American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Acute Pancreatitis**

Variant 1: **First time presentation, typical abdominal pain, and increased amylase and lipase with high clinical certainty of diagnosis; <48–72 hours after onset of symptoms; clinical score irrelevant; unknown cause.**

Radiologic Procedure	Rating	Comments	RRL*
US abdomen	9	This is essential to assess for gallstones with the first episode of acute pancreatitis; secondarily, it can be used to assess for choledocholithiasis.	O
CT abdomen with IV contrast	4	Select this only if US is nondiagnostic because of obesity, gas, etc. See variant 4 for use in equivocal or uncertain cases; results generally do not alter initial management; it can miss or underestimate necrosis.	☢☢☢
MRI abdomen without IV contrast with MRCP	4	This is useful if US is nondiagnostic or choledocholithiasis is suspected; generally, it is not used at initial presentation.	O
MRI abdomen without and with IV contrast with MRCP	4		O
CT abdomen without IV contrast	3	Select this only if iodinated contrast cannot be administered and if MR is not possible.	☢☢☢
CT abdomen without and with IV contrast	3		☢☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 2: **Critically ill, systemic inflammatory response syndrome (SIRS), severe clinical scores (eg, acute physiology and chronic health evaluation [APACHE], bedside index of severity in acute pancreatitis score (BISAPS), and/or Marshall); >48–72 hours after onset of symptoms.**

Radiologic Procedure	Rating	Comments	RRL*
CT abdomen with IV contrast	8	This is the single best, most practical examination.	☢☢☢
MRI abdomen without and with IV contrast with MRCP	7	This is a reasonable alternative to CT abdomen with contrast, but it is not as practical or easy to perform in critically ill patients.	O
MRI abdomen without IV contrast with MRCP	6	If acute kidney injury (AKI) exists, this is preferred over CT abdomen without contrast.	O
US abdomen	6		O
CT abdomen without IV contrast	5	Select this only if rapid examination is needed, if MR is not practical or possible, and if iodinated contrast is contraindicated.	☢☢☢
CT abdomen without and with IV contrast	4	Without contrast portion of examination, this is generally not necessary.	☢☢☢☢
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 Pancreatitis**

Variant 3: **Continued SIRS, severe clinical scores, leukocytosis, and fever; >7–21 days after onset of symptoms.**

Radiologic Procedure	Rating	Comments	RRL*
CT abdomen with IV contrast	9		☢☢☢
CT abdomen without and with IV contrast	7	There may be reasons for a noncontrast portion of examination, but it is generally not necessary.	☢☢☢☢
MRI abdomen without and with IV contrast with MRCP	7	This is a reasonable alternative to CT but not as practical or easy to perform on acutely ill patients.	O
CT abdomen without IV contrast	6	Select this only if rapid examination is needed, if MR is not practical or possible, and if iodinated contrast is contraindicated.	☢☢☢
MRI abdomen without IV contrast with MRCP	6		O
US abdomen	5		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 4: **Initial presentation with atypical signs and symptoms, including equivocal amylase and lipase values (possibly confounded by AKI or chronic kidney disease) and when diagnoses other than pancreatitis may be possible (bowel perforation, bowel ischemia, etc).**

Radiologic Procedure	Rating	Comments	RRL*
CT abdomen with IV contrast	8	This is overall the best survey for equivocal or uncertain presentations when other diagnoses are possible.	☢☢☢
CT abdomen without IV contrast	7	This is a reasonable, rapid examination if contrast administration is not possible or safe.	☢☢☢
MRI abdomen without and with IV contrast with MRCP	6	This may not be as efficacious as CT, especially if bowel ischemia is in the differential diagnosis.	O
CT abdomen without and with IV contrast	5		☢☢☢☢
MRI abdomen without IV contrast with MRCP	5	The addition of contrast is preferred; this has a limited role in equivocal cases without contrast.	O
US abdomen	5	This is not a generalized survey; it is more focused on the right upper quadrant.	O
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 Pancreatitis**

Variant 5: **Known necrotizing pancreatic and peripancreatic pancreatitis, significant deterioration in clinical status, including abrupt decrease in hemoglobin/hematocrit, hypotension, tachycardia, tachypnea, abrupt change in fever curve, or increase in white blood cells; time after symptom onset irrelevant.**

Radiologic Procedure	Rating	Comments	RRL*
CT abdomen with IV contrast	9	This is the single best, most practical examination.	☢☢☢
CT abdomen without IV contrast	7	This is a reasonable, rapid examination if contrast administration is not possible or safe.	☢☢☢
MRI abdomen without and with IV contrast with MRCP	6	This is not as rapid or practical as CT; it is more difficult to perform in acutely ill patients.	O
MRI abdomen without IV contrast with MRCP	6	This examination is more limited without intravenous contrast enhancement.	O
CT abdomen without and with IV contrast	5		☢☢☢☢
US abdomen	5		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

ACUTE PANCREATITIS

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Summary of Literature Review

Introduction/Background

The focus of this document is on the diagnosis and subsequent assessment of patients with suspected or known acute pancreatitis. The proposed guidelines are based on the severity, timing, and natural history of the disease and emphasize the role of imaging in patients with this disease. Although the document does not focus on image-guided intervention or the specifics of the imaging findings, these aspects are mentioned as they are essential in the image-centric approach to the disease.

An estimated 210,000 admissions for acute pancreatitis occur each year in the United States. [1,2]. Acute pancreatitis is clinically described as nonsevere (or mild) and severe [2]. Nonsevere pancreatitis is generally seen only in interstitial edematous pancreatitis, and severe pancreatitis is generally seen only in necrotizing pancreatitis, including glandular and peripancreatic fat necrosis [1,2]. Interstitial edematous pancreatitis is severe in only 1%–3% of patients [3].

The Atlanta Classification by the Acute Pancreatitis Classification Working Group recently modified the terminology for the clinical course and the morphologic changes identified on imaging, primarily contrast-enhanced multidetector computed tomography (MDCT) [2,4-6]. The 2 distinct clinical courses of the disease are classified as (1) early phase, which lasts approximately 1 week, and (2) late phase, which starts after the first week and can last for months after the initial episode. The timing of imaging, primarily contrast-enhanced MDCT, is based on the clinical phases and is, therefore, important for these imaging guidelines. During the early phase of the disease, patient care is supportive and independent of imaging findings. Clinical scoring methods that can be easily performed and validated are used to facilitate patient care independent of imaging (as referenced). The modified terminology is based on changes in the pancreatic parenchyma vis-à-vis enhancement as well as fluid collections associated with pancreatitis. The reclassification of the clinical course and terminology for the morphological changes emphasizes both the timing and importance of imaging.

Determinants of the natural course of acute pancreatitis are multisystem organ failure, pancreatic parenchymal necrosis, extrapancreatic mesenteric and/or peripancreatic, retroperitoneal fatty tissue necrosis, biologically active compounds in pancreatic ascites, infection of necrosis, and clinical factors including age and obesity [1]. Early in the course of acute pancreatitis, multiple organ failure can result from inflammatory mediators released in the inflammatory process from activated leukocytes attracted by pancreatic injury; this is also known as systemic inflammatory response syndrome (SIRS) [1]. Local and systemic septic complications can occur at least 1 week after presentation.

Pancreatic inflammation may result in enlargement of the pancreas, peripancreatic inflammation with or without fluid, solitary or loculated fluid collections, vascular compromise of adjacent arteries and veins, necrosis of pancreatic parenchyma, necrosis of peripancreatic fat, and subsequent infection in any of these inflammation sites. Distant organ complications can lead to organ failure, protracted course, and death [1]. Clinical scoring systems and imaging findings are used to predict these complications in patients [1,2,5,7].

Clinical scoring systems are very useful in assessing SIRS and organ failure, especially in patients with early presentation of acute pancreatitis [1,5,7-9]. SIRS is defined by a pulse >90 beats per minute, respiration >20 per minute or PaC02 <32 mm Hg, temperature >100.4°F or <96.8°F, and a white blood cell count >12,000 or <4,000

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cells/mm³. Commonly used scoring systems include acute physiology and chronic health evaluation (APACHE), Marshall, and the bedside index of severity in acute pancreatitis, which evaluates blood urea nitrogen, impaired mental status, SIRS, age, and pleural effusion (BISAP). Systemic complications contribute substantially to early morbidity and mortality associated with acute severe pancreatitis [1]. Other laboratory values have been helpful in assessing the severity of pancreatitis, including the hemoglobin level. High levels suggest hemoconcentration and have been associated with third spacing of fluids and adverse outcomes [1].

Acute pancreatitis is suspected in patients presenting with epigastric and acute-onset upper abdominal pain that increases rapidly in severity and persists without relief. The intensity of the pain almost always results in the patient seeking medical attention. Differential diagnosis includes mesenteric ischemia, perforated ulcer, intestinal obstruction, biliary colic, and myocardial infarction, among others [1]. Serum amylase and/or lipase are used in diagnosing acute pancreatitis; levels are considered diagnostic when the reported value(s) is ≥3 times normal. The serum lipase level tends to remain elevated longer than the amylase level does, however both levels tend to normalize over time [1]. Serum enzyme levels do not correlate with the severity of the disease [1]. Consequently, clinical scoring systems and imaging tests have been advocated to classify patients in terms of severity. Furthermore, the diagnosis may be overlooked if the typical enzyme elevation is absent. Some patients with acute pancreatitis have no enzyme abnormalities [1]. As a result, there is growing acceptance that a diagnosis of acute pancreatitis now requires 2 of the following 3 features: (1) abdominal pain characteristic of pancreatitis, (2) serum amylase and/or lipase level ≥3 times normal, and (3) characteristic imaging findings on CT [1]. In many cases of acute pancreatitis, presenting with characteristic abdominal pain and appropriately elevated amylase and/or lipase, early enhanced CT is performed, regardless of whether the criteria for diagnosis have been met (see information for timing of imaging as follows). The justification for early scanning in these cases is weak and should be questioned (again, see as follows).

An important aspect of imaging patients with acute pancreatitis is to consider causes other than gallstones and alcohol. When patients have presented with idiopathic acute pancreatitis, the differential diagnosis should include ductal adenocarcinoma and intraductal, papillary mucinous neoplasms, both main ductal and side-branch. This is particularly important in patients who have had multiple episodes of idiopathic, acute pancreatitis. Assessing for these entities is often reserved for follow-up imaging after the pancreatic and peripancreatic changes have resolved. Nonetheless, neoplastic causes of acute pancreatitis must be considered in the initial evaluation, even when gallstones and alcohol are not etiologic agents.

Overview of Imaging Modalities

MDCT and scoring systems related to CT have been the most studied imaging tests used for evaluating patients with acute pancreatitis. However, other imaging tests can be used, including transabdominal ultrasound (US), endoscopic ultrasound (EUS), magnetic resonance imaging (MRI), and magnetic resonance cholangiopancreatography (MRCP) [10,11]. In patients with pancreatitis, imaging tests are performed for various reasons, including the detection of gallstones, detection of biliary obstruction, diagnosis of pancreatitis when the clinical situation is unclear, and detection and classification of the severity of the process and its complications [1,2,12].

Computed Tomography

MDCT is the primary imaging technique used to determine the extent of disease [12-19] in patients suspected of having acute pancreatitis to determine the extent of disease. CT can demonstrate morphological changes in the pancreas, confirm pancreatitis, and assess the severity of the disease [1,12]. It is the only imaging modality that has consistently shown clinical value in predicting the severity of the disease as well as clinical outcomes. The CT severity index (CTSI), in conjunction with other clinical scoring systems, is the basis for decision making related to patient care [12,16,17,19,20]. Patients with low CTSI have low morbidity and mortality rates and can be safely triaged out of intensive care [19]. The CTSI is based on (1) assessed changes in the pancreas, (2) associated acute fluid collections, and (3) the presence and amount of pancreatic necrosis (see Table 1) [12].

Table 1. Balthazar CT Severity Index	
CT Grade	**Score**
A. Normal	0
B. Enlarged gland	1
C. Peripancreatic inflammation	2
D. One fluid collection	3
E. Two or more collections	4
Necrosis	**Score**
<30%	(2)
30%–50%	(4)
>50%	(6)

Patients receive an overall score based on the CT grade and a score based on the presence and amount of necrosis. Scores ranging from 0 to 10 are possible. Patients with increased CTSI scores have been shown to have increased morbidity and mortality [21]. Multiple studies have confirmed the use of CTSI in assessing patient outcomes [12,16,17,19,20].

A modified CTSI has been proposed [22]. This scoring system adds extrapancreatic findings (ie, pleural effusions, ascites, etc.); reduces the classification of necrosis to none, <30%, and >30%; and simplifies the scoring of peripancreatic changes. A recent investigation showed no significant differences between the modified CT index and CTSI in assessing acute pancreatitis severity. It also reported that both indexes detect clinically severe disease more accurately, when compared with APACHE II [23].

Pancreatic necrosis is defined as focal or diffuse areas of hypoenhancing or nonenhancing pancreatic parenchyma after the administration of intravenous (IV) contrast material. The degree of necrosis is generally graded qualitatively as <30%, 30% to 50%, and >50%. To assess for possible pancreatic necrosis, IV contrast needs to be administered. There has been some controversy about IV contrast because it has been shown to impair microcirculation of the pancreas in rats that have acute necrotizing pancreatitis and to increase the severity of the disease [24,25]. These results, however, could not be reproduced in the opossum [26]. No prospective human trials have been published to date. Most experts believe the benefits of detecting necrosis outweigh any theoretical risk [1,2]. An advantage of CT over clinical scoring systems (eg, Ranson and APACHE II) is its direct visualization of the pancreas and the damage to the pancreas [12]. In addition, with CT it is easy to see the retroperitoneum and associated fluid collections [2].

Many factors contribute to determining the best time to perform CT in patients with acute pancreatitis [1,2]. In patients presenting with abdominal pain and elevated pancreatic enzymes, the pancreas may be entirely normal, a so-called Balthazar Grade A [12]. In these patients, the course of the disease tends to be very mild, with little morbidity and no mortality [12], and CT will have no effect on patient management or outcome. If CT is performed immediately after the initial event, pancreatic necrosis could be underestimated or missed entirely [1,2,12,27]. Thus, the initial CT will not accurately assess the presence or extent of the most important finding: glandular or peripancreatic fat necrosis.

However, in patients presenting with severe abdominal pain atypical for acute pancreatitis and/or when the amylase and lipase levels are equivocal, such as with acute kidney injury (AKI) or chronic kidney disease (CKD), an immediate CT may be useful in detecting the disease or alternative diagnoses, such as bowel ischemia.

In a recent study of a relatively large cohort of patients with acute pancreatitis, in whom enhanced CT was performed on admission, while the Balthazar grading system (any CT technique) and CTSI system were highly accurate for predicting the severity of disease, there were no statistical differences between the predictive accuracies of CT and clinical scoring systems [28]. The authors did not recommend CT on admission for severity assessment only. A recent Dutch investigation showed that early (<1 week after the onset of symptoms) scanning did not significantly alter patient management. Furthermore, in these early CTs, the number of examinations, the timing of the examinations, and the Balthazar CT score of these early CT's were not significantly different for mild and severe disease. Other investigations have shown that patients with acute pancreatitis often have multiple CT examinations, depending on the severity of the disease, without dramatic influence on clinical outcomes

[29,30]. These multiple scans lead to a relatively high radiation dose with only infrequent changes in clinical management [31].

There is growing evidence, and it is our opinion, that a CT is not indicated in the first 48 to 72 hours after the onset of symptoms in patients with an unequivocal clinical presentation and appropriately elevated amylase and lipase; it could lead to inappropriate conclusions. Further, because renal function is often compromised in patients with severe acute pancreatitis, enhanced CT should be reserved for times in the disease process when the findings will have a significant impact. Some advocate delaying initial contrast-enhanced CT for at least 7 to 21 days, even in critically ill patients, as it does not alter patient management. During the first phase of the disease (7–10 days after the onset of symptoms), treatment can be supported in the ICU.

Follow-up Computed Tomography

Another important issue is the timing for follow-up CT in patients with acute pancreatitis, especially in those with necrotizing pancreatitis. In the second phase of the disease, patients, especially those with necrosis, can have persistent leukocytosis, fever, multiorgan system dysfunction or failure, and SIRS. It is important to rescan these patients after 7 to 10 days to assess the size, extent, and character of the postnecrotic fluid collections and to plan for aspiration. In many institutions, in consultation with the gastroenterologist or surgeon caring for the patient, contrast-enhanced MDCT is used to examine patients with necrotizing pancreatitis and continued leukocytosis, fever, SIRS, and organ dysfunction or failure. In these cases, 1 or several of the identified postnecrotic fluid collections is aspirated for culture. Although image-guided aspiration and drainage of pancreatic and peripancreatic collections are an integral part of the image-centric approach to this disease, a discussion of their use is beyond the scope of these guidelines.. Another reason for using contrast-enhanced MDCT to re-examine patients is to evaluate those who have had significant decreases in hemoglobin or hematocrit or an abrupt deterioration in clinical status. In these patients, the identification of new, hemorrhagic components can explain the acute anemia and identify the cause, commonly a ruptured pseudoaneurysm. Lastly, there are uncommon to rare instances of bowel perforation in acute pancreatitis.

A potential limitation of MDCT in assessing acute pancreatitis is that it has only moderate sensitivity for detecting stones in the gallbladder and bile duct [32,33]. However, the biliary tree should be carefully inspected, and, if biliary dilation is present, isoattenuating stones should be suspected.

Ultrasound

Because of its high sensitivity for detecting gallstones, US is often performed when evaluating patients with acute pancreatitis [1,2]. This examination is indicated early in the disease in patients who present with acute pancreatitis for the first time, even when alcohol is the suspected cause. The purpose of the examination is primarily to identify gallstones and secondarily to identify biliary ductal dilation and/or choledocholithiasis. However, patients may have gallstones or another etiology of their pancreatitis. Moreover, stones in the distal common bile duct may be difficult to visualize with US. Finally, portions of the pancreas are often obscured by overlying bowel gas, which limits the effectiveness of US in assessing the severity of the pancreatitis and determining the presence and amount of necrosis [1,12].

Some centers have used contrast-enhanced US to evaluate patients with acute pancreatitis and found the technique equivalent to contrast-enhanced CT and clinical scoring [34,35]. However, the technique is operator-dependent, and US contrast agents are approved in the US for echocardiology only. Thus, this would be an off-label use.

Magnetic Resonance Imaging

The use of MRI in evaluating patients with acute pancreatitis is gaining acceptance [10,11,36-38]. Compared with other noninvasive imaging modalities, it offers several advantages, especially with heavily T2-weighted sequences for assessing biliary and pancreatic ducts. These advantages are as follows: (1) bile duct stones and gallstones can be seen easily, the pancreatic duct can be followed in its entirety, and duct disruption can often be assessed easily; and (2) its effectiveness for evaluating morphologic changes to the pancreas and peripancreatic regions is similar to that of MDCT [10,11,39]. An advantage of MRI, relative to MDCT, in evaluating peripancreatic fluid collections is that solid debris is more easily appreciated with MRI [40]. This finding can help distinguish pancreatitis-induced fluid collections from other cystic lesions and aid in the use of appropriate drainage techniques. Another advantage of MRI is that it does not use ionizing radiation.

When IV contrast cannot be administered (primarily because of AKI), the use of T2-weighted sequences can be very helpful in assessing the pancreatic duct and evaluating the presence of high-signal fluid that would suggest necrosis in the pancreatic parenchyma.

The disadvantages of MRI are as follows: (1) it is often not readily available in an acute setting; (2) it is more difficult to perform in acutely ill patients; and (3) the acquisition times are considerably longer than with MDCT. Further, percutaneous intervention cannot be as easily performed simultaneously with MRI as it can be with CT. However, MRI appears to offer diagnostic capabilities similar to MDCT, with a better depiction of the stones and the pancreatico-biliary ductal system.

Other Modalities

Endoscopic US and endoscopic retrograde cholangiopancreatography in the evaluation of acute pancreatitis are primarily used to assess and confirm choledocholithiasis and subsequent stone removal in patients with gallstone pancreatitis as well as to identify other anatomic abnormalities (eg, pancreas divisum, malignancy) that can lead to acute pancreatitis [41-44].

Summary

- In the acute setting (<48–72 hours after the onset of symptoms), an enhanced CT should not be performed when a typical clinical presentation and unequivocal elevations of amylase and lipase are present.
- In the acute setting, an enhanced CT should be performed if the clinical presentation and amylase and lipase levels are equivocal.
- Early (within the first 72 hours) imaging with CT may underestimate the full severity of the disease.
- Enhanced CT after 48–72 hours will detect pancreatic and peripancreatic necrosis as well as acute pancreatic fluid collections.
- Delayed enhanced CT (>7–21 days after the onset of symptoms) is very effective in assessing severity and will guide management, including image-guided aspiration and/or drainage as well as other forms of minimally invasive drainage.
- Enhanced CT should be performed when there is a significant deterioration of the patient's condition, including an acute drop in hemoglobin and hematocrit, tachycardia, and hypotension, an abrupt change in fever, or leukocytosis.
- CT with IV contrast provides the best overall assessment of the pancreas and complications related to pancreatitis.
- US is primarily used to assess for gallstones and should be performed early in patients who present for the first time and in whom the cause is uncertain.
- MRI with IV contrast and MRCP have the potential to be an all-inclusive examination for assessing pancreatitis; however, use may be limited in the acute setting.

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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The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.