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Gallbladder and Pancreas

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- 1 Which of the following is true regarding the natural history of asymptomatic cholelithiasis?
- A Less than 10% of patients will develop complications requiring cholecystectomy during their lifetime.
 - B 20–30% of patients will develop complications requiring cholecystectomy during their lifetime.
 - C Cholecystectomy is indicated for asymptomatic gallstones > 1 cm in diameter.
 - D It is common for patients to develop acute cholecystitis without any prior symptoms of biliary colic.
 - E It is never appropriate to perform a prophylactic cholecystectomy for asymptomatic gallstones.

Cholelithiasis is extremely prevalent and affects approximately 10% of the United States population. Most patients never go on to develop symptoms that warrant surgical intervention. In fact, only about 30% of patients with asymptomatic gallstones will develop complications that require cholecystectomy during their lifetime. Further, it is quite rare for a patient to develop severe complications (cholecystitis, cholangitis, pancreatitis, gallbladder cancer) from gallstones if they have not previously had symptoms of biliary colic. For these reasons, the risks of prophylactic cholecystectomy do not outweigh the potential benefits for most patients.

That being said, some patients are at a higher risk of developing severe complications and so are likely to benefit from prophylactic cholecystectomy in the setting of asymptomatic cholelithiasis. This includes patients with large (>2 cm) gallstones, hemolytic anemias, porcelain gallbladder (calcified gallbladder wall), and/or a long common bile duct or pancreatic duct. These patients are more likely to benefit from prophylactic cholecystectomy to reduce risk of gallstone complications and/or gallbladder cancer.

Answer: B

Festi D, Reggiani ML, Attili AF, et al. Natural history of gallstone disease: expectant management or active treatment? Results from a population-based cohort study. *Journal of Gastroenterology and Hepatology*. 2010;25(4):719–24.

Lammert F, Gurusamy K, Ko CW, et al. Gallstones. *Nature Reviews Disease Primers*. 2016;2:16024.

- 2 A 50-year-old woman with a history of biliary colic presents to the emergency department with right upper quadrant pain and subjective fever that started 6 hours ago. Heart rate is 115 bpm, blood pressure is 110/70 mmHg, and she is febrile to 39.3 °C. On exam, she has mild jaundice, scleral icterus, and severe tenderness in the right upper quadrant. Which of the following is true regarding this constellation of signs when used as a diagnostic tool for acute cholangitis?
- A <5% of patients with acute cholecystitis are falsely diagnosed with acute cholangitis based on these findings.
 - B Low sensitivity, high specificity.
 - C High sensitivity, low specificity.
 - D >50% of patients with acute cholecystitis are falsely diagnosed with acute cholangitis based on these findings.
 - E Of these symptoms, abdominal pain is the most specific for acute cholangitis.

The 2007 Tokyo Guidelines (TG07) outlined data from a large, systematic review that compared Charcot's Triad (fever, right upper quadrant abdominal pain, jaundice) to the gold standard for diagnosis of cholangitis (purulent bile, clinical improvement after biliary drainage, and/or remission after antibiotic therapy alone). This review showed that Charcot's Triad had excellent specificity for

diagnosing acute cholangitis (95.9%), but lacked sensitivity (26.4%). Based on these findings, a new set of diagnostic criteria were proposed. These criteria were revised in the 2013 Tokyo Guidelines (TG13) and were found to have significantly improved sensitivity (91.8%) with comparable specificity (77.7%) to Charcot's Triad.

These criteria are based on three categories: inflammation (leukocytosis/elevated inflammatory markers and/or fever/chills), cholestasis (elevated bilirubin and/or jaundice/icterus), and imaging findings (ductal dilatation and/or obstruction). Inflammation plus either cholestasis or imaging evidence qualifies as "suspected diagnosis," while patients who fulfill criteria in all three of the categories qualify for a "confirmed diagnosis." The TG13 diagnostic criteria also showed a lower false-positive rate in patients who were ultimately diagnosed with acute cholecystitis (5.9%) compared to Charcot's Triad (11.9%), presumably because the TG13 criteria excluded abdominal pain and prior history of biliary disease.

Answer: B

Kiriyama S, Takada T, Strasberg SM, et al.; Tokyo Guidelines Revision Committee. TG13 guidelines for diagnosis and severity grading of acute cholangitis. *Journal of Hepato-biliary-pancreatic Sciences*. 2013;20(1):24–34.

Wada K, Takada T, Kawarada Y, et al. Diagnostic criteria and severity assessment of acute cholangitis: Tokyo guidelines. *Journal of Hepato-biliary-pancreatic Surgery*. 2007;14(1):52–8.

- 3 Which of the following is false regarding pigmented gallstones?
- A They form when heme breakdown products become concentrated in the bile.
 - B Black pigment stones predominantly occur in the gallbladder and not the biliary tree.
 - C Brown pigment stones are associated with biliary dysmotility and stasis.
 - D Dark pigmentation comes from the combination of calcium and cholesterol, as opposed to pure cholesterol stones which are lighter in color.
 - E Biliary infection is a risk factor for brown stone formation.

Gallstone formation results when bile becomes concentrated, when stone components become supersaturated in the bile, and/or when gallbladder dysmotility/stasis is present. There are two major types of gallstones: cholesterol and pigment stones. Cholesterol stones are most commonly a combination of precipitated cholesterol and calcium, while pure cholesterol gallstones account for less than 10% of the gallstones identified in the United

States. Risk factors for cholesterol stone formation include high-estrogen states, parenteral nutrition, advanced age, and rapid weight loss.

Pigment stones are further subclassified into black and brown stones. Black stones are more common and are formed when bile becomes super-saturated with bilirubin and its metabolic conjugates, all of which are formed in the breakdown of heme. As such, black stones are almost always associated with diseases that cause hyperbilirubinemia (i.e., hemoglobinopathies, hemolytic diseases, cirrhosis). Because the super-saturated bile is further concentrated in the gallbladder, black stones form nearly exclusively in the gallbladder. Brown pigment stones are made up of bilirubin as well, but also have a significant cholesterol content which makes them lighter in color. Brown stones can form anywhere along the biliary tract and arise when there is biliary stasis and/or infection.

Answer: D

Jackson PG, Evans SRT (2017). Biliary System. In Townsend CM, Beauchamp RD, Evers BM, Mattox KL (Ed.). *Sabiston Textbook of Surgery: The Biological Basis of Modern Surgical Practice* (20th edition). Philadelphia, PA: Elsevier Saunders.

Lammert F, Gurusamy K, Ko CW, et al. Gallstones. *Nature Reviews Disease Primers*. 2016;2:16024.

- 4 A 76-year-old man with COPD (baseline oxygen requirement of 2L) and heart failure with ejection fraction of 35% presents to the emergency department with clinical and radiographic evidence of acute cholecystitis. His blood pressure is 91/55 mmHg, heart rate is 118 bpm, and he is requiring 6L via nasal cannula to maintain SpO₂ in the high 80s. He is mildly confused. He is admitted to the ICU where appropriate antibiotics and resuscitative measures are initiated. By noon the following day, his hypotension worsens and pressors are started. Which of the following is the best plan to achieve source control in this patient?
- A Laparoscopic cholecystectomy within 72 hours of admission.
 - B Continued antibiotics and supportive care, cholecystectomy as soon as the patient is optimized and deemed an acceptable surgical candidate.
 - C Urgent percutaneous cholecystostomy tube placement, cholecystectomy as soon as the patient is optimized and deemed an acceptable surgical candidate.
 - D Urgent percutaneous cholecystostomy tube placement, outpatient cholecystectomy only if cholangiogram at 3 weeks shows persistent blockage of the cystic duct.

This patient, who is a poor surgical candidate at baseline, meets criteria for grade III cholecystitis (Table 38.1) based on the 2013 and 2018 Tokyo Guidelines (TG13 and TG18). Per TG18, it is reasonable to try nonoperative management with IV antibiotics and supportive therapy first. The patient in this scenario did not respond and in fact worsened after this treatment. While there has been some debate as to the best step from this point, the general consensus is that source control and gallbladder decompression should be achieved via placement of a percutaneous cholecystostomy (PC) tube.

The next step is definitive treatment with cholecystectomy, though timing will depend on patient-specific factors. In patients with grade III cholecystitis who do not have significant baseline comorbidities, cholecystectomy should be completed as soon as the patient is stabilized from a sepsis standpoint. This patient, however, will also need to be medically optimized from a cardiopulmonary standpoint. The patient may be discharged home with the PC tube in place if he is suitable for discharge but not for major surgery. If he is discharged with the PC tube in place, the tube may be removed once the patient is asymptomatic and a cholangiogram demonstrates a

patent cystic duct. However, per the 2018 Tokyo Guidelines, the only definitive management for calculous cholecystitis is cholecystectomy when able.

Answer: C

Dimou FM, Riall TS. Proper use of cholecystostomy tubes. *Advances in Surgery*. 2018;52(1):57–71.

Okamoto K, Suzuki K, Takada T, et al. Tokyo Guidelines 2018: flowchart for the management of acute cholecystitis. *Journal of Hepato-biliary-pancreatic Sciences*. 2018;25(1):55–72.

5 A 35-year-old woman with a history of obesity and biliary colic has been admitted to the trauma ICU for the last 5 days after a motor vehicle crash in which she sustained a femur fracture, pelvic fractures, and multiple left-sided rib fractures with an associated large left pneumothorax. On hospital day six, the patient develops fever to 39.5 °C, significant right-sided abdominal pain and right upper quadrant tenderness, jaundice with total bilirubin of 4 mg/dL, alkaline phosphatase of 300 U/L, mild transaminitis, and a white blood cell count of 20000/μL. Imaging reveals choledocholithiasis. Which of the following antibiotic regimens would be inappropriate at this time?

- A Ciprofloxacin and vancomycin
- B Piperacillin/tazobactam and vancomycin
- C Meropenem and linezolid
- D Cefepime and linezolid
- E Cefepime and daptomycin

The most common organisms isolated from both community-acquired and healthcare-associated biliary infections include *E. coli*, *Klebsiella* species, *Pseudomonas* species, and *Enterococcus* species. This patient has been hospitalized for >48 hours prior to development of cholangitis, which by definition is a hospital-associated biliary infection. According to the 2018 Tokyo Guidelines, vancomycin should be added for all hospital-associated biliary infections due to the increased risk of multidrug-resistant *Enterococcus* species. If the patient has a history of vancomycin-resistant *Enterococcus* (VRE) infection, has a severe vancomycin allergy, has already failed vancomycin therapy, and/or there is a high local prevalence of VRE in the area, daptomycin or linezolid may be substituted for vancomycin. Piperacillin/tazobactam, meropenem, and cefepime-based regimens with the addition of vancomycin (or other *Enterococcus*-covering agent) would all be appropriate options. Ciprofloxacin-based therapy, however, would not be appropriate for hospital-associated or grade III community-acquired cholangitis due to high fluoroquinolone resistance in Gram-negative extended-spectrum beta-lactamase (ESBL) species.

Table 38.1 TG13/18 severity grading for acute cholecystitis.

Grade III (severe) acute cholecystitis

“Grade III” acute cholecystitis is associated with dysfunction of any one of the following organs/systems:

- 1) Cardiovascular dysfunction: hypotension requiring treatment with dopamine ≥ 5 μg/kg per min, or any dose of norepinephrine
- 2) Neurological dysfunction: decreased level of consciousness
- 3) Respiratory dysfunction: PaO₂/FiO₂ ratio <300
- 4) Renal dysfunction: oliguria, creatinine >2.0 mg/dL
- 5) Hepatic dysfunction: PT-MR >1.5
- 6) Hematological dysfunction: platelet count <100 000/mm³

Grade II (moderate) acute cholecystitis

“Grade II” acute cholecystitis is associated with any one of the following conditions:

- 1) Elevated WBC count (>18 000/mm³)
- 2) Palpable tender mass in the right upper abdominal quadrant
- 3) Duration of complaints >72 h^a
- 4) Marked local inflammation (gangrenous cholecystitis, pericholecystic abscess, hepatic abscess, biliary peritonitis, emphysematous cholecystitis)

Grade I (mild) acute cholecystitis

“Grade I” acute cholecystitis does not meet the criteria of “Grade III” or “Grade II” acute cholecystitis. It can also be defined as acute cholecystitis in a healthy patient with no organ dysfunction and mild inflammatory changes in the gallbladder, making cholecystectomy a safe and low-risk operative procedure

Source: Reproduced from Yokoe et al. (2018); with permission from publisher John Wiley and Sons.

Answer: A

Gomi H, Solomkin JS, Schlossberg D, et al. Tokyo guidelines 2018: antimicrobial therapy for acute cholangitis and cholecystitis. *Journal of Hepato-biliary-pancreatic Sciences*. 2018;25(1):3–16.

- 6 Which vessel is most commonly injured during laparoscopic cholecystectomy?
- A Proper hepatic artery
 - B Left hepatic artery
 - C Portal vein
 - D Branches of the superior pancreaticoduodenal artery
 - E Right hepatic artery

The right hepatic artery (RHA) is the most frequently injured vessel during laparoscopic cholecystectomy. This is likely related to its proximity to the common hepatic duct, which can be mistaken for an accessory duct or aberrant cystic duct during difficult dissections. Transection of the RHA typically results in brisk bleeding intraoperatively and may cause significant postoperative hemorrhage requiring reoperation or angioembolization. Occlusion of the RHA is often silent but can result in clinically relevant hepatic ischemia and/or abscess in about 10% of patients, some of whom go on to require partial hepatectomy.

Answer: E

Stewart L. Iatrogenic biliary injuries: identification, classification, and management. *Surgical Clinics of North America*. 2014;94(2):297–310.

Strasberg SM, Helton WS. An analytical review of vasculobiliary injury in laparoscopic and open cholecystectomy. *HPB (Oxford)*. 2011;13(1):1–14.

- 7 A 32-year-old woman is currently admitted with grade II, community-acquired, acute cholangitis with choledocholithiasis on ultrasound. She was started on appropriate antibiotic therapy when she was admitted last night and underwent urgent ERCP with successful removal of a large stone from the common bile duct. She is no longer febrile and has remained hemodynamically normal. She is scheduled for laparoscopic cholecystectomy tomorrow morning. What is the most appropriate duration of antibiotic therapy for this patient?
- A Four to 7 days after source control (ERCP).
 - B Seven to 14 days after source control (ERCP).
 - C Discontinue antibiotics now that the patient is afebrile and source control has been achieved.

- D Total 14-day course of IV antibiotics to decrease the patient's risk of infective endocarditis.
- E Continue antibiotics perioperatively, then discontinue after successful completion of cholecystectomy.

Per the 2018 Tokyo Guidelines, the appropriate treatment sequence for grade II (Table 38.2) acute cholangitis is: antibiotics and supportive care, urgent biliary drainage (ERCP vs. PTC), then subsequent definitive treatment of the cause of cholangitis (for this patient, cholecystectomy to decrease the risk of recurrent choledocholithiasis). Though source control has technically been achieved in this patient, continuation of antibiotics for an additional four to 7 days is recommended. It is also important to follow-up on the results of this patient's blood cultures. Gram-positive bacteremia would necessitate a full 2 weeks of IV antibiotics to reduce her risk of infective endocarditis. While the majority of biliary flora are Gram-negative, *Enterococcus* species are relatively common both in bile cultures and in blood cultures collected from cholangitis patients who developed bacteremia.

Table 38.2 TG13/18 severity grading for acute cholangitis.

Grade III (severe) acute cholangitis

"Grade III" acute cholangitis is defined as acute cholangitis that is associated with the onset of dysfunction at least in any one of the following organs/systems:

- 1) Cardiovascular dysfunction: hypotension requiring dopamine ≥ 5 $\mu\text{g}/\text{kg}$ per min, or any dose of norepinephrine
- 2) Neurological dysfunction: disturbance of consciousness
- 3) Respiratory dysfunction: $\text{PaO}_2/\text{FiO}_2$ ratio < 300
- 4) Renal dysfunction: oliguria, serum creatinine > 2.0 mg/dL
- 5) Hepatic dysfunction: PT-INR > 1.5
- 6) Hematological dysfunction: platelet count $< 100,000/\text{mm}^3$

Grade II (moderate) acute cholangitis

"Grade II" acute cholangitis is associated with any two of the following conditions:

- 1) Abnormal WBC count ($> 12,000/\text{mm}^3$, $< 4,000/\text{mm}^3$)
- 2) High fever ($\geq 39^\circ\text{C}$)
- 3) Age (≥ 75 years old)
- 4) Hyperbilirubinemia (total bilirubin ≥ 5 mg/dL)
- 5) Hypoalbuminemia ($< \text{STD}^a \times 0.7$)

Grade I (mild) acute cholangitis

"Grade I" acute cholangitis does not meet the criteria of "Grade III (severe)" or "Grade II (moderate)" acute cholangitis at initial diagnosis.

Source: Reproduced from Kiriya et al. (2018); with permission from publisher, John Wiley and Sons.

Answer: A

- Miura F, Okamoto K, Takada T, et al. Tokyo Guidelines 2018: initial management of acute biliary infection and flowchart for acute cholangitis. *Journal of Hepato-biliary-pancreatic Sciences*. 2018;25(1):31–40.
- Gomi H, Solomkin JS, Schlossberg D, et al. Tokyo guidelines 2018: antimicrobial therapy for acute cholangitis and cholecystitis. *Journal of Hepato-biliary-pancreatic Sciences*. 2018;25(1):3–16.
- 8** A 28-year-old woman who is 27 weeks pregnant with her first child presents to the emergency department with acute onset right upper quadrant pain, nausea, vomiting, and fever. She is hemodynamically normal and febrile to 39.2 °C. Labs and imaging suggest acute cholecystitis with low concern for choledocholithiasis. She is started on antibiotics and scheduled for same-admission cholecystectomy. Which of the following is the most appropriate operative plan?
- A** Prophylactic tocolytics, laparoscopic cholecystectomy with patient in partial left lateral decubitus position.
 - B** Prophylactic tocolytics, open cholecystectomy with patient in partial left lateral decubitus position.
 - C** Open cholecystectomy with patient in supine position, tocolytics only as needed if preterm labor occurs perioperatively.
 - D** Laparoscopic cholecystectomy with patient in supine position, tocolytics only as needed if preterm labor occurs perioperatively.
 - E** Laparoscopic cholecystectomy with patient in partial left lateral decubitus position, tocolytics only as needed if preterm labor occurs perioperatively.

According to recent literature, laparoscopic surgery can be safely performed during any trimester of pregnancy without increased risk to the mother or fetus. Further, postponing necessary operations has been associated with higher rates of fetal loss during the first trimester, as well as preterm labor during the third trimester. A 2017 meta-analysis conducted by SAGES found that the benefits of laparoscopy over laparotomy in pregnant patients are similar to the benefits observed in nonpregnant patients. When patients have passed the first trimester, the gravid uterus can compress the vena cava while in supine position and lead to decreased cardiac preload. It is recommended that the patient be placed in partial left lateral decubitus position intraoperatively to alleviate this compression. There is no literature to support prophylactic use of tocolytics to prevent preterm labor. However, perioperative-threatened preterm labor can be successfully managed with tocolytics administered at the recommendation of an obstetrician.

Answer: E

- Pearl JP, Price RR, Tonkin AE, et al. SAGES guidelines for the use of laparoscopy during pregnancy. *Surgical Endoscopy*. 2017;31(10):3767–82.
- 9** A 60-year-old man undergoes outpatient laparoscopic cholecystectomy for biliary colic. Pathology reveals gallbladder carcinoma that invades the muscularis propria. The tumor does not extend to the cystic duct. CT of the chest, abdomen, and pelvis is negative for nodal involvement and metastases. What is the most appropriate recommendation for this patient?
- A** Close observation, no further surgical interventions
 - B** Medical Oncology referral for chemotherapy, no further surgical interventions
 - C** Gallbladder fossa wedge resection and portal lymphadenectomy
 - D** Gallbladder fossa wedge resection, portal lymphadenectomy, CBD resection and reconstruction
 - E** Neoadjuvant chemotherapy, gallbladder fossa wedge resection, portal lymphadenectomy

This patient's tumor invades into the muscularis propria, making it T1b disease. T1a tumors are considered cured by cholecystectomy alone, while all tumors with higher T stages will require further surgery due to the high risk of residual disease. The recommended surgical management of gallbladder carcinoma is wedge resection of the gallbladder fossa and portal lymphadenectomy. Extrahepatic bile duct resections are only indicated when the tumor invades past the cystic duct and CBD resection is necessary to achieve negative margins. Neoadjuvant chemotherapy may be helpful for down-staging more advanced tumors to allow for a more limited resection. However, neoadjuvant chemotherapy has not been studied thoroughly enough to warrant routine use.

Answer: C

- Cherkassky L, D'Angelica M. Gallbladder cancer: managing the incidental diagnosis. *Surgical Oncology Clinics of North America*. 2019;28(4):619–630.
- 10** An otherwise healthy, 48-year-old woman presents to the emergency department with severe right upper quadrant pain. Vital signs are remarkable for a temperature of 39.5 °C, blood pressure 92/58 mmHg, and heart rate 122 bpm. Jaundice and mild scleral icterus are noted on exam, as well as severe tenderness in the right upper quadrant. She has a white blood cell count of 18 000/μL, total

bilirubin of 3.5 mg/dL, mild transaminitis, and creatinine of 1.5 mg/dL. Abdominal ultrasound shows cholelithiasis, pericholecystic fluid, and common bile duct diameter of 7 mm, though no choledocholithiasis is noted. After starting antibiotics and IV fluids, what are the next best steps in management?

- A Confirmatory MRCP, ERCP if choledocholithiasis is present, same-admission laparoscopic cholecystectomy
- B Urgent ERCP, same-admission laparoscopic cholecystectomy
- C Confirmatory MRCP, laparoscopic cholecystectomy, laparoscopic common bile duct exploration if MRCP was positive for choledocholithiasis
- D Urgent laparoscopic cholecystectomy without intraoperative cholangiogram
- E Urgent laparoscopic cholecystectomy with intraoperative cholangiogram

When considering further work-up and management of suspected choledocholithiasis, the American Society of Gastroenterology recommends stratifying patients based on likelihood of having choledocholithiasis. “Very strong” predictors of choledocholithiasis include clinical ascending cholangitis, choledocholithiasis noted on ultrasound, and total bilirubin > 4 mg/dL. “Strong” predictors include common bile duct (CBD) dilatation and total bilirubin level 1.8–4 mg/dL (Table 38.3). Patients have a high likelihood of choledocholithiasis if they have any one of the “very strong” predictors, or if they have both of the “strong” predictors.

Patients with a high likelihood of choledocholithiasis do not need further diagnostic evaluation and should proceed directly to ERCP for biliary decompression (Figure 38.1). Low likelihood patients may proceed to laparoscopic cholecystectomy for treatment of cholecystitis/symptomatic cholelithiasis. Patients with intermediate likelihood may proceed to laparoscopic cholecystectomy with intraoperative cholangiogram, or they may be further evaluated with MRCP prior to intervention.

Though this patient’s ultrasound was negative for choledocholithiasis, she has clinical signs of ascending cholangitis. As such, she does not require confirmatory MRCP and should proceed directly to ERCP for biliary decompression.

Answer: B

Costi R, Gnocchi A, Di Mario F, Sarli L. Diagnosis and management of choledocholithiasis in the golden age of imaging, endoscopy and laparoscopy. *World Journal of Gastroenterology*. 2014;20(37):13382–401.

Table 38.3 American Society for Gastrointestinal Endoscopy estimation of risk for choledocholithiasis in patients with symptomatic cholelithiasis.

Predictors of choledocholithiasis	
“Very strong”	
CBD stone on transabdominal US	
Clinical ascending cholangitis	
Bilirubin > 4 mg/dL	
“Strong”	
Dilated CBD an US (>6 mm with gallbladder <i>in situ</i>)	
Bilirubin level 1.8–4 mg/dL	
“Moderate”	
Abnormal liver biochemical rest other than bilirubin	
Age older than 55 years	
Clinical gallstone pancreatitis	
Assigning a likelihood of choledocholithiasis based on clinical predictors	
Presence of any very strong predictor	High
Presence of both strong predictors	High
No predictors present	Low
All other patients	Intermediate

Source: Reproduced from ASGE Standards of Practice Committee: The Role of Endoscopy in the Management of Choledocholithiasis (2011); with permission from publisher, Elsevier.

ASGE Standards of Practice Committee, Maple JT, Ikenberry SO, Anderson MA, et al. The role of endoscopy in the management of choledocholithiasis. *Gastrointestinal Endoscopy*. 2011;74(4):731–44.

11 A 49-year-old man is currently on ICU day eight with severe acute pancreatitis. CT scan shows pancreatic necrosis without gas formation. The patient has been persistently febrile and his white blood cell count is currently 21 000/ μ L; up from 15 000/ μ L on admission. Fine needle aspiration confirms the diagnosis of infected pancreatic necrosis. What is the next best step?

- A Antibiotics, open necrosectomy once patient is stable enough for surgery
- B Antibiotics, aggressive fluid resuscitation, NPO, NJ tube placement for enteral nutrition
- C Antibiotics, image-guided drain placement, video-assisted retroperitoneal debridement if needed
- D Antibiotics, image-guided drain placement, open necrosectomy if needed
- E Antibiotics, video-assisted retroperitoneal debridement once patient is stable enough for surgery

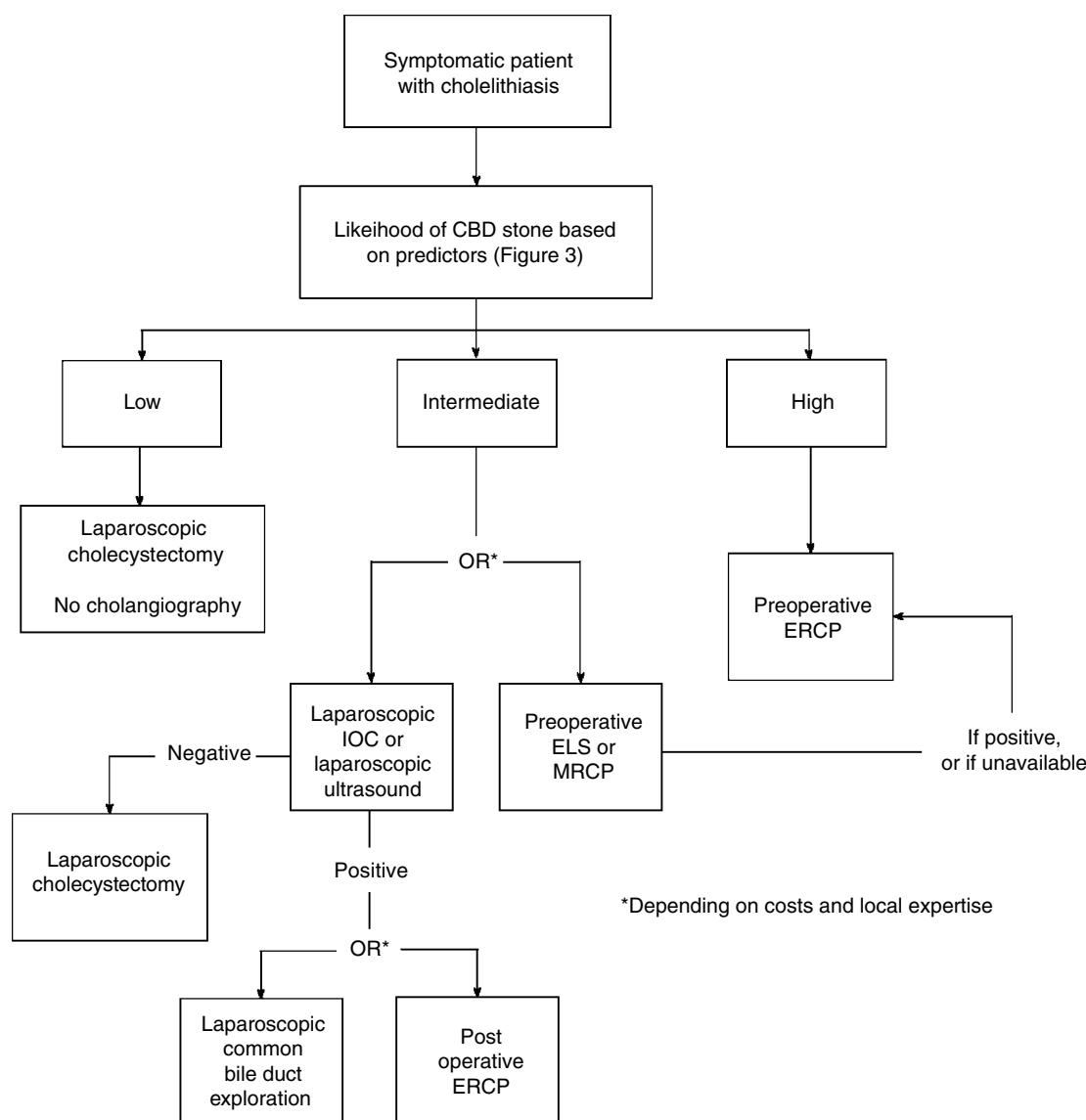


Figure 38.1 American Society for Gastrointestinal Endoscopy algorithm for management of symptomatic cholelithiasis based on likelihood of choledocholithiasis. *Source:* Reproduced from ASGE Standards of Practice Committee: The Role of Endoscopy in the Management of Choledocholithiasis (2011); with permission from publisher, Elsevier.

Infected pancreatic necrosis is a feared complication of necrotizing pancreatitis. The risk of infection is directly proportional to the extent of pancreatic necrosis, with over 40% risk in patients who have >70% pancreatic necrosis. Antibiotics do not prevent the infection of pancreatic necrosis; however, once infection is confirmed or at least strongly suspected, antibiotics need to be initiated. Previously, the standard of treatment for infected pancreatic necrosis was to perform a laparotomy and complete debridement of necrotic tissue. However, the 2010 PANTER Trial showed that the “step up” approach leads to decreased rates of mortality, major complications, and postoper-

ative development of diabetes. In the “step up” approach, a percutaneous drain is placed near the pancreas first. In about 35% of patients, no further intervention is required. If the patient’s clinical condition still requires further source control, video-assisted retroperitoneal debridement surgery (VARDs) is the procedure of choice.

Answer: C

van Santvoort HC, Besselink MG, Bakker OJ, et al.; Dutch Pancreatitis Study Group. A step-up approach or open necrosectomy for necrotizing pancreatitis. *New England Journal of Medicine*. 2010;362(16):1491–502.

Beger HG, Rau BM. Severe acute pancreatitis: clinical course and management. *World Journal of Gastroenterology*. 2007;13(38):5043–51.

- 12** A 40-year-old woman with a history of type 2 diabetes and biliary colic presents to the emergency department with 6 hours of intense epigastric pain that radiates to the back, as well as nausea, vomiting, and anorexia. She is afebrile, blood pressure is 102/55 mmHg, and heart rate is 112 bpm. On exam she is non-distended and very tender to palpation of the epigastrium. There is no jaundice or scleral icterus present. Labs are remarkable for white blood cell count of 12000/ μ L, creatinine of 0.8 mg/dL, lipase of 1025 U/L, amylase 465 U/L, total bilirubin of 0.9 mg/dL, and normal AST/ALT and alkaline phosphatase. RUQ ultrasound shows cholelithiasis without cholecystitis, no choledocholithiasis, and CBD measuring 5 mm. What are the next best steps after initial fluid resuscitation?
- A** Confirmatory MRCP, cholecystectomy at 6 weeks
 - B** Urgent ERCP, same-admission cholecystectomy
 - C** Same-admission cholecystectomy
 - D** IV antibiotics, urgent ERCP, same-admission cholecystectomy
 - E** IV antibiotics, same-admission cholecystectomy

Acute pancreatitis (AP) is a common illness with more than 240000 cases in the United States per year. By far, the two most common etiologies are gallstone disease and alcohol abuse. In this patient with characteristic abdominal pain and serum amylase and lipase greater than three times the upper limits of normal, the diagnosis of acute pancreatitis can be reasonably made without further investigation. There is no indication for confirmatory CT scan or MRCP unless the diagnosis is unclear or the patient fails to respond to treatment within 72 hours of presentation. The recommended treatment course for this patient with likely biliary pancreatitis is supportive care followed by same-admission cholecystectomy. When patients have concomitant cholangitis or evidence of biliary obstruction, ERCP is recommended within the first 24 hours. However, this patient has no evidence of cholangitis or biliary obstruction and so does not require ERCP. In fact, preoperative ERCP for patients with isolated, mild AP has been shown to increase length of stay and hospital cost without any significant benefit on mortality or local/systemic complications. This patient has mild AP (no evidence of organ dysfunction or local complications such as necrosis), so same-admission cholecystectomy is preferred over delayed cholecystectomy due to the high risk (~20%) of recurrent biliary events. There is no indication for antibiotics in AP unless infected necrosis is confirmed or at least strongly

suspected, or unless there is a concomitant infection (cholangitis, pneumonia, UTI, etc.).

Answer: C

- Tenner S, Baillie J, DeWitt J, Vege SS; American College of Gastroenterology. American college of gastroenterology guideline: management of acute pancreatitis. *American Journal of Gastroenterology*. 2013;108(9):1400–15; 1416.
- Costi R, Gnocchi A, Di Mario F, Sarli L. Diagnosis and management of choledocholithiasis in the golden age of imaging, endoscopy and laparoscopy. *World Journal of Gastroenterology*. 2014;20(37):13382–401.
- Chang L, Lo S, Stabile BE, et al. Preoperative versus postoperative endoscopic retrograde cholangiopancreatography in mild to moderate gallstone pancreatitis: a prospective randomized trial. *Annals of Surgery*. 2000;231(1):82–7.
- 13** Which of the following is true regarding nutrition in a patient with severe acute pancreatitis?
- A** Nasojejunal and oral feeds are associated with similar rates of major infection and death.
 - B** Nasojejunal feeds are favored over oral feeds.
 - C** Oral feeds are associated with a greater risk of major infection than nasojejunal feeds.
 - D** Parenteral feeding is favored over enteral feeding.
 - E** Enteral feeds should not be started until amylase and lipase are down-trending.

Previously, parenteral feeding was thought to be superior to enteral feeding because it avoided stimulation of the inflamed pancreas. However, pancreatic rest did not demonstrate a clear benefit and instead, likely contributes to bowel atrophy with increased risk of bacterial translocation. Multiple studies over the years have demonstrated a clear reduction in risk of peripancreatic infection and multiple organ failure with enteral feeding when compared to parental feeding. As such, enteral feeding, if tolerated, is the preferred route of nutrition in acute pancreatitis.

Nasojejunal feeds were previously considered superior to oral feeds. In 2014, the Dutch Pancreatitis Study Group conducted a randomized controlled trial in patients with severe AP (all patients had an APACHE II score >7). This landmark trial compared nasojejunal feeds started at 24 hours and oral feeds started at 72 hours. No significant differences were found in rates of major infection or death. The most current recommendation from the Dutch Pancreatitis Study Group is to start oral feeds once abdominal pain starts to resolve, and not to start nasojejunal feeds unless the patient is unable to tolerate oral feeds after three to 5 days. They do not recommend starting feeds based on trends in serum amylase or lipase levels.

Answer: A

Bakker OJ, van Brunshot S, van Santvoort HC, et al.; Dutch Pancreatitis Study Group. Early versus on-demand nasoenteric tube feeding in acute pancreatitis. *New England Journal of Medicine*. 2014;371(21):1983–93.

van Dijk SM, Hallensleben ND, van Santvoort HC, et al.; Dutch Pancreatitis Study Group. Acute pancreatitis: recent advances through randomised trials. *Gut*. 2017;66(11):2024–32.

James TW, Crockett SD. Management of acute pancreatitis in the first 72 hours. *Current Opinion in Gastroenterology*. 2018;34(5):330–335.

14 A 43-year-old man with alcoholism and a recent episode of acute pancreatitis 3 weeks ago is admitted following a motor vehicle crash. No acute injuries are identified on radiographic survey; however, CT of the abdomen notes a 7 cm × 3 cm × 5 cm, uncomplicated pseudocyst near the tail and body of the pancreas which was not present on his last CT scan 3 weeks ago. The patient denies abdominal pain, distension, early satiety, nausea, and emesis. Vital signs and labs are unremarkable. Which of the following is correct?

- A** Because the pseudocyst is large, endoscopic drainage should be performed during this admission.
- B** Because the pseudocyst is large, endoscopic intervention is unlikely to be successful and surgical drainage should be performed.
- C** Endoscopic drainage should be performed as this patient's alcoholism puts him at high risk of recurrent pancreatitis, which makes the pseudocyst unlikely to resolve on its own.
- D** No intervention is indicated at this time as the patient is asymptomatic and is only 3 weeks out from his episode of pancreatitis.
- E** Endoscopic drainage is associated with fewer complications than surgical cystogastrostomy, but is also significantly less effective.

This patient has a large pseudocyst as a complication of a recent episode of acute pancreatitis. While the pseudocyst is large, the patient is completely asymptomatic and has no evidence of infection, so intervention is not indicated at this time. Though the patient's alcoholism puts him at risk of developing recurrent pancreatitis, that alone is not a reason to intervene on a pseudocyst. The large size (>4 cm) does decrease the likelihood of spontaneous resolution; however, the patient is asymptomatic and so it is still reasonable to allow time for spontaneous resolution. If the pseudocyst does not resolve on its own by 6 weeks, it is unlikely to do so and will likely require

intervention. Typically, endoscopic intervention is preferred over surgical intervention as it has been associated with similar success and recurrence rates but also with fewer complications and shorter length of stay.

Answer: D

Tenner S, Baillie J, DeWitt J, Vege SS; American College of Gastroenterology. American college of gastroenterology guideline: management of acute pancreatitis. *American Journal of Gastroenterology*. 2013;108(9):1400–15; 1416.

Andalib I, Dawod E, Kahaleh M. Modern management of pancreatic fluid collections. *Journal of Clinical Gastroenterology*. 2018;52(2):97–104.

15 A 21-year-old man is riding a dirt bike and crashes head-on into a pole. Upon arrival in the trauma bay, he is mildly tachycardic, normotensive, and complains of severe abdominal pain. On exam, he is very tender in the epigastrium and has ecchymoses in that area, but he has no peritoneal signs. CT scan shows a moderate-size duodenal hematoma, as well as fat stranding near the pancreatic groove. It is unclear based on this scan whether or not a pancreatic injury is present. What is the best initial management strategy for this potential pancreatic injury?

- A** Exploratory laparotomy to evaluate for missed pancreatic injury.
- B** Consult to Interventional Radiology for percutaneous drain placement.
- C** Consult to Gastroenterology for ERCP with pancreatic duct stent placement.
- D** Serial abdominal exams, trend lipase and amylase every 6 hours, pancreatic protocol CT scan at 12–24 hours.
- E** Serial abdominal exams, pancreatic protocol CT scan at 12–24 hours.

Traumatic pancreatic injuries are rare but can occur, especially in blunt mechanisms and with associated duodenal injuries. Up to 40% of pancreatic injuries can be missed on initial CT scan, and sensitivity for ductal injuries is only about 50% on initial CT. The sensitivity and specificity of CT scan for pancreatic injury increases significantly after the first 12–48 hours, especially when a pancreatic protocol (curved, multi-planar reconstruction with specific pancreatic phase contrast) is utilized.

Given this patient's hemodynamic stability and lack of obvious intra-abdominal injury, surgical intervention is not indicated at this time. In 2019, the World Society of Emergency Surgery (WSES) and American Association for the Surgery of Trauma (AAST) released a set of guidelines on management of pancreatic, biliary, and

duodenal injuries. Their recommendation in unconfirmed pancreatic injuries is to trend lipase and amylase every three to 6 hours. Up-trending values would indicate the presence of a pancreatic injury and would warrant a repeat CT scan with pancreatic protocol. If a pancreatic injury were confirmed on repeat CT, management would depend on the severity of the pancreatic injury (see Table 38.4 and Figure 38.2). WSES class I injuries should receive nonoperative management first as

this is successful in 96–100% of cases. If the patient were to fail nonoperative management, intervention should ideally occur within the first 24 hours to reduce the risk of complications. Depending on their location, WSES class II injuries would require percutaneous/endoscopic intervention or distal pancreatectomy. However, it would still be reasonable to confirm this diagnosis via labs and CT scan over a 12 to 24-hour period prior to intervention.

Table 38.4 WSES-AAST severity classification of traumatic pancreatic injuries.

Grade	WSES class	Organ	AAST	Description of injury
Minor	WSES class I	Pancreas	I–II	<ul style="list-style-type: none"> Minor contusion without duct injury Superficial laceration without duct injury Major contusion without duct injury or tissue loss Major laceration without duct injury or tissue loss
		Duodenum	I	<ul style="list-style-type: none"> Hematoma involving a single portion of duodenum Laceration: partial thickness, no perforation
		Extrahepatic biliary three	I–II–III	<ul style="list-style-type: none"> Gallbladder contusion/hematoma. Portal triad contusion Partial gallbladder avulsion from liver bed; cystic duct intact Laceration or perforation of the gallbladder Complete gallbladder avulsion from liver bed. Cystic duct laceration
Moderate	WSES class II	Pancreas	III	<ul style="list-style-type: none"> Distal transection or parenchymal injury with duct injury
		Duodenum	II	<ul style="list-style-type: none"> Hematoma involving more than one portion Laceration with disruption of less than 50% of circumference
		Extrahepatic biliary three	IV	<ul style="list-style-type: none"> Partial or complete right hepatic duct laceration Partial or complete left hepatic duct laceration Partial common hepatic duct laceration (<50%) Partial common bile duct laceration (<50%)
Severe	WSES class III	Pancreas	IV–V	<ul style="list-style-type: none"> Proximal transection or parenchymal injury involving ampulla Massive disruption of pancreatic head
		Duodenum	III–IV–V	<ul style="list-style-type: none"> Disruption 50–75% of circumference of D2 Disruption 50–100% of circumference of D1, D3, and D4 Disruption >75% of circumference of D2 involving ampulla or distal common bile duct Massive disruption of duodeno-pancreatic complex Devascularization of duodenum
		Extrahepatic biliary three	V	<ul style="list-style-type: none"> 50% transection of common hepatic duct 50% transection of common bile duct Combined right and left hepatic duct injuries Intraduodenal or intrapancreatic bile duct injuries
	WSES class IV	Any	Any	Any degree of lesion with hemodynamic instability

Source: Reproduced from Coccolini et al. (2019); open-access article published by Springer Nature.

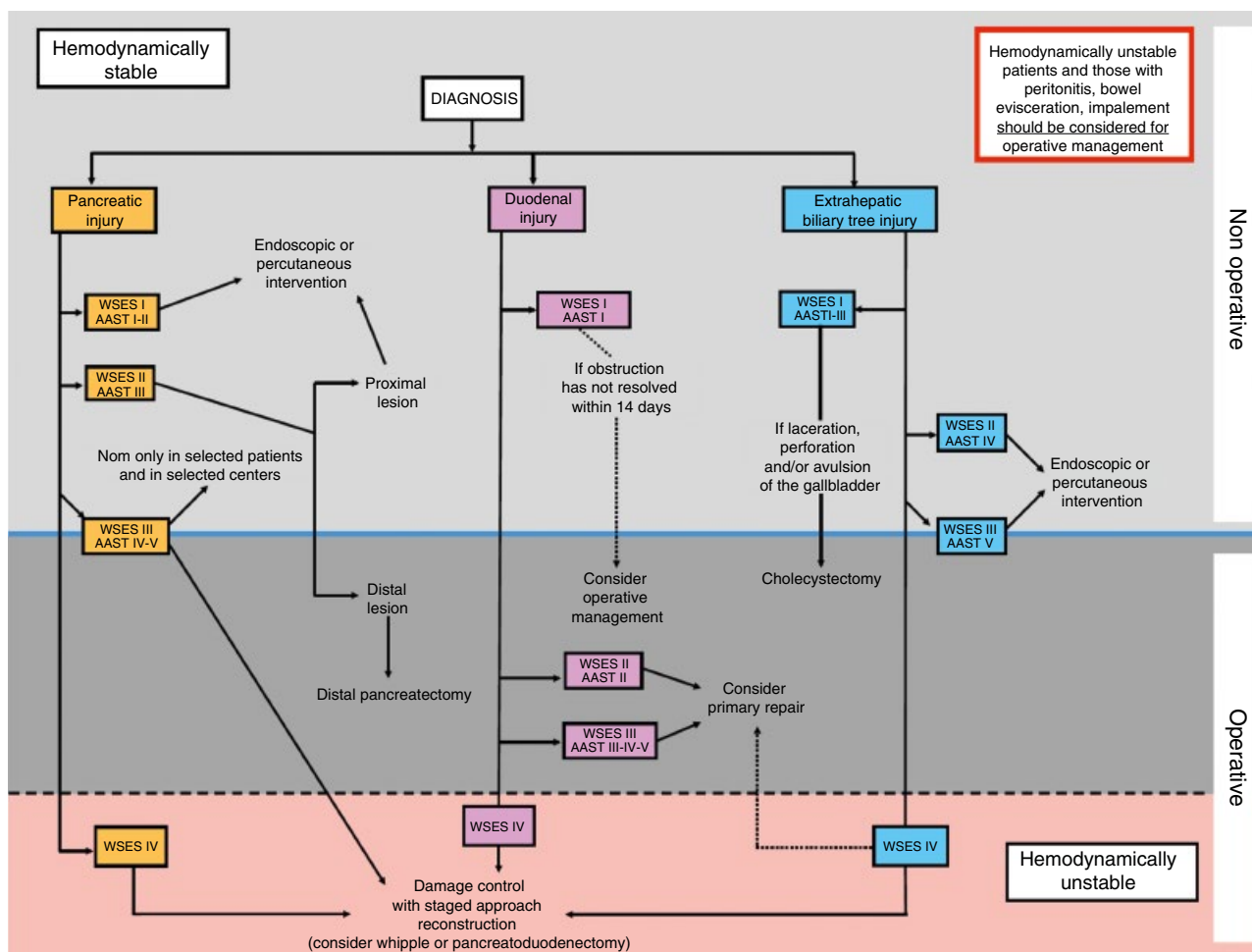


Figure 38.2 WSES-AAST algorithm for treatment of duodenal, pancreatic, and extrahepatic biliary injuries after trauma. *Source:* Reproduced from Coccolini et al. (2019); open-access article published by Springer Nature.

- 16 A 47-year-old man presents with severe acute pancreatitis. Aggressive fluid resuscitation is initiated and the patient is admitted to the ICU. Which of the following is an appropriate strategy for determining the rate of fluid administration?
- Initial 30 mL/kg fluid bolus followed by goal-directed resuscitation with goal urine output of 1.0 mL/kg/hr.
 - Rapid resuscitation with goal hematocrit <35% 48 hours after admission.
 - Initial fluid bolus of 20 mL/kg followed by goal-directed resuscitation with goal heart rate < 120 bpm.
 - Initial 10 mL/kg bolus followed by 1.5 mL/kg/hr and additional boluses as needed.
 - 10–15 mL/kg/hr continuously until mean arterial pressure is > 85 mmHg.

While adequate fluid resuscitation is a cornerstone in the management of acute pancreatitis, specific resuscitation protocols remain under debate. Overly aggressive resuscitation

protocols (i.e., 10–15 mL/kg/hr continuously) have been associated with increased rates of abdominal compartment syndrome, need for mechanical ventilation, and mortality. Under-resuscitation has also been associated with poor outcomes. Most current recommendations involve early, goal-directed therapy. A review by the Dutch Pancreatitis Group in 2017 recommended goal-directed therapy with initial fluid bolus of 20 mL/kg, followed by continuous crystalloid infusion rates titrated according to clinical parameters of heart rate < 120 bpm, urine output > 0.5 mL/kg/hr, and mean arterial pressure 64–85 mmHg. Dilutional anemia should be avoided and goal hematocrit should be 35–44% during resuscitation.

Answer: C

van Dijk SM, Hallensleben NDL, van Santvoort HC, et al.; Dutch Pancreatitis Study Group. Acute pancreatitis: recent advances through randomised trials. *Gut*. 2017;66(11):2024–32.

17 Which of the following is true regarding pancreatic pseudocysts that directly abut intra-abdominal vasculature?

- A Pseudocyst-induced hemorrhage is usually caused by pseudocyst erosion into splenic and gastroduodenal veins.
- B Pseudocyst-induced hemorrhage most commonly involves the pancreaticoduodenal arteries.
- C Angiography is the most appropriate treatment for acute pseudocyst-induced hemorrhage with hemodynamic instability.
- D After hemorrhage control, the best definitive management of the pseudocyst is surgical resection.
- E After hemorrhage control, the best definitive management of the pseudocyst is cystoenterostomy.

Pancreatic pseudocysts that abut the vasculature pose a significant risk of life-threatening arterial hemorrhage. Pseudocysts tend to compress adjacent veins, leading to thrombosis rather than hemorrhage. Arteries, however, are not as compressible and instead can develop inflammation-induced pseudoaneurysms, which then can rupture and hemorrhage. The most common source of pseudocyst-induced hemorrhage is the splenic artery, followed by the gastroduodenal and pancreaticoduodenal arteries. When hemorrhage is present but the patient is stable enough for interventional radiology, the preferred treatment is angiography and embolization. Due to the significant increase in associated complications and mortality, surgical intervention is typically reserved for patients who are hemodynamically unstable. Intraoperatively, once the hemorrhage has been controlled, preferred definitive management of the pseudocyst is resection rather than cystoenteric drainage. Resection of the cyst decreases the risk of further hemorrhagic complications. For hemorrhage associated with the splenic artery, this typically requires distal pancreatectomy and splenectomy. For hemorrhage associated with the gastroduodenal or pancreaticoduodenal arteries, pancreaticoduodenectomy is usually the operation of choice.

Answer: D

Matsuoka L, Alexopoulos SP. Surgical management of pancreatic pseudocysts. *Gastrointestinal Endoscopy Clinics of North America*. 2018;28(2):131–41.

18 Which of the following is the most common complication of nonoperative management for pancreatic injuries?

- A Pancreatic fistula
- B Intra-abdominal abscess
- C Glucose intolerance

- D Pancreatic pseudocyst
- E Exocrine pancreatic insufficiency

The most common complication following nonoperative management of pancreatic injury (PI) is a pancreatic pseudocyst. This occurs in about one-fifth of patients who succeed without operative intervention. Intra-abdominal abscess occurs in up to 25% of all patients with PI; however, it is more common in patients who undergo operative intervention. Pancreatic fistulae develop in 10–35% of patients who undergo operative drainage and/or pancreatic resection, but are rare for nonoperative patients. Endocrine and exocrine pancreatic insufficiency are very rare complications. When they do occur, they are typically transient and occur after pancreatic resection, not nonoperative management.

Answer: D

Coccolini F, Kobayashi L, Kluger Y, et al.; WSES-AAST Expert Panel. Duodeno-pancreatic and extrahepatic biliary tree trauma: WSES-AAST guidelines. *World Journal of Emergency Surgery*. 2019;14:56.

Ho VP, Patel NJ, Bokhari F, et al. Management of adult pancreatic injuries: a practice management guideline from the Eastern Association for the Surgery of Trauma. *Journal of Trauma and Acute Care Surgery*. 2017;82(1):185–99.

19 A 22-year-old woman is recovering in the ICU after she was struck by a car while crossing the street. She is currently on postoperative day three after exploratory laparotomy, splenectomy, and distal pancreatectomy. Drain amylase has been 300–500 U/L daily, suggesting pancreatic leak. She is afebrile and hemodynamically normal, and her white blood cell count is down-trending. What is the next best step?

- A Obtain a stat CT scan of the abdomen and pelvis to evaluate for fluid collection.
- B Close observation and nutritional optimization.
- C Stat consult to Interventional Radiology for placement of a second percutaneous drain.
- D Initiate antibiotic therapy, obtain a CT scan of the abdomen and pelvis to evaluate for fluid collection.
- E Planned return to OR for exploratory laparotomy, washout, and wide drainage.

According to the International Study Group on Pancreatic Fistula (ISGPF), this patient has a biochemical leak (Table 38.5). Since she has no evidence of infection, close observation and nutritional optimization (preferably enteral if tolerated) would be sufficient.

Table 38.5 2017 ISGPF definitions and grades of postoperative pancreatic fistula.

Event	Biochemical leak	Grade B POPF	Grade C POPF
Drain amylase concentration >3 × upper limit of normal serum value	Yes	Yes	Yes
Persisting peripancreatic drainage >3 weeks	No	Yes	Yes
Clinically relevant change in the management of POPF	No	Yes	Yes
Percutaneous or endoscopic drainage of POPF-associated collections	No	Yes	Yes
Angiographic procedures for POPF-associated bleeding	No	Yes	Yes
Reoperation for POPF	No	No	Yes
Signs of infection related to POPF	No	Yes (without organ failure)	Yes (with organ failure)
POPF-related organ failure	No	No	Yes
POPF-related death	No	No	Yes

Abbreviations: ISGPF, International Study Group on Pancreatic Fistula; POPF, postoperative pancreatic fistula.

Source: Reproduced from Bassi et al. (2017); with permission from publisher, Elsevier.

Somatostatin analogues have been evaluated for their role in expedited resolution of pancreatic fistulae, though no clear benefit has been demonstrated in the literature. If the patient were to develop signs of infection, a contrast-enhanced CT scan and initiation of broad-spectrum antibiotics would be appropriate. Additional percutaneous drainage and/or endoscopic drainage could also be considered if there were concern for infection. Re-exploration is typically reserved for hemodynamically unstable patients and patients in whom more conservative treatments have failed.

Answer: B

Nahm CB, Connor SJ, Samra JS, Mittal A. Postoperative pancreatic fistula: a review of traditional and emerging concepts. *Clinical and Experimental Gastroenterology*. 2018;11:105–118.

20 Which of the following is true regarding amylase and lipase when diagnosing acute pancreatitis?

- A** Elevated serum amylase is more specific for acute pancreatitis than serum lipase.
- B** Serum lipase returns to normal levels more quickly than serum amylase.
- C** Serum lipase may be artificially low in patients with diabetes mellitus.
- D** Serum amylase may remain normal in patients with alcohol or triglyceride-induced acute pancreatitis.
- E** Serum amylase and lipase have similar sensitivities for acute pancreatitis.

According to the American College of Gastroenterology (ACG), the diagnosis of acute pancreatitis can be made if the patient has at least two of the following: characteristic abdominal pain, serum amylase and/or lipase greater than three-to-five times the upper limit of normal, and/or characteristic findings on abdominal imaging. While elevation in either serum amylase or lipase is sufficient based on these criteria, lipase is typically relied upon more heavily as it has better sensitivity, specificity, and positive and negative predictive values than amylase. Serum lipase also remains elevated longer than serum amylase, which typically normalizes as soon as 3–5 days after onset of pancreatitis. Importantly, serum amylase may remain within normal limits during episodes of alcohol or hypertriglyceridemia-induced acute pancreatitis. While lipase does appear to be the superior test for acute pancreatitis, patients with diabetes mellitus tend to have higher median levels of serum lipase at baseline compared to non-diabetics. This is why most guidelines recommend a serum lipase threshold of at least three times the upper limit of normal to support the diagnosis of acute pancreatitis.

Answer: D

Tenner S, Baillie J, DeWitt J, Vege SS; American College of Gastroenterology. American college of gastroenterology guideline: management of acute pancreatitis. *American Journal of Gastroenterology*. 2013;108(9):1400–15; 1416.

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