients who had initially undergone multidetector CT interpreted by experienced readers showed that CT was 100% sensitive in the detection of tubo-ovarian abscesses (n = 9), and performing a follow-up US did not aid in diagnosis [40]. Although not specifically performed to evaluate for abscesses, a large prospective study evaluating the usefulness of CT and US in patients presenting with abdominal pain (n = 1,021) showed better sensitivity with CT in diagnosis of appendicitis (94% versus 76%, $P < .01$) and diverticulitis (81% versus 61%, $P = .048$) [41]. US and CT had similar sensitivities for the detection of acute cholecystitis.

FDG-PET/CT Skull Base to Mid-Thigh

Although generally not the primary modality of choice in the setting of acute or emergent abdominal pain, nuclear medicine studies could be used as an adjunct to inconclusive cross-sectional imaging. Because of its whole body imaging and sensitivity for infectious, inflammatory, and neoplastic processes, PET using the tracer fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG)/CT is useful in the setting of nonlocalized fevers of unknown origin, particularly if previous cross-sectional imaging did not yielded a source [42]. Nevertheless, there are no recent studies evaluating its use when patients present with symptoms localizing to the abdomen.

Nuclear Medicine

Older studies performed in the 1980s to 1990s suggested that gallium scans and indium and technetium leukocyte scans are useful in evaluating abdominal infections and abscesses when the CT scan is negative or equivocal [43-45]. However, it is important to recognize that CT technology has significantly advanced since these studies were published. Older literature on technetium-labeled leukocytes also suggested a very high sensitivity and specificity for abdominal abscesses, although there are no adequate recent comparisons with CT [46]. In addition, cholescintigraphy may have a role if there is specific concern regarding gallbladder or other hepatobiliary disease. Refer to the ACR Appropriateness Criteria® topic on "Right Upper Quadrant Pain" for further discussion [9].

Variant 2: Acute nonlocalized abdominal pain and fever. Postoperative patient. Initial imaging.

In the setting of recent abdominal surgery, a variety of conditions could produce abdominal pain, including postoperative fluid collections, hemorrhage, vascular injuries, intestinal ileus, omental torsion/infarction, etc. However, the presence of concomitant fever is primarily concerning for a postoperative abscess and warrants cross-sectional imaging for further evaluation. In addition, patients who have had recent bowel manipulation or

resection could present with similar symptoms in the setting of postoperative visceral injury and/or anastomotic leaks. In this scenario, particular emphasis is often placed on ascertaining the integrity of an anastomosis, most often using CT with positive oral and IV contrast and/or fluoroscopic studies.

Radiography Abdomen

There are no recent studies evaluating the use of radiographs in the setting of nonlocalized abdominal pain and fever in the postoperative patient, and its role is limited in the detection of abscesses. Although it has been shown to have high sensitivity (90%) for detecting intra-abdominal foreign bodies and moderate sensitivity for detecting bowel obstruction (49%), it has low sensitivity for sources of abdominal pain and fever or abscess, which limits its role in this setting [15]. If there is concern for retained surgical instrument or sponge, a radiograph may be useful in this population because of the classic appearance of surgical sponge markers on radiographs.

Fluoroscopy

Although limited in the detection of abscesses, fluoroscopic examinations are useful in the evaluation of some intestinal postoperative leaks, particularly when there are equivocal findings on CT [47]. Fluoroscopic examinations can be augmented or complemented by the use of CT with positive oral contrast in the evaluation of a potential leak, as discussed below. CT has the added advantage of allowing for abscess drainage should nonoperative or endoscopic management be pursued in the setting of postoperative leaks.

Fluoroscopy Contrast Enema

In the setting of recent colorectal anastomoses, one study demonstrated that water-soluble enemas may have better sensitivity for detecting distal anastomotic leaks than CT, but neither was sensitive for a leak if the patient had a proximal colonic anastomosis [47].

Fluoroscopy Upper GI with SBFT

The sensitivity of upper GI contrast examinations for detecting leaks after bariatric surgery varies among reports between 22% to 79% [48-51].

CT Abdomen and Pelvis

CT of the abdomen and pelvis with IV contrast is often the first study and generally considered to be an optimal imaging modality for the evaluation of pain and suspected abscess in the postoperative patient. One study assessing the use of positive oral and IV contrast-enhanced CT scans obtained in all patients with suspected abscesses between 3 and 30 days demonstrated a similar diagnostic yield regardless of whether the scan was performed in the first postoperative week or later [23]. However, it is important to recognize that clinical suspicion can impact diagnostic yield. A retrospective study looking at postoperative patients after colorectal resection revealed that nearly 75% of patients with clinical concern for an infection will have a fluid collection, but many of these will not represent abscesses. Of the clinical, laboratory, and radiologic parameters studied, only a high index of clinical suspicion and close proximity of the fluid collection to the site of surgery were associated with predicting an infected collection [52]. In a retrospective review of elective pancreatic resections, intra-abdominal infections were diagnosed at a mean of 11.8 days following the procedure; notably, abdominal pain and peritonitis were uncommon presentations and early postoperative CT was encouraged in any patient presenting with fever and sepsis [53].

When evaluating anastomotic integrity, positive oral or rectal contrast administration can be useful to demonstrate leaks as the presence of extraluminal contrast may localize the source of patient symptoms. In the setting of postoperative anastomotic leaks, CT and fluoroscopic examinations can have complementary roles, as neither is 100% sensitive [47-51]. In the setting of bariatric surgery, one study comparing the sensitivity of leak detection demonstrated a 95% sensitivity with CT (95% CI, 81.8–99.1) compared to 79% for fluoroscopy (95% CI, 61.6–90.0) for clinically significant leaks requiring intervention; however, it is important to note that there were only 20 cases of clinically proven leaks in their cohort of postoperative patients [48]. In this setting, clinicians need to maintain a high index of suspicion for leak if imaging is negative, with consideration for operative exploration if unexplained symptoms persist.

In the setting of colorectal anastomoses, one study evaluating 36 patients with proven leaks demonstrated water-soluble enema may have better sensitivity for detecting distal anastomotic leaks than CT (88% versus 12%, P <.001), but in a very small number of patients (n = 10) neither was sensitive for a leak if the patient had a proximal colonic anastomosis [47]. CT can also help diagnose other causes of postoperative abdominal pain, including omental infarction or torsion [54]. Although IV contrast can help define and characterize postoperative fluid collections, in patients with severe renal insufficiency CT without IV contrast, but with positive oral

contrast, it can be used as a substitute to screen for fluid collections and anastomotic leaks. Similarly, in patients with recent renal or liver transplantation in whom IV contrast cannot be administered, CT with oral contrast can be used to evaluate for intra-abdominal abscesses. CT with and without IV contrast typically is not necessary for this indication. Contraindications are not considered in the appropriateness assessment.

MRI Abdomen and Pelvis

There are no recent studies evaluating the use of MRI in the setting of nonlocalized abdominal pain and fever in the postoperative patient. CT is most commonly performed; however, MRI can be an accurate examination for detecting abdominal and pelvic abscesses when the image acquisition is optimized [35]. Although not specifically performed in postoperative patients, a retrospective review of 29 patients with known abscesses who underwent MRI admixed with 29 patients with simple noninfected ascites, MRI demonstrated 100% accuracy for 2 observers in the detection of abdominal abscesses in examinations performed with standard T2-weighted and postcontrast T1-weighted sequences. Interestingly, there were similar sensitivities for 2 observers when the images were reviewed with only T2-weighted and diffusion-weighted imaging (100% for observer 1, and 96.6% for observer 2), demonstrating the feasibility to detect and discriminate infected from noninfected fluid on noncontrast MRI [38]. In addition to appendicitis detection, in the retrospective study by Singh et al [37], the authors were able to detect 5 abscesses (2 tubo-ovarian abscesses) in female patients who underwent MRI presenting with acute pelvic pain. In their prospective evaluation of noncontrast, rapid acquisition half-Fourier acquisition single-shot turbo spin-echo MRI in patients presenting with acute abdominal pain, Byott and Harris [36] demonstrated an overall accuracy of 99% (463 of 468 patients), including detection of diverticular and renal abscesses.

The accuracy of MRI in detecting anastomotic leaks has not been studied.

US Abdomen

There are no recent studies evaluating the use of US in the setting of nonlocalized abdominal pain and fever in the postoperative patient. US may be difficult to perform in the region of surgery, as postoperative pain, superficial staples and bandages may limit the sonographer's ability to evaluate the area of surgery. In addition, in those patients with a postoperative ileus, artifact related to overlying bowel gas may obscure visualization of deeper soft tissues. An older prospective study comparing accuracy of US, CT, radiography, and scintigraphy in the evaluation of abdominal abscesses in 40 patients, many of whom were postoperative, demonstrated US to have an overall accuracy of approximately 60% and negative predictive value of 55%, compared with postcontrast CT accuracy of 82% and negative predictive value of 77% [55]. With regards to the detection of abscesses in general, US can be useful in specific indications, but one retrospective review of 92 patients who underwent multiple studies to specifically evaluate for an intra-abdominal abscess demonstrated a sensitivity and specificity for US of 75% and 91% compared to 88% and 93%, respectively, for CT [39]. The authors concluded that CT was the only test that was necessary for abscess localization.

FDG-PET/CT Skull Base to Mid-Thigh

There are limited recent studies evaluating the use of nuclear medicine imaging in the setting of nonlocalized abdominal pain and fever in the postoperative patient. FDG-PET/CT is useful in the workup of nonlocalized fevers of unknown origin, but in the setting of recent abdominal or pelvic surgery, normal postoperative inflammation could lead to false-positive results. As such, FDG-PET/CT could be used in a complementary fashion to other imaging studies when correlated with relevant surgical and clinical information and when other imaging studies are negative or inconclusive [42].

Nuclear Medicine

Older studies performed in the 1980s to 1990s suggested gallium scans and indium and technetium leukocyte scans are useful in evaluating abdominal infections and abscesses when the CT scan is negative or equivocal [43-45]. However, it is important to recognize that CT technology has significantly advanced since these studies were published. Older literature on technetium-labeled leukocytes also suggested a very high sensitivity and specificity for abdominal abscesses as well, although there are no adequate recent comparisons with CT [46]. In the setting of recent hepatobiliary surgery and specific concern for biliary ductal injury, cholescintigraphy can confirm the presence of a bile leak.

Variant 3: Acute nonlocalized abdominal pain. Neutropenic patient. Initial imaging.

In neutropenic patients, abdominal pain remains a diagnostic challenge because of the lack of classic clinical and laboratory signs of intra-abdominal disease [8]. Therefore, the diagnosis of acute abdomen may be delayed in these patients [7]. Neutropenia is being encountered more commonly in clinical practice and may be because of

cytotoxic chemotherapy or immunosuppressive therapy. Colitidies and enteritidies are commonly found in this patient population, including clostridium difficile colitis, cytomegalovirus colitis, graft-versus-host disease, neutropenic enterocolitis, and bowel ischemia and perforation [8,56]. One study reported the most frequent causes of abdominal pain are neutropenic enterocolitis (28%) and SBO (12%) [8]. Atypical and opportunistic infections, chemotherapeutic-related mucosal injury, and tumors can all result in bowel pathology, and are commonly approached with IV contrast-enhanced CT as the initial imaging modality.

Radiography Abdomen
There are no recent studies that evaluate the use of radiography in the setting of acute nonlocalized or diffuse abdominal pain in the neutropenic patient. Radiography demonstrates low overall sensitivity in the detection of colitidies and enteritidies, and even low-dose CT demonstrates superior diagnostic yield in comparison with abdominal radiography [16]. Many authors suggest that radiographs have a limited role in the evaluation of nontraumatic abdominal pain in adults [17-22].

Fluoroscopy Contrast Enema
There are no recent studies evaluating the use of contrast enema in the setting of acute nonlocalized or diffuse abdominal pain in the neutropenic patient.

Fluoroscopy Upper GI with SBFT
There are no recent studies evaluating the use of upper GI series with SBFT in the setting of acute nonlocalized or diffuse abdominal pain in the neutropenic patient. CT is often the initial imaging study to diagnose small bowel pathology in the immunocompromised patient, but occasionally barium studies may offer additional complementary information when mucosal lesions are small.

CT Abdomen and Pelvis
CT with IV contrast is extremely useful in the evaluation of the neutropenic patient with abdominal pain secondary to its high spatial resolution and ability to display key imaging features [57]. Infectious and inflammatory processes of the small bowel and colon are well depicted by CT with IV contrast, which offers the additional advantage of depicting abscesses or perforations. Given the frequency of neutropenic enterocolitis (28%) and SBO (12%) in this setting, and as neutropenic enterocolitis is largely managed nonsurgically, an early and accurate diagnosis with CT can avoid unnecessary surgery and initiate appropriate medical management [8]. In addition, other abdominal infections, chemotherapeutic-related mucosal injury, and visceral tumors may be depicted by CT. CT without IV but with positive oral contrast can be used as an alternative if patients have severe renal insufficiency or a history of iodinated contrast allergies. Contraindications are not considered in the appropriateness assessment. Multiphasic CT imaging offers little additional benefit in absence of specific clinical indications related to liver or kidneys.

MRI Abdomen and Pelvis
There are no recent studies available to evaluate the use of MRI in acute nonlocalized or diffuse abdominal pain in the neutropenic patient. Although MRI with contrast may be used to evaluate SBO [58], there are no studies available to evaluate its diagnostic accuracy for neutropenic enterocolitis or other common colitidies or enteritidies in the neutropenic patient. MRI with contrast offers high soft-tissue contrast and the ability to administer gadolinium in patients with a history of allergic reaction to iodinated contrast material [58]. Specialized protocols (MR enterography or colonography) exist to interrogate the small bowel and colon and are mostly designed for use in patients with history of inflammatory bowel disease in the nonemergent setting. For clinically stable patients who are not able to undergo CT and in whom the bowel is a primary diagnostic consideration, MRI without and with contrast (and in particular MR enterography) may be an alternative imaging option.

US Abdomen
There are no recent studies available for the evaluation of US in the setting of acute nonlocalized abdominal pain in the neutropenic patient. US may serve as a fast way of evaluating the liver, kidneys, and biliary tree, including the evaluation of HIV cholangiopathy. In the HIV-infected patient presenting with prolonged fever, one study demonstrated abdominal US successfully identifies liver lesions and splenic microabscesses in 14% of the presenting population [59].

Nuclear Medicine and FDG-PET/CT Skull Base to Mid-Thigh
There are no recent studies evaluating the use of nuclear medicine imaging in the setting of acute abdominal pain in the neutropenic patient, and there are no specific indications for its use in this setting. Because of its whole

body imaging and sensitivity for infectious, inflammatory, and neoplastic processes, FDG-PET/CT is useful in the setting of nonlocalized fevers of unknown origin, particularly if previous cross-sectional imaging has not yielded a source [42]. In addition, cholescintigraphy may have a role if there is specific concern regarding gallbladder or other hepatobiliary disease. Refer to the ACR Appropriateness Criteria® topic on "Right Upper Quadrant Pain" for further discussion [9].

Variant 4: Acute nonlocalized abdominal pain. Not otherwise specified. Initial imaging.

The causes of nonlocalized, nontraumatic abdominal pain are extensive, and, as such, imaging needs to be broad enough to visualize the entire abdomen and pelvis, screening for visceral, solid organ, and vascular abnormalities. Imaging strategies are similar to those in patients who have concomitant fever, as many of the sources of pain overlap. CT is frequently performed first.

Radiography Abdomen

Although conventional radiographs are commonly performed, studies have shown that they have a limited role in the evaluation of nontraumatic abdominal pain in adults [17-22]. Although one study indicated that they could be useful in the setting of bowel obstruction and constipation [17], these are recommended only if a positive result will prevent subsequent imaging. In a study of 874 patients who underwent abdominal radiography in a nontrauma ED, abdominal radiography was helpful in changing clinical management in only 4% of patients [18]. Another large study demonstrated no significant change in accuracy when abdominal radiographs were used in conjunction with clinical diagnoses compared to clinical diagnoses alone [60]. Two studies have shown that low-dose CT can provide better clinical information than abdominal radiographs, which are positive in only approximately 20% of patients [16,17]. One of these studies, done with only twice the radiation dose of an abdominal radiograph and without oral or IV contrast, showed that low-dose CT can make the correct diagnosis in 64% of patients [16]. For recommendations in the setting of known or suspected SBO, refer to the ACR Appropriateness Criteria® topic on "Suspected Small-Bowel Obstruction" [13].

Fluoroscopy Contrast Enema

There are no recent studies evaluating the use of contrast enema imaging in the setting of nonlocalized abdominal pain, and there are no specific indications for its use in this setting. Endoscopy is the preferred initial examination of the stomach and colon in patients suspected of having inflammatory bowel disease.

Fluoroscopy Upper GI with SBFT

There are no recent studies evaluating the use of upper GI series with SBFT in the setting of nonlocalized abdominal pain, and there are no specific indications for its use in this setting. Abdominal CT and CT or MRI enterography are the recommended studies in evaluation of the small bowel in suspected Crohn disease. Refer to the ACR Appropriateness Criteria® topic on "Crohn Disease" for further discussion [11].

CT Abdomen and Pelvis

CT can be performed without and/or with IV contrast and with or without oral contrast, depending on localizing symptoms and/or laboratory findings. In general, a single-phase IV contrast-enhanced examination is performed as additional precontrast and postcontrast images are not required for diagnosis. Abdominal CT without the use of oral or IV contrast has been advocated as an alternative to abdominal radiographs for evaluating appendicitis [17,24]. However, the use of IV contrast increases the spectrum of detectable pathology [25,26]. Unless otherwise specified, the subsequent discussion of CT refers to IV contrast-enhanced CT. Contraindications are not considered in the appropriateness assessment.

Many institutions no longer routinely use oral contrast because of the associated delay in scan acquisition and departmental and ED throughput balanced against questionable diagnostic advantage [27-30]. Positive oral contrast may help improve confidence in identifying bowel-related pathology; however, advances in CT technology with multiplanar reformations can also improve diagnostic confidence in patients with abdominal pain [61-63].

Several studies have shown that CT improves the final diagnosis and management of patients who present with abdominal pain [5,24,31,64-67]. A prospective trial of 547 patients presenting to the ED with abdominal pain demonstrated that CT altered the diagnosis in 54% of patients and frequently changed disposition patterns, with a greater proportion of patients discharged in lieu of admission for observation [68]. Other studies have shown that CT outperforms clinical diagnosis [69,70]. Additionally, the use of CT in patients with acute abdominal pain

increases the ED clinician's level of certainty, reduces hospital admissions by 24% [26], and is associated with decreased 30-day patient revisit rates [71].

In a prospective study of 584 ED patients presenting with nontraumatic abdominal pain, CT was shown to change the diagnosis, improve diagnostic certainty, and affect potential patient management decisions [31]. In this study, CT was used to alter the leading diagnosis in 49% of the patients and increase mean physician diagnostic certainty from 70.5% (pre-CT) to 92.2% (post-CT). The management plan was changed by CT in 42% of the patients. In another study of 522 young adult patients presenting to the ED with abdominal pain, no laboratory test was sufficient to offer reassurance that a CT was not necessary [72]. One retrospective study evaluating 333 ED patients with acute abdominal pain and an abdominal CT demonstrated no significant difference in accuracy if the radiologist was blinded to relevant clinical or laboratory information (approximately 85%) [73]. CT is highly accurate in determining the site of visceral perforation, particularly in the setting of upper intestinal perforation, which could impact the surgical approach [74].

With an aging United States population and the relatively high frequency of ED presentations for acute abdominal pain, multiple recent studies have looked at the imaging evaluation of elderly patients, particularly the range of diagnoses and the use of abdominal CT. Depending on the article, elderly is defined as ranging from >65 years of age to >80 years of age. In this subset of the population, many laboratory tests are nonspecific and may be normal despite serious abnormalities [4-6]. Many authors advocate for liberal use of CT in elderly patients [4,75,76]. The most common causes of abdominal pain in elderly patients undergoing a CT examination are different than those in younger patients. One retrospective study looked at the use of CT in 464 patients >80 years of age and found the most common diagnoses were SBO (18%), diverticulitis (9%), nonischemic vascular emergencies including abdominal aortic aneurysm and dissection (6%), bowel ischemia (4%), appendicitis (3%), and colonic obstruction (2%). These diagnoses were clinically unsuspected in 43% of patients [4]. Another study evaluating the incidence of acute mesenteric ischemia in patients >75 years of age demonstrated a high age-specific incidence in this population, with a greater incidence of acute mesenteric ischemia than acute appendicitis or ruptured abdominal aortic aneurysms. These patients often have a nonspecific presentation and authors suggest use of dual-phase (arterial and portal venous phase) CT with contrast to ensure adequate evaluation of mesenteric vasculature in all patients >75 years of age presenting with acute abdominal pain [75].

In patients with intestinal ischemia, CT can detect vessel thrombosis, intramural or portal gas, and lack of bowel wall enhancement. CT angiography is the preferred modality when mesenteric ischemia is suspected; however, if clinical presentation is less specific, a routine IV contrast-enhanced abdominal CT will screen for findings of ischemia and evaluate for other pathologies. Reduced segmental bowel-wall enhancement has been shown to be 100% specific for segmental bowel ischemia [77], stressing the importance of IV contrast material administration in this setting. Refer to the ACR Appropriateness Criteria® topic on "Imaging of Mesenteric Ischemia" [78] for further discussion.

Although CT has a very high value in the setting of acute abdominal pain, it is important to note some factors that can influence the decision to obtain a CT. One randomized controlled trial looking at the impact of obtaining a CT scan in all patients presenting to the ED with acute abdominal pain showed higher treatment costs in patients when the CT was obtained randomly compared to patients with CT performed for specific clinical indications; the results of this study suggest that abdomen and pelvic CTs should be obtained when indicated by clinical suspicion [79]. Cost is not considered in the appropriateness assessment for this document. Attempts to lower radiation dose by decreasing the area covered based on patients' symptoms revealed that this approach visualized all acute pathology in only 33% of abnormal cases, with potential for an unacceptably high rate of misdiagnosis [80]; thus, often the entire abdomen and pelvis are scanned. A retrospective study of 200 patients showed that repeat abdominal CT after initially negative CT(s) performed for nontraumatic abdominal pain has a low diagnostic yield, dropping from 22% on initial presentation to 5.9% on the fourth CT or greater; clinical factors that may predict higher diagnostic CT yield are leukocytosis and APACHE-II scores [81]. A retrospective study of 574 patients with abdominal pain, a subset of which (124 patients) had concomitant diarrhea, found that CT changed management in 53% of patients solely with abdominal pain, but in only 11% of patients with concomitant diarrhea, stressing a "thoughtful approach" to CT imaging in this setting [82]. In addition, a retrospective analysis of 127 patients with nonspecific upper abdominal pain showed a negative predictive value for CT to be relatively low at 64%, with more commonly missed diseases to include pancreaticobiliary inflammatory processes as well as gastritis and duodenitis [83]. In the setting of pregnancy, CT may have a role, particularly if the scenario is emergent and MRI is not readily available and/or when US findings are nondiagnostic or equivocal.

MRI Abdomen and Pelvis

MRI has been shown to provide clinically useful information for rapid diagnosis of acute bowel pathology [35,58,84,85] and the following gynecological emergencies: ovarian hemorrhage, ectopic pregnancy, tumor rupture, torsion, hemorrhage, infarction, and pelvic inflammatory disease [36,86,87]. Although MRI has longer acquisition times relative to CT, improvements in technology combined with tailored abdominal protocols could be performed in 10 minutes or less [36,88]. One prospective study looking at the use of noncontrast MRI in 468 patients with acute abdominal pain (excluding renal colic), with an image acquisition time of under 2 minutes, showed an overall accuracy of 99% in diagnosing diseases ranging from acute bowel inflammation, obstruction, and pancreaticobiliary diseases, to renal inflammation and gynecological processes [36]. In the setting of acute pelvic pain, MRI with contrast can accurately diagnose acute appendicitis, ovarian torsion, and other adnexal diseases [37]. Because useful information can be obtained without contrast, MRI, when available, has been shown to be a reliable next step following US in the imaging of pregnant patients [89]. MRI is becoming a favored, invaluable problem-solving modality used in the imaging of pregnant patients because it avoids many of the drawbacks of US and CT. The ratings of MRI for this variant presume the patient is not pregnant.

US Abdomen

US can be used to screen the abdomen for sources of abdominal pain. In the nonpregnant adult patient, it has been suggested that obtaining a US followed by CT in patients with negative or inconclusive results offers the best sensitivity for disease [60]. In addition, US may be useful in selected localizing conditions, including cholecystitis, cholangitis, liver abscess, diverticulitis, appendicitis, and small-bowel inflammation, where it may be used to assess activity of Crohn disease [41,90-93]. Although not frequently used for this indication, some small studies suggest US maybe more sensitive and specific than abdominal radiographs in the diagnosis of suspected SBOs and can have a similar sensitivity to CT in specialized centers [41,94]. Although US may be able to depict portions of an abscess or malignancy (such as lymphoma), it is not optimized to view many areas of the abdomen, particularly in the presence of increased bowel gas or free intraperitoneal air. In spite of these shortcomings, US may be useful in this setting in the initial imaging of younger patients [60].

In the pregnant patient, most necessary diagnostic information in the evaluation of nontraumatic abdominal pain can be obtained with US as the primary imaging modality. Appendicitis is the most common cause of abdominal pain requiring emergent surgery in the pregnant patient [95]. Although in a nonpregnant patient the pain may follow a more reliable pattern (periumbilical or right lower quadrant), the location of pain may not correlate with presence of appendicitis in pregnant patients [86]. US is frequently the first imaging modality used in this scenario. Refer to the ACR Appropriateness Criteria® topic on "Right Lower Quadrant Pain–Suspected Appendicitis" for further discussion [12]. Other causes of nontraumatic abdominal pain in pregnant women include urinary tract infection, urolithiasis, ectopic pregnancy, ovarian torsion, adnexal masses, placental abnormalities, acute cholecystitis, pancreatitis, or inflammatory bowel disease. Many of these can be diagnosed with US, and for equivocal findings, may be followed by noncontrast MRI [89]. The ratings of US for this variant presume the patient is not pregnant.

Nuclear Medicine

In general, there are limited studies evaluating the use of nuclear medicine imaging in the setting of nonlocalized abdominal pain with or without fever. Cholescintigraphy may have a role if there is specific concern regarding gallbladder or other hepatobiliary disease. Refer to the ACR Appropriateness Criteria® topic on "Right Upper Quadrant Pain" for further discussion [9].

Summary of Recommendations

- **Variant 1:** In the setting of nonlocalized abdominal pain and fever, CT of the abdomen and pelvis with IV contrast is usually appropriate to evaluate for abdominal abscesses and a broad range of additional pathologies.
- **Variant 2:** In the setting of nonlocalized abdominal pain and fever in the postoperative patient, CT of the abdomen and pelvis with IV contrast is usually appropriate to evaluate for postoperative abscesses, leaks, or hemorrhage.
- **Variant 3:** In the setting of abdominal pain and neutropenia, CT of the abdomen and pelvis with IV contrast is usually appropriate to evaluate for atypical and opportunistic abdominal infections, visceral pathologies, and tumors.

- **Variant 4:** In the setting of nonlocalized abdominal pain not otherwise specified, CT of the abdomen and pelvis with IV contrast is usually appropriate and can screen for a broad range of pathologies. CT of the abdomen and pelvis without IV contrast is appropriate if the patient is unable to receive IV contrast. MRI of the abdomen and pelvis without and with IV contrast can also be used to provide clinically useful information in this clinical setting.

Summary of Evidence

Of the 96 references cited in the ACR Appropriateness Criteria® *Acute Nonlocalized Abdominal Pain* document, 2 are categorized as therapeutic references including 2 quality studies that may have design limitations. Additionally, 93 references are categorized as diagnostic references including 2 well-designed studies, 16 good-quality studies, and 34 quality studies that may have design limitations. There are 41 references that may not be useful as primary evidence. There is 1 reference that is a meta-analysis study.

The 96 references cited in the ACR Appropriateness Criteria® *Acute Nonlocalized Abdominal Pain* document were published from 1985 to 2017.

Although there are references that report on studies with design limitations, 18 well-designed or good-quality studies provide good evidence.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

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 [96].

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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