Revised Atlanta Classification of Acute Pancreatitis

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Introduction

The introduction of the 1992 Atlanta Classification was a major milestone in the practice of pancreatology at that time [1]. The classification was aimed to define a common terminology and define the severity of the disease in a globally acceptable uniform manner. Even though it generated great enthusiasm initially, it was observed over the years that many issues pertaining to the disease were either not addressed or lacked clarity [2]. It was observed that over the past two decades, the terminologies from the Atlanta Classification were inappropriately used. For example, terms like pancreatic phlegmon and infected pseudocyst were still used, even after being abandoned in the Atlanta Classification. With generation of more data on the natural history and pathophysiology of the disease, and with development in cross-sectional imaging techniques, new terminologies like organized pancreatic necrosis, subacute pancreatic necrosis, necroma, and pseudocyst associated with necrosis came into existence [3]. These ambiguities called for a revision of the 1992 Atlanta Classification, which was long awaited in the pancreatology community. The process of revision was initiated in 2007 and after 5 long years of efforts that included modifications, revisions, and acquiring global consensus, the Revised Atlanta Classification was finally published in 2013 [4]. Table 1.1 shows the gross differences between the original and revised classification.

Objectives of Revision

The objectives of the revision of the Atlanta Classification were to (1) incorporate modern concepts of the disease; (2) address areas of confusion; (3) improve clinical assessment of severity; (4) enable standardized data reporting; (5) assist objective evaluation of new treatments; and (6) facilitate communication among treating physicians and different institutions.

However, the revision was not meant to be a management guideline, even though the definitions have potential to guide appropriate management strategies.

Methodology

The Revised Atlanta Classification resulted from an international, web-based, multiply reiterative process that began in 2007 at the Digestive Diseases Week. The process began

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Table 1.1 Changes made in the Revised Atlanta validation compared to the 1992 Atlanta Classification

1992 Atlanta Classification	Revised Atlanta Classification
• No defined threshold of amylase/lipase levels for the diagnosis of AP	• Elevation of serum amylase and lipase of greater than three times the upper limit of normal is required to make a diagnosis
• Inclusion of local complications and/or organ failure under the severe category	• The presence of local complications in the absence of persistent organ failure is categorized as moderately severe acute pancreatitis
• No distinction between transient and persistent organ failure	• Transient organ failure is defined as organ failure that resolves within 48 h • Persistent organ failure is defined as organ failure that persists beyond 48 h
• Nonuniform use in the classification for organ failure	• Organ failure should be defined according to the Modified Marshall scoring system • Gastrointestinal bleeding as an organ failure has been removed
	• Discrete definitions of local complications (acute peripancreatic fluid collections, pancreatic pseudocyst, acute necrotic collection, and walled-off necrosis)
• No distinction of peripancreatic collections with and without necrotic debris	• Terms like pancreatic abscess have been abandoned
• Local complications included necrosis, abscess, and pseudocyst	• Terms like "organized pancreatic necrosis," "subacute pancreatic necrosis," "necroma," and "pseudocyst associated with necrosis," pancreatic sequestration are now collectively termed as walled-off necrosis

with a meeting of 40 selected pancreatologists and pancreatic surgeons to agree on the process and areas of revision. A working group, consisting of three pancreatic surgeons, two pancreatologists, and one pancreatic radiologist, prepared an initial draft. This was the first working document that was circulated among the 40 participants; the document was revised according to their suggestions. This working draft was then sent electronically to all members of 11 national and international organizations interested in acute pancreatitis. The working group prepared a second working draft after discussing the modification suggested in the first draft and resent to the members. The process was repeated and a third draft was generated, which contained minor modifications and was submitted to Gut. Based on journal reviewers' comments, a fourth revision of the document was made in which the three-tier classification of severity was incorporated.

Definition of a Diagnosis of Acute Pancreatitis

According to the Revised Atlanta Classification, a diagnosis of acute pancreatitis (AP) can be made if two of the following three features are present, namely abdominal pain consistent with AP (acute onset of a persistent, severe, epigastric pain often radiating to the back); serum lipase activity (or amylase activity) at least three times greater than the upper limit of normal; and characteristic findings of AP on contrast-enhanced computed tomography (CECT), magnetic resonance imaging (MRI), or transabdominal ultrasonography. Acute pancreatitis runs a dynamic clinical course and levels of serum lipase and amylase tend to fall over time. Therefore, in patients presenting after a prolonged duration following onset of symptoms, serum lipase and amylase may not be greater than three times the upper limit of normal in spite of typical pancreatitis type abdominal pain. These are the patients in which CECT could help in making the diagnosis. In situations where a diagnosis can be satisfactorily made on the basis of pain and serum lipase/amylase, CECT should be reserved for potential future use when it can diagnose local complications and provide important leads for complication-specific management approaches.

Phases of Acute Pancreatitis

The natural course of AP runs through two overlapping but pathophysiologically discrete phases. The early phase, which usually runs for 1–2 weeks, is clinically marked by systemic inflammatory response syndrome (SIRS) that is triggered by the cytokine cascade released as result of local pancreatic inflammation [5–7]. Persistent and severe SIRS during this phase could lead to development of transient or persistent organ failure [8, 9]. Persistent organ failure, which is defined as organ failure lasting for greater than 48 h primarily determines the severity of AP in the first phase [6, 9, 10]. Acute pancreatitis is a dynamic disease and local complications do develop during this phase; however, they are not proportional to the extent of organ dysfunction, thereby negating them as the predominant determinant of severity during this phase [11, 12]. Therefore, imaging with CECT or MRCP is unlikely to be of benefit in assessment and prognostication in this phase.

In the second or late phase, which can run a protracted course of weeks to months, the additional determinant of severity besides persistent systemic inflammation is local complications. This phase is also marked by a compensatory anti-inflammatory response syndrome (CARS), which makes the patient prone to infections that in turn can further determine severity by contributing to organ dysfunction. Therefore, besides clinical monitoring a meticulous evaluation of the local complications by appropriate imaging also becomes essential during this phase. Distinguishing between the different types of local complications would not only help to prognosticate but will also aid in selecting the appropriate treatment modality.

Types of Acute Pancreatitis

Acute pancreatitis can be divided into two broad categories, namely interstitial edematous pancreatitis (IEP) and necrotizing pancreatitis (NP); and this definition is predominantly directed by the degree of enhancement of the pancreas on CECT imaging (Table 1.2).

Interstitial Edematous Pancreatitis

In IEP, which constitutes 80–90 % of AP, CECT shows a relatively homogenously enhanced pancreas with or without mild peripancreatic stranding or peripancreatic fluid collection (Fig. 1.1a, b). However, it is important to understand that confirmation of IEP is not an indication for CECT.

Necrotizing Pancreatitis

Necrotizing pancreatitis, on the other hand, is characterized by tissue necrosis within the pancreatic parenchyma and/or peripancreatic tissues (Fig. 1.2a–c). Necrosis is marked by lack of enhancement, which is a function of impaired or absent tissue perfusion. Involvement of the pancreatic parenchyma alone is exceedingly uncommon and in most of the cases both the pancreatic parenchyma and peripancreatic tissues are involved. Peripancreatic necrosis alone (which is as frequent as pancreatic necrosis) results in a less severe disease course compared to involvement of the pancreatic parenchyma, but higher morbidity compared to IEP. Pancreatic and peripancreatic necrosis usually evolves over the first week of the disease and might not be mature enough to be detected early on by imaging. This is more so for peripancreatic necrosis, which is essentially necrosis of peripancreatic fat, which has little radiologically detectable perfusion even in health [13–16]. After 1 week, the necrosis will gradually liquefy and contain both solid and liquid components, thereby resulting in a more heterogeneous appearance that would make radiological diagnosis evident. Therefore, a diagnosis of NP can be most reliably made after about 1 week of development of AP.

Infected Necrosis

Infection of necrotic pancreatic and/or peripancreatic tissues usually occurs after the first week of AP. Most of the current evidence failed to establish a positive correlation between the extent of necrosis and the duration of symptoms with development of infected necrosis [11, 17–19].

Table 1.2 Definitions and CECT appearance

Terminology	Definitions	CECT appearance
Interstitial edematous pancreatitis (IEP)	• Acute inflammation of the pancreatic parenchyma and peripancreatic tissues, but without recognizable tissue necrosis	• Pancreatic parenchyma enhancement by intravenous contrast agent • No findings of peripancreatic necrosis
Necrotizing pancreatitis	• Inflammation associated with pancreatic parenchymal necrosis and/or peripancreatic necrosis	• Lack of pancreatic parenchymal enhancement by intravenous contrast agent and/or • The presence of findings of peripancreatic necrosis
APFC (acute peripancreatic fluid collection)	• Peripancreatic fluid associated with IEP with no associated peripancreatic necrosis. This term applies only to areas of peripancreatic fluid seen within the first 4 weeks after onset of IEP and without the features of a pseudocyst	• Occurs in the setting of IEP • Homogeneous collection with fluid density • Confined by normal peripancreatic fascial planes • No definable wall encapsulating the collection • Adjacent to pancreas (no intrapancreatic extension)
Pancreatic pseudocyst	• An encapsulated collection of fluid with a well-defined inflammatory wall usually outside the pancreas with minimal or no necrosis. This entity usually occurs more than 4 weeks after onset of IEP to mature	• Well circumscribed, usually round or oval homogeneous fluid density • No nonliquid component • Well-defined wall; that is, completely encapsulated • Maturation usually requires >4 weeks after onset of acute pancreatitis; occurs after IEP
ANC (acute necrotic collection)	• A collection containing variable amounts of both fluid and necrosis associated with necrotizing pancreatitis; the necrosis can involve the pancreatic parenchyma and/or the peripancreatic tissues	• Occurs only in the setting of acute necrotizing pancreatitis • Heterogeneous and nonliquid density of varying degrees in different locations (some appear homogeneous early in their course). • No definable wall encapsulating the collection • Location—intrapancreatic and/or extrapancreatic
WON (walled-off necrosis)	• A mature, encapsulated collection of pancreatic, and/or peripancreatic necrosis that has developed a well-defined inflammatory wall. WON usually occurs >4 weeks after onset of necrotizing pancreatitis	• Heterogeneous with liquid and nonliquid density with varying degrees of loculations (some may appear homogeneous) • Well-defined wall, that is, completely encapsulated • Location—intrapancreatic and/or extrapancreatic • Maturation usually requires 4 weeks after onset of acute necrotizing pancreatitis

Since development of infected necrosis has several therapeutic implications, it is essential to recognize it early [18]. The telltale sign of infected necrosis is the presence of extraluminal gas in pancreatic or peripancreatic tissues on CECT (Fig. 1.3a, b), although gas can be present without infection due to a communication with the gut. In such communications, one could presume infection still exists

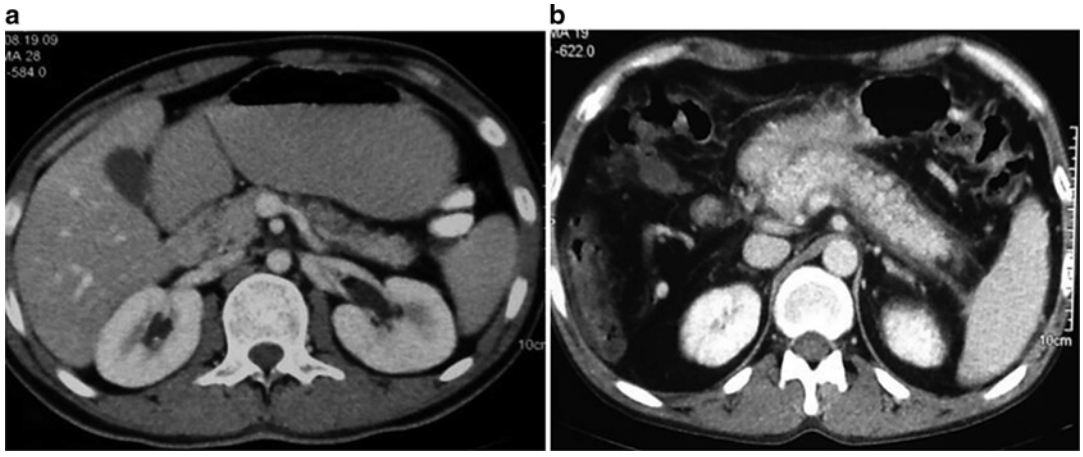

Fig. 1.1 Interstitial edematous pancreatitis with (**a**) peripancreatic fat stranding and (**b**) minimal peripancreatic fluid

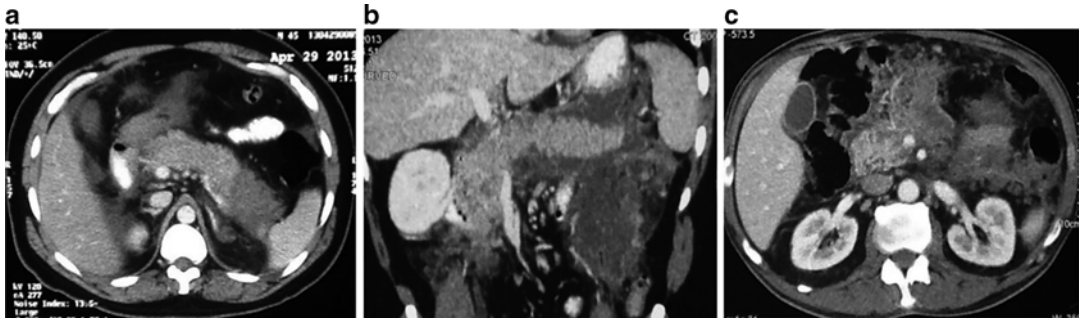

Fig. 1.2 Necrotizing pancreatitis showing (**a**) only pancreatic necrosis; and (**b**) only peripancreatic necrosis and (**c**) both parenchymal and peripancreatic necrosis

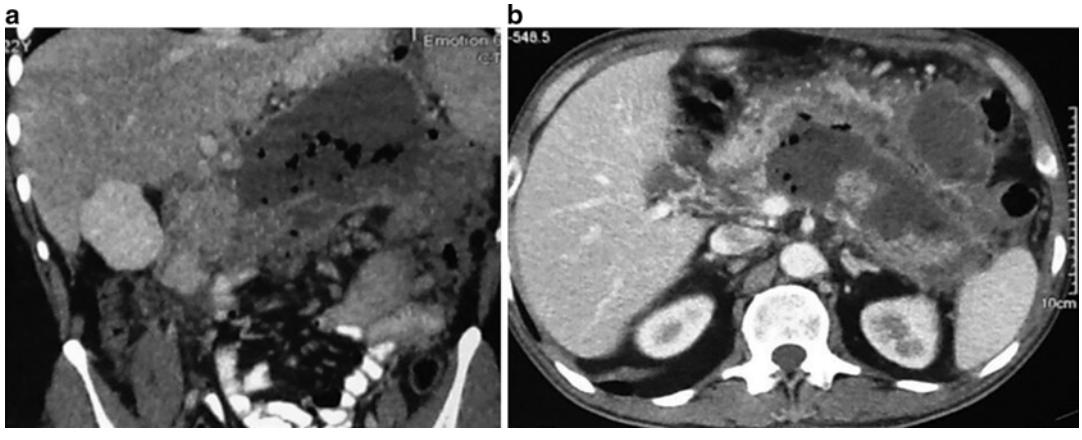

Fig. 1.3 Infected necrosis showing the presence of air within the necrotic areas

due to contamination with gut bacteria. Confirmation can be done by the presence of bacteria/fungi on gram staining or culture of image-guided FNA of necrotic tissue. It should, however, be borne in mind that FNA might not be always positive even in the presence of infection, and thus a negative aspirate should be interpreted with caution. The key to diagnosis of infected necrosis is a strong clinical suspicion based on signs of sepsis. Thus, FNA of necrosis is not being advocated routinely now. Infected necrosis can also result from interventions (percutaneous, endoscopic, and surgical) and has been shown to have adverse impact on morbidity and mortality [20].

Complications of Acute Pancreatitis

Complications of AP include organ failure, local and systemic complications.

Organ Failure

The Revised Atlanta Classification has recommended the use of the Modified Marshall scoring system (Table 1.3) to assess organ dysfunction and failure [21]. The Modified Marshall system assesses three organ systems that are usually involved by SIRS, namely respiratory, renal, and circulatory. A score of 2 or more in any one of these organ systems qualifies the diagnosis of organ failure. If organ failure persists for less than 48 h, it is termed as transient organ failure; and if at least or more than 48 h, then persistent organ failure. Involvement of one organ is defined as single organ failure while more than one organ is called multiorgan failure. The Modified Marshall system is simple, universally feasible and has an edge over the other commonly used system called sequential organ failure assessment (SOFA) [22], which also requires measurement of additional parameters like inotrope and respiratory support.

Local Complication

A better understanding of the natural history of AP and advancements in imaging have now enabled identification of morphological changes of AP in a more efficient manner. Accordingly, discrete types of local complications have been defined in the Revised Atlanta Classification.

Table 1.3 Modified Marshall scoring system[a]

	Score				
Organ system	0	1	2	3	4
Respiratory (PaO_2/FiO_2)	>400	301–400	201–300	101–200	≤101
Renal[b]					
(serum creatinine, μmol/L)	≤134	134–169	170–310	311–439	>439
(serum creatinine, mg/dL)	<1.4	1.4–1.8	1.9–3.6	3.6–4.9	>4.9
Cardiovascular (systolic blood pressure, mmHg)[c]	>90	<90, fluid-responsive	<90, not fluid-responsive	<90, pH <7.3	<90, pH <7.2
For non-ventilated patients, the FiO_2 can be estimated from below:					
Supplemental oxygen (L/min)	*FiO_2 (%)*				
Room air	21				
2	25				
4	30				
6–8	40				
9–10	50				

[a]A score of 2 or more in any system define the presence of organ failure
[b]A score for patients with preexisting chronic renal failure depends on the extent of further deterioration of baseline renal function. No formal correction exists for a baseline serum creatinine ≥134 μmol/L or ≥1.4 mg/dL
[c]Off inotropic support

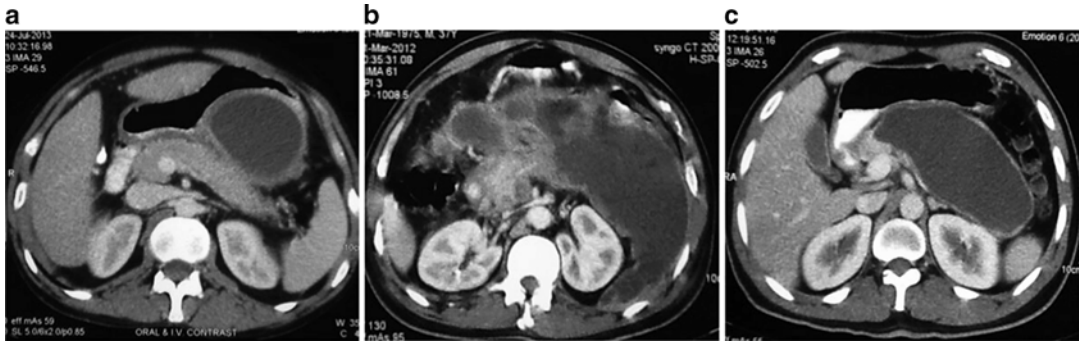

Fig. 1.4 Pictures of different types of fluid collections. (**a**) Pseudocyst. (**b**) ANC. (**c**) WON

These include acute peripancreatic fluid collection (APFC), pancreatic pseudocysts (Fig. 1.4a), acute necrotic collections (ANCs) (Fig. 1.4b), and walled-off necrosis (Fig. 1.4c) (see Table 1.2). Other local complications include gastric outlet dysfunction, splenic and portal vein thrombosis, and colonic necrosis.

A major highlight of the revised classification is the CECT-based definitions of pancreatic and peripancreatic collections that distinguish between collections that contain only fluid content (APFC and pancreatic pseudocyst) and those that contain a solid component with or without a fluid component (ANC and WON) (see Table 1.2). APFCs are associated with IEP and often resolve spontaneously without intervention [16, 23]. These collections are confined to the fascial planes in the retroperitoneum and may be multiple. If an APFC persists beyond 4 weeks and acquires a well-defined wall, it is termed as a pancreatic pseudocyst. Pseudocysts are very uncommon, and specifically refer to the encapsulated fluid collections in the peripancreatic tissues. Even though pseudocysts may rarely involve the pancreatic tissue, these kind of collections are more likely to be ANCs; therefore, an MRI, EUS, or transabdominal ultrasound might be necessary to look for the presence of solid material that distinguish between ANC and a pseudocyst. The term pseudocyst should not be used if there is evidence of solid debris within the collection. Pseudocysts usually develop as a result of disruption of the main pancreatic duct or a side branch in the absence of necrosis. A pseudocyst may also result from a disconnected duct syndrome resulting from localized necrosis in the neck or body of the pancreas [24].

ANC is characterized by the presence of variable amount of solid and fluid components within the first 4 weeks of illness. ANCs may be pancreatic, peripancreatic, or both; and may appear multiple and loculated on CECT. It is important to interpret CECT findings of collections with caution in the first week of illness since CECT may not distinguish between APFC and ANC. MRI, EUS, or transabdominal ultrasound can be of help in distinguishing the two, if necessary. Otherwise, serial imaging can reliably confirm the diagnosis of ANC from the second week and beyond. An ANC may be associated with a disrupted pancreatic duct within the area of necrosis. The presence of a mature reactive wall around ANC defines it as a WON and this maturation usually occurs after 4 weeks from the onset of disease. WON may be single or multiple and involve areas even distant from the pancreas. ANCs and WONs are prone to develop infections.

The presence of the following features should prompt the caregiver to suspect development of local complications: (1) persistence of recurrence of abdominal pain; (2) increasing degrees of organ dysfunction; and/or (3) development of clinical signs of sepsis. The presence of any of these forms a definitive indication for a high-resolution cross-sectional imaging. Findings of cross-sectional imaging of pancreatic and peripancreatic collections should be described as shown in Table 1.4.

Table 1.4 Format to record morphologic features observed on CECT

1. Pancreatic parenchymal necrosis	None	<30 %	30–50 %	>50 %
2. Peripancreatic necrosis				
3. Pancreatic/peripancreatic fluid or collections				
(a) Location				
Intrapancreatic, location _____				
Peripancreatic, location _____				
(b) Characteristics of fluid				
Homogenous	Heterogeneous			
(c) Well-demarcated wall (*measure thickness in mm*)				
No	Yes			
(d) Extraluminal loculated gas bubbles				
No	Yes			
(e) Gas/fluid level				
No	Yes			
(f) Shape of collection				
Round or oval	Irregular			
4. Related extrapancreatic findings				
(a) Cholelithiasis				
(b) Choledocholithiasis				
(c) Extrahepatic biliary dilation				
(d) Portal venous thrombosis/obstruction				
Gastroesophageal varices				
(e) Superior mesenteric venous thrombosis/obstruction				
(f) Splenic vein thrombosis/obstruction				
Gastric varices				
(g) Arterial pseudoaneurysm				
Location and size: _____				
(h) Pleural effusions				
(i) Ascites				
(j) Inflammatory involvement of organs				
Stomach				
Duodenum				
Jejunum				
Colon				
Appendix				
Liver				
Kidney (right/left)				
Ureter (right/left)				
(k) Colonic necrosis				
(l) Signs of chronic pancreatitis—pancreatic calcification				
5. Unrelated intraabdominal or intrathoracic findings				
Describe findings _____				

Systemic Complications

This is defined as exacerbation of preexisting conditions like coronary artery disease, congestive cardiac failure, chronic obstructive pulmonary disease, diabetes, and chronic liver disease, precipitated by acute pancreatitis. It should be understood that persistent organ failure (as defined by the Modified Marshall scoring) inherent to the pancreatitis episode should

be considered as the primary determinant of severity and should not be defined as a systemic complication.

Definition of Severity of Acute Pancreatitis

The original Atlanta Classification classified AP into two severity types, namely mild and severe (presence of local complications and/or organ failure). However, it was observed over time that the group of severe AP was heterogeneous and encompassed patients who would have different clinical outcomes based on the type of complications. Most importantly, patients who had local complications but no persistent organ failure had low mortality but high morbidity. Furthermore, early stratification could guide the caregiver to triage the patients for early referral to advanced centers; ensure focused care to the priority problems; aid better communication with relatives; and provide homogeneous groups for comparative research. With these in mind, the three-tier category of severity of AP has been introduced, which categorizes severity of AP as mild, moderately severe, and severe. This definition of severity is determined by the presence or absence of organ failure, and local or systemic complications. It is therefore important to assess and record the duration of organ failure and also to perform a meticulous morphologic evaluation of the local complications.

Mild Acute Pancreatitis

This category is defined as acute pancreatitis without organ failure and local/systemic complications; and usually resolves within the first phase, with minimal morbidity and very rare mortality [25]. Patient will usually not require advanced pancreatic imaging for morphological assessment and can be discharged within a week.

Moderately Severe Acute Pancreatitis

This is defined as AP with transient organ failure and/or local complications and/or systemic complications, in the absence of persistent organ failure. In patients with moderately severe AP, the management strategy is guided by the type of local complications, the presence of symptoms and development of issues related to the defining local complications (e.g., infection of pancreatic and peripancreatic necrosis or bleeding from a pseudoaneurysm). Mortality is significantly less among these patients compared to severe acute pancreatitis [12, 26]; and many of them can be discharged in 2–3 weeks without major interventions. Other patients with symptomatic local complications might require prolonged hospitalization with or without major radiologic, endoscopic, or surgical interventions.

Severe Acute Pancreatitis

This category is characterized by the presence of persistent organ failure, irrespective of the time of development in relation to disease onset (i.e., early phase or late phase) [6, 8]. Persistent organ failure in the early phase of disease usually results from severe and persistent SIRS and can result in a mortality rate of 36–50 % [5, 6, 8]. Persistent organ failure that develops in the late phase of the disease is usually associated with infected necrosis or severe extrapancreatic infections, in addition to persistent SIRS. Mortality in this group of patients (infected necrosis with persistent organ failure) is high (43 %) [20]. It is essential to treat a patient with severe early and persistent SIRS even in the absence of organ failure as potentially severe disease.

How to Use the Revised Atlanta Classification in Clinical Practice?

The Revised Atlanta Classification was developed based on a web-based consensus process. The original drafts by the working group and subsequent additions from pancreatologists and pancreatic surgeons were based on both evidence from the literature and clinical experience and expertise. Since this classification has not stemmed out of results from a single focused multicenter prospective study, its validity in

clinical practice needs to be evaluated. The application of the revised classification in clinical practice and for research will necessitate precise use of the proposed definitions and documentation of the clinical events and test results in a meticulous manner. Figure 1.5a–c present an algorithmic approach on the use and interpretation of the various definitions as a function of dynamic progression of the illness. Table 1.4 depicts the manner in which CECT data should be documented.

Since the first week (early phase) of the disease is the phase of SIRS and associated organ failure, priority should be given to evaluation of organ dysfunction. Clinical and laboratory-based assessment gains importance in this phase. Even though local complications evolve during this phase, it is not mandatory to document these during the first

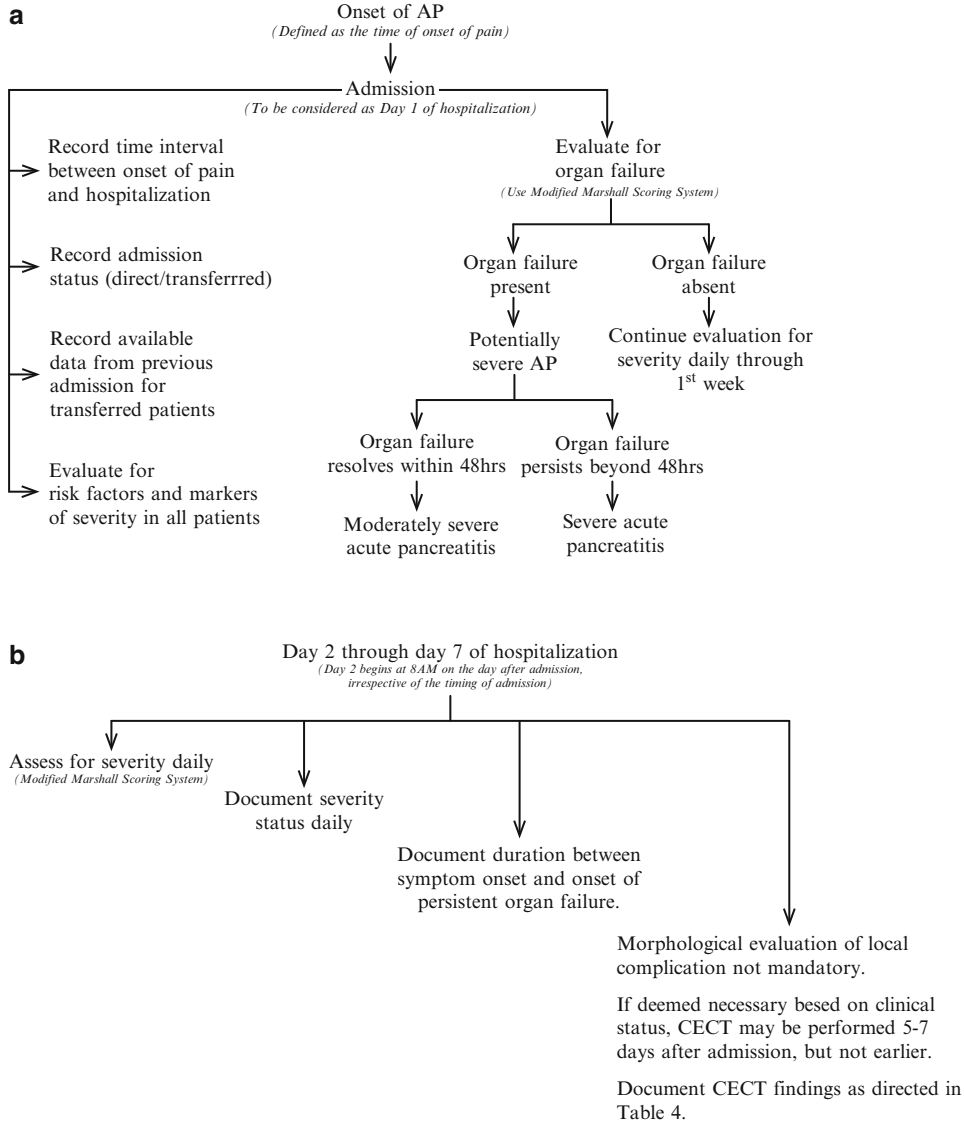

Fig. 1.5 Algorithmic approach to the utility of the Revised Atlanta Classification. (**a**) At admission. (**b**) During the early phase. (**c**) During the late phase . N.B.: Risk factors include age, body mass index, and comorbidities; clinically feasible severity markers at admission (and following 3 days) includes scoring systems like APACHE II, Ranson's, BISAP, HAPS, etc.; hematocrit; serial BUN; serum creatinine; pleural effusion or pulmonary opacities; serum CRP; procalcitonin. Serum amylase and lipase do not have any correlation with severity of acute pancreatitis; therefore, serial measurement should not be performed. Their use should be restricted to only making a diagnosis of acute pancreatitis

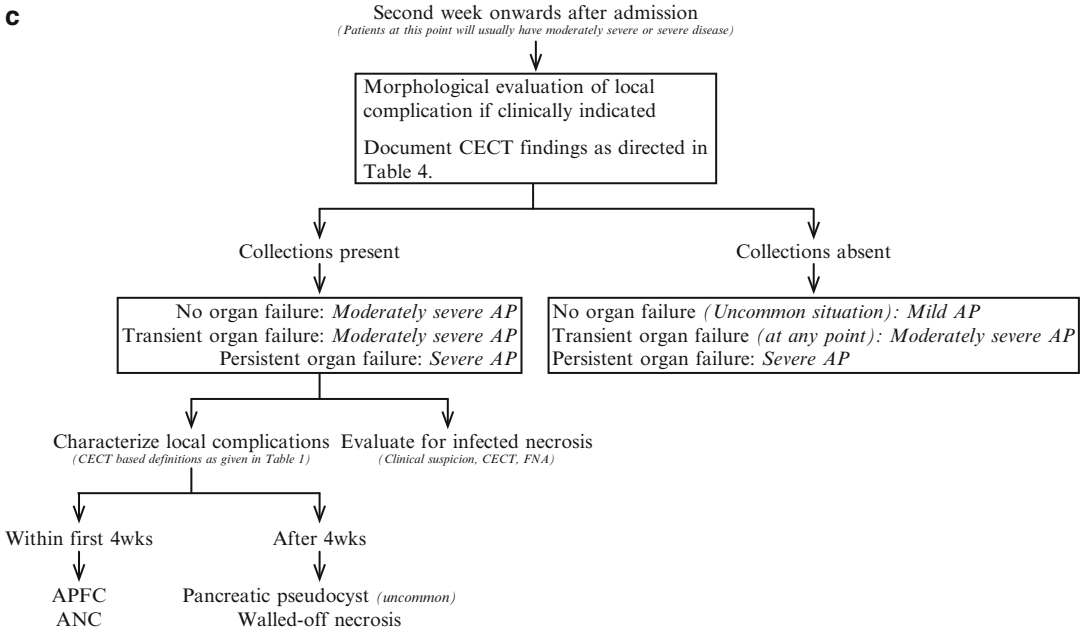

Fig. 1.5 (continued)

week since the extent of necrosis cannot be clearly defined during this phase, extent of necrosis does not correlate to severity of organ failure [11, 27] and no specific treatment is required for necrosis and collections during this phase. On the other hand, it becomes important to perform morphological evaluation for local complications and also assess for infection of the necrotic tissue during the late phase of the disease. Mortality in patients with organ failure and infected necrosis is much higher compared to patients with organ failure without infected necrosis [20].

Conclusion

The Revised Atlanta Classification of acute pancreatitis has addressed several areas of confusion and issues unaddressed in the 1992 Atlanta Classification. More plausible definitions of organ failure and local complication (including pancreatic and peripancreatic collections) have been proposed. Table 1.1 shows the revised nomenclatures as opposed to the terminologies used in the original Atlanta Classification. The severity of the disease has also been classified into three clinically relevant categories with discrete clinical outcomes. The new classification needs to be validated in large-scale multicenter prospective studies, which could possibly uncover inadvertently overlooked areas in the consensus process and thereby create scope for further improvement. It is expected that revised classification would soon emerge as the gold standard for evaluation of acute pancreatitis for decades to come.

References

1. Bradley III EL. A clinically based classification system for acute pancreatitis. Summary of the International Symposium on Acute Pancreatitis, Atlanta, GA, September 11 through 13, 1992. Arch Surg. 1993;128:586–90.
2. Banks PA, Freeman ML. Practice guidelines in acute pancreatitis. Am J Gastroenterol. 2006;101:2379–400.
3. Bollen TL, van Santvoort HC, Besselink MG, van Leeuwen MS, Horvath KD, Freeny PC, et al. The Atlanta classification of acute pancreatitis revisited. Br J Surg. 2008;95:6–21.
4. Banks PA, Bolen TL, Dervenis C, Gooszen HG, Johnson CD, Sarr MG, et al. Classification of acute pancreatitis-2102: revision of the Atlanta classification and definitions by international consensus. Gut. 2013;62(1):102–11.

5. Buter A, Imrie CW, Carter CR, Evans S, McKay CJ. Dynamic nature of early organ dysfunction determines outcome in acute pancreatitis. Br J Surg. 2002;89:298–302.
6. Johnson CD, Abu-Hilal M. Persistent organ failure during the first week as a marker of fatal outcome in acute pancreatitis. Gut. 2004;53:1340–4.
7. Muckart DJ, Bhagwanjee S. American College of Chest Physicians/Society of Critical Care Medicine Consensus Conference definitions of the systemic inflammatory response syndrome and allied disorders in relation to critically injured patients. Crit Care Med. 1997;25:1789–95.
8. Mofidi R, Duff MD, Wigmore SJ, Madhavan KK, Garden OJ, Parks RW. Association between early systemic inflammatory response, severity of multiorgan dysfunction and death in acute pancreatitis. Br J Surg. 2006;93:738–44.
9. Singh VK, Wu BU, Bollen TL, Repas K, Maurer R, Mortele KJ, et al. Early systemic inflammatory response syndrome is associated with severe acute pancreatitis. Clin Gastroenterol Hepatol. 2009;7: 1247–51.
10. Lytras D, Manes K, Triantopoulou C, Paraskeva C, Delis S, Avgerinos C, et al. Persistent early organ failure: defining the high risk group of patients with severe acute pancreatitis. Pancreas. 2008;36: 249–54.
11. Perez A, Whang EE, Brooks DC, Moore Jr FD, Hughes MD, Sica GT, et al. Is severity of necrotizing pancreatitis increased in extended necrosis and infected necrosis? Pancreas. 2002;25:229–33.
12. Vege SS, Gardner TB, Chari ST, Munukuti P, Pearson RK, Clain JE, et al. Low mortality and high morbidity in severe acute pancreatitis without organ failure: a case for revising the Atlanta classification to include "moderately severe acute pancreatitis". Am J Gastroenterol. 2009;104:710–5.
13. Spanier BWM, Nio Y, van der Hulst RWN, Tuynman HA, Dijkgraaf MG, Bruno MJ. Practice and yield of early CT scan in acute pancreatitis: a Dutch observational multicenter study. Pancreatology. 2010;10: 222–8.
14. Bollen TL, Singh VK, Maurer R, Repas K, van Es HW, Banks PA, et al. A comparative evaluation of radiologic and clinical scoring systems in the early prediction of severity of acute pancreatitis. Am J Gastroenterol. 2012;107:612–9.
15. Isenmann R, Buechler M, Uhl W, Malfertheiner P, Martini M, Beger HG. Pancreatic necrosis: an early finding in severe acute pancreatitis. Pancreas. 1993;8: 358–61.
16. Balthazar EJ, Robinson DL, Megibow AJ, Ranson JH. Acute pancreatitis: value of CT in establishing prognosis. Radiology. 1990;174:331–6.
17. Besselink MG, van Santvoort HC, Boermeester MA, Nieuwenhuijs VB, van Goor H, Dejong CH, et al. Timing and impact of infections in acute pancreatitis. Br J Surg. 2009;96:267–73.
18. van Santvoort HC, Bakker OJ, Bollen TL, Besselink MG, Ahmed Ali U, Schrijver AM, et al. A conservative and minimally invasive approach to necrotizing pancreatitis improves outcome. Gastroenterology. 2011;141:1254–63.
19. Beger HG, Bittner R, Block S, Büchler M. Bacterial contamination of pancreatic necrosis. A prospective clinical study. Gastroenterology. 1986;91:433–8.
20. Petrov MS, Shanbhag S, Chakraborty M, Phillips AR, Windsor JA. Organ failure and infection of pancreatic necrosis as determinants of mortality in patients with acute pancreatitis. Gastroenterology. 2010;139: 813–20.
21. Marshall JC, Cook DJ, Christou NV, Bernard GR, Sprung CL, Sibbald WJ. Multiple organ dysfunction score: a reliable descriptor of a complex clinical outcome. Crit Care Med. 1995;23:1638–52.
22. Vincent JL, Moreno R, Takala J, Willatts S, De Mendonça A, Bruining H, et al. The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure. On behalf of the working group on sepsis-related problems of the European Society of Intensive Care Medicine. Intensive Care Med. 1996;22:707–10.
23. Lenhart DK, Balthazar EJ. MDCT of acute mild (non-necrotizing pancreatitis): abdominal complications and fate of fluid collections. Am J Roentgenol. 2008;190:643–9.
24. Pelaez-Luna M, Vege SS, Petersen BT, Chari ST, Clain JE, Levy MJ, et al. Disconnected pancreatic duct syndrome in severe acute pancreatitis: clinical and imaging characteristics and outcomes in a cohort of 31 cases. Gastrointest Endosc. 2008;68:91–7.
25. Singh VK, Bollen TL, Wu BU, Repas K, Maurer R, Yu S, Mortele KJ, et al. An assessment of the severity of interstitial pancreatitis. Clin Gastroenterol Hepatol. 2011;9:1098–103.
26. Talukdar R, Clemens M, Vege SS. Moderately severe acute pancreatitis: prospective validation of this new subgroup of acute pancreatitis. Pancreas. 2012;41: 306–9.
27. Tenner S, Sica G, Hughes M, Noordhoek E, Feng S, Zinner M, et al. Relationship of necrosis to organ failure in severe acute pancreatitis. Gastroenterology. 1997;113:899–903.