Date of origin: 1998
Last review date: 2010

American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Acute Pancreatitis**

Variant 1: **Etiology unknown, first episode of pancreatitis; abdominal pain, elevated amylase lipase; no fever or evidence of fluid loss at admission; clinical score pending.**

Radiologic Procedure	Rating	Comments	RRL*
US abdomen	8	Primarily to assess for gallstones.	O
CT abdomen with contrast	8	Best test to assess pancreatic parenchyma.	☢☢☢
CT abdomen without contrast	6		☢☢☢
MRI abdomen without contrast including MRCP	6		O
MRI abdomen without (including MRCP) and with contrast	6	Can also demonstrate pancreatic parenchyma as well as ducts and gallstones. May be somewhat limited in acutely ill patients related to procedure time. See statement regarding contrast in text under "Anticipated Exceptions."	O
US abdomen endoscopic	4		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 2: **Severe abdominal pain, elevated amylase lipase, 48 hours later assuming no improvement or degradation (assume no prior imaging).**

Radiologic Procedure	Rating	Comments	RRL*
CT abdomen with contrast	8	Generally easier access to this modality.	☢☢☢
MRI abdomen without (including MRCP) and with contrast	8	Allows evaluation for choledocholithiasis. See statement regarding contrast in text under "Anticipated Exceptions."	O
MRI abdomen without contrast including MRCP	7		O
CT abdomen without contrast	6		☢☢☢
US abdomen	6		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 3: **Severe abdominal pain, elevated amylase lipase, fever, and elevated white blood cell count.**

Radiologic Procedure	Rating	Comments	RRL*
CT abdomen with contrast	9		☢☢☢
MRI abdomen without (including MRCP) and with contrast	7	See statement regarding contrast in text under "Anticipated Exceptions."	O
CT abdomen without contrast	6		☢☢☢
MRI abdomen without contrast including 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: **Severe abdominal pain, elevated amylase lipase, hemoconcentration, oliguria, tachycardia.**

Radiologic Procedure	Rating	Comments	RRL*
CT abdomen with contrast	8		☢☢☢
CT abdomen without contrast	7		☢☢☢
MRI abdomen without (including MRCP) and with contrast	7	See statement regarding contrast in text under "Anticipated Exceptions."	O
MRI abdomen without contrast including 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**

ACUTE PANCREATITIS

Expert Panel on Gastrointestinal Imaging: Michael Macari, MD[1]; Max Paul Rosen, MD, MPH [2]; Michael A. Blake, MB, BCh[3]; Mark E. Baker, MD[4]; Brooks D. Cash, MD[5]; Jeff L. Fidler, MD[6]; Frederick L. Greene, MD[7]; Bronwyn Jones, MD[8]; Douglas S. Katz, MD[9]; Tasneem Lalani, MD[10]; Frank H. Miller, MD[11]; William C. Small, MD, PhD[12]; Gary S. Sudakoff, MD[13]; Judy Yee, MD.[14]

Summary of Literature Review

This document focuses on the diagnosis and initial evaluation of patients with suspected or known acute pancreatitis. It does not address interventional procedures or documentation of complications such as abscess, pseudocyst, or pseudoaneurysm.

Background

It is estimated that there are approximately 210,000 admissions for acute pancreatitis each year in the U.S. [1-2]. Acute pancreatitis is divided clinically into nonsevere (previously called mild) and severe pancreatitis [2]. Nonsevere pancreatitis represents interstitial edematous pancreatitis, and severe pancreatitis manifests as necrotizing pancreatitis or as pancreatitis associated with organ failure [1-2]. The terminology for fluid collections associated with acute pancreatitis is evolving and currently includes the entities acute peripancreatic fluid collection, postnecrotic fluid collection, walled-off pancreatic necrosis, and pancreatic pseudocyst [2]. For an update on the definitions of these various fluid collections refer to a recent publication on imaging of acute pancreatitis and its complications [2]. For an update on the terms used to define acute pancreatitis and management issues refer to the revision of the Atlanta Classification Working Group on Acute Pancreatitis [3].

Determinants of the natural course of acute pancreatitis are multisystem organ failure, pancreatic parenchymal necrosis, extrapancreatic 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 is the consequence of various inflammatory mediators that are released from the inflammatory process and from activated leukocytes attracted by pancreatic injury, the so-called systemic inflammatory response syndrome (SIRS) [1]. Local and systemic septic complications, when they occur, typically do so at least a week after presentation.

Pancreatic inflammation may result in enlargement of the gland, peripancreatic inflammation with or without fluid, solitary or loculated fluid collections, vascular compromise of adjacent arteries and veins, necrosis of pancreatic parenchyma, and subsequent infection in any of the above sites of inflammation. Distant organ complications can lead to organ failure, protracted course, and death [1]. Prediction of which patients will develop these complications is achieved through clinical scoring systems and imaging findings [1-2,4-5]. Choice of scoring system is beyond the scope of these recommendations.

Clinical scoring systems are very useful, especially in the early presentation of patients with acute pancreatitis, in assessing for SIRS and organ failure [1,4-5]. Systemic complications contribute substantially to the early morbidity and mortality associated with acute severe pancreatitis [1]. A number of other laboratory values have proven 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 outcome [1].

Acute pancreatitis is suspected in patients presenting with epigastric and upper abdominal pain that is acute in onset, rapidly increasing in severity, and persistent 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 levels can be considered diagnostic when the reported value(s) is ≥3 times normal. The serum lipase level tends to remain elevated longer than does the amylase level; however, over time both levels tend to normalize [1]. Of note is that 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 individual patients in terms of severity. Furthermore, the diagnosis may be overlooked in the absence of typical enzyme elevation; in some patients, acute pancreatitis may be present in the absence of enzyme abnormalities [1]. As a result there is growing acceptance that the diagnosis of acute pancreatitis now requires two of the following three features: 1) abdominal pain characteristic of pancreatitis, 2) serum amylase and or lipase level ≥3 times normal, and 3) characteristic imaging findings on computed tomography (CT) [1].

[1]Principal Author, Tisch Hospital, New York, New York.
[2]Panel Chair, Beth Israel Deaconess Medical Center, Boston, Massachusetts.
[3]Panel Vice-chair, Massachusetts General Hospital, Boston, Massachusetts.
[4]Cleveland Clinic, Cleveland, Ohio.
[5]National Naval Medical Center, Bethesda, Maryland, American Gastroenterological Association.
[6]Mayo Clinic, Rochester, Minnesota.
[7]Carolinas Medical Center, Charlotte, North Carolina, American College of Surgeons.
[8]Johns Hopkins Hospital, Baltimore, Maryland.
[9]Winthrop University Hospital, Mineola, New York.
[10]Inland Imaging Associates and University of Washington, Seattle, Washington.
[11]Northwestern University Feinberg School of Medicine/NMH, Chicago, Illinois.
[12]Emory University, Atlanta, Georgia.
[13]Medical College of Wisconsin, Milwaukee, Wisconsin.
[14]University of California San Francisco, San Francisco, California.

Reprint requests to: Department of Quality & Safety, American College of Radiology, 1891 Preston White Drive, Reston, VA 20191-4397.

Overview of Imaging Modalities

Multidetector computed tomography (MDCT) and scoring systems related to CT has been the most studied imaging test in the evaluation of patients with acute pancreatitis. However, there are other imaging tests available for the diagnosis, including transabdominal ultrasound (US), endoscopic ultrasound (EUS), magnetic resonance imaging (MRI), and magnetic resonance cholangiopancreatography (MRCP) [6-7]. Imaging tests are performed for various reasons in patients with pancreatitis, 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 [1-2,8].

Computed Tomography

MDCT is the primary imaging technique used in evaluating patients suspected of having acute pancreatitis to determine the extent of disease [8-15]. CT demonstrates morphologic changes in the pancreas that allow confirmation of pancreatitis and an assessment of the severity [1,8]. It is the only imaging study that has consistently shown clinical value in predicting not only the severity but clinical outcomes as well. The CT severity index (CTSI), as described by Balthazar in conjunction with clinical scoring systems is the basis for patient decision-making [8,12-13,15-16]. Patient with low CTSI have low morbidity and mortality rates and can be safely triaged out of intensive care [15]. The CTSI is based on an assessment of changes in the pancreas, associated acute fluid collections, and the presence and amount of pancreatic necrosis (Table 1) [8].

Table 1. Balthazar CT Severity Index

CT Grade	Score
A. Normal	0
B. Enlarged gland	1
C. Peri-pancreatic 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 0-10 are possible. Using the CTSI, patients with increasing CTSI scores have been shown to have increasing morbidity and mortality [17]. Multiple studies have confirmed the utility of using the CTSI in assessing patient outcomes [8,12-13,15-16].

Pancreatic necrosis is defined as confluent areas of pancreatic parenchyma that do not demonstrate enhancement after the administration of intravenous (IV) contrast material. In order to assess for possible pancreatic necrosis, IV contrast needs to be administered. There has been some controversy related to the observation that IV contrast impairs the microcirculation of the pancreas in rats with acute necrotizing pancreatitis and may increase the severity of the disease [18-19]. These results could not be reproduced in the opossum [20]. 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 that with CT direct visualization of the pancreas and the damage to it is possible [8]. In addition the retroperitoneum and associated fluid collections are easily seen [2].

The best time to perform CT in patients with acute pancreatitis is unclear [1-2]. In some patients presenting with abdominal pain and elevated pancreatic enzymes the pancreas may be entirely normal, a so-called Balthazar Grade A [8]. In these patients the course of the disease tends to be very mild, with little morbidity and no mortality [8]. If CT is performed immediately after the initiation of the event, the full extent of the pancreatic damage is likely to be underestimated [1-2,8]. However, in patients presenting with severe abdominal pain, immediate CT is useful because necrosis and other local complications (eg, fluid collections) are easily seen and can be correlated with clinical outcome [8,15-16]. In some patients with mild abdominal pain and/or mild elevation of pancreatic enzymes, MDCT may not be necessary, especially not immediately. The decision about when to perform MDCT depends on the overall clinical presentation and should be based on a clinical assessment [1-2].

A potential limitation of MDCT in assessing acute pancreatitis is that it has only moderate sensitivity for detecting gallstones and biliary stones [21-22]. However, the biliary tree should be carefully inspected, and, if biliary dilatation is present, a high index of suspicion for isoattenauting stones should be considered.

Ultrasound

US is often performed in the evaluation of a patient with acute pancreatitis since it has a high sensitivity for detecting gallstones [1-2]. However, patients may have gallstones or another etiology of their pancreatitis. Moreover, stones in the distal common bile duct may be difficult to visualize on 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 [1,8].

Magnetic Resonance Imaging

The use of MRI in evaluating patients with acute pancreatitis is gaining acceptance [6-7,23]. It offers several advantages, especially with heavily T2-weighted sequences for assessing biliary and pancreatic ducts, compared to other noninvasive imaging modalities. These advantages include 1) the facts that bile duct stones and gallstones are easily seen, the pancreatic duct can be followed in its entirety, and duct disruption can often be assessed easily; and 2) that its effectiveness for evaluating morphologic changes to the pancreas and peripancreatic regions is similar to that of MDCT [6-7,24]. An advantage of MRI relative to MDCT in the evaluation of peripancreatic fluid collections is that solid debris is more easily appreciated with MRI [25]. This finding can help to distinguish pancreatitis-induced fluid collections from other cystic lesions and may also aid in allowing appropriate drainage techniques to be used. Another advantage of MRI is that ionizing radiation is not used.

In the situation where IV contrast can be administered, the use of T2-weighted sequences can be very helpful in assessing the pancreatic duct as well as in evaluating for the presence of high-signal fluid within the pancreatic parenchyma that would suggest necrosis.

The disadvantages of MRI are that it is often not readily available in an acute setting and that the acquisition times are considerably longer than with MDCT. That said, MRI appears to offer diagnostic capabilities similar to MDCT with better depiction of the stones and the pancreatico-biliary ductal system.

The role of endoscopic US and endoscopic retrograde cholangiopancreatography (ERCP) in the evaluation of acute pancreatitis is primarily reserved for assessing and confirming choledocholithiasis and subsequent stone removal in patients with gallstone pancreatitis, as well as for identifying other anatomic abnormalities (eg, pancreas divisum, malignancy) that can lead to acute pancreatitis [26-29].

Summary

- In the acute setting, imaging should be performed only if clinically indicated.
- Initial imaging with CT may underestimate the full severity of the disease.
- CT with IV contrast gives best overall assessment of the pancreas and complications related to pancreatitis.
- US is primarily used to assess for gall stones.
- MRI with IV contrast and MRCP has the potential to be an all-inclusive examination for assessing pancreatitis.

Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (ie, <30 mL/min/1.73m^2), and almost never in other patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73m^2. For more information, please see the ACR *Manual on Contrast Media* [30].

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 NS (not specified).

Supporting Document(s)

- ACR Appropriateness Criteria® Overview
- Procedure Contrast Information
- Evidence Table

References

1. Banks PA, Freeman ML. Practice guidelines in acute pancreatitis. *Am J Gastroenterol* 2006; 101(10):2379-2400.
2. Morgan DE. Imaging of acute pancreatitis and its complications. *Clin Gastroenterol Hepatol* 2008; 6(10):1077-1085.
3. Acute Pancreatitis Classification Working Group. Revision of the Atlanta classification of acute pancreatitis (3rd revision). http://www.pancreasclub.com/resources/AtlantaClassification.pdf. Accessed 1 June 2010.

4. Mayumi T, Ura H, Arata S, et al. Evidence-based clinical practice guidelines for acute pancreatitis: proposals. *J Hepatobiliary Pancreat Surg* 2002; 9(4):413-422.
5. Uhl W, Warshaw A, Imrie C, et al. IAP Guidelines for the Surgical Management of Acute Pancreatitis. *Pancreatology* 2002; 2(6):565-573.
6. Arvanitakis M, Koustiani G, Gantzarou A, et al. Staging of severity and prognosis of acute pancreatitis by computed tomography and magnetic resonance imaging-a comparative study. *Dig Liver Dis* 2007; 39(5):473-482.
7. Viremouneix L, Monneuse O, Gautier G, et al. Prospective evaluation of nonenhanced MR imaging in acute pancreatitis. *J Magn Reson Imaging* 2007; 26(2):331-338.
8. Balthazar EJ. Acute pancreatitis: assessment of severity with clinical and CT evaluation. *Radiology* 2002; 223(3):603-613.
9. Chatzicostas C, Roussomoustakaki M, Vardas E, Romanos J, Kouroumalis EA. Balthazar computed tomography severity index is superior to Ranson criteria and APACHE II and III scoring systems in predicting acute pancreatitis outcome. *J Clin Gastroenterol* 2003; 36(3):253-260.
10. Gurleyik G, Emir S, Kilicoglu G, Arman A, Saglam A. Computed tomography severity index, APACHE II score, and serum CRP concentration for predicting the severity of acute pancreatitis. *JOP* 2005; 6(6):562-567.
11. Kaya E, Dervisoglu A, Polat C. Evaluation of diagnostic findings and scoring systems in outcome prediction in acute pancreatitis. *World J Gastroenterol* 2007; 13(22):3090-3094.
12. Kim YS, Lee BS, Kim SH, Seong JK, Jeong HY, Lee HY. Is there correlation between pancreatic enzyme and radiological severity in acute pancreatitis? *World J Gastroenterol* 2008; 14(15):2401-2405.
13. Makela JT, Eila H, Kiviniemi H, Laurila J, Laitinen S. Computed tomography severity index and C-reactive protein values predicting mortality in emergency and intensive care units for patients with severe acute pancreatitis. *Am J Surg* 2007; 194(1):30-34.
14. Ocampo C, Zandalazini H, Kohan G, Silva W, Szelagowsky C, Oria A. Computed tomographic prognostic factors for predicting local complications in patients with pancreatic necrosis. *Pancreas* 2009; 38(2):137-142.
15. Vriens PW, van de Linde P, Slotema ET, Warmerdam PE, Breslau PJ. Computed tomography severity index is an early prognostic tool for acute pancreatitis. *J Am Coll Surg* 2005; 201(4):497-502.
16. Casas JD, Diaz R, Valderas G, Mariscal A, Cuadras P. Prognostic value of CT in the early assessment of patients with acute pancreatitis. *AJR Am J Roentgenol* 2004; 182(3):569-574.
17. Balthazar EJ, Robinson DL, Megibow AJ, Ranson JH. Acute pancreatitis: value of CT in establishing prognosis. *Radiology* 1990; 174(2):331-336.
18. Foitzik T, Bassi DG, Fernandez-del Castillo C, Warshaw AL, Rattner DW. Intravenous contrast medium impairs oxygenation of the pancreas in acute necrotizing pancreatitis in the rat. *Arch Surg* 1994; 129(7):706-711.
19. Kaiser AM, Grady T, Gerdes D, Saluja M, Steer ML. Intravenous contrast medium does not increase the severity of acute necrotizing pancreatitis in the opossum. *Dig Dis Sci* 1995; 40(7):1547-1553.
20. Saifuddin A, Ward J, Ridgway J, Chalmers AG. Comparison of MR and CT scanning in severe acute pancreatitis: initial experiences. *Clin Radiol* 1993; 48(2):111-116.
21. Anderson SW, Lucey BC, Varghese JC, Soto JA. Accuracy of MDCT in the diagnosis of choledocholithiasis. *AJR Am J Roentgenol* 2006; 187(1):174-180.
22. Anderson SW, Rho E, Soto JA. Detection of biliary duct narrowing and choledocholithiasis: accuracy of portal venous phase multidetector CT. *Radiology* 2008; 247(2):418-427.
23. Arvanitakis M, Delhaye M, De Maertelaere V, et al. Computed tomography and magnetic resonance imaging in the assessment of acute pancreatitis. *Gastroenterology* 2004; 126(3):715-723.
24. Mofidi R, Lee AC, Madhavan KK, Garden OJ, Parks RW. The selective use of magnetic resonance cholangiopancreatography in the imaging of the axial biliary tree in patients with acute gallstone pancreatitis. *Pancreatology* 2008; 8(1):55-60.
25. Macari M, Finn ME, Bennett GL, et al. Differentiating pancreatic cystic neoplasms from pancreatic pseudocysts at MR imaging: value of perceived internal debris. *Radiology* 2009; 251(1):77-84.
26. Mark DH, Lefevre F, Flamm CR, Aronson N. Evidence-based assessment of ERCP in the treatment of pancreatitis. *Gastrointest Endosc* 2002; 56(6 Suppl):S249-254.
27. Napoleon B, Dumortier J, Keriven-Souquet O, Pujol B, Ponchon T, Souquet JC. Do normal findings at biliary endoscopic ultrasonography obviate the need for endoscopic retrograde cholangiography in patients with suspicion of common bile duct stone? A prospective follow-up study of 238 patients. *Endoscopy* 2003; 35(5):411-415.
28. Adler DG, Baron TH, Davila RE, et al. ASGE guideline: the role of ERCP in diseases of the biliary tract and the pancreas. *Gastrointest Endosc* 2005; 62(1):1-8.
29. Harrison ME, Anderson MA, Appalaneni V, et al. The role of endoscopy in the management of patients with known and suspected colonic obstruction and pseudo-obstruction. *Gastrointest Endosc* 2010; 71(4):669-679.
30. American College of Radiology. *Manual on Contrast Media*. Available at: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/contrast_manual.aspx.