ME 2491 Medicine and Surgery
Infectious Diseases
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Intraabdominal infections

Russell Lewis

Associate Professor of Medicine, Infectious Diseases

Department of Molecular Medicine, University of Padua

DMM

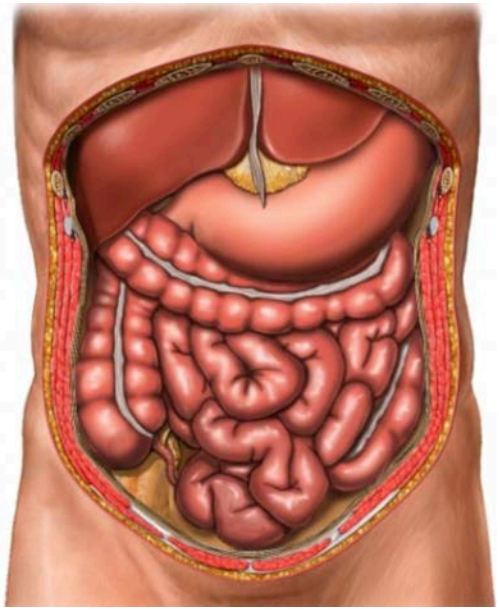
Università degli Studi di Padova

Infection of the peritoneal cavity or retroperitoneal space

- **Peritonitis and peritoneal abscess**
  - (Appendicitis, diverticulitis and typhlitis)
- **Infections on the liver and biliary system**
  - liver abscess, cholangitis, cholecystitis, splenic abscess
- **Pancreatic infections**

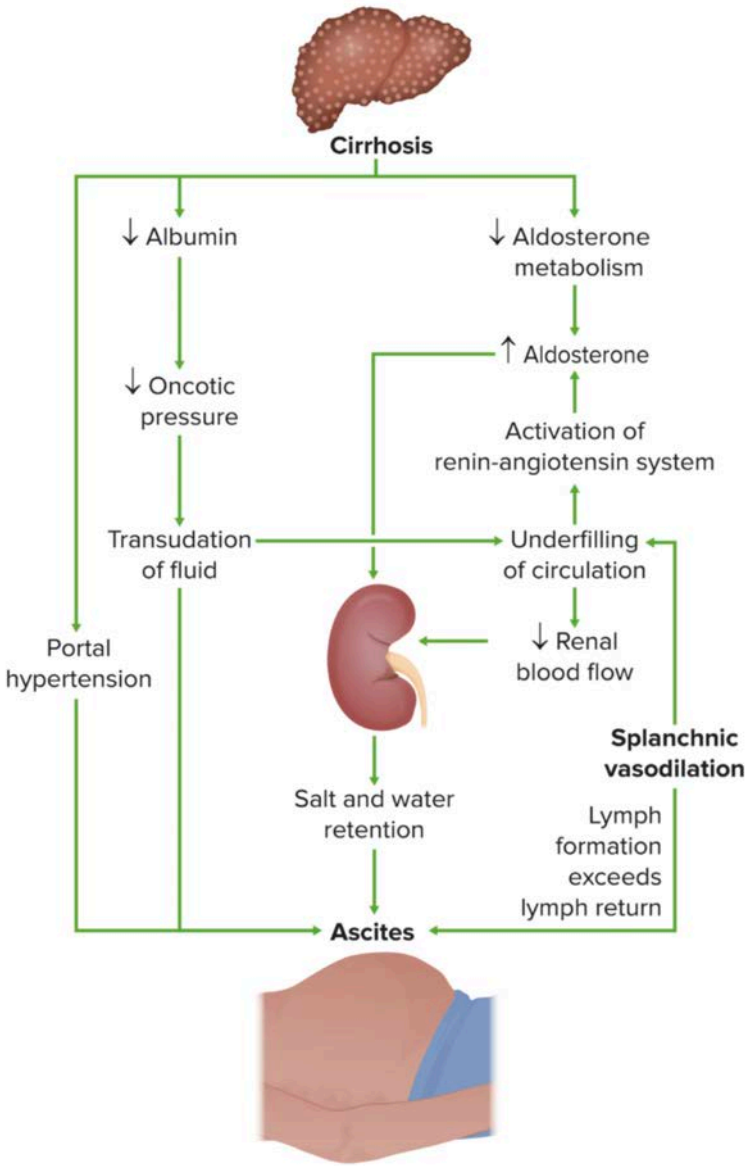
Peritonitis

- **Primary (*spontaneous bacterial peritonitis*)**
  - Not related to intraabdominal pathology
- **Secondary**
  - Intraabdominal pathology results in infection
  - Microbial or chemical contamination by disease processes
- **Tertiary peritonitis**
  - Later stage of infection when clinical peritonitis persists or recurs following treatment of secondary disease, often due to low virulence of MDR pathogens
- **Peritoneal dialysis**
  - Catheter infection, typically caused by *Staphylococcus or Streptococcus*
  - Recurs in 20-30% of patients, most common reason for switch to hemodialysis
- **Intraperitoneal abscess** occur secondarily as a consequence of disease organ, penetrating trauma or surgical procedure



Case #1

- 52 year-old male is hospitalized for 3 days with abdominal pain and fever. He has a history if decompensated alcoholic cirrhosis and ascetics managed with diuretics.
- His medications are furosemide, spironolactone and lactulose.
- Vitals are notable for a temperature of 38.0°C, blood pressure 115/60 mm HG, and heart rate of 110/min. His abdomen is distended and moderately tender to palpation with a positive fluid wave
- Lab studies show
  - bilirubin of 4.5 mg/dL
  - serum creatinine of 1.3 mg/dL
  - WBC of 12,000/µL


Cirrhosis
↓ Albumin
↓ Aldosterone metabolism
↑ Aldosterone
↓ Oncotic pressure
Activation of renin-angiotensin system
Transudation of fluid
Underfilling of circulation
Portal hypertension
↓ Renal blood flow
Splanchnic vasodilation
Salt and water retention
Lymph formation exceeds lymph return
Ascites

1° peritonitis (SBP)

- **Liver cirrhosis and ascites most common risk factors**
  - SBP is present in ~10% of patients admitted to the hospital with cirrhotic ascites
- **Risk factors: concomitant GU bleeds, previous peritonitis, low ascitic protein concentrations**
  - Patients are immunocompromised- gut dysbiosis, systemic inflammation, immune paralysis, bacterial translocation into bloodstream
- **In children, hematogenous spread of *Streptococcus pneumoniae* and other streptococci more common**
- ***Staphylococcus aureus* rarely isolated**

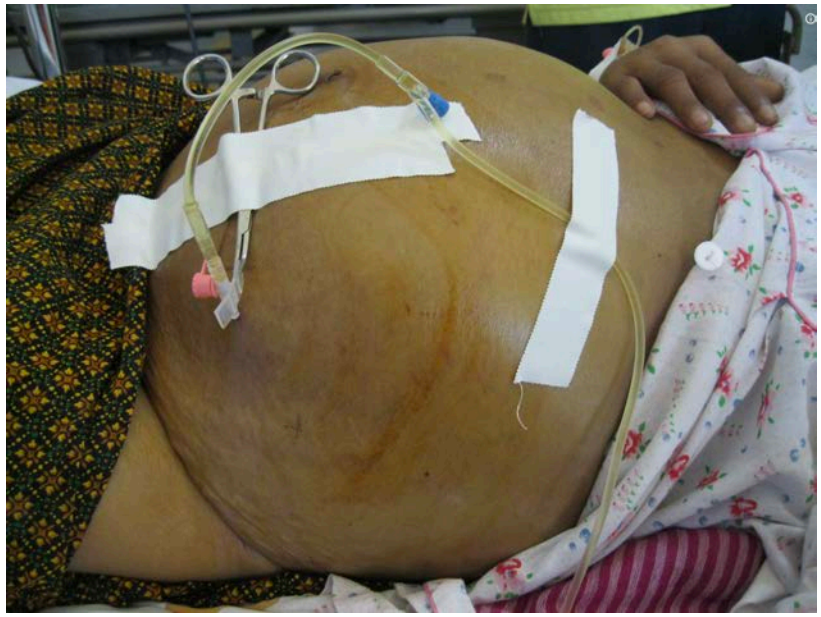


Photo: John Campbell

1° Peritonitis

- **Three variants:**
  - **Culture-negative neutrocytic ascites** - difficult to culture organisms (*M. tuberculosis*) and noninfective cases
  - **Monomicrobial non-neutrocytic bacterascites** - early bacterial colonization of ascites fluid→85% progress to infection
  - **Polymicrobial bacterascitis**- organ injury, post-surgical

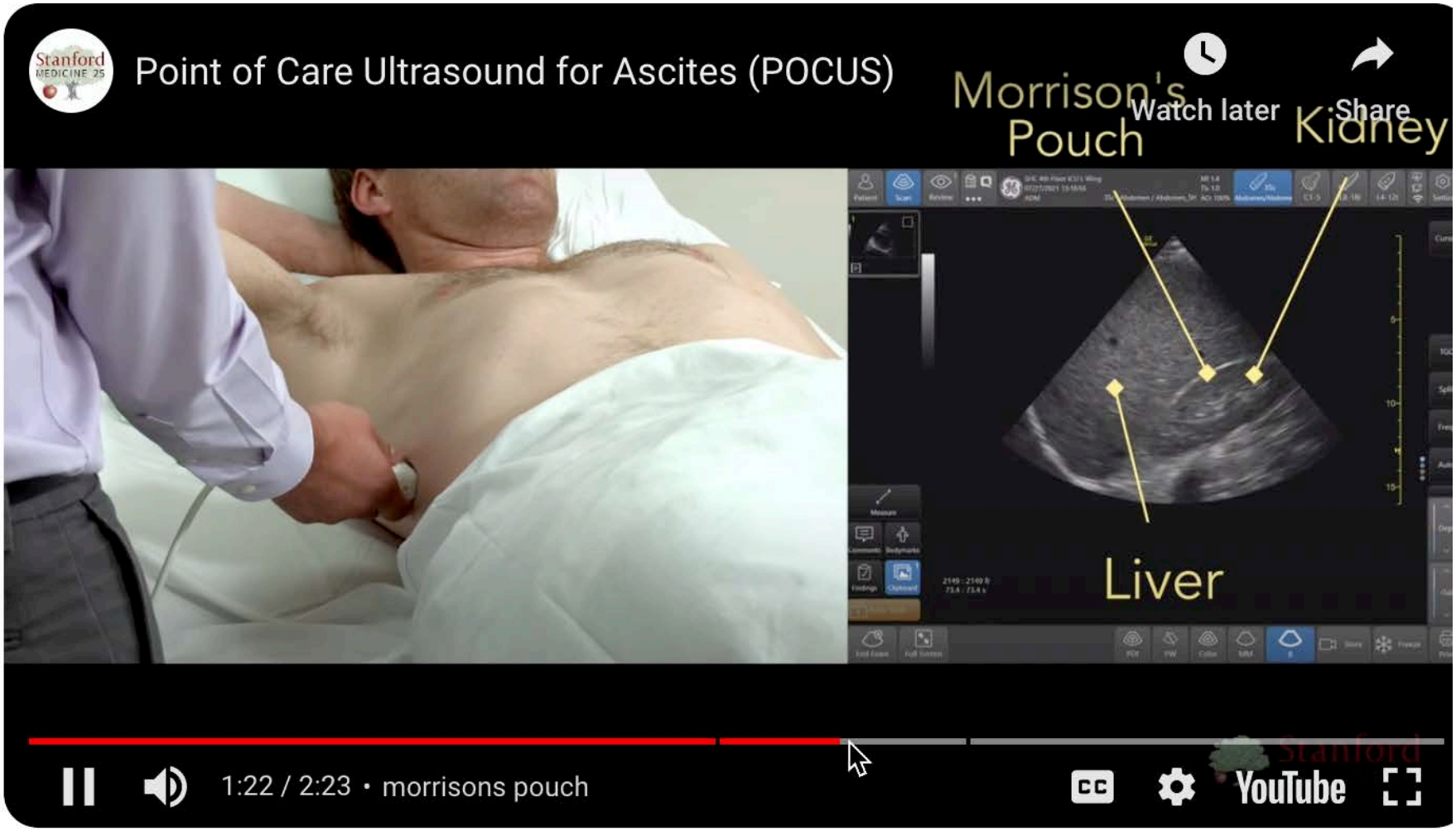
Spontaneous bacterial peritonitis

- **Symptoms:**
  - Fever
  - Abdominal pain
    - However, SBP usually *doesn't* always cause frank peritoneal signs or focal pain (if these are present, then 2° bacterial peritonitis should be suspected.
  - Hypotension
  - Encephalopathy
  - Gastrointestinal haemorrhage
  - Acute kidney injury (AKI)
  - Septic shock

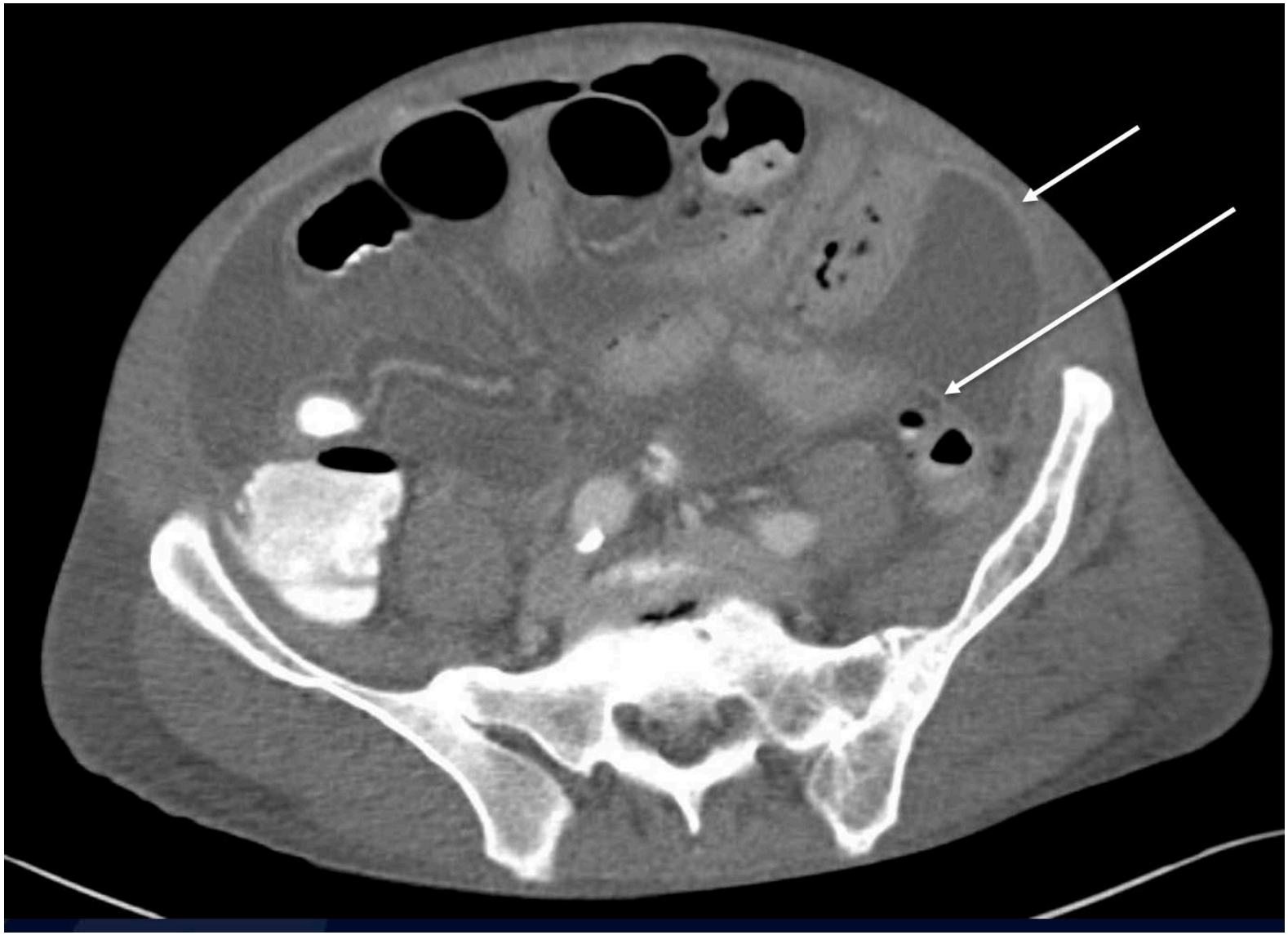
Diagnostic workup

1. Ultrasound/CT and diagnostic paracentesis
2. Start empiric antimicrobial therapy
3. Analyze ascitic fluid: albumin, total protein, cell count, and culture

Imaging

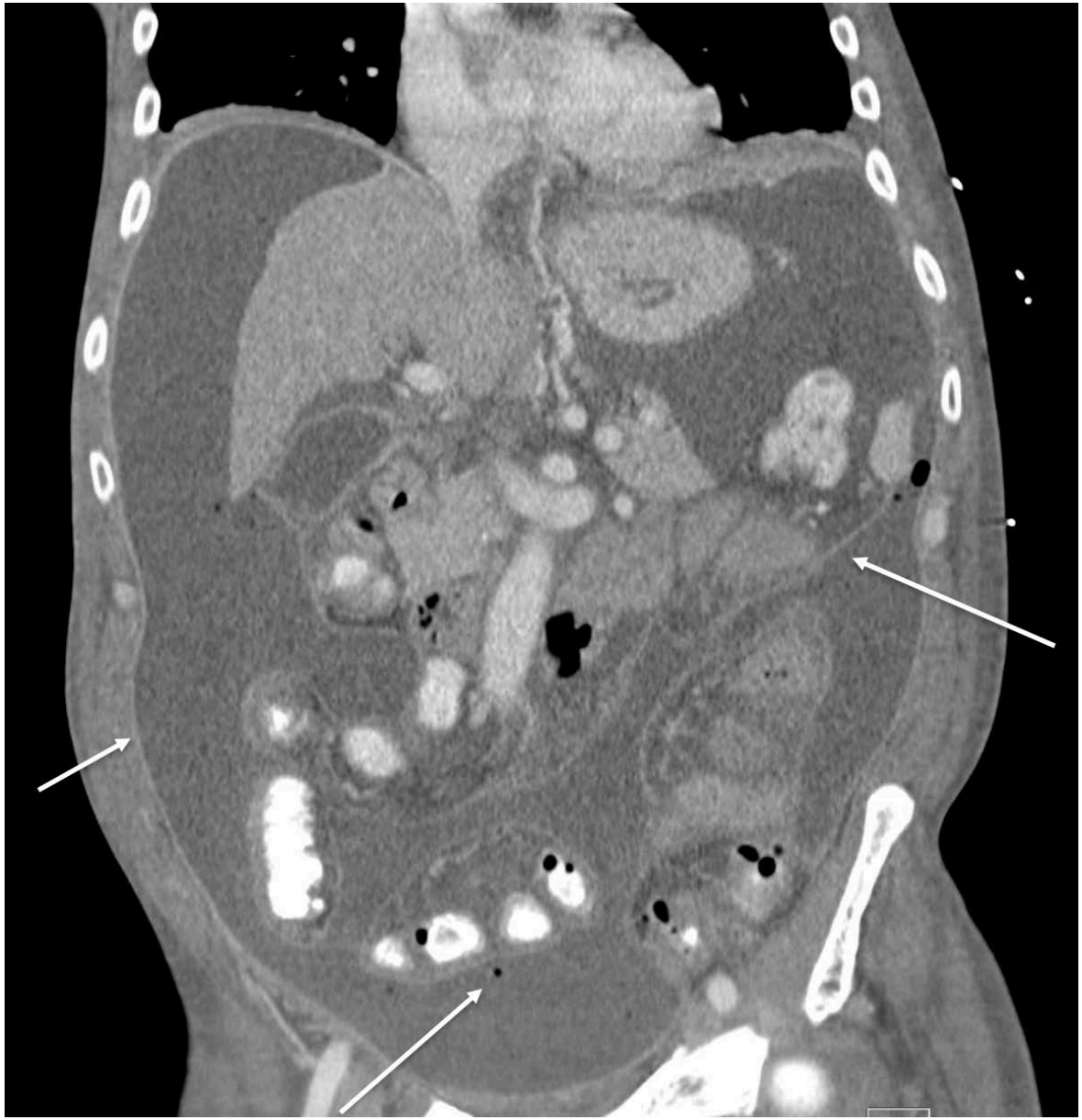


Morrison's pouch



Abdominal CT with contrast needed if secondary peritonitis suspected

Axial contrast-enhanced CT in this cirrhotic patient with spontaneous bacterial peritonitis demonstrates loculated ascites with enhancement and thickening of the visceral and parietal peritoneum.



Coronal contrast-enhanced CT reveals ascites fluid with classic imaging finding of bacterial peritonitis. Few locules of air are also present in the peritoneum from recent paracentesis.

Parencentesis

- **Labs to obtain**
  - CBC with diff, metabolic panel, blood cultures
  - Analysis of ascitic fluid
  - Cell count & differential
  - Gram stain
  - Bacterial cultures (Ideally, culture bottles should be inoculated at the bedside: 10 ml each into an anaerobic bottle and an aerobic bottle.)
  - Total protein, albumin
  - Glucose
  - Lactate dehydrogenase

	Peritonitis							
	Primary				Secondary	Tertiary	Peritoneal Dialysis (PD)	Tuberculosis (TB)
	Typical	CNNA	MNBA	PBA				
Leucocyte count[a] /μLr	≥250 PMN		<250 PMN		≥250 PMN	≥250 PMN	≥100 total[b] usually >50% PMN	150–4000 total usually lymphocytes
Gram	Variable[c]	Negative	Variable	Usually positive	Variable	Variable	Positive 10%–50%	Negative AAFB smear has low yield
Culture	Positive	Negative	Positive	Positive	Positive	Variable	Positive	Negative <20% culture positive
Organisms	Monomicrobial	Variable	Monomicrobial	Polymicrobial	Polymicrobial	Polymicrobial	Monomicrobial	Monomicrobial
Total protein	<1 g/dL	Variable	Normal	Normal	>1 g/dL	Variable	Variable	>3 g/dL
Glucose	≥2.8 mmol/L	Variable	Normal	Normal	<2.8 mmol/L	Variable	Variable	Low
LDH	Within serum range	Variable	Normal	Normal	>Serum	Variable	Variable	High (>90 U/ml)
Blood culture	75% positive	Negative	Negative	Negative	Negative	Negative	Negative	Negative

[d]Increase bacterial yield (up to 100%) if inoculated early into enrichment media.

CNNA, culture-negative neutrocytic ascites; LDH, lactate dehydrogenase; MNBA, monomicrobial non-neutrocytic bacterascites; PBA, polymicrobial bacterascites; PMN, polymorphonuclear leucocyte.

Note: Lactate and pH are unhelpful.

a Corrected PMN count should be calculated if aspirate is traumatic (bloody) due to entry of excess PMN: 1 PMN subtracted for every 250 RBC/mm3.

b Eosinophilia may be seen after tube placement (and rarely in some cases of fungal disease).

c Insensitive with high false-positive rate.

Microbiology of SBP

Bacteria isolated from ascitic fluid in 519 patients with spontaneous bacterial peritonitis

Organism	Percent of isolates
Escherichia coli	43
Klebsiella pneumoniae	11
Streptococcus pneumoniae	9
Other streptococcal species	19
Enterobacteriaceae	4
Staphylococcus	3
Pseudomonas	1
Miscellaneous*	10

*In some regions of the world, such as Korea, Aeromonas hydrophila infection is an important cause of SBP, particularly in warm weather months. Affected patients commonly also have diarrhea. [Choi JP, et al. Clin Infect Dis 2008; 47:67.]

Data from McHutchison JG, Runyon BA. Spontaneous bacterial peritonitis. In: Gastrointestinal and Hepatic Infections, Surawicz CM, Owen RL (Eds), WB Saunders, Philadelphia 1995. p.455.

1° peritonitis (SBP) microbiology

- **Typically mono microbic infection caused by enteric flora**
  - e.g., *E. coli, Proteus* spp. and *K. pneumoniae, Enterobacter spp.*
- Multimicrobial infection suggestive of secondary disease
- Anaerobes and yeast are uncommon due to bacteriostatic properties in ascites
- *Streptococcus pneumoniae* may cause SBP in children with bacteremia, patients with HIV and pre-pubertal girls (ascending infection from genital tract)
- TB infection can be seen in at-risk individuals

Selecting empiric antimicrobial therapy

- **CLIF-SOFA score**
  - Broader spectrum with higher scores
- **Recent antibiotic use and resistance patters**
  - Recent fluoroquinolone use for SBP prophylaxis
  - 3rd generation cephalosporins (e.g., cefotaxime 2 grams very 8 hours, ceftriaxone 2 grams daily) for 5 days
  - Reserve carbapenems (ertapenem, meropenem, imipenem) or piperacillin-tazobactam for patients who are critically-ill (i.e. CLIF SOFA ≥ 7), or nosocomial onset
    - Longer duration of therapy should laos be considered for unusual organisms (e..g *Pseudomonas*) or bacteria associated with endocarditis (e.g., viridian streptococci, *Staphylococcus aureus*)
  - Antibiotic therapy should be narrowed when culture and sensitivity results are available

SBP complications

- Spontaneous bacterial peritonitis may push patients into a state of decompensated cirrhosis, marked by hypotension, malperfusion, and hepatorenal syndrome.
- In severe cases, this may evolve into acute-on-chronic liver failure -
- The following treatments should be implemented preemptively, to avoid this.
  - Albumin has been proven to reduce the incidence of hepatorenal syndrome and mortality.
  - The treatment regimen is 1.5 gram/kg of 20% albumin at the time of diagnosis, followed by 1 gram/kg albumin 48 hours later.
  - Discontinue beta-blockers, as these may increase the risk of hypotension and hepatorenal syndrome.Consider holding other antihypertensives or vasodilators as well (especially ACE inhibitors or ARBs)
  - Discontinue or avoid any nephrotoxins.

2° peritonitis vs. 1° peritonitis (SBP)

- Fever and pain persist on empiric antibiotic therapy
- Free air seen on ultrasound
- A repeat paracentesis with re-culturing of the ascitic fluid may be considered after 48 hours
  - If the neutrophil count isn't decreasing to <25% of the pretreatment value, this carries a substantial likelihood of treatment failure
  - Surgical source of infection
    - Abdominal CT with contrast
    - Broader-spectrum therapy that has anaerobic coverage
- Hepatic hydrothorax

Peritoneal abscess

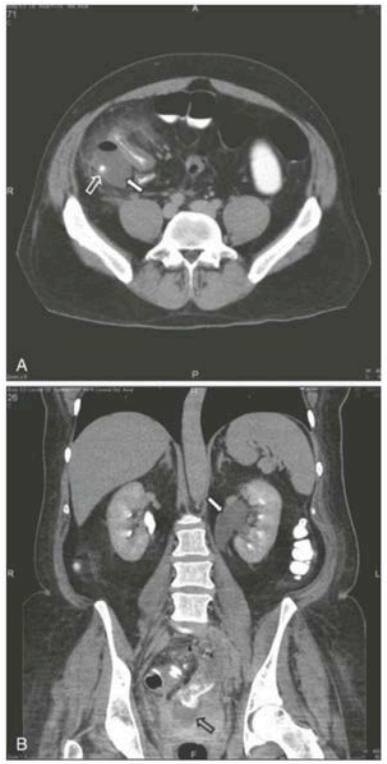


FIGURE 76-4 Computed tomographic scans of abdomen and pelvis after administration of oral and intravenous contrast medium. **A,** Perforated appendicitis: right lower quadrant collection with an air-fluid level *(solid arrow)* surrounding a dilated appendix

- Intraperitoneal abscesses develop as a result of localization of diffuse peritonitis, usually in the pelvis, perihepatic spaces, and paracolic gutters.
- Abscesses may develop around diseased organs (e.g., periappendiceal or pericholecystic abscesses) or after a penetrating wound (stabbing, gunshot, auto accident, or other trauma) or surgical procedure.
- Treatment: CT guided drainage + antibiotics similar to 2° peritonitis

Observed findings consistent with abscess include a low-density tissue mass and a definable capsule . CT can detect extraluminal gas, a finding highly suggestive of abscess.

1° peritonitis (SBP) Prognosis

- With appropriate treatment and in absence of renal failure (< 10%)
- With renal failure (67%)
- With septic shock (82%)

antibiotic prophylaxis

- One or more prior episodes of SBP
  - Recurrence rates approach 70%
- Patients with cirrhosis and gastric bleeds
- Patients with cirrhosis with ascetic fluid protein < 1.5 g/dL with either:
  - Impaired renal function (SeCr ≥ 1.2 mg/dL; BUN ≥ 25 mg/dL; Se Na^+ ≤ 130 mEq/L
  - Liver failure: Child-Pugh ≥ 9 and bilirubin ≥ 3 mg/dL
- Patients hospitalized for other reasons with ascites protein conc < 1 g/dL

Antibiotic prophylaxis

- Trimethoprim-sulfamethoxazole (1 DS tablet daily)
  - Alternatives: ciprofloxacin 500 mg daily, norfloxacin 400 mg daily
  - Ceftriaxone 1g daily can be used with vatical bleeding transitioned to TMP/SMX once the patient is eating

SBP, Patient is not responding

- Fever and pain persist on empiric antibiotic therapy-
- A repeat paracentesis with reculturing of the ascitic fluid may be considered after 48 hours
  - If the neutrophil count isn't decreasing to <25% of the pretreatment value, this carries a substantial likelihood of treatment failure
  - Surgical source of infection
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Case #2

- A patient with advanced alcoholic cirrhosis presents to the hospital with fever and altered mental status.
- Examination is notable for abdominal distention with rebound tenderness.
- Bedside ultrasound reveals a large amount of ascites, which is carefully sampled revealing a cloudy fluid with 15,000 neutrophils/uL and a differential of 90% neutrophils. Ultrasound confirms ascites without obvious bowel abnormalities
- The diagnosis of spontaneous bacterial peritonitis is made, and the patient is treated.
- However, ten hours later the patient develops worsening hypotension and tachycardia requiring transfer to the ICU.

Runyon's criteria for 2° peritonitis

- Two of these three features:
  - total protein >1 g/dL
  - glucose <50 mg/dL (2.8 mM)
  - lactate dehydrodgenase above the upper limit of normal for serum

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Case #2, cont.

- The patient was stabilized in the ICU with intubation, vasopressors, and central line placement.
  - CT scan revealed duodenal perforation.
  - Due to worsening mutiorgan failure, the patient was not deemed to be a surgical candidate.
  - Despite aggressive care the patient did not survive

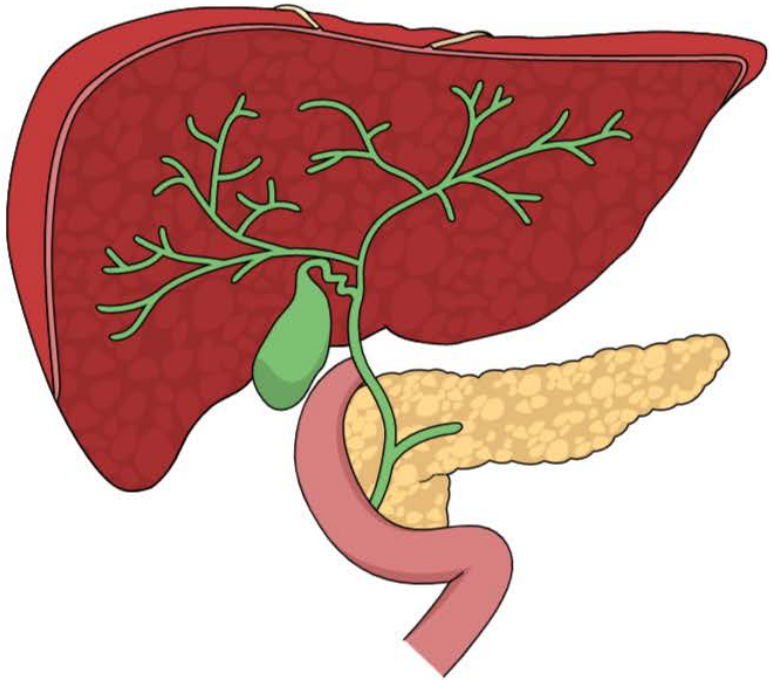
TABLE 21-1 Causes of Secondary Peritonitis

Modified from Solomkin JS, Mazuski JE, Bradley JS, et al. Diagnosis and management of complicated intra-abdominal infection in adults and children: guidelines by the Surgical Infection Society and the Infectious Diseases Society of America. *Clin Infect Dis.* 2010;50:133-164.

Distal esophagus	Boerhaave syndrome
	Malignancy
	Trauma
	Iatrogenic*
Stomach	Peptic ulcer perforation
	Malignancy
	Trauma
	Iatrogenic*
Duodenum	Peptic ulcer perforation
	Trauma
	Iatrogenic*
Biliary tract	Cholecystitis
	Stone perforation from gallbladder or common duct
	Malignancy
	Trauma
	Iatrogenic*
Pancreas	Pancreatitis (e.g., alcohol, drugs, gallstones)
	Trauma
	Iatrogenic*
Small bowel	Ischemic bowel
	Incarcerated hernia
	Crohn's disease
	Malignancy
	Meckel's diverticulum
	Trauma
Large bowel and appendix	Ischemic bowel
	Diverticulitis
	Malignancy
	Ulcerative colitis and Crohn's disease
	Appendicitis
	Volvulus
	Trauma (mostly penetrating)
	Iatrogenic*
Uterus, salpinx, and ovaries	Pelvic inflammatory disease (e.g., salpingo-oophoritis, tubo-ovarian abscess, ovarian cyst)
	Trauma
	Malignancy
	Iatrogenic*

perforated viscus, appendicitis, cholecystitis, mesenteric ischemia
(30 fold less common then SBP, but diagnosis can be delayed or missed)

Liver and biliary infections

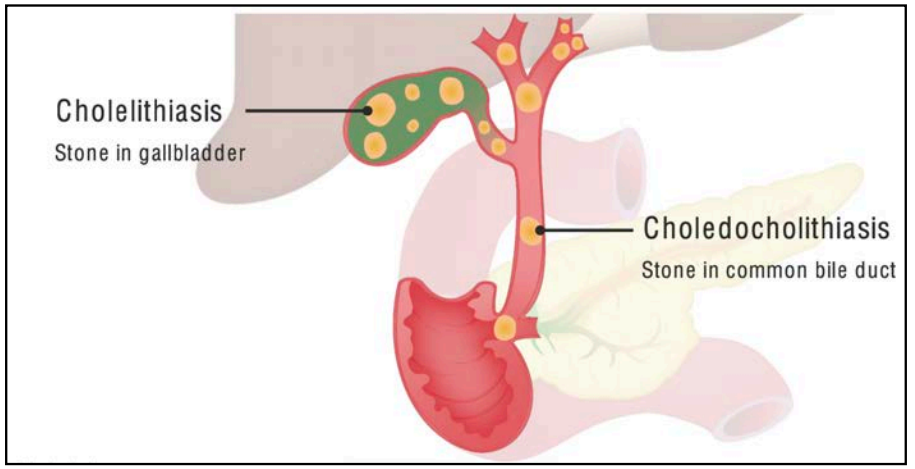


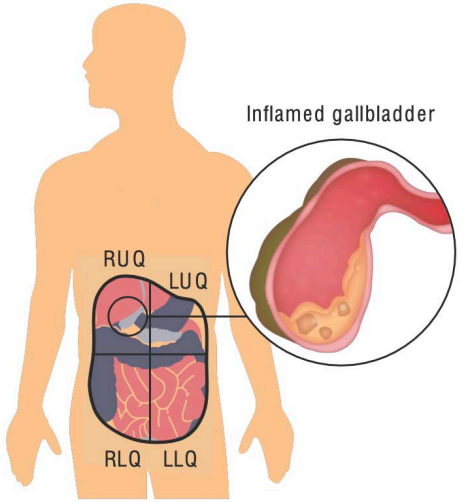
Case #3

- 43 year old male with no PMH presents with RUQ pain accompanied by fever, nausea and vomiting. Over the past few months he has noted intermittent abdominal pain after eating. These episodes last for a few minutes then resolve
- Vitals are notable for a temperature of 38.2°C. On abdominal exam he has right-upper quadrant tenderness to palpation, but no rebound tenderness or guarding
- Lab studies show mild elevation of AST, ALT and total bilirubin. An abdominal ultrasound show percholecystic fluid and gallbladder wall thickening

Cholelithiasis vs. acute cholecystitis?

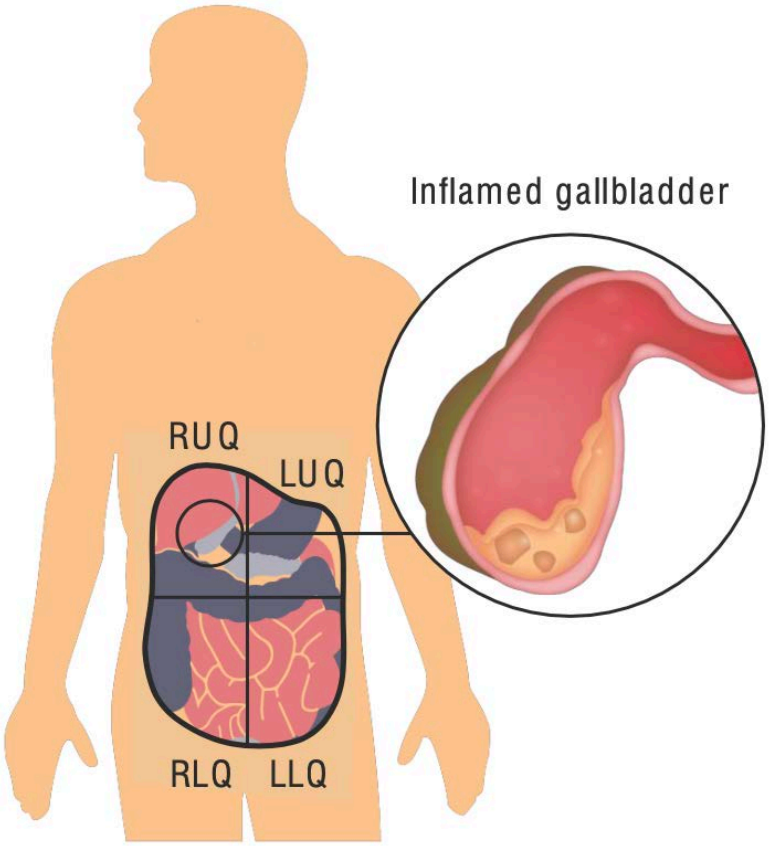
Cholelithiasis	Acute cholecystitis
Biliary colic is self-limiting and intermittent	Acute cholecystitis presents with persistent RUQ pain, fever, elevated liver history studies





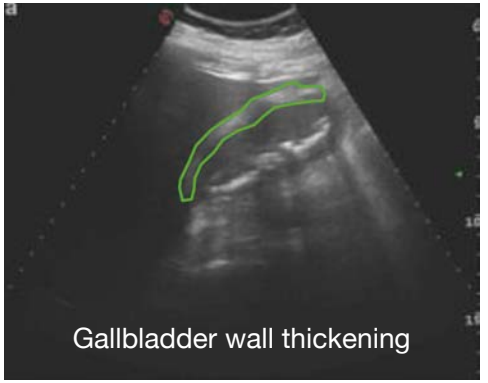
Acute calculus cholecystitis and ascending cholangitis (Community onset)

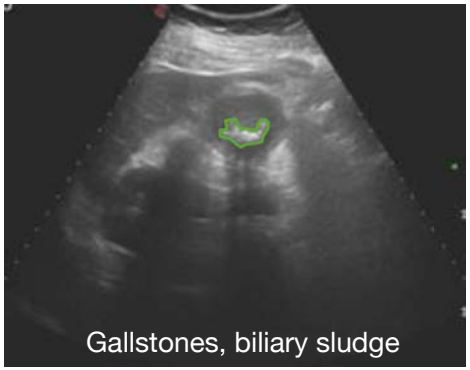
- Clinical presentation:
  - Right-upper quadrant pain
  - Nausea, vomiting
  - Murphy's sign



Acute cholecystitis

- 90% of cases caused by obstruction
- Diagnosis: RUO ultrasound
- Common features:
  - Pericholecystic fluid
  - Gallbladder wall thickening
  - Gallstones
  - Sonographic Murphy's sign

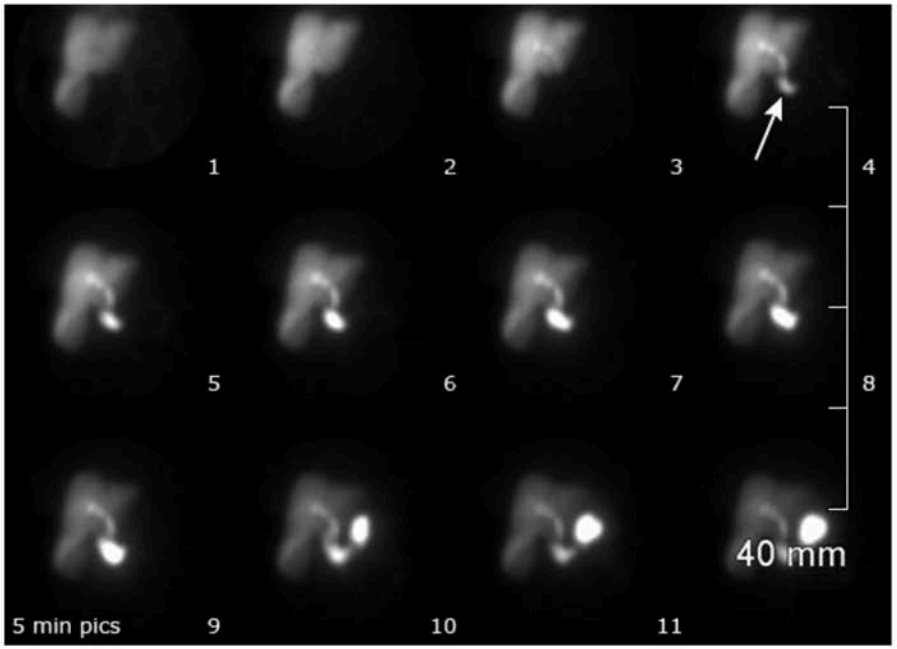

Gallbladder wall thickening


Gallstones, biliary sludge

Cholescintigraphy: HIDA Scan

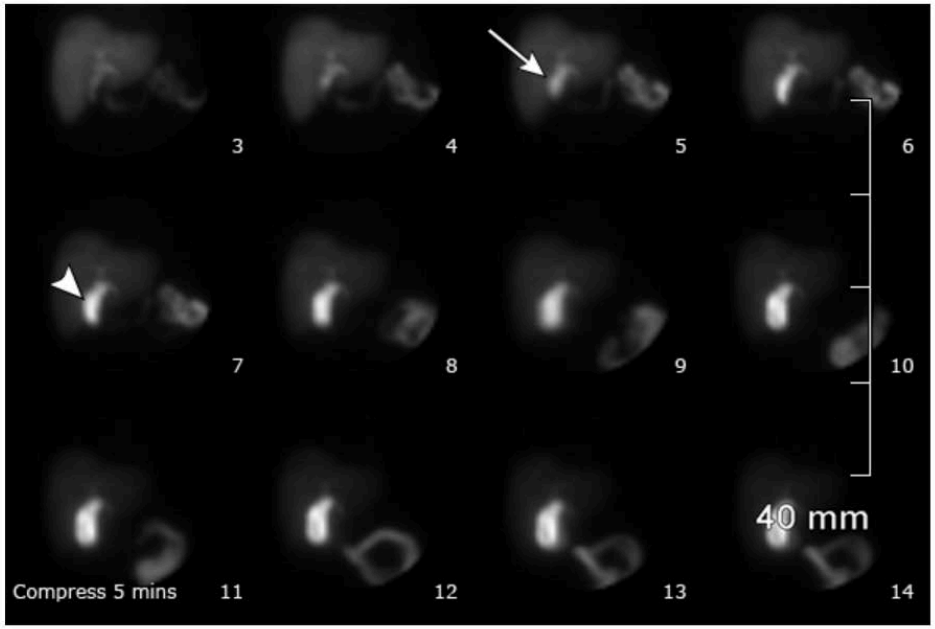
Used when ultrasound is equivocal

HIDA scan in a patient with acute cholecystitis



The hepatic iminodiacetic acid (HIDA) scan is abnormal and shows absence of filling of the gallbladder, indicating obstruction of the cystic duct. The duodenum starts to fill with radioisotope at about 20 minutes (white arrow). The radioisotope flows directly into the duodenum (white arrow) starting at 20 minutes. The gallbladder never fills during the course of the 60 minute examination. These findings are consistent with the diagnosis of acute cholecystitis.

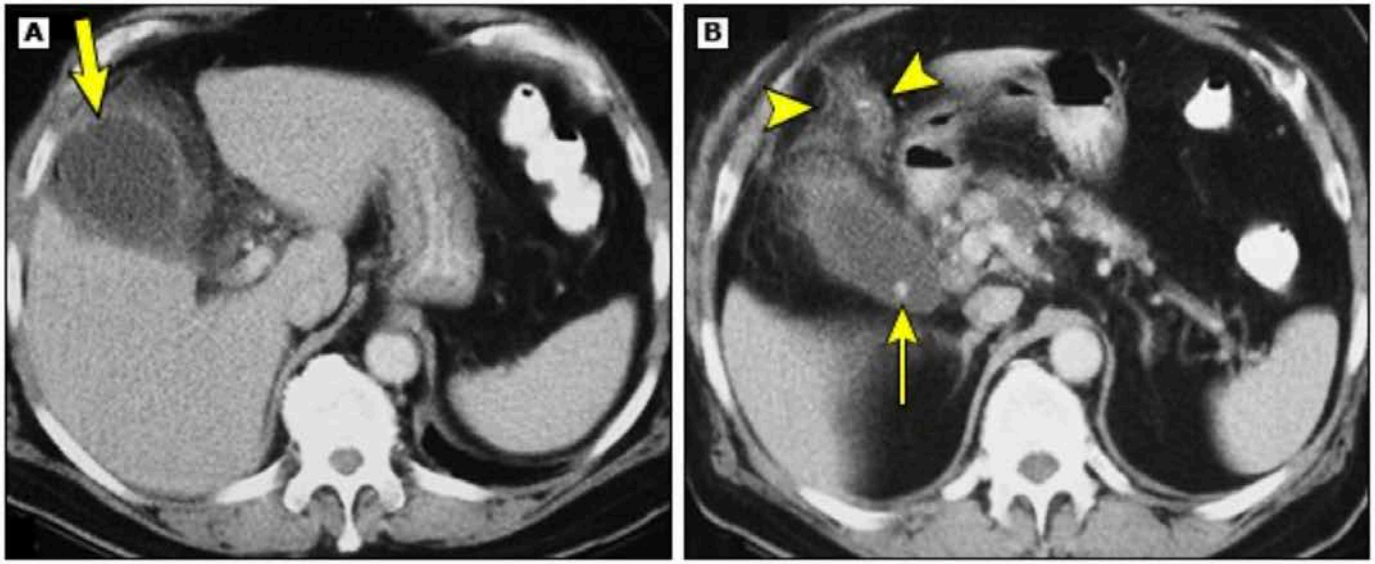
Normal HIDA scan



This is an example of a normal 99mTc-hepatic iminodiacetic acid (HIDA) scan and shows early filling of the gallbladder at 15 minutes (arrow) and complete filling by 25 minutes (arrowhead), indicating a patent cystic duct.

CT imaging

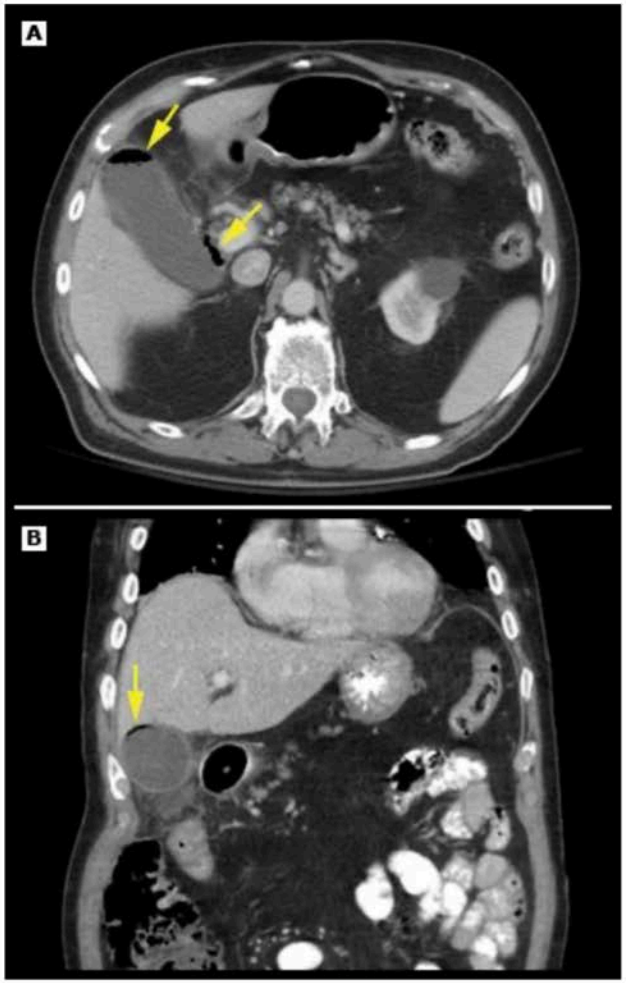
Computed tomographic (CT) scan from a patient with acute cholecystitis



The CT scan shows a distended gallbladder with an edematous and hyperemic wall (thick arrow) and inflammatory induration in the fat surrounding the gallbladder (arrowheads). A calcified stone is visible lying dependently at the base of the gallbladder (thin arrow).

Emphysematous cholecystitis

Gas-forming organisms (*Clostridium spp.)*



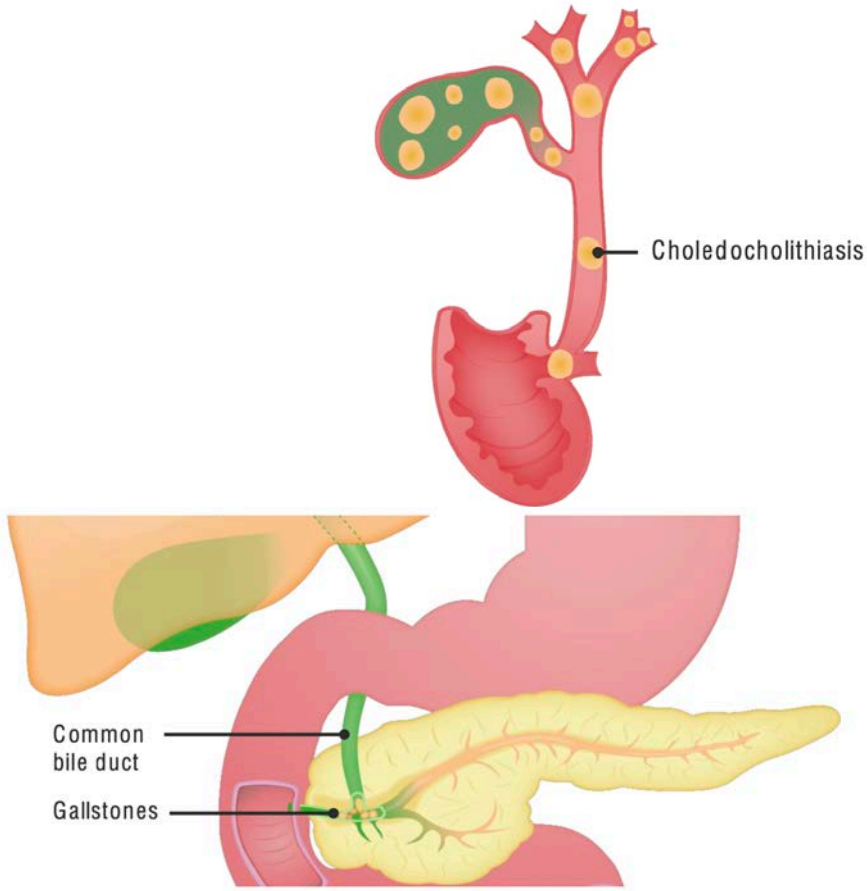
Important clue: Crepitus in bowel wall

Ultrasound report may report presence of overlying bowel gas makingadequate visualization of the gallbladder difficult

Heralds development of gangrene, perforation and other complications

Ascending cholangitis or gallstone pancreatitis

- Gallstone impacted in ascending bile duct
- Presents similarly to cholelithiasis
- Causes transient elevation in serum AST, ALT and bilirubin
- If gallstone blocks both common bile duct and pancreatic duct, leads to gallstone pancreatitis

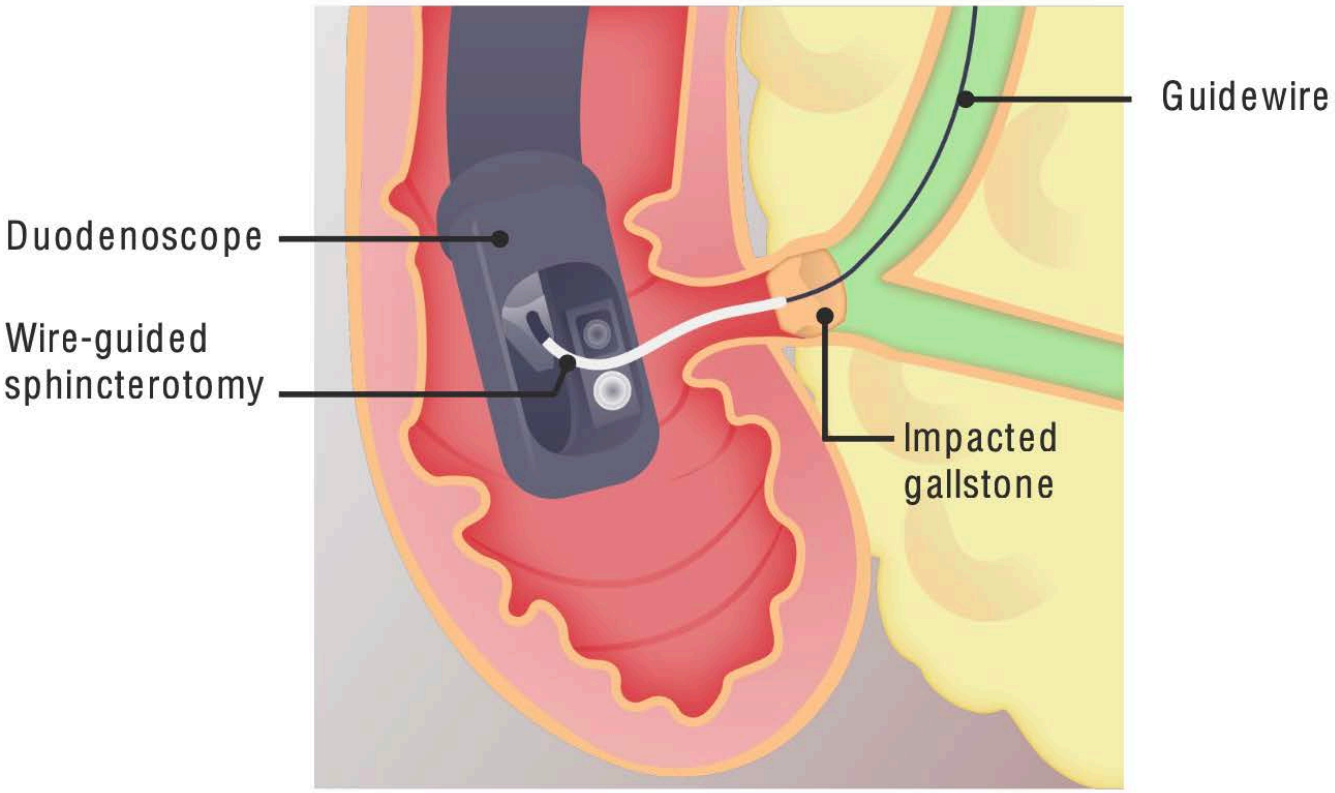


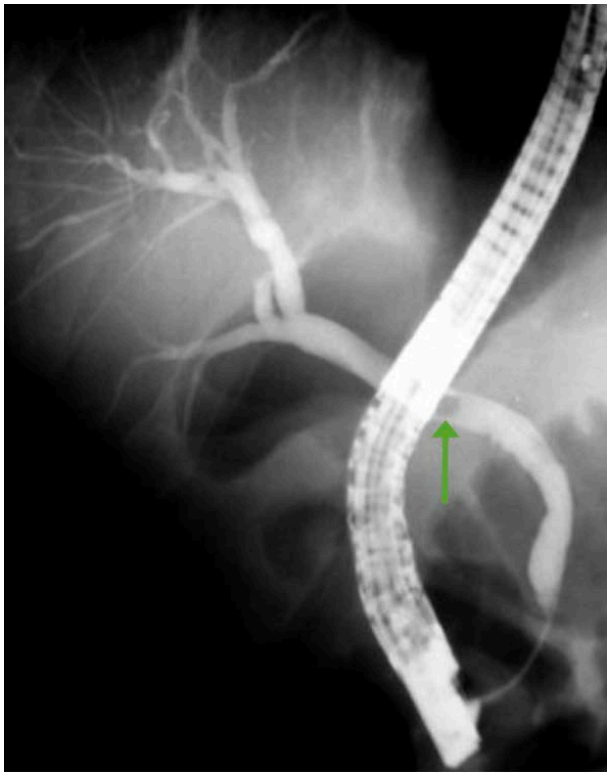
Choledocholithiasis

- Complications: ascending cholangitis or gallstone pancreatitis
- Diagnosis:
  - MRCP (magnetic resonance cholangiopancreatography)
  - RUQ ultrasound may detect ductal dilatation
- Management: ERCP (endoscopic retrograde cholangiopancreatography) for removal of stone

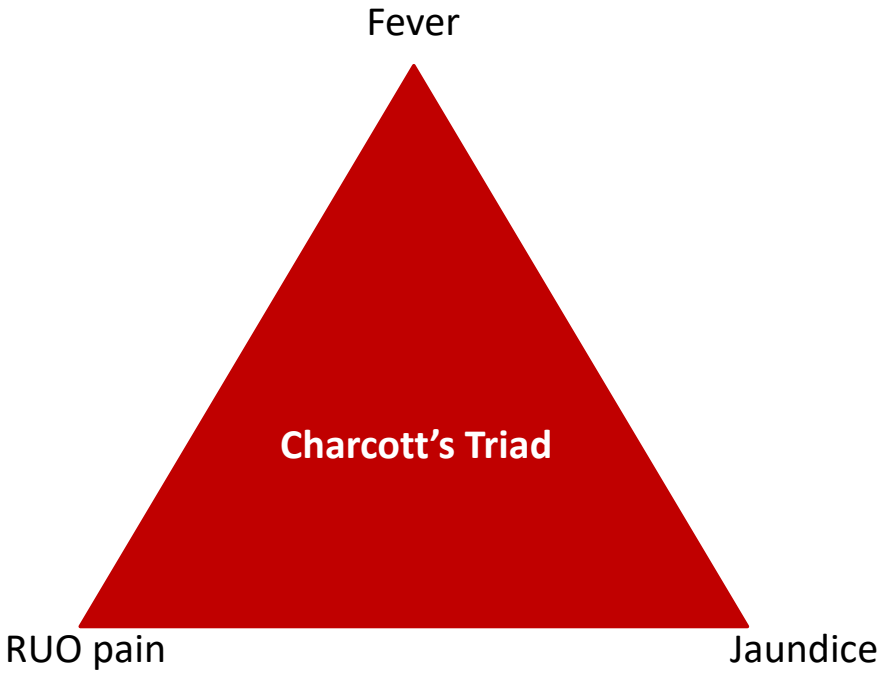
ERCP for choledocholithiasis

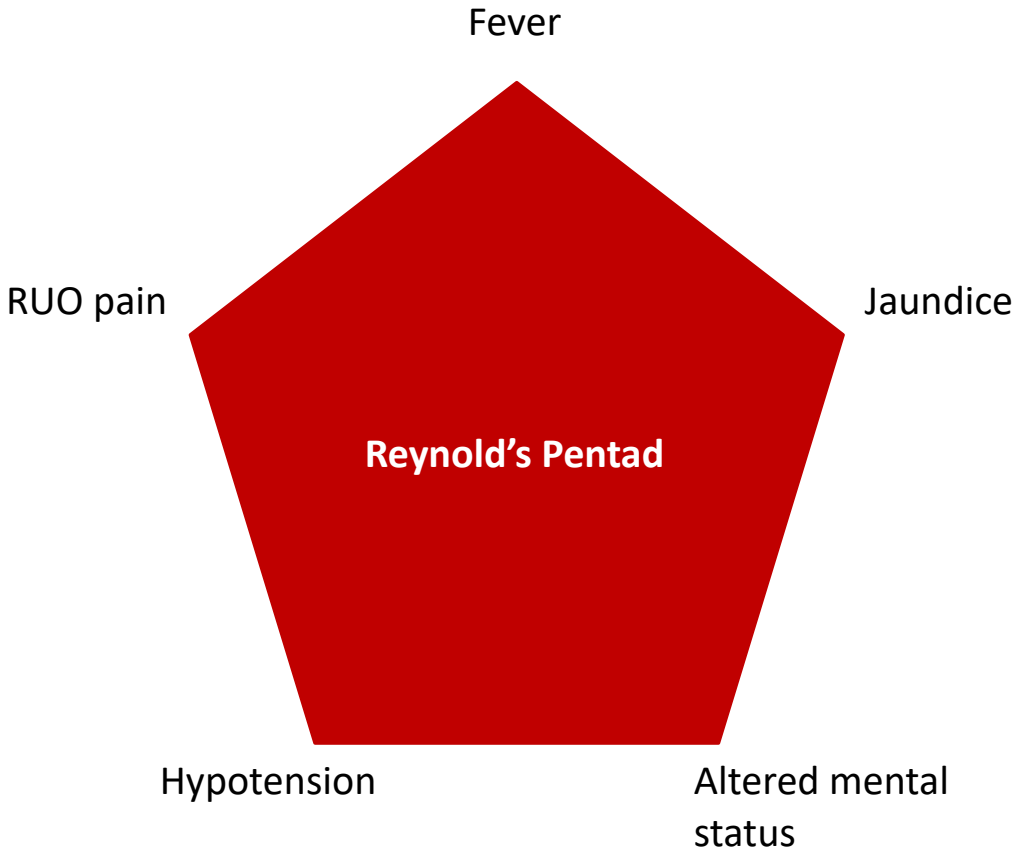
Endoscopic retrograde cholangio-pancreatography





Ascending cholangitis





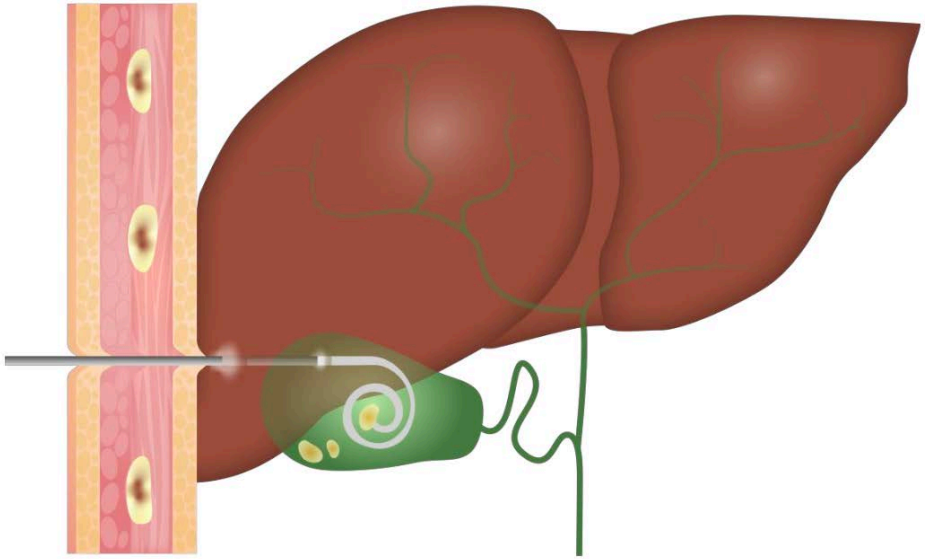
Differences in cholecystitis vs. ascending cholangitis

- **Cholecystitis is usually self-contained**
  - The disease process is usually limited to the gallbladder
  - Cholecystitis tends to have a more gradual, smoldering disease course (unless it progresses to gangrenous or emphysematous cholecystitis)
  - Patients more often respond to medical management
- **Ascending cholangitis is never self-contained:**
  - Bacteria under pressure spread readily up bile ducts, across hepatic sinusoids, and into the blood. This physiology generates characteristic bacteremia and rigors
  - Ascending cholangitis has a greater tendency to evolve rapidly into septic shock
  - Timely source control in ascending cholangitis is more important, as this decompresses the biliary tree and stops the reflux of bacteria into the blood
  - Ascending cholangitis are less likely to respond to medical management alone (although in many cases the obstructing stone may pass spontaneously)

Acalculous cholecystitis

Cholecystitis in the absence of gallstones in critically-ill

- This usually requires percutaneous cholecystostomy drainage.



If the patient is too unstable to tolerate ERCP, then placement of a percutaneous drain in the gallbladder may be adequate to drain both the gallbladder and biliary tree. This has the advantage of being a simple and quick procedure, but it doesn't allow definitive treatment (stone removal).

Biliary disorders-summary

	Cholelithiasis	Cholecystitis	Choledocholithiasis	Cholangitis
Clinical picture	Biliary colic, self resolves	RUO pain, fever	Biliary colic, intermittent jaundice	RUO pain, fever, jaundice
Lab findings	Normal	↑WBC, mild ↑ ALP and bilirubin	↑↑ ALP and GGT ↑↑ Bilirubin ↑ AST, ALT	↑ WBC ↑↑ ALP and GGT ↑↑ Bilirubin ↑AST, ALT
Diagnosis	RUO ultrasound	RUO ultrasound	MRCP or endoscopic US	MRCP or endoscopic US
Treatment	Elective cholecystectomy	IV antibiotics, cholecystectomy	ERCP to remove stone	IV antibiotics, ERCP to remove stone

Organisms isolated from bile

- **Gram negatives**
  - E. coli (~35%)
  - Klebsiella spp. (~15%)
  - Enterobacter spp. (7%)
  - Pseudomonas spp. (0.5-1.9%)
  - **Gram positives**
    - *Enterococcus* spp. (~15%) -debatable whether coverage is needed- howeveralways treat if blood cultures are positives
    - *Streptococcus* spp. (2-10%)
  - **Anaerobes**, including *Bacteroides fragilis* (4-20%)

Antibiotic penetration into bile

Good penetration efficiency (ABSCR > =1)	Low penetration efficiency (ABSCR <1)
Piperacillin/tazobactam (4.8)	Ceftriaxone (0.75)
Tigecycline (> 10)	Cefotaxime (0.23)
Amoxicillin/clavulanate (1.1)	Meropenem (0.38)
Ciprofloxacin (> 5)	Ceftazidime (0.18)
Ampicillin/Sulbactam (2.4)	Vancomycin (0.41)
Cefepime (2.04)	Amikacin (0.54)
Levofloxacin (1.6)	Gentamicin (0.30)
Penicillin "G" (>5)	
Imipenem (1.01)	

ABSCR Antibiotics Bile/Serum Concentration Ratio

Ansaloni et al. PMID 27307785

Antibiotic treatment

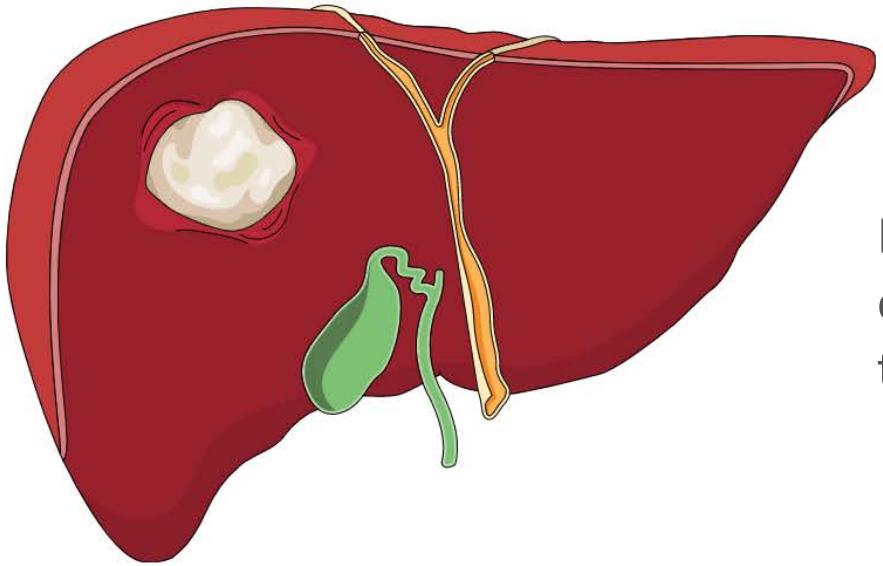
- **Piperacillin-tazobactam is generally the front-line therapy for empiric treatment of biliary sepsis**
  - Adequate coverage of gram-negatives, enterococci, and anaerobes.
  - Good biliary penetration.
  - Low risk of *C. difficile*
- **Meropenem:** In locales with a high incidence of extended-spectrum beta-lactamase resistant (ESBL) E. coli, meropenem could be considered as empiric therapy. This should be based upon the frequency of ESBL (+) E. coli in a local antibiogram, possibly using a cutoff of >10-20%.
  - For patients with penicillin allergy: Piperacillin-tazobactam or meropenem are generally still fine
  - These infections are often polymicrobial, so narrowing antibiotics based on a single organism isolated from the blood should be done with caution.

Duration of therapy

- Generally, once source control has been achieved, antimicrobial therapy is recommended for 4-7 days
- If gram-positive bacteremia is detected (e.g., *Enterococcus*) then therapy should be extended to 14 days (since these bacteria have a tendency to stick to heart valves).
- If the source has been surgically removed (cholecystectomy), then shorter courses of antibiotics may be adequate.

Liver abscesses

Usually develop in setting of biliary disease, portal pyremia, arterial hematogenous seeding, or via direct spread

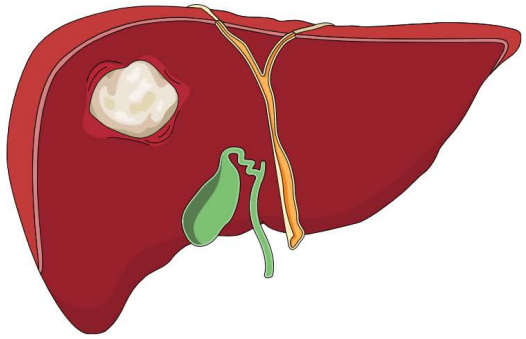


In Asia, association with colorectal cancer, same true in Western countries?

Risk factors: Diabetes mellitus, underlying hepatic or biliary disease, pancreatic disease, liver transplant, regular use of protein pump inhibitors

Pyogenic liver abscess

- Liver abscesses most commonly involve the right lobe of the liver, probably because it is larger and has greater blood supply than the other lobes.
- Abscesses need to be distinguished from tumors and cysts
  - Cysts appear as fluid collections without surrounding stranding or hyperemia
  - Tumors have a solid radiographic appearance and may contain areas of calcification
  - Necrosis and bleeding within a tumor may lead to a fluid-filled appearance; in such circumstances, radiographic differentiation from abscess can be challenging

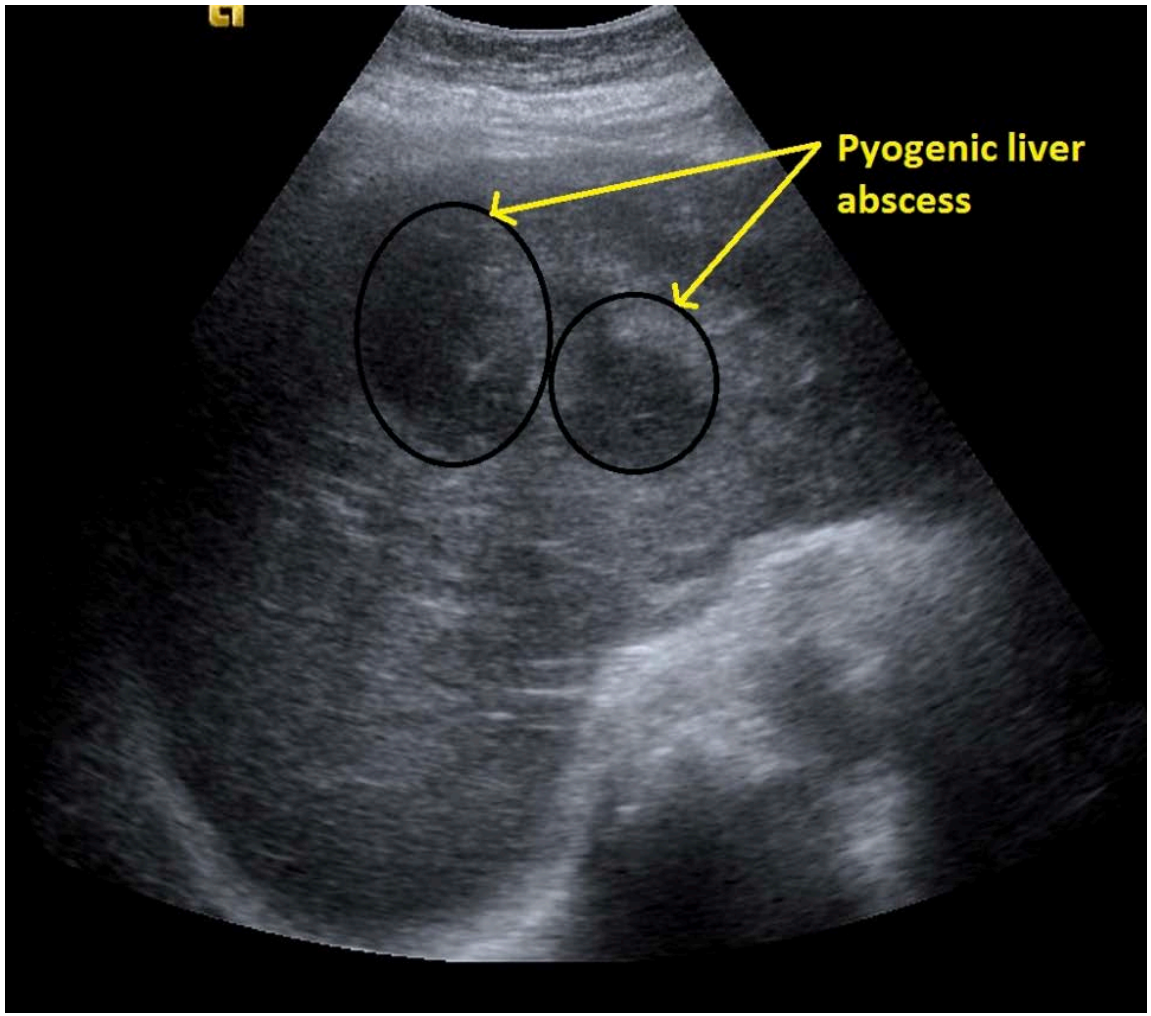


Klebsiella pneumoniae postive string test

Clinical presentation

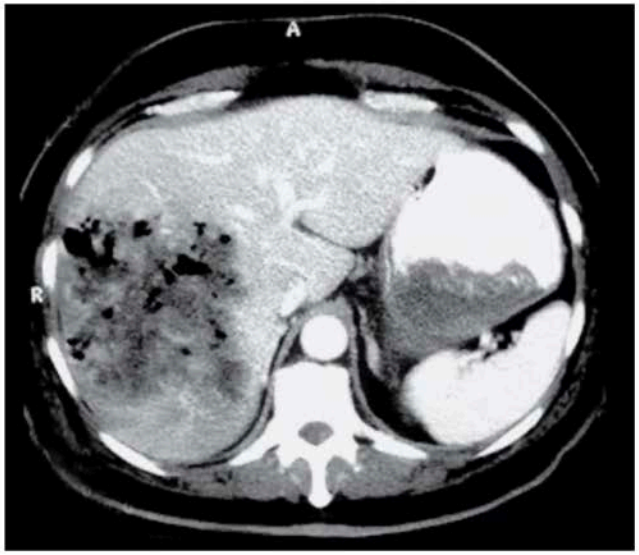
- Fever (90%)
- Abdominal symptoms- 50-75% (RUO), pain, guarding, rocking signs, rebound tenderness
- Hepatomegaly (50%)
- Laboratory
  - Elevated bilirubin and/or liver enzymes
  - ALP elevated in 67-90% of cases
  - Bilirubin and AST elevated in 50%

Liver abscess imaging (ultrasound)



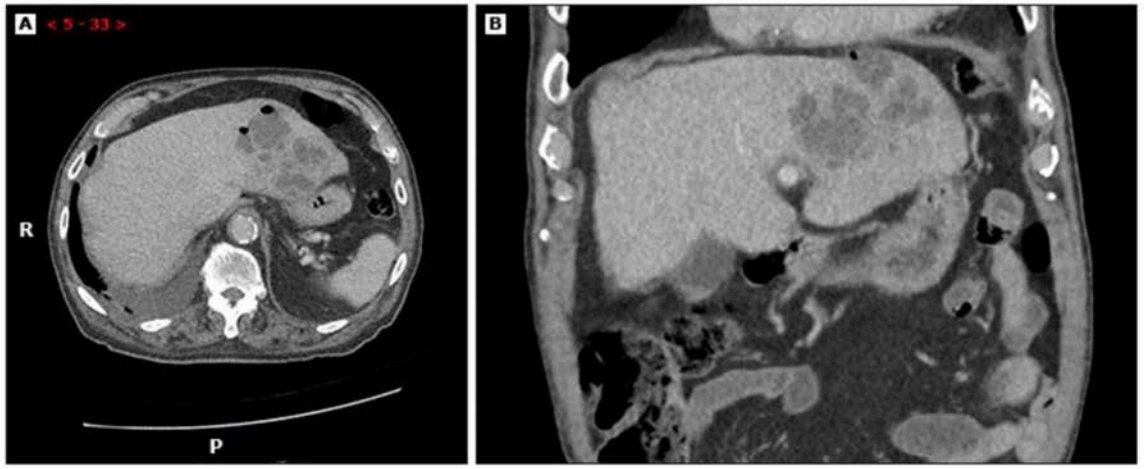
Liver abscess CT imaging
Contrast-enhanced

Liver abscess



A contrast-enhanced CT scan of the upper abdomen demonstrates a large gas-containing abscess in the right lobe of the liver. This location is easily amenable to percutaneous CT-guided drainage.

Computed tomography images of a pyogenic liver abscess



Axial (A) and coronal (B) views of an air-containing, multiloculated pyogenic liver abscess caused by *Klebsiella pneumoniae*.

Diagnosis

- **CT or ultrasound-guided drainage**
  - Purulent material?
  - Histopathology and microbiology
  - Gram strain and culture (aerobic and anaerobic)
  - Do not follow culture from preexisting percutaneous drains (skin flora)

Pyogenic liver abscess
Differential diagnosis

- Mycobacterium tuberculosis
- *Burkholderia pseudomallei* (melioidosis)- Southeast Asia, Northern Australia, South Asia, China
- Echinococcus (hepatic hydatid cysts)- differentia using serology
- *Candida* species- hepatosplenic candidiasis
- Uncommon- *Bartonella*, *Fasciola*, endemic fungal infections, simple cyst, necrotic tumor, biloma

Pyogenic liver abscess
Treatment

- **Single, unilocular abscess ≤ 5 cm**: Percutaneous drainage with catheter placement or needle aspiration
  - Drainage catheter may need to remain 7 days
- **Single, unilocular abscess > 5 cm:** Drainage catheter preferred
- **Giant abscess (> 10 cm):** High risk of failure with drainage
- ERCP may be used if abscess associated with infection of biliary tree

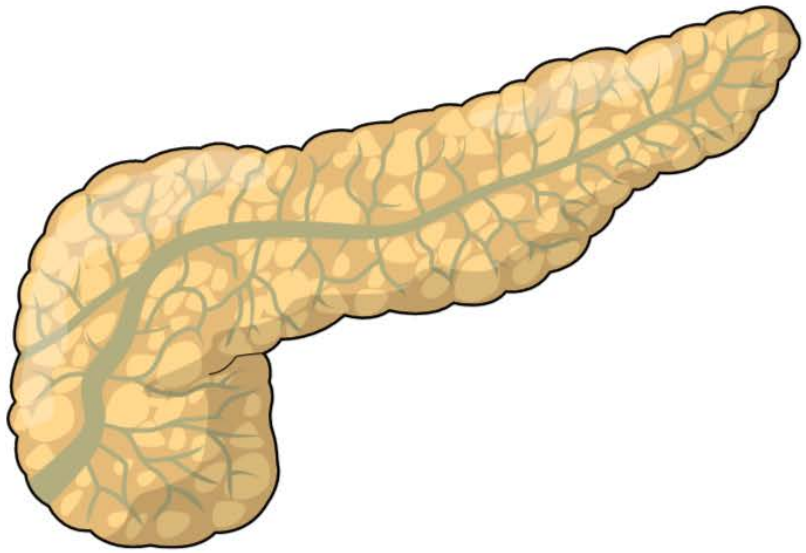
Antibiotic regimens for pyogenic liver abscess

Regimen	Dose (adult)*
Preferred[¶]	
Beta-lactam/beta-lactamase inhibitor:[Δ]	
Piperacillin-tazobactam	3.375 or 4.5 g IV every six hours[◇]
Ticarcillin-clavulanate[§]	3.1 g IV every four hours
Third generation cephalosporin[¥] **PLUS metronidazole:**	
Ceftriaxone **plus**	2 g IV once daily
Metronidazole	500 mg IV or orally every eight hours
Ampicillin PLUS gentamicin PLUS metronidazole:	
Ampicillin **plus**	2 g IV every four to six hours
Gentamicin **plus**	5 to 7 mg per kg IV daily[‡]
Metronidazole	500 mg IV or orally every eight hours
Alternative regimens[¶]	
Fluoroquinolone PLUS metronidazole:	
Ciprofloxacin **or**	400 mg IV every 12 hours or 750 mg orally twice daily
Levofloxacin **plus**	500 or 750 mg IV or orally once daily
Metronidazole	500 mg IV or orally every eight hours
Carbapenem:[¶†]	
Imipenem-cilastatin	500 mg IV every six hours
Meropenem	1 g IV every eight hours
Ertapenem	1 g IV once daily

An empiric antibiotic regimen for pyogenic liver abscess should cover streptococci, enteric gram-negative bacilli, and anaerobes.

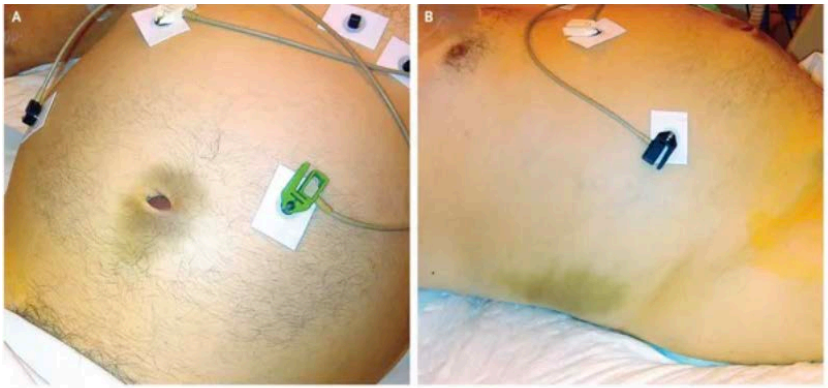
Antibiotic therapy for 4-6 weeks recommended; step-down after 5-7 days of IV therapy to oral therapy can be considered

Acute pancreatitis



Clinical presentation

- Typically in epigastric area or left upper-quadrant, may radiate to the back, may be relieved by sitting.
- Epigastric tenderness on exam is usually present.
- Persistent nausea/vomiting.
- Hemorrhagic pancreatitis may cause Cullen Sign and Grey Turner Signs If seen, this suggests a high disease severity.



Several signs of pancreatitis are shown here. Most obvious are ecchymosis of the umbilicus (Cullen sign) and flanks (Grey Turner Sign) due to retroperitoneal bleeding. Jaundice (corresponding to a bilirubin of 4.2 mg/dL here) and abdominal distension can also be seen. Valette X & du Cheyron D 2015 NEJM PMID 26650175

Common causes of pancreatitis

- Gallstones (~40-50%).(30243452)
- Alcoholism (~30%).
- Hypertriglyceridemia (~10%).
- Hypercalcemia.
- Medications include:
  - Antibiotics: tetracyclines, sulfonamides, pentamidine, HIV medications, isoniazid, metronidazole.
  - Immunosuppressives: azathioprine, sulfasalazine, mesalamine, 6-mercaptopurine.
  - Cardiac: amiodarone, losartan, furosemide, pravastatin, simvastatin.
  - Valproic acid.
  - All-trans-retionic acid (ATRA).
  - Glucagon-like peptide-1 agonist therapy for diabetes.
- Posterior penetrating ulcer.
- Trauma.
- Iatrogenic:
  - ERCP
  - Endoscopic ultrasound (EUS) with fine needle aspiration.
  - Surgery (including aortic surgery or CABG).
  - Radiation therapy,
- Pancreatic malignancy:
  - Intraductal papillary mucinous neoplasms (IPMNs)
  - Adenocarcinoma
- Cystic fibrosis

Laboratory diagnosis
Lipase

- Sensitivity and specificity are ~90% for acute pancreatitis
- Causes of elevated lipase include:
  - Pancreatic disease of any sort (e.g., pancreatitis, pseudocyst, cancer)
  - Intestinal obstruction/pseudo-obstruction, perforation, duodenal ulceration, ischemia
  - Biliary disease (cholecystitis, cholangitis, choledocholithiasis)
  - Renal failure
  - Heparin therapy (through activation of lipoprotein lipase)
  - Elevations of lipase due to diseases other than pancreatitis tend to be less than three times the upper-limit normal
  - Very high lipase values are more specific for a diagnosis of pancreatitis
  - Higher lipase values don't correlate with worse prognostic outcome

- **Diagnostic criteria for acute pancreatitis**
  - At least two of the following are required:
    - Elevation of lipase >3 times upper limit normal (i.e., >~750 U/L)
    - Clinical history and examination suggestive of pancreatitis (e.g., epigastric abdominal pain, nausea/vomiting)
    - Imaging evidence of pancreatitis on CT, MRI, or ultrasound

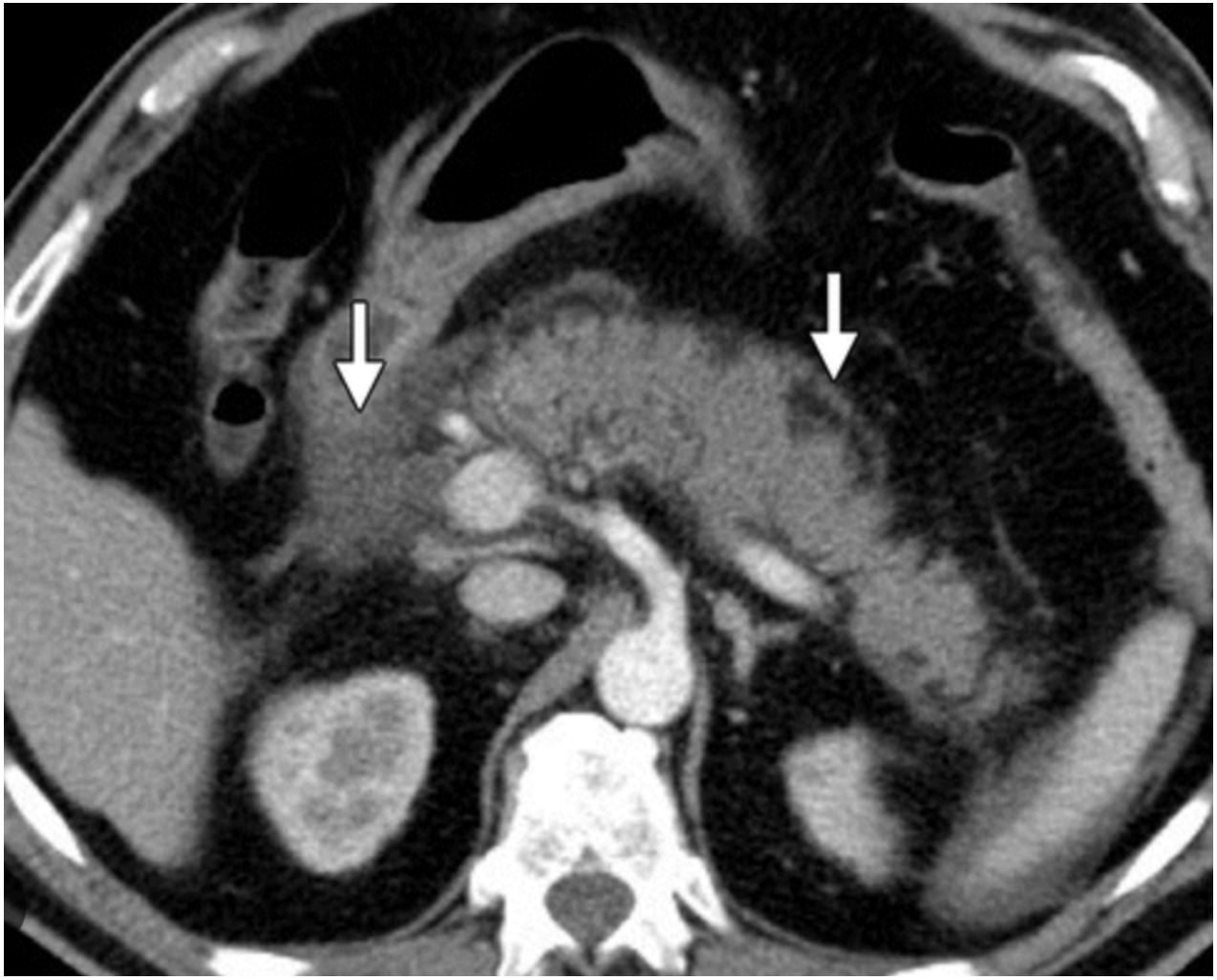
RUQ Ultrasonography

- This should be obtained on all pancreatitis patients
- Gallstones may suggest gallstone pancreatitis
- The most important finding is size of the common bile duct

CT imaging

- **Early CT if necessary to clarify the diagnosis:**
  - CT is sensitive and specific for pancreatitis (>90%), also providing information about severity (ie necrotizing)
  - If the patient definitely has pancreatitis (based on typical history, exam, and labs), then early CT isn't necessary
  - For patients in shock, CT scan is often sensible to exclude a focus of intra-abdominal sepsis

CT imaging
necrotizing pancreatitis



Edematous vs. necrotizing pancreatitis

- **Interstitial edematous pancreatitis (90%)** – diffuse inflammation of the pancreas, tissue remains viable.
- **Necrotizing pancreatitis (10%)** – areas of pancreatic tissue become necrotic.
  - The diagnosis of necrotizing pancreatitis is generally made based on contrast CT scan, ***which shows a lack of blood flow to necrotic areas***
- Patients with necrotizing pancreatitis are at risk for developing multiorgan failure or superinfection of the devitalized pancreatic tissue (infected pancreatic necrosis).
- The mortality rate of necrotizing pancreatitis is 17%, much higher than the mortality of interstitial edematous pancreatitis at 3%.

Pancreatitis Management
Lots of controversies

- ERCP vs. non ERCP?
- Large volume fluid resuscitation? (ARDS and abdominal compartment syndrome)
- Avoid opioids?
- Pancreatic rest (nutrition) vs. no rest?

Avoid antibiotics in the first week of pancreatitis

- **There are many parallels between sepsis and pancreatitis.**
  - The pancreatitis patient to look infected upon arrival (e.g. pancreatitis commonly causes fever, leukocytosis, hypotension, and vasodilatory shock).
  - However, this is generally a reflection of sterile inflammation rather than true infection.
- Historically there was a concept that prophylactic antibiotics could prevent the development of infected pancreatic necrosis. This has been debunked and should not be used. Up-front antibiotics will select out resistant organisms, which cause problems later on (when true infection actually does occur).
- **Antibiotics should generally be avoided during the first week, with the following exceptions:**
  - The diagnosis of pancreatitis is unclear and there is concern for septic shock with a focus of infection elsewhere
  - The patient has coexisting ascending cholangitis (which is a true bacterial infection and requires decompression & antibiotics).
  - Infectious complications of pancreatitis (e.g., infected necrosis) are rare during the first week.
    - During this time frame, inflammatory symptoms (e.g., fever, leukocytosis) likely reflect sterile pancreatic inflammation.

Infected pancreatic necrosis

- **This peaks about 10-14 days after the onset of pancreatitis.** The classic presentation would be a patient who initially improves, but subsequently deteriorates with worsening sepsis.
- Investigation typically begins with repeat CT scan. Occasionally, radiologic features may be diagnostic (e.g., gas within pancreatic tissue implies infection).
- Fine-needle aspiration to determine whether infection is present is routinely used at some centers. However, empiric antibiotics are favored at other centers due to fear of introducing infection into the pancreas during fine-needle aspiration.
- Traditionally a carbapenem (e.g., meropenem) as used for improved penetration of the pancreas. However, other antibiotics also penetrate the pancreas well (e.g., cefepime/metronidazole and probably piperacillin-tazobactam).
- Given that these patients often remain in the ICU for some weeks, using piperacillin-tazobactam initially (instead of a carbapenem) could delay the selection of resistant pathogens.
- A team approach is required, including pancreatic surgeons, interventional radiologists, and invasive gastroenterologists. Ideally this should be managed at a large center which offers a range of minimally invasive debridement techniques.

Differing antibiotic recommendations

Table 4 Agents and Regimens that May Be Used for the Initial Empiric Treatment of Biliary Infection in Adults

Infection	Regimen
Community-acquired acute cholecystitis of mild-to-moderate severity	Cefazolin, cefuroxime, or ceftriaxone
Community-acquired acute cholecystitis of severe physiologic disturbance, advanced age, or immunocompromised state	Imipenem-cilastatin, meropenem, doripenem, piperacillin-tazobactam, ciprofloxacin, levofloxacin, or cefepime, each in combination with metronidazole[a]
Acute cholangitis following bilio-enteric anastamosis of any severity	Imipenem-cilastatin, meropenem, doripenem, piperacillin-tazobactam, ciprofloxacin, levofloxacin, or cefepime, each in combination with metronidazole[a]
Health care–associated biliary infection of any severity	Imipenem-cilastatin, meropenem, doripenem, piperacillin-tazobactam, ciprofloxacin, levofloxacin, or cefepime, each in combination with metronidazole, vancomycin added to each regimen[a]

a Because of increasing resistance of *Escherichia coli* to fluoroquinolones, local population susceptibility profiles and, if available, isolate susceptibility should be reviewed.

Table 2 Agents and Regimens that May Be Used for the Initial Empiric Treatment of Extra-biliary Complicated Intra-abdominal Infection

		Community-acquired infection in adults	
Regimen	**Community-acquired infection in pediatric patients**	**Mild-to-moderate severity: perforated or abscessed appendicitis and other infections of mild-to-moderate severity**	**High risk or severity: severe physiologic disturbance, advanced age, or immunocompromised state**
Single agent	Ertapenem, meropenem, imipenemcilastatin, ticarcillin-clavulanate, and piperacillin-tazobactam	Cefoxitin, ertapenem, moxifloxacin, tigecycline, and ticarcillin-clavulanic acid	Imipenem-cilastatin, meropenem, doripenem, and piperacillin-tazobactam
Combination	Ceftriaxone, cefotaxime, cefepime, or ceftazidime, each in combination with metronidazole; gentamicin or tobramycin, each in combination with metronidazole or clindamycin, and with or without ampicillin	Cefazolin, cefuroxime, ceftriaxone, cefotaxime, ciprofloxacin, or levoflox-acin, each in combination with metronidazole[a]	Cefepime, ceftazidime, ciprofloxacin, or levofloxacin, each in combination with metronidazole[a]

a Because of increasing resistance of *Escherichia coli* to fluoroquinolones, local population susceptibility profiles and, if available, isolate susceptibility should be reviewed.

Solomkin JS, Mazuski JE, Bradley JS, et al. Diagnosis and management of complicated intra-abdominal infection in adults and children: guidelines by the Surgical Infection Society and the Infectious Diseases Society of America. Clin Infect Dis **2010**; 50:133–164.

Table 3 Recommendations for Empiric Antimicrobial Therapy for Health Care–Associated Complicated Intra-abdominal Infection

	Regimen			
Organisms seen in health care–associated infection at the local institution	**Carbapenem**[a]	**Piperacillin-tazobactam**	**Ceftazidime or cefepime, each with metronidazole**	**Aminoglycoside**
<20% Resistant *Resudomonas aeruginosa*, ESBL-producing Enterobacteriaceae, *Acinetobacter*, or other MDR GNB	Recommended	Recommended	Recommended	Not recommended
ESBL-producing Enterobacteriaceae	Recommended	Recommended	Not recommended	Recommended
P. aeruginosa >20% resistant to ceftazidime	Recommended	Recommended	Not recommended	Recommended
MRSA	Not recommended	Not recommended	Not recommended	Not recommended

NOTE. ESBL, extended-spectrum β-lactamase; GNB, gram-negative bacilli; MDR, multidrug resistant; MRSA, methicillin-resistant *Staphylococcus aureus*. "Recommended" indicates that the listed agent or class is recommended for empiric use, before culture and susceptibility data are available, at institutions that encounter these isolates from other health care–associated infections. These may be unit-or hospital-specific.

Solomkin JS, Mazuski JE, Bradley JS, et al. Diagnosis and management of complicated intra-abdominal infection in adults and children: guidelines by the Surgical Infection Society and the Infectious Diseases Society of America. Clin Infect Dis **2010**; 50:133–164.