

EDUCATION PRACTICE

Acute Pancreatitis Part I: Approach to Early Management

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This article has an accompanying continuing medical education activity on page e57. Learning Objectives—At the end of this activity, the learner should be able to identify elements of the diagnosis and assessment of severity of acute pancreatitis, as well as guidelines for diagnosis and management of more complicated or prolonged disease.

Podcast interview: www.gastro.org/podcast.

Clinical Scenario

A 51-year-old man presents to his local hospital for evaluation of abdominal pain. He describes a 1-day history of a gnawing sharp pain, 7/10 in severity, located in the upper abdomen with radiation to the back. He also experienced nausea and intermittent vomiting 4–6 hours preceding emergency room evaluation. He is unable to tolerate oral intake.

Past medical history is pertinent for hypercholesterolemia, hypertension, glucose intolerance, hyperlipidemia, depression, anxiety, and metabolic syndrome. He is a nonsmoker, denies drug allergies and intravenous drug use. There is a history of moderate baseline alcohol consumption (1–2 alcoholic beverages per day) as well as recent increased intake. Surgical history is notable for a left knee arthroscopy for meniscus tear.

Current medications include aspirin, a statin, and a beta blocker.

On physical examination, he is obese, diaphoretic, anxious, and in obvious discomfort. He is afebrile with dry mucous membranes. Vital signs are consistent with orthostatic hypotension. Upon further examination he has tachycardia without rubs or gallops. Breath sounds are normal. Abdominal examination is pertinent for mild tenderness in the upper abdomen without voluntary guarding, rebound tenderness, or a succussion splash. The liver and spleen are not enlarged. The remainder of the physical examination is unremarkable.

Routine laboratory studies including a complete blood count, metabolic panel, and lipase are obtained. The admission white blood cell count is 15 k/uL (reference range 4–10), lipase is elevated at 10,700 U/L (ref range 3–60), liver function tests are normal, and the blood urea nitrogen (BUN) is elevated at 36 mg/dL (ref range 9–25). Contrast-enhanced computerized tomography (CT) scan obtained in the emergency department reveals changes of acute interstitial pancreatitis, small bilateral pleural effusions, and minimal abdominal ascites (Figure 1).

On hospital day 3, he develops fever (temperature 102°F) with dyspnea and progressive hypoxia. He is transferred to the intensive care unit (ICU) for mechanical ventilation support and hemodynamic monitoring and ultimately requires mechanical ventilation for respiratory support. Repeat abdominal CT scan on day 5 shows decreased enhancement of the pancreas consistent with extensive necrosis (Figure 2). He is started on

intravenous antibiotics. On hospital day 4, he is transferred to a specialized tertiary care center for further management.

Upon transfer, antibiotics are discontinued after cultures return negative. Enteral nutrition is initiated via a nasojejunal tube. The patient's blood glucose is monitored closely and maintained between 80–120 mg/dL. The patient continues to experience intermittent low grade fever over the next several days but does not develop further signs of organ dysfunction.

What are the early management issues for acute pancreatitis?

The Problem

Clinical Presentation

There are multiple causes of acute abdominal pain that need to be considered in the evaluation of a patient with this clinical scenario. The differential diagnosis includes peptic ulcer disease, perforated viscus, pneumonia, diabetic ketoacidosis, renal colic, mesenteric ischemia, inferior myocardial infarction, abdominal aortic dissection, and acute pancreatitis.

This patient had an initial working diagnosis of acute pancreatitis based on his characteristic clinical picture of abdominal pain, nausea, vomiting, and markedly elevated serum lipase. Evaluation of the patient with acute pancreatitis begins with a thorough history and physical examination that focuses on clues to etiology. Subsequent CT scan, although not necessary for the diagnosis in this case, demonstrated changes consistent with acute interstitial pancreatitis.

Abdominal pain is the most common finding in patients presenting with acute pancreatitis. The pain is typically epigastric with radiation to the back. Patients often present with nausea and vomiting. Examination findings include fever, tachycardia, and/or tachypnea, which reflect the systemic inflammatory response to local pancreatic tissue injury. Other findings on physical examination include respiratory distress, crackles or

Abbreviations used in this paper: ACG, American College of Gastroenterology; ACR, American College of Radiology; AGA, American Gastroenterological Association; APACHE, Acute Physiology and Chronic Health Evaluation; ASGE, American Society of Gastrointestinal Endoscopy; BUN, blood urea nitrogen; CT, computerized tomography; ICU, intensive care unit; JPN, Japan; ref, reference; SIRS, systemic inflammatory response syndrome; SSAT, Society of Surgery of the Alimentary Tract.

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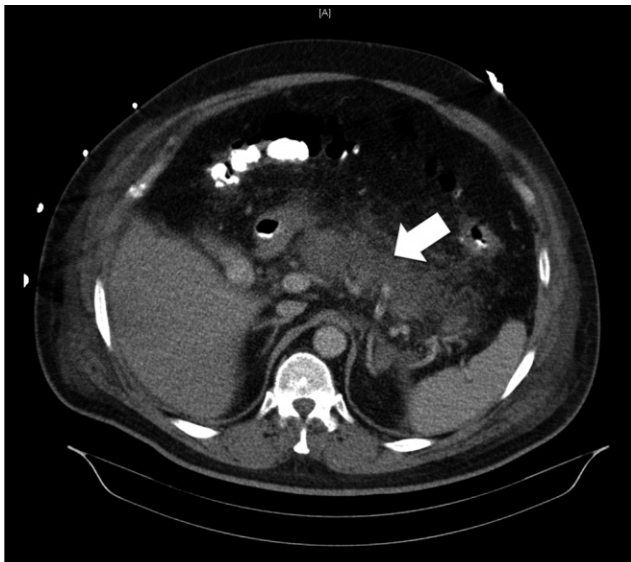


Figure 1. Contrast-enhanced CT scan on hospital day 1 demonstrating interstitial pancreatitis (arrow).

diminished breath sounds on lung auscultation, cool extremities, impaired mental status, decreased bowel sounds, abdominal distension, oliguria, or anuria. The presence of Cullen's sign (periumbilical ecchymoses) and Grey Turner's sign (flank ecchymoses) is rare. If present, these signs suggest possible hemorrhage and are associated with increased mortality.

Diagnosis and Evaluation

The following management recommendations are based on current practice guidelines published by the following societies:

American Gastroenterological Association 2007 (AGA)
 American College of Gastroenterology 2006 (ACG)
 American Society of Gastrointestinal Endoscopy 2005 (ASGE)
 Society of Surgery of the Alimentary Tract 2004 update (SSAT)
 American College of Radiology 2006 update (ACR)
 United Kingdom 2005 (UK)
 Japan 2006 (JPN)

Current practice guidelines recommend establishing the diagnosis of acute pancreatitis within 48 hours of admission (AGA, UK, JPN). However, every attempt should be made to arrive at a diagnosis as soon as possible in order to initiate appropriate resuscitation efforts. Diagnostic criteria for acute pancreatitis are based upon recommendations from the Atlanta Symposium held in 1992. The diagnosis requires at least 2 of the following: typical abdominal pain, elevated amylase/lipase greater than 3 times the upper limit of normal, and/or confirmatory findings on cross-sectional abdominal imaging.

Serum amylase levels can be elevated in nonpancreatic disorders involving the salivary glands, ovaries, and fallopian tubes. Serum amylase is also rapidly cleared. By contrast, serum lipase rises later and has a longer half-life making it a more useful marker for evaluation of acute pancreatitis. The clinician must be aware that both amylase and lipase levels can be elevated in patients with renal insufficiency without acute pancreatitis. A combined approach to diagnosis that incorporates exam findings, biochemical parameters, and imaging ensures accurate diagnosis.

A transabdominal ultrasound is preferred to abdominal CT for initial evaluation to identify gallstones (AGA, ACG, UK, ACR). An initial CT study is only recommended for confirmation if the diagnosis is uncertain. If performed, a rapid bolus intravenous contrast CT is the study of choice for identification of necrosis. Due to concerns regarding potential contrast-induced renal impairment, it is recommended that CT scan be performed only after adequate fluid resuscitation. It is also important to realize that an initial CT may underestimate extent of necrosis. This is believed to be due to the development of zones of tissue liquefaction that are better defined and more easily recognized 2–3 days after onset of symptoms.

Management and Supporting Evidence

1. Assess Severity

Assessment of initial disease severity is an integral part of the evaluation of patients with acute pancreatitis (Figure 3). Although the majority of current practice guidelines recommend use of the Acute Physiology and Chronic Health Evaluation (APACHE) II score (score ≥ 8 for severe disease) (AGA, ACG, UK), this score is complex and requires collection of multiple variables, many of which are not routinely available in clinical practice. To address this issue, our group recently developed a simplified bedside index of severity in acute pancreatitis (**BISAP**) that incorporates the following routine clinical parameters for early risk stratification: **BUN**>25, **I**mpaired mental status, **S**ystemic inflammatory response syndrome (**SIRS**), **A**ge>60, and **P**leural effusion. The presence of 3 or more of these criteria within the first 24 hours of hospitalization was associated with significantly increased in-hospital mortality.

Serial bedside assessment is crucial during the initial 24–72 hours of acute pancreatitis. This enables evaluation of a patient's response to initial resuscitation. Clinical evaluation during this period should consist of assessment of a patient's symptoms (pain, nausea, vomiting, abdominal tenderness) and intravascular volume status (orthostatics, thirst, urine output)

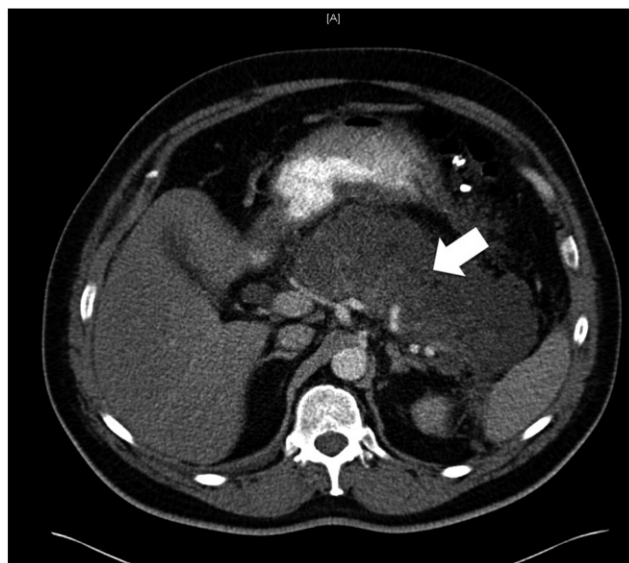


Figure 2. Contrast-enhanced CT scan from the same patient on hospital day 5 demonstrating extensive pancreatic necrosis (arrow).

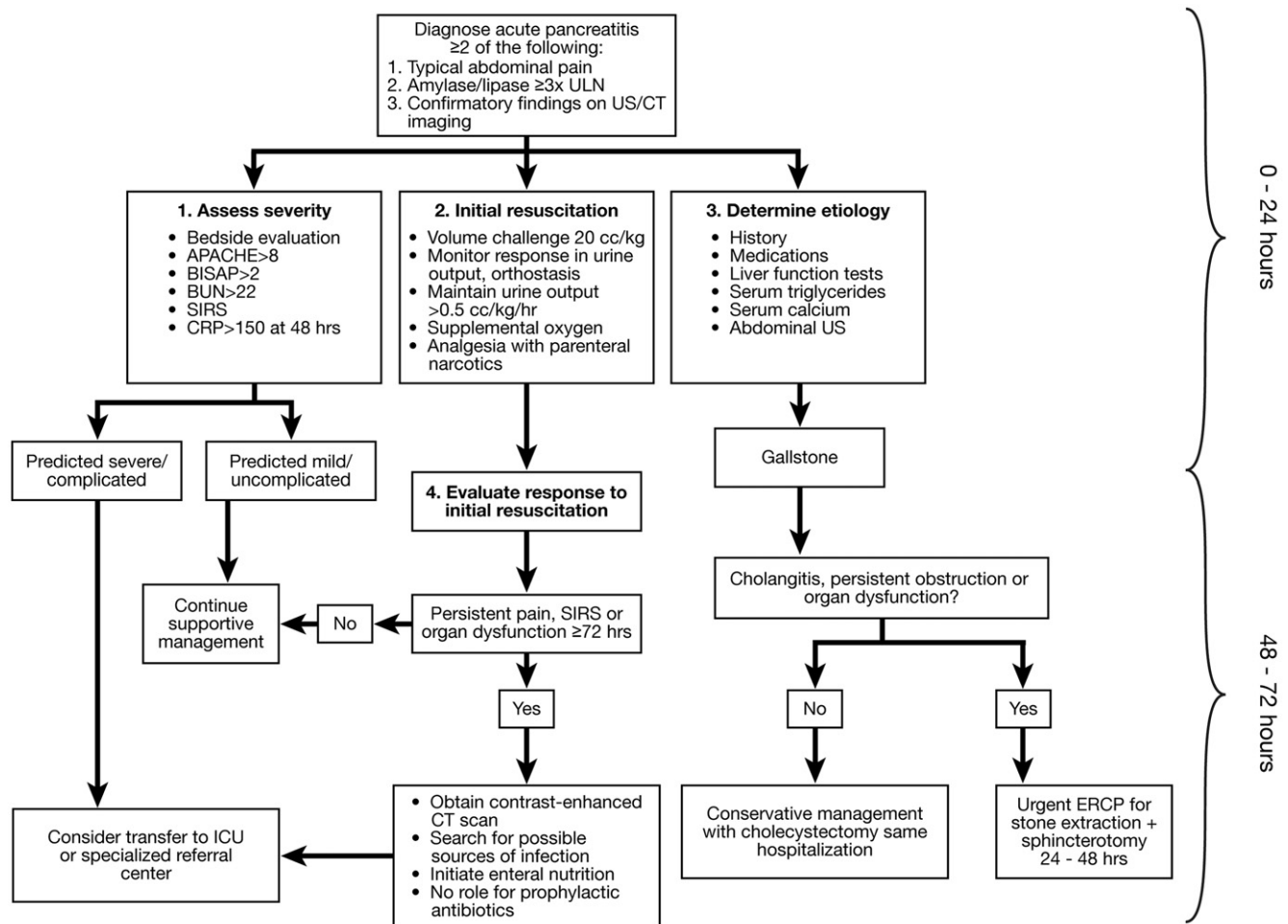


Figure 3. Suggested initial management (0–72 hours) for patients with acute pancreatitis. BISAP, bedside index of severity in acute pancreatitis; CRP, c-reactive protein; ERCP, endoscopic retrograde cholangiopancreatography; ULN, upper limit normal; US, ultrasound.

as well as the systemic inflammatory response (temperature, pulse, respirations, and leukocytosis).

Because the majority of cases are self-limited, routine use of invasive intravascular monitoring devices is not justified in acute pancreatitis. However, other clinical findings that may indicate persistent intravascular volume depletion such as orthostatic hypotension, diminished urine output, hemoconcentration, and/or azotemia are useful to identify a patient that is not responding appropriately to initial fluid resuscitation. Although hemoconcentration has been suggested as a predictor of complications in acute pancreatitis, the literature has been inconsistent in this regard. We recently reported that early changes in BUN were more accurate than hemoglobin or alternative routine laboratory tests (white blood count, calcium, creatinine, or glucose) for the prediction of in-hospital mortality in a large, multicenter cohort study.

Monitoring disease course in acute pancreatitis also involves careful attention to systemic inflammation. Most guidelines recommend a serum C-reactive protein level at 48 hours to assess severity (AGA, UK). The development of SIRS is an important clinical feature in the early phase of acute pancreatitis. SIRS was defined in 1992 by a joint conference of the American College of Chest Physicians and Society of Critical Care Medicine as a standardized clinical syndrome to

indicate the presence of systemic inflammation irrespective of etiology. SIRS is defined by the presence of ≥ 2 of the following criteria:

- pulse > 90 beats per minute
- respirations >20 per minute or PaCO₂ <32 mm Hg
- temperature $>100.4^{\circ}\text{F}$ or $<96.8^{\circ}\text{F}$
- white blood cell count $>12,000$ or <4000 cells/mm³ or $>10\%$ immature neutrophils (bands)

The presence of SIRS during the initial 24 hours of hospitalization, and in particular the persistence of SIRS through the first 48 hours of hospitalization, have been linked to increased mortality in several recent clinical studies.

Mild/uncomplicated disease. The majority of patients ($\sim 85\%$) will experience self-limited disease with symptom improvement within several days. Current recommendations are to begin oral refeeding once a patient has resolution of pain, is no longer receiving parenteral narcotics, and expresses a desire to eat (AGA, ACG). Traditionally, a clear liquid diet is first initiated for refeeding. Recent data suggests that a solid, low fat diet may also be appropriate for initial refeeding in patients with uncomplicated pancreatitis.

Severe/complicated disease. Approximately 15% of patients with acute pancreatitis develop either local or systemic complications. Complications of acute pancreatitis can be categorized as either early (during the first several weeks of hospitalization) or late (persistent/late-term sequelae). In many circumstances, patients with severe acute pancreatitis will require treatment in an intensive care unit. Indications for transfer to intensive care relate to organ dysfunction (hypotension, respiratory and/or renal insufficiency) (AGA, ACG, UK).

2. Initial Resuscitation

The initial 24 hours of hospitalization is a crucial period in the management of acute pancreatitis. Recent findings from the critical care literature indicate that the median time to ICU transfer was 1–3 days after admission. Therefore, optimization of early resuscitation efforts is paramount in the effort to prevent subsequent complications such as necrosis and/or organ failure. Practice guidelines universally recommend vigorous intravenous fluid resuscitation, supplemental oxygen, and analgesia for initial management.

There is substantial variation among current guidelines regarding optimal approaches to fluid resuscitation as highlighted in a recent review article. While many guidelines simply call for “aggressive resuscitation,” the AGA technical review and UK guidelines recommend fluid resuscitation to achieve a urine output >0.5 mL/kg/h. Guidelines from Japan recommend intravenous fluid resuscitation at a rate of 60–160 cc/kg/24 hours to maintain urine output >1 mL/kg/h.

Guidelines are less specific with respect to pain management. Although there is a theoretical concern regarding sphincter of Oddi spasm related to morphine, no evidence exists to indicate that morphine is contraindicated for use in human acute pancreatitis. Patient-controlled analgesia is an attractive option that is mentioned in several guidelines (ACG, AGA, UK). However, the efficacy of patient-controlled analgesia versus traditional on-demand analgesia in acute pancreatitis has not been prospectively evaluated.

3. Determine Etiology

The initial evaluation of acute pancreatitis should also include a search for potential causes that may impact hospital management. Although gallstones and alcohol may be readily identified, additional considerations should include medications, neoplasm, hypercalcaemia, and hyperlipidemia. Initial laboratory evaluation should include a liver biochemical profile, chemistry profile including BUN, complete blood count, calcium, and triglyceride levels (AGA, ACG). A 3-fold elevation in the alanine aminotransferase level in the setting of acute pancreatitis has been shown to have a 95% positive predictive value for gallstone pancreatitis. Guidelines from both the AGA and UK indicate that a presumptive etiology should be established in at least 75%–80% of cases.

Gallstone pancreatitis. Early endoscopic retrograde cholangiopancreatography (within 24–48 hours) for relief of biliary obstruction due to choledocholithiasis is only recommended in the setting of suspected cholangitis or severe/complicated acute pancreatitis (AGA, ACG, UK).

Hypertriglyceridemia. Typically, mild elevations in triglyceride levels can be observed in acute pancreatitis. However, triglyceride levels greater than 1000 mg/dL are highly suggestive of hypertriglyceridemia-induced acute pancreatitis.

Case series have described successful use of combined heparin and insulin therapy for the induction of lipoprotein lipase. Apheresis is another potential therapeutic option. However, none of these treatment regimens have been evaluated in prospective trials. The interested reader is referred to a recent review on the topic.

Hypercalcemia. Hypercalcemia is a rare cause of acute pancreatitis. When present, management should consist of acute medical therapy to normalize the serum calcium level as well as a thorough investigation for the underlying etiology, which may include hyperparathyroidism, neoplasm, and familial hypocalciuric hypercalcemia. It should be noted that Lactated Ringer’s is contraindicated in this clinical setting (contains 3 mEq/L calcium) and normal saline is the preferred fluid for volume resuscitation.

4. Evaluate Response to Initial Therapy

Patients who respond appropriately to initial resuscitation efforts should continue to receive supportive care. However, patients with persistent pain, fever, SIRS, or evidence of organ dysfunction (partial pressure of oxygen <60 mm Hg, oxygen saturation $<90\%$, systolic blood pressure <90 mm Hg, creatinine >2.0 g/dL) after 72 hours should have a rapid-bolus contrast-enhanced CT scan to evaluate for necrosis. These patients should be considered for transfer to an intensive care unit and/or a specialty care center (AGA, ACG, UK, JPN). Additional evaluation should also include a thorough investigation for potential sources of extra-pancreatic infection including chest radiography, urine, and blood cultures.

Patients with persistent organ failure require additional monitoring to ensure adequate intravascular volume resuscitation. Use of central venous pressure measurement via a centrally placed catheter is most commonly used to determine volume status in this clinical setting. However, recent data indicate that the intrathoracic blood volume index (ITBI) may have a better correlation with cardiac index than central venous pressure, allowing more accurate assessment of volume status for patients managed in the ICU.

There is evidence in the form of randomized controlled trials and meta-analysis to support a beneficial role for enteral nutrition compared with total parenteral nutrition in severe acute pancreatitis. Specifically, enteral nutrition via nasojejunal feeding has been associated with reduction in infectious complications and length-of-stay when compared with total parenteral nutrition. Most guidelines recommend initiation of enteral nutrition if the patient is unlikely to initiate oral intake within 5–7 days (AGA, ACG, UK). In practice, this determination can be difficult. Patients with refractory pain, persistent SIRS, or organ dysfunction after 48 hours should strongly be considered for initiation of enteral nutrition. A multicenter randomized controlled trial sponsored by the National Institutes of Health is currently underway to determine the optimal route of enteral nutrition in severe acute pancreatitis (nasojejunal versus nasogastric alimentation, [clinicaltrials.gov #NCT00580749](https://clinicaltrials.gov/ct2/show/study/NCT00580749)).

5. Management of Early Complications (First 2 Weeks of Hospitalization)

Diagnosis of necrosis. The most accurate study for diagnosis of necrosis remains rapid-bolus contrast-enhanced abdominal CT. Current recommendations are to obtain a CT scan for evaluation of necrosis in a patient with evidence of

ongoing pain, fever, persistent SIRS, or organ dysfunction after 72 hours of illness (AGA, ACR). In addition to necrosis, a CT scan can help identify further complications such as acute fluid collections, pleural effusion, or ascites. Whether the extent of necrosis correlates with disease severity is controversial.

Role of prophylactic antibiotics. Guidelines are equivocal on the use of prophylactic antibiotics (AGA, ACG, UK, JPN). Two recent randomized double-blind, placebo-controlled trials failed to demonstrate any benefit of prophylactic antibiotics for prevention of infection in necrotizing pancreatitis. An additional meta-analysis demonstrated that higher quality studies were less likely to demonstrate a benefit for prophylactic antibiotics. Overall, there is little evidence to support use of prophylactic antibiotics for the prevention of infected necrosis.

Treatment of infected necrosis. A CT-guided fine needle aspiration of necrosis is useful in the diagnosis of infected necrosis (AGA, ACG, Society of Surgery of the Alimentary Tract). This approach has been demonstrated to be safe and accurate for the detection of pancreatic infection. It is reasonable to start antibiotics in a febrile patient after appropriate cultures have been obtained. If cultures return negative, antibiotics should then be discontinued.

Overall, rates of infected necrosis have been in decline over the past several decades, from 30%–32% in reports from the 1990s to 9%–12% in more recently published trials. Management of infected necrosis remains surgical debridement, although there is now greater experience with usage of percutaneously placed drainage catheters in unstable patients as a temporizing maneuver until surgical debridement can be safely performed.

Impact of extrapancreatic (hospital-acquired) infection. Two large, multicenter studies have recently called attention to the impact of extrapancreatic infection in acute pancreatitis. In a study from the Netherlands, more than 25% of patients with acute pancreatitis developed either bacteremia or pneumonia during their hospitalization. The majority of these infections occurred within the first 2 weeks. By contrast, infected necrosis occurred on average 4 weeks after presentation. In a separate cohort study involving 177 United States hospitals, we determined that hospital-acquired, extrapancreatic infection was associated with greater than a 2-fold increased risk of mortality even after adjusting for disease severity. The clinical implication of these findings is that an extensive evaluation for potential sources of extrapancreatic infection should be undertaken and if detected, these infections should be treated aggressively.

Management of organ failure. Respiratory failure is the most common form of organ dysfunction in acute pancreatitis. Circulatory shock and renal insufficiency are also observed in severe cases. Although various measures of organ failure exist, the majority of guidelines define organ failure as an arterial oxygen pressure at <60 mmHg, room air oxygen saturation <90%, a systolic blood pressure <90 mm Hg, or a serum creatinine >2.0 g/dL after initial fluid resuscitation. Up to 20% of patients may have evidence of persistent organ failure 48 hours into their hospitalization. Patients with multiorgan dysfunction are at the greatest risk for mortality and specialty care referral is strongly recommended for these patients (AGA, ACG, UK, JPN).

Areas of Uncertainty

Fluid Resuscitation

Currently there is no evidence available from prospective controlled trials to support recommendations for aggressive fluid resuscitation for preventing complications in acute pancreatitis. The optimal rate, type, and volume of fluid for initial resuscitation remain unclear. At present, there are 2 active multicenter randomized clinical trials registered at Clinicaltrials.gov that focus on fluid resuscitation in acute pancreatitis. Our study, the Trial of Intravenous, Goal-directed Early fluid Resuscitation (TIGER, clinicaltrials.gov #NCT0085315) seeks to compare a targeted approach to resuscitation that utilizes early changes in BUN to direct resuscitation parameters. A concurrent study in Germany (EAGLE, clinicaltrials.gov #NCT00894907) is evaluating targeted fluid resuscitation in the critical care setting utilizing a proprietary system of hemodynamic monitoring (PiCCO, Pulsion Medical Systems AG, Munich, Germany).

Analgesia

The optimal method of delivering analgesia to patients with acute pancreatitis has yet to be established. International guidelines vary widely regarding recommendations for both types of analgesic medication as well as dosing regimens. Further prospective studies are needed to help determine which regimens are most effective at achieving rapid and durable pain relief. The World Health Organization has recommended a stepwise approach to pain control in cancer that may have some applicability in acute pancreatitis.

Anti-Inflammatory Therapy

The role of anti-inflammatory therapy remains uncertain. Currently, Japanese guidelines call for use of protease inhibitors despite marginal evidence from clinical trials and meta-analysis. Previous investigations evaluating the impact of platelet activating factor inhibitor (lexipafant) and interleukin-10 have not demonstrated benefit. Although numerous candidate anti-inflammatory agents have demonstrated benefit in experimental models of acute pancreatitis, none have proven beneficial in human disease.

Prevention of Hospital-Acquired Infection

There is a high incidence of extrapancreatic, hospital-acquired infection in acute pancreatitis. These infections can have substantial impact on outcome. It remains to be determined whether aggressive infection control measures can help reduce the rate of hospital-acquired infection in acute pancreatitis. Certainly, in patients with ongoing systemic inflammation or evidence of clinical deterioration, a thorough investigation for extrapancreatic infection is warranted.

Impact of Specialty Care

Several guidelines including those from the UK and Japan recommend a specialist team dedicated to the treatment of acute pancreatitis. Other guidelines recommend consideration of transfer to a hospital with specialty care services in the case of severe forms of acute pancreatitis. It remains to be determined which patients benefit from specialty care and at what stage of illness. In this era of cost containment, it may be

worthwhile to consider the opposite as well. For example, not all patients may require the added expertise and expense associated with treatment in a tertiary referral center. A recent scoring system (Harmless) was developed to identify patients likely to have mild disease that might be appropriately triaged to an observation unit.

Published Guidelines

Numerous practice guidelines have been published on the management of acute pancreatitis.¹⁻³ Guidelines on medical management have been recently published from the AGA (2007) and ACG (2006). Updated recommendations on

Table 1. Summary of Selected Recommendations for Management of Acute Pancreatitis from Major Societies

| | AGA (2007) | ACG (2006) | SSAT (2004) | UK (2005) | JPN (2006) |
|---|--|---|---|---|---|
| Atlanta criteria for diagnosis | Yes | Yes | Yes | Yes | Yes |
| Etiology established | 75% | NS | NS | 80% | NS |
| Initial imaging test | Ultrasound | NS | NS | Ultrasound within 24 hrs | Ultrasound and CT at admission |
| Indication for CT | 1. Admission: if diagnosis unclear 2. At 72 hours: if APACHE II >8 or organ failure | 1. Admission: if diagnosis unclear 2. After several days: if severe | Time not specified: recommended for severe pancreatitis | 1. Admission: not recommended 2. After 1 week: if organ failure, persistent pain or sepsis | Admission: all cases Day 3 or 4: all cases |
| Risk stratification | Organ dysfunction APACHE II CRP | Organ dysfunction APACHE II Hematocrit | NS | APACHE II CRP Glasgow score | Japan scoring system |
| Fluid resuscitation goals | Urine output >0.5 cc/kg/h | Decrease in hematocrit at 12 and 24 hours | NS | Urine output >0.5 cc/kg/h | Urine output >1 mL/kg/h |
| Pain management | Parenteral narcotics PCA mentioned | Parenteral narcotics PCA for severe pain | NS | NS | Buprimorphine, pentazocine opium alkaloids + atropine |
| Supplemental oxygen | Yes | Yes | NS | Yes | Yes |
| ERCP | 1. 24 hours: cholangitis 2. 72 hours: persistent duct obstruction | 24 hours: 1. Cholangitis 2. Persistent duct obstruction | Cholangitis | Within 72 hours: severe gallstone pancreatitis | 24 hours: 1. cholangitis; 2. biliary obstruction; 3. elevated bilirubin |
| Prophylactic antibiotics | No recommendation | Not recommended | Possible benefit | No recommendation; maximum 2 weeks in absence of positive culture | Recommended for severe disease |
| Indication for transfer to intensive care | 1. Severe comorbidity 2. Organ dysfunction 3. APACHE II >8 | 1. Sustained organ failure | 1. Severe pancreatitis | 1. Organ failure | 1. JPN severity score \geq 2 |
| Nutritional support | Nasojejunal enteral feeding in patients expected to remain NPO >7 days | TPN or nasojejunal enteral feeding if expected to remain NPO >5 days | NS | Enteral nutrition preferred: either nasojejunal or nasogastric | Enteral nutrition combined with TPN |
| Prevention of recurrence | Prompt cholecystectomy ethyl alcohol counseling | NS | Cholecystectomy same admission | Cholecystectomy within 2 weeks | NS |
| Management by specialty care team | Yes | NS | Yes | Yes | Yes |
| Expected outcome | 20% mortality complicated pancreatitis | 5% overall mortality; 12%–30% necrosis (sterile-infected) 47% multiorgan failure | 15% mortality complicated disease | <10% mortality uncomplicated <30% mortality complicated | NS |
| Screen for endocrine/exocrine dysfunction | NS | NS | NS | NS | NS |

CRP, c-reactive protein; ERCP, endoscopic retrograde cholangiopancreatography; JPN, Japan; NPO, nil per os (nothing by mouth); NS, not specified; PCA, patient-controlled analgesia; SSAT, Society for Surgery of the Alimentary Tract; TPN, total parenteral nutrition; UK, United Kingdom.

appropriateness of radiographic imaging were published by the ACR in 2005. Endoscopic guidelines are available from the ASGE (2005) and surgical recommendations exist from the SSAT (2004). Many of these guidelines overlap regarding their recommendations, which are summarized in Table 1.

Recommendations for This Patient

Initial clues to this patient's risk for a more complicated course included obesity, admission azotemia with elevated BUN (36 mg/dL), and the presence of SIRS (tachycardia with leukocytosis). For initial management, we pursue a strategy similar to that recommended for sepsis: all patients receive an initial volume challenge with bolus of 20 cc/kg over 60 to 90 minutes followed by continuous infusion of crystalloid (normal saline or Lactated Ringer's) at 3 cc/kg/h. Subsequent adjustments are made to fluid resuscitation parameters based upon a patient's response to initial volume challenge.

In the setting of persistent fever and organ dysfunction, the patient underwent a CT scan on day 5 at the outside hospital (Figure 3). Given the presence of necrosis on imaging, he was started on prophylactic antibiotics, transferred to an ICU, and referred to a specialty care center.

In a patient such as this who is febrile or hemodynamically unstable, it is reasonable to begin broad spectrum antibiotics while awaiting results of an infectious workup. However, once alternative sources of infection have been excluded, we discontinue antibiotics as was the case in this patient.

The patient remained febrile during the ensuing week and on day 10 of illness underwent a repeat contrast-enhanced CT. This study demonstrated extensive necrosis with an acute fluid

collection. This area was aspirated under CT guidance on hospital day 12 with subsequent negative gram stain and culture.

A nasojejunal feeding tube was placed upon his arrival to the ICU (Figure 4). We use an endoscopic placement technique that involves passage of a guidewire under direct visualization and subsequent passage of the feeding tube. A confirmatory abdominal radiograph is necessary to document placement (Figure 4). This patient was treated in the ICU for 10 days and made steady improvement after being transferred out of intensive care.

Suggested Reading

1. AGA Institute medical position statement on acute pancreatitis. *Gastroenterology* 2007;132:2019–2021.
2. Forsmark CE, Baillie J. AGA Institute technical review on acute pancreatitis. *Gastroenterology* 2007;132:2022–2044.
3. Banks PA, Freeman ML. Practice guidelines in acute pancreatitis. *Am J Gastroenterol* 2006;101:2379–2400.
4. 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;62:1–8.
5. Treatment of acute pancreatitis. The Society for Surgery of the Alimentary Tract Patient Care Committee. *J Gastrointest Surg* 1998;2:487–488.
6. Megibow AJ, Ralls PW, Balfe DM, et al. Acute pancreatitis. American College of Radiology. ACR Appropriateness Criteria. *Radiology* 2000;215 Suppl:203–207.
7. UK guidelines for the management of acute pancreatitis. *Gut* 2005;54 Suppl 3:iii1–iii9.
8. Otsuki M, Hirota M, Arata S, et al. Consensus of primary care in acute pancreatitis in Japan. *World J Gastroenterol* 2006;12:3314–3323.
9. Bradley EL 3rd. 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;128:586–590.
10. Balthazar EJ. Acute pancreatitis: assessment of severity with clinical and CT evaluation. *Radiology* 2002;223:603–613.
11. Wu BU, Johannes RS, Sun X, et al. The early prediction of mortality in acute pancreatitis: a large population-based study. *Gut* 2008;57:1698–1703.
12. Wu BU, Johannes RS, Sun X, et al. Early changes in blood urea nitrogen predict mortality in acute pancreatitis. *Gastroenterology* 2009;137:129–135.
13. Mofidi R, Duff MD, Wigmore SJ, et al. Association between early systemic inflammatory response, severity of multiorgan dysfunction and death in acute pancreatitis. *Br J Surg* 2006;93:738–744.
14. Gardner TB, Vege SS, Pearson RK, et al. Fluid resuscitation in acute pancreatitis. *Clin Gastroenterol Hepatol* 2008;6:1070–1076.
15. Tsuang W, Navaneethan U, Ruiz L, et al. Hypertriglyceridemic pancreatitis: presentation and management. *Am J Gastroenterol* 2009;104:984–991.

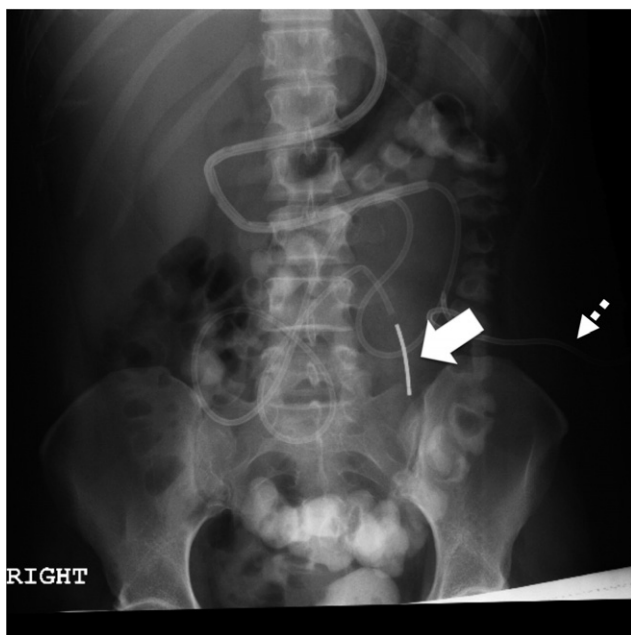


Figure 4. Nasojejunal tube placement for enteral nutrition in patient with persistent SIRS and organ failure. Distal catheter tip in jejunum (solid arrow). Percutaneous pig-tail drainage catheter (broken arrow).

Reprint requests

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Conflict of interest

The authors disclose no conflicts.