Endoscopic interventions for walled-off pancreatic fluid collections

AUTHOR: Raj J Shah, MD, MASGE, AGAF, FACG
SECTION EDITOR: Douglas G Adler, MD, FACG, AGAF, FASGE
DEPUTY EDITOR: Kristen M Robson, MD, MBA, FACG

All topics are updated as new evidence becomes available and our peer review process is complete.

Literature review current through: **Sep 2023.**
This topic last updated: **Apr 27, 2022.**

INTRODUCTION

Walled-off pancreatic fluid collections (PFCs) are mature, encapsulated collections of pancreatic fluid (with or without necrosis) that may be a complication of acute or chronic pancreatitis. Drainage is indicated for a persistent walled-off PFC associated with symptoms related to mass effect (eg, abdominal pain, early satiety, jaundice from biliary compression). The approach to draining a PFC is individualized and based on multiple factors including characteristics of the collection (eg, location, maturity of the wall, communication with the pancreatic duct), presence of walled-off necrosis, and hemodynamic status of the patient. In addition, management of some patients with walled-off PFCs who require drainage can require a multidisciplinary approach with specialists in interventional gastroenterology, interventional radiology, and surgery.

This topic will review endoscopy-guided interventions for walled-off PFCs with a focus on an endoscopic ultrasound (EUS)-guided approach, efficacy, and complications. The diagnostic evaluation and approach to management for adults with walled-off PFCs are discussed separately. (See "Approach to walled-off pancreatic fluid collections in adults".)

The classification of pancreatic cysts and the diagnosis of pancreatic cystic neoplasms are discussed separately:

- (See "Classification of pancreatic cysts".)
- (See "Pancreatic cystic neoplasms: Clinical manifestations, diagnosis, and management".)

The clinical manifestations and diagnosis of acute and chronic pancreatitis are discussed separately:

- (See "Clinical manifestations and diagnosis of acute pancreatitis".)
- (See "Chronic pancreatitis: Clinical manifestations and diagnosis in adults".)

The indications and technique for surgical debridement of pancreatic necrosis are discussed separately. (See "Pancreatic debridement".)

CLASSIFICATION

Walled-off PFCs are classified as follows (table 1) [1]:

- **Pancreatic pseudocysts** – Pancreatic pseudocysts are encapsulated, mature PFCs that have a well-defined wall with minimal or no necrosis (image 1). Pancreatic pseudocysts are often related to chronic pancreatitis as a result of progressive ductal obstruction. If a pseudocyst is related to acute pancreatitis, a minimum of four weeks is often required before a mature wall develops.

- **Walled-off pancreatic necrosis (or walled-off necrosis)** – Walled-off PFCs with necrosis are mature, encapsulated collections of pancreatic and/or peripancreatic necrosis that have developed a well-defined inflammatory wall, usually after at least four weeks following an episode of acute necrotizing pancreatitis (image 2). Walled-off pancreatic necrosis is usually a mixture of both liquid and solid elements (with or without loculation). (See "Clinical manifestations and diagnosis of acute pancreatitis", section on 'Local complications'.)

Acute peripancreatic fluid collections and acute necrotic collections are discussed in detail separately. (See "Management of acute pancreatitis".)

PREPROCEDURE EVALUATION

Our approach to testing prior to endoscopic drainage of a walled-off PFC includes:

- Laboratory studies – We obtain a complete blood count, prothrombin time/international normalized ratio, and platelet count.

- Imaging – We obtain contrast-enhanced cross-sectional imaging (ie, computed tomography [CT] scan or magnetic resonance imaging [MRI]) to confirm the maturity of the wall and its proximity to the gastrointestinal tract, to assess the size and extent of the PFC, and to evaluate for any potentially interposed vascular structures (including pseudoaneurysms) and for disconnection of a viable portion of the pancreatic body or tail [2-4]. (See 'Contraindications' below.)

  For differentiating walled-off pancreatic necrosis from simple pseudocysts, the diagnostic accuracy of MRI is superior compared with CT scan [5-7]. However, if criteria for drainage are met by contrast-enhanced CT scan (ie, well-defined, mature wall that is in close apposition to the gastrointestinal tract), endoscopic ultrasound (EUS) is sufficient to assess the fluid collection prior to drainage, and additional imaging is not necessary. (See "Approach to walled-off pancreatic fluid collections in adults", section on 'Radiologic imaging'.)

CONTRAINDICATIONS

Contraindications to endoscopic drainage include:

- Patients who cannot tolerate anesthesia. (See "Anesthesia for gastrointestinal endoscopy in adults".)

- Patients who are hemodynamically unstable.

- Patients with known or suspected perforated viscus.

- Patients with uncorrectable disorders of hemostasis (eg, platelet count <50,000/microL). (See "Gastrointestinal endoscopy in patients with disorders of hemostasis".)

- Patients with pancreatic pseudoaneurysm. We regard the presence of a pseudoaneurysm within the area of pancreatic necrosis as an absolute contraindication to endoscopic drainage. Decompression of the vessel upon transmural puncture can result in severe, life-threatening hemorrhage. However, when a pseudoaneurysm is identified with preprocedure imaging, it can usually be embolized with percutaneous vascular embolization or placement of a covered stent, whereas surgery is an option if endovascular treatment is unsuccessful [8-12] (see "Angiographic control of nonvariceal

gastrointestinal bleeding in adults", section on 'Embolization'). After successful treatment of the pseudoaneurysm, endoscopic intervention can be performed [11,12].

Pseudoaneurysms develop in approximately 10 percent of patients with pancreatitis, and they often result from erosion of the splenic or gastroduodenal artery into a walled-off PFC [8,13]. Clinical features that suggest ruptured pancreatic pseudoaneurysm include unexplained gastrointestinal bleeding, abdominal pain associated with drop in hemoglobin, and sudden enlargement of the PFC.

ENDOSCOPIC ULTRASOUND-GUIDED TRANSMURAL DRAINAGE

General principles — The goal of endoscopic drainage is to resolve the walled-off PFC and, thus, relieve symptoms such as abdominal pain, nausea, and early satiety and/or gastric outlet or biliary obstruction that were related to compression of the gastrointestinal lumen. (See "Approach to walled-off pancreatic fluid collections in adults", section on 'Patients with symptoms or complications'.)

Endoscopic ultrasound (EUS)-guided transmural drainage of walled-off PFCs is performed by creating a tract through the gastric or duodenal wall and by placing one or more stents [14]. If necrotic material is present within the fluid collection, endoscopic necrosectomy can be performed during the initial drainage procedure by using a lumen-apposing self-expandable metal stent (LAMS) and/or at a subsequent endoscopic session. While successful transmural drainage of walled-off PFC can be achieved, many patients require repeated endoscopies for direct endoscopic necrosectomy or additional stent placement. It is important to discuss the potential for additional procedures with the patient prior to the index endoscopic procedure, particularly if walled-off pancreatic necrosis is identified on preprocedural imaging. (See 'Patients with walled-off necrosis' below.)

Patient preparation — Patient preparation prior to endoscopy-guided drainage includes:

- Adjusting medications – Most patients do not need to discontinue aspirin or nonsteroidal anti-inflammatories when undergoing endoscopic drainage. The management of antiplatelet and anticoagulant therapy is typically individualized, managed in conjunction with the prescribing subspecialist, and discussed separately. (See "Management of antiplatelet agents in patients undergoing endoscopic procedures" and "Management of anticoagulants in patients undergoing endoscopic procedures" and "Gastrointestinal endoscopy in patients with disorders of hemostasis".)

- Antibiotic prophylaxis – Antibiotic prophylaxis is given prior to the procedure. Broad spectrum antibiotic coverage is provided (eg, fluoroquinolone) and is typically continued for several days postprocedure (table 2) [15].

- Anesthesia – The procedure is typically performed using general anesthesia. Anesthetic management for endoscopic procedures including preprocedure fasting is discussed separately. (See "Anesthesia for gastrointestinal endoscopy in adults".)

Equipment

Needles and other devices — For patients in whom plastic stent placement is planned, puncture of the walled-off fluid collection and dilation of the tract can be performed with a needle and fistula dilating device. Choice of device depends mainly on endoscopist preference and availability [16]. As an example, a 19-gauge needle can be used to puncture the fluid collection and allow placement of a guide wire. The tract can then be dilated with an 8 to 10 mm balloon.

Where available, placement of an electrocautery-enhanced, fully covered LAMS is performed using EUS guidance. (See 'Stents' below.)

Stents — Internal stents maintain patency of the cystgastrostomy or cystoduodenostomy fistula. The types of stents and placement techniques are evolving and have not been standardized. Stent type varies by material, size, and delivery system:

- Plastic stents – Plastic, double-pigtailed stents with diameter 7 to 10 Fr may be used for drainage of pancreatic pseudocysts [17].

- Metal stents – Fully covered, self-expandable metal stents (SEMS) that were designed for treating biliary strictures have also been used for pancreatic drainage. However, following US Food and Drug Administration (FDA) approval of LAMS, the lumen-apposing stents have become the preferred metal device. LAMS are barbell shaped and are available with a luminal diameter of 10, 15, or 20 mm in the United States, while additional sizes and different designs are available in other countries. For patients with walled-off necrosis, endoscopic necrosectomy can be performed following index LAMS placement by exchanging the echoendoscope for a gastroscope. In addition, the LAMS delivery system has an electrocautery-enabled access catheter that provides the ability for over-the-wire or free-hand thermal puncture of the cyst cavity followed by stent delivery using the same sheath under EUS guidance, obviating the need for an access needle, a guidewire, or tract dilation [18-21].

Whether larger diameter metal stents provide more effective drainage than plastic stents is uncertain [17,22-24]. In a systematic review of 17 studies including 881 patients with PFCs treated with endoscopic transmural drainage, there were no significant differences in rates of overall treatment success for patients with plastic compared with metal stents (81 versus 82 percent) [17]. In addition, rates of adverse events or PFC recurrence were not significantly different between the groups (16 versus 23 percent and 10 versus 9 percent, respectively). In subgroup analysis, success rates for plastic compared with metal stents were not significantly different for patients with nonnecrotic walled-off PFC or with necrotic walled-off PFC.

An advantage of LAMS placement is ease of delivery for the advanced endoscopist with experience in both EUS and endoscopic retrograde cholangiopancreatography (ERCP). Another possible advantage of LAMS is that necrosis may resolve with fewer interventions (picture 1) [22,23]. In a cohort study including 313 patients who underwent endoscopic drainage, stent placement, and debridement of walled-off necrosis, LAMS placement was associated with fewer endoscopic procedures for PFC resolution compared with fully covered SEMS or double-pigtail plastic stents (2.2 versus 3 and 3.6 procedures, respectively) [22].

Data have suggested that LAMS placement was not associated with a higher risk of bleeding. In a meta-analysis of 15 studies including nearly 1700 patients with PFCs, bleeding rates were not significantly different for patients with LAMS compared with plastic stents (7 versus 4 percent; odds ratio [OR] 1.47, 95% CI 0.57-3.28) [25]. (See 'Adverse Events' below.)

Procedure

Patients with a pancreatic pseudocyst — The technique of EUS-guided cystenterostomy for draining a pancreatic pseudocyst varies by the stent type (eg, plastic stent, LAMS). The technique for stent placement is summarized as follows [16,26,27] (see 'Equipment' above):

- Perform diagnostic EUS. (See "Endoscopic ultrasound: Examination of the upper gastrointestinal tract".)
- Visualize the walled-off fluid collection.
- Identify the cyst wall and its area of contact with the gastric (or duodenal) wall (image 3). The luminal site for initial puncture can often be identified endoscopically by a visible bulge into the intestinal lumen, and the target site is confirmed with ultrasound imaging.
- Assess the distance from the intestinal lumen to the cyst.

- Confirm that the selected puncture site is avascular by using Doppler ultrasound (ie, no vascular structures such as gastric varices are seen in the intended path of the needle).

- For plastic stent insertion, or if placing LAMS over a guidewire, puncture the fluid collection under EUS visualization using a needle device.

  If placing LAMS, direct puncture of the fluid collection with a single step is also possible with limited fluoroscopic imaging.

- Place a guidewire into the fluid collection. Fluoroscopy is generally used to confirm adequate looping of the wire within the fluid collection cavity.

- Prior to plastic stent placement, dilate the tract with a balloon dilator over the guidewire (image 4). Following dilation of the tract, there may be a large quantity of fluid released into the intestinal lumen. The tract of the cystenterostomy is dilated prior to placing plastic stents, but the tract does not require dilation if LAMS is being used. (See 'Patients with walled-off necrosis' below.)

- Place two double-pigtail plastic stents through the fistula tract into the cavity. The procedure is complete after stent placement (picture 2) [28].

EUS-guided drainage for pancreatic pseudocysts is effective for relieving symptoms, while recurrence rates are low. In a systematic review of 57 studies including 2115 patients with walled-off PFC, the pooled clinical success rate of EUS-guided drainage was 90 percent with a mean adverse event rate of 17 percent and a recurrence rate of 8 percent [29]. (See 'Adverse Events' below.)

Patients with walled-off necrosis — Walled-off pancreatic necrosis may be managed endoscopically but may require additional intervention following creation of the cystenterostomy (see 'Stents' above):

- Initial drainage – For patients with walled-off necrosis based on imaging or if the fluid expressed after puncture is turbid or contains debris, we place LAMS, and debridement can be performed during the index endoscopy. The echoendoscope is removed, and transgastric or transduodenal entry into the PFC is typically performed with a front-viewing gastroscope. The necrotic material is removed using snares, nets, baskets, and/or forceps (figure 1). Often, we routinely place a double-pigtail plastic stent through the LAMS to maintain patency from debris and possibly reduce trauma to the back wall of the cyst cavity during decompression.

For patients with a limited window for stent placement because of anatomic considerations (eg, proximity of splenic artery), plastic stent placement is an alternative to LAMS. For such patients, direct endoscopic necrosectomy can be performed following tract maturation (eg, after four weeks). (See 'Patients with a pancreatic pseudocyst' above.)

- Subsequent interventions – Indications for additional endoscopic sessions for debridement include persistent symptoms (eg, abdominal pain, fever), residual necrotic material following initial debridement, or imaging (eg, CT scan) that suggests the necrotic collection has not resolved. We generally obtain a follow-up CT scan with timing guided by the patient's clinical status and need for hospitalization.

  If necrotic material remains after endoscopic debridement, repeat debridement is typically performed after an interval of at least one week, but timing may vary based on the patient's response to initial debridement and endoscopist preference. It is common for patients to require multiple sessions of endoscopic debridement. If the patient has clinically improved (ie, improvement in abdominal pain, no fever), we manage the patient as an outpatient and will bring the patient back for endoscopic debridement sessions weekly or biweekly until the necrotic PFC resolves [22]. If the patient requires inpatient hospitalization, direct endoscopic necrosectomy may be performed more frequently with the goal of improvement in symptoms to permit outpatient management.

  Endoscopic drainage of walled-off pancreatic necrosis has been associated with nonsurgical resolution rates of approximately 70 to 80 percent [30-33]. In a systematic review of 14 studies including 455 patients with walled-off pancreatic necrosis, endoscopic drainage with necrosectomy was associated with clinical success rates of 81 percent with a mean of four endoscopic interventions per patient [31]. Recurrence rates of up to 30 percent have been observed in patients treated for walled-off necrosis, but most studies were performed prior to the availability of LAMS [33].

- Adjunctive measures – Hydrogen peroxide lavage has been used as adjunctive therapy during endoscopic necrosectomy [34,35]. In a systematic review of 15 studies including 454 patients with walled-off necrosis, the pooled rate of clinical success (defined as resolution of the collection by imaging) with hydrogen peroxide-assisted necrosectomy was 90 percent (median hydrogen peroxide concentration, 3 percent; diluted with saline; volume ranging from 20 to 1000 mL) [34]. The pooled rate of adverse events after hydrogen peroxide-assisted necrosectomy was 18 percent, and the most common

adverse event was bleeding, with an overall bleeding rate of 7 percent. In a retrospective study including 204 patients with walled-off necrosis who underwent endoscopy-guided intervention, necrosectomy with hydrogen peroxide was associated with higher rates of clinical success after six months compared with no hydrogen peroxide (94 versus 79 percent) [35]. Rates of adverse events were similar for both groups. While these data show promise, randomized trials are needed to establish the optimal technique and safety of using hydrogen peroxide lavage with endoscopic necrosectomy.

Postprocedure care — The decision to admit a patient to the hospital following endoscopic drainage is individualized and depends on endoscopist preference, complexity of the procedure (eg, need for necrosectomy), and patient comorbidities. For patients who are discharged from the endoscopy unit or hospital following the procedure, we advise them to promptly report symptoms such as fever or worsening abdominal pain. Possible causes of such symptoms include stent malfunction or an infected, loculated fluid collection that is not endoscopically accessible, and such patients should be referred to the interventional endoscopist for further evaluation and intervention if necessary.

Postprocedure instructions and care include:

- Diet – We suggest clear liquids for 24 hours and then advancing to small, frequent meals containing low to moderate fat (ie, 30 to 50 grams of fat per day).
- Activity – We advise patients with a cystgastrostomy to avoid heavy lifting until the course of treatment is completed and the stent is removed.
- Antibiotics – Most patients receive a short (eg, three-day) antibiotic course with a fluoroquinolone or broader-spectrum antibiotic (table 2). If fluid obtained during the endoscopic drainage procedure is infected based on culture results, antibiotic therapy is adjusted accordingly. In such patients, we continue antibiotics for a total of seven days.

Stent removal — Timing for stent removal is guided by imaging appearance of walled-off PFC:

- Pancreatic pseudocyst – For patients with pancreatic pseudocyst, we obtain CT scan in four to six weeks after stent placement. If there is complete resolution of the fluid collection, the stents are removed endoscopically. If follow-up examination demonstrates that the fluid collection has not resolved, additional intervention may be needed. (See 'Nonresolving fluid collections' below.)

- Walled-off pancreatic necrosis – For most patients with walled-off pancreatic necrosis that has resolved following LAMS placement and endoscopic necrosectomy, LAMS are generally removed within four weeks.

NONRESOLVING FLUID COLLECTIONS

Patients whose PFCs have not resolved within four to six weeks after endoscopic ultrasound (EUS)-guided drainage and stent placement usually have retained necrotic debris. Therefore, we typically perform repeat endoscopy and direct endoscopic necrosectomy with stent replacement in an attempt to achieve complete drainage with collapse of the fluid collection cavity. Drainage can be done through a fully covered, lumen-apposing, self-expandable metal stent (LAMS) or after dilation of a cystgastrostomy if double-pigtail plastic stents were used [30]. (See 'Procedure' above.)

If the PFC has multiple compartments or if portions are not being drained by the original cystenterostomy, additional transmural puncture and/or transpapillary stent placement may be required for resolution. (See 'ERCP-guided transpapillary drainage' below.)

Percutaneous drainage of a nonresolving walled-off PFC is also a reasonable option, especially if the PFC is extending into the pelvis and/or the paracolic gutters [36]. (See "Approach to walled-off pancreatic fluid collections in adults", section on 'Management'.)

If these approaches are not successful, referral to surgery is an option for managing nonresolving fluid collections, but in our experience this is rarely required when utilizing both endoscopic and percutaneous approaches. (See "Pancreatic debridement".)

Patients with complete disconnection of the distal body/tail portion of viable pancreas (ie, disconnected pancreatic duct syndrome) are at higher risk for developing recurrent fluid collections [4]. Such patients may require surgical resection for definitive therapy [37]. However, more typically we offer an alternative to surgery by endoscopy-guided removal of the initial LAMS and long-term placement of transmural pigtail stents. In a study including 167 patients with disconnected pancreatic duct syndrome, long-term transmural stenting was associated with lower rates of recurrence compared with temporary stenting (2 versus 17 percent) [38]. Possible advantages of performing subsequent endoscopic intervention for disconnected pancreatic duct syndrome include lower risk of diabetes mellitus [39,40]. However, permanent stenting has been associated with increased risk of chronic pancreatitis [4]. Further studies with long-term follow-up are needed to determine the optimal duration for stenting in patients who are managed nonoperatively. We tend to leave the plastic stents

in place for one year or longer with follow-up imaging based on patient symptoms. (See "Pancreatic debridement", section on 'Anatomical considerations'.)

ADVERSE EVENTS

Adverse events (AEs) related to endoscopy-guided drainage of walled-off PFCs have been reported in 5 to 20 percent of patients and include infection, bleeding, perforation, and stent migration [41-44]. Most are managed medically or with endoscopic therapy. Careful attention to preprocedure imaging and to the details of the endoscopy-guided techniques can help minimize risk of AEs.

Endoscopy related — AEs associated with endoscopic ultrasound (EUS) may be due to the upper gastrointestinal endoscopy itself (without intervention) and/or the associated sedation and anesthesia. These are discussed in more detail separately. (See "Endoscopic ultrasound: Examination of the upper gastrointestinal tract", section on 'Adverse events' and "Adverse events related to procedural sedation for gastrointestinal endoscopy in adults".)

Intervention related — AEs associated with EUS-guided transmural drainage for walled-off PFCs include:

- Infection – Infection is a common AE following endoscopic drainage of walled-off PFCs that is often related to stent occlusion or undrained pancreatic necrosis [33]. Most infections are managed with antibiotic therapy and additional endoscopic drainage and/or necrosectomy. As an example, in a study of 148 patients who underwent EUS-guided drainage of PFCs, AEs were reported in eight patients (5 percent) and the most common was infection (four patients) [44].

- Bleeding – The most common cause of bleeding during endoscopic drainage is the inadvertent puncture of intervening blood vessels. Predrainage evaluation with contrast-enhanced CT scan and EUS with Doppler are performed to identify and avoid intervening blood vessels. When immediate bleeding occurs following transmural puncture and/or stent placement, a solution of epinephrine diluted with saline to 1:10,000 is injected in 0.5 to 2 mL aliquots in four quadrants within 3 mm of the bleeding site. Injection therapy is followed by thermal coagulation or hemostatic clipping. Rarely, angiography and embolization or surgery may be necessary to control bleeding [45].

  The most serious, but fortunately rare, cause of bleeding is pseudoaneurysm, but this

can be avoided by using EUS with Doppler imaging. If a pseudoaneurysm is identified on predrainage imaging, angiography with endovascular therapy is performed. Clinical features of bleeding pseudoaneurysm include gastrointestinal bleeding, a sudden expansion of the fluid collection size, and/or syncope. (See 'Contraindications' above.)

- Perforation – Reported rates of luminal perforation related to endoscopic drainage procedures have ranged from 1 to 5 percent [30,46]. Perforation can occur immediately or may be delayed. Perforation can often be managed without surgery (observation, bowel rest), but some patients may require emergency surgery [26,47-50]. (See 'Endoscopic ultrasound-guided transmural drainage' above.)

ERCP-GUIDED TRANSPAPILLARY DRAINAGE

Endoscopic retrograde cholangiopancreatography (ERCP)-guided transpapillary drainage can be performed if there is a communication between the walled-off PFC and the main pancreatic duct or if the cyst is too distant (>1 cm) from the gastrointestinal lumen to allow for endoscopic ultrasound (EUS)-guided transmural drainage [51]. This technique can be useful for treating smaller pseudocysts (≤4 cm). ERCP-guided placement of a transpapillary pancreatic stent provides continuous drainage of pancreatic fluid and facilitates resolution of the pancreatic ductal disruption and often downstream stricture that is responsible for the pseudocyst [52,53]. (See "Pancreatic stenting at endoscopic retrograde cholangiopancreatography (ERCP): Indications, techniques, and complications".)

The transpapillary pancreatic stent is positioned such that it bridges the ductal disruption, if possible.

We obtain follow-up cross-sectional imaging in two to three weeks following pancreatic stent placement. If the pseudocyst has resolved, we remove the pancreatic stent. If the fluid collection has not resolved, the pancreatic stent can be replaced with a larger diameter stent.

Adverse events related to ERCP and pancreatic stent placement are discussed separately:

- (See "Overview of endoscopic retrograde cholangiopancreatography (ERCP) in adults".)
- (See "Post-endoscopic retrograde cholangiopancreatography (ERCP) pancreatitis".)
- (See "Pancreatic stenting at endoscopic retrograde cholangiopancreatography (ERCP): Indications, techniques, and complications".)

Data have suggested that transpapillary drainage provided effective pseudocyst drainage

with resolution rates ranging from 81 to 94 percent [51,54]. Treating pancreatic ductal obstruction caused by strictures or stones with pancreatic stenting may reduce the risk of pseudocyst recurrence, while published data to confirm this benefit are lacking.

Because of the favorable PFC resolution rates with EUS-guided transmural drainage alone or with transpapillary stent placement alone, we do not routinely combine transmural with transpapillary drainage [29,51]. However, for selected patients (eg, those with recurrent pseudocysts or those with pancreatic duct strictures), combining drainage methods may be a reasonable option.

Whether combining transmural drainage with transpapillary drainage provides additional benefit for most patients with pancreatic pseudocyst remains uncertain [55,56]. Some observational studies demonstrated that pancreatic stenting combined with transmural drainage was associated with higher rates of PFC resolution compared with transmural drainage alone [56], while other studies have not shown a significant difference between the approaches [55].

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Pancreatic cysts".)

SUMMARY AND RECOMMENDATIONS

- **Classification** – Walled-off pancreatic fluid collections (PFCs) are classified as follows (table 1) (see 'Classification' above):
  - **Pancreatic pseudocysts** – Pancreatic pseudocysts are encapsulated, mature PFCs that have a well-defined wall with minimal or no necrosis.
  - **Walled-off pancreatic necrosis** – Walled-off PFCs with necrosis are mature, encapsulated collections of pancreatic or peripancreatic necrosis that have developed a well-defined inflammatory wall after at least four weeks following an episode of acute necrotizing pancreatitis.
- **Preprocedure testing** – For patients with a walled-off PFC that requires endoscopic drainage, preprocedure testing includes (see 'Preprocedure evaluation' above):

- Laboratory studies – Complete blood count, prothrombin time/international normalized ratio, and platelet count.

- Imaging – Contrast-enhanced cross-sectional imaging (ie, CT scan or MRI) is obtained to confirm the maturity of the wall and its proximity to the gastrointestinal tract, to assess the size and extent of the PFC, and to evaluate for vascular structures (including pseudoaneurysms).

- **Contraindications** – We regard pancreatic pseudoaneurysm as an absolute contraindication to endoscopic drainage because it can result in life-threatening hemorrhage. However, when a pseudoaneurysm is identified with preprocedure imaging, it can usually be managed with an endovascular procedure. After successful treatment of the pseudoaneurysm, endoscopic drainage can be performed. (See 'Contraindications' above.)

- **Endoscopic ultrasound (EUS)-guided drainage** – The goal of endoscopic drainage is to resolve the walled-off PFC and, thus, relieve symptoms such as abdominal pain, nausea, and early satiety that were related to compression of the gastrointestinal lumen. EUS-guided transmural drainage of walled-off PFCs is performed by creating a tract through the gastric or duodenal wall and by placing one or more stents to maintain patency. If necrotic material is present within the fluid collection, endoscopic necrosectomy can be performed during the initial drainage procedure and/or at a subsequent endoscopic session. (See 'General principles' above.)

- **Stent removal** – Timing for stent removal is guided by imaging appearance of the walled-off PFC. For patients with pancreatic pseudocyst, we obtain CT scan in four to six weeks after stent placement. If there is complete resolution of the fluid collection, the stents are removed endoscopically. (See 'Stent removal' above.)

- **Adverse events** – Adverse events related to EUS-guided drainage of walled-off PFCs have been reported in 5 to 20 percent of patients and include infection, bleeding, perforation, stent migration, and fistula formation. Most adverse events can be treated medically or with endoscopic therapy. (See 'Adverse Events' above.)

- **ERCP-guided transpapillary drainage** – Endoscopic retrograde cholangiopancreatography (ERCP)-guided transpapillary drainage can be performed for smaller pseudocysts (≤4 cm) if there is a communication between the walled-off PFC and the main pancreatic duct or if the cyst is too distant (>1 cm) from the gastrointestinal lumen to allow for EUS-guided transmural drainage. (See 'ERCP-guided

transpapillary drainage' above.)

ACKNOWLEDGMENT

The UpToDate editorial staff acknowledges Douglas A Howell, MD, FASGE, FACG, who contributed to earlier versions of this topic review.

REFERENCES

1. Banks PA, Bollen TL, Dervenis C, et al. Classification of acute pancreatitis--2012: revision of the Atlanta classification and definitions by international consensus. Gut 2013; 62:102.
2. Arvanitakis M, Delhaye M, De Maertelaere V, et al. Computed tomography and magnetic resonance imaging in the assessment of acute pancreatitis. Gastroenterology 2004; 126:715.
3. Elmunzer BJ. Endoscopic Drainage of Pancreatic Fluid Collections. Clin Gastroenterol Hepatol 2018; 16:1851.
4. Verma S, Rana SS. Disconnected pancreatic duct syndrome: Updated review on clinical implications and management. Pancreatology 2020; 20:1035.
5. Hirota M, Kimura Y, Ishiko T, et al. Visualization of the heterogeneous internal structure of so-called "pancreatic necrosis" by magnetic resonance imaging in acute necrotizing pancreatitis. Pancreas 2002; 25:63.
6. Dhaka N, Samanta J, Kochhar S, et al. Pancreatic fluid collections: What is the ideal imaging technique? World J Gastroenterol 2015; 21:13403.
7. Morgan DE, Baron TH, Smith JK, et al. Pancreatic fluid collections prior to intervention: evaluation with MR imaging compared with CT and US. Radiology 1997; 203:773.
8. Marshall GT, Howell DA, Hansen BL, et al. Multidisciplinary approach to pseudoaneurysms complicating pancreatic pseudocysts. Impact of pretreatment diagnosis. Arch Surg 1996; 131:278.
9. Bhasin DK, Rana SS, Sharma V, et al. Non-surgical management of pancreatic pseudocysts associated with arterial pseudoaneurysm. Pancreatology 2013; 13:250.
10. Razik R, May GR, Saibil F. Non-operative Management of Necrotic Pancreatic Collection and Bleeding Pseudoaneurysm Communicating with Bowel Lumen at Multiple Sites: a

Case Report and Review of the Literature. J Gastrointestin Liver Dis 2016; 25:109.

11. Larrey Ruiz L, Luján Sanchis M, Peño Muñoz L, et al. Pseudoaneurysm associated with complicated pancreatic pseudocysts. Rev Esp Enferm Dig 2016; 108:583.
12. Venturini M, Marra P, Colombo M, et al. Endovascular Repair of 40 Visceral Artery Aneurysms and Pseudoaneurysms with the Viabahn Stent-Graft: Technical Aspects, Clinical Outcome and Mid-Term Patency. Cardiovasc Intervent Radiol 2018; 41:385.
13. Balthazar EJ. Complications of acute pancreatitis: clinical and CT evaluation. Radiol Clin North Am 2002; 40:1211.
14. ASGE Standards of Practice Committee, Muthusamy VR, Chandrasekhara V, et al. The role of endoscopy in the diagnosis and treatment of inflammatory pancreatic fluid collections. Gastrointest Endosc 2016; 83:481.
15. ASGE Standards of Practice Committee, Khashab MA, Chithadi KV, et al. Antibiotic prophylaxis for GI endoscopy. Gastrointest Endosc 2015; 81:81.
16. Giovannini M. Endoscopic Ultrasound-Guided Drainage of Pancreatic Fluid Collections. Gastrointest Endosc Clin N Am 2018; 28:157.
17. Bang JY, Hawes R, Bartolucci A, Varadarajulu S. Efficacy of metal and plastic stents for transmural drainage of pancreatic fluid collections: a systematic review. Dig Endosc 2015; 27:486.
18. Itoi T, Binmoeller KF, Shah J, et al. Clinical evaluation of a novel lumen-apposing metal stent for endosonography-guided pancreatic pseudocyst and gallbladder drainage (with videos). Gastrointest Endosc 2012; 75:870.
19. Gornals JB, De la Serna-Higuera C, Sánchez-Yague A, et al. Endosonography-guided drainage of pancreatic fluid collections with a novel lumen-apposing stent. Surg Endosc 2013; 27:1428.
20. Patil R, Ona MA, Papafragkakis C, et al. Endoscopic ultrasound-guided placement of AXIOS stent for drainage of pancreatic fluid collections. Ann Gastroenterol 2016; 29:168.
21. Anderloni A, Leo MD, Carrara S, et al. Endoscopic ultrasound-guided transmural drainage by cautery-tipped lumen-apposing metal stent: exploring the possible indications. Ann Gastroenterol 2018; 31:735.
22. Siddiqui AA, Kowalski TE, Loren DE, et al. Fully covered self-expanding metal stents versus lumen-apposing fully covered self-expanding metal stent versus plastic stents for endoscopic drainage of pancreatic walled-off necrosis: clinical outcomes and success. Gastrointest Endosc 2017; 85:758.

23. Abu Dayyeh BK, Mukewar S, Majumder S, et al. Large-caliber metal stents versus plastic stents for the management of pancreatic walled-off necrosis. Gastrointest Endosc 2018; 87:141.
24. Shah RJ, Shah JN, Waxman I, et al. Safety and efficacy of endoscopic ultrasound-guided drainage of pancreatic fluid collections with lumen-apposing covered self-expanding metal stents. Clin Gastroenterol Hepatol 2015; 13:747.
25. Lyu Y, Li T, Wang B, et al. Comparison Between Lumen-Apposing Metal Stents and Plastic Stents in Endoscopic Ultrasound-Guided Drainage of Pancreatic Fluid Collection: A Meta-analysis and Systematic Review. Pancreas 2021; 50:571.
26. Antillon MR, Shah RJ, Stiegmann G, Chen YK. Single-step EUS-guided transmural drainage of simple and complicated pancreatic pseudocysts. Gastrointest Endosc 2006; 63:797.
27. Jansen JM, Hanrath A, Rauws EA, et al. Intracystic wire exchange facilitating insertion of multiple stents during endoscopic drainage of pancreatic pseudocysts. Gastrointest Endosc 2007; 66:157.
28. Ahlawat SK, Charabaty-Pishvaian A, Jackson PG, Haddad NG. Single-step EUS-guided pancreatic pseudocyst drainage using a large channel linear array echoendoscope and cystotome: results in 11 patients. JOP 2006; 7:616.
29. Fabbri C, Luigiano C, Lisotti A, et al. Endoscopic ultrasound-guided treatments: are we getting evidence based--a systematic review. World J Gastroenterol 2014; 20:8424.
30. Seifert H, Biermer M, Schmitt W, et al. Transluminal endoscopic necrosectomy after acute pancreatitis: a multicentre study with long-term follow-up (the GEPARD Study). Gut 2009; 58:1260.
31. van Brunschot S, Fockens P, Bakker OJ, et al. Endoscopic transluminal necrosectomy in necrotising pancreatitis: a systematic review. Surg Endosc 2014; 28:1425.
32. Yasuda I, Nakashima M, Iwai T, et al. Japanese multicenter experience of endoscopic necrosectomy for infected walled-off pancreatic necrosis: The JENIPaN study. Endoscopy 2013; 45:627.
33. Bang JY, Wilcox CM, Trevino J, et al. Factors impacting treatment outcomes in the endoscopic management of walled-off pancreatic necrosis. J Gastroenterol Hepatol 2013; 28:1725.
34. Garg R, Gupta S, Singh A, et al. Hydrogen peroxide assisted endoscopic necrosectomy for walled-off pancreatic necrosis: A systematic review and meta-analysis. Pancreatology 2021; 21:1540.

35. Messallam AA, Adler DG, Shah RJ, et al. Direct Endoscopic Necrosectomy With and Without Hydrogen Peroxide for Walled-off Pancreatic Necrosis: A Multicenter Comparative Study. Am J Gastroenterol 2021; 116:700.
36. Ross AS, Irani S, Gan SI, et al. Dual-modality drainage of infected and symptomatic walled-off pancreatic necrosis: long-term clinical outcomes. Gastrointest Endosc 2014; 79:929.
37. Baron TH, DiMaio CJ, Wang AY, Morgan KA. American Gastroenterological Association Clinical Practice Update: Management of Pancreatic Necrosis. Gastroenterology 2020; 158:67.
38. Bang JY, Wilcox CM, Navaneethan U, et al. Impact of Disconnected Pancreatic Duct Syndrome on the Endoscopic Management of Pancreatic Fluid Collections. Ann Surg 2018; 267:561.
39. Rana SS, Shah J, Sharma RK, Gupta R. Clinical and morphological consequences of permanent indwelling transmural plastic stents in disconnected pancreatic duct syndrome. Endosc Ultrasound 2020; 9:130.
40. Lawrence C, Howell DA, Stefan AM, et al. Disconnected pancreatic tail syndrome: potential for endoscopic therapy and results of long-term follow-up. Gastrointest Endosc 2008; 67:673.
41. Kahaleh M, Shami VM, Conaway MR, et al. Endoscopic ultrasound drainage of pancreatic pseudocyst: a prospective comparison with conventional endoscopic drainage. Endoscopy 2006; 38:355.
42. Holt BA, Varadarajulu S. The endoscopic management of pancreatic pseudocysts (with videos). Gastrointest Endosc 2015; 81:804.
43. Varadarajulu S, Bang JY, Phadnis MA, et al. Endoscopic transmural drainage of peripancreatic fluid collections: outcomes and predictors of treatment success in 211 consecutive patients. J Gastrointest Surg 2011; 15:2080.
44. Varadarajulu S, Christein JD, Wilcox CM. Frequency of complications during EUS-guided drainage of pancreatic fluid collections in 148 consecutive patients. J Gastroenterol Hepatol 2011; 26:1504.
45. Gambiez LP, Ernst OJ, Merlier OA, et al. Arterial embolization for bleeding pseudocysts complicating chronic pancreatitis. Arch Surg 1997; 132:1016.
46. Gardner TB, Coelho-Prabhu N, Gordon SR, et al. Direct endoscopic necrosectomy for the treatment of walled-off pancreatic necrosis: results from a multicenter U.S. series. Gastrointest Endosc 2011; 73:718.

47. Hookey LC, Debroux S, Delhaye M, et al. Endoscopic drainage of pancreatic-fluid collections in 116 patients: a comparison of etiologies, drainage techniques, and outcomes. Gastrointest Endosc 2006; 63:635.
48. Krüger M, Schneider AS, Manns MP, Meier PN. Endoscopic management of pancreatic pseudocysts or abscesses after an EUS-guided 1-step procedure for initial access. Gastrointest Endosc 2006; 63:409.
49. Cahen D, Rauws E, Fockens P, et al. Endoscopic drainage of pancreatic pseudocysts: long-term outcome and procedural factors associated with safe and successful treatment. Endoscopy 2005; 37:977.
50. Sahel J. Endoscopic drainage of pancreatic cysts. Endoscopy 1991; 23:181.
51. Agalianos C, Passas I, Sideris I, et al. Review of management options for pancreatic pseudocysts. Transl Gastroenterol Hepatol 2018; 3:18.
52. Catalano MF, Geenen JE, Schmalz MJ, et al. Treatment of pancreatic pseudocysts with ductal communication by transpapillary pancreatic duct endoprosthesis. Gastrointest Endosc 1995; 42:214.
53. Varadarajulu S, Noone TC, Tutuian R, et al. Predictors of outcome in pancreatic duct disruption managed by endoscopic transpapillary stent placement. Gastrointest Endosc 2005; 61:568.
54. Andrén-Sandberg A, Dervenis C. Pancreatic pseudocysts in the 21st century. Part II: natural history. JOP 2004; 5:64.
55. Yang D, Amin S, Gonzalez S, et al. Transpapillary drainage has no added benefit on treatment outcomes in patients undergoing EUS-guided transmural drainage of pancreatic pseudocysts: a large multicenter study. Gastrointest Endosc 2016; 83:720.
56. Trevino JM, Tamhane A, Varadarajulu S. Successful stenting in ductal disruption favorably impacts treatment outcomes in patients undergoing transmural drainage of peripancreatic fluid collections. J Gastroenterol Hepatol 2010; 25:526.

Topic 5650 Version 20.0

GRAPHICS

Revised definitions of morphological features of acute pancreatitis

1. Interstitial edematous pancreatitis
Acute inflammation of the pancreatic parenchyma and peripancreatic tissues, but without recognizable tissue necrosis *Contrast-enhanced computed tomography criteria:* ▪ Pancreatic parenchyma enhancement by intravenous contrast agent ▪ No findings of peripancreatic necrosis
2. Necrotizing pancreatitis
Inflammation associated with pancreatic parenchymal necrosis and/or peripancreatic necrosis *Contrast-enhanced computed tomography criteria:* ▪ Lack of pancreatic parenchymal enhancement by intravenous contrast agent, and/or ▪ Presence of findings of peripancreatic necrosis (refer to below–acute peripancreatic fluid collection and walled off necrosis)
3. Acute peripancreatic fluid collection (APFC)
Peripancreatic fluid associated with interstitial edematous pancreatitis with no associated peripancreatic necrosis. This term applies only to areas of peripancreatic fluid seen within the first four weeks after onset of interstitial edematous pancreatitis and without the features of a pseudocyst. *Contrast-enhanced computed tomography criteria:* ▪ Occurs in the setting of interstitial edematous pancreatitis ▪ Homogeneous collection with fluid density ▪ Confined by normal peripancreatic fascial planes ▪ No definable wall encapsulating the collection ▪ Adjacent to pancreas (no intrapancreatic extension)
4. Pancreatic pseudocyst

An encapsulated collection of fluid with a well-defined inflammatory wall usually outside the pancreas with minimal or no necrosis. This entity usually occurs more than four weeks after onset of interstitial edematous pancreatitis to mature.

Contrast-enhanced computed tomography criteria:

- Well circumscribed, usually round or oval
- Homogeneous fluid density
- No non-liquid component
- Well-defined wall (ie, completely encapsulated)
- Maturation usually requires >4 weeks after onset of acute pancreatitis; occurs after interstitial edematous pancreatitis

5. Acute necrotic collection (ANC)

A collection containing variable amounts of both fluid and necrosis associated with necrotizing pancreatitis; the necrosis can involve the pancreatic parenchyma and/or the peripancreatic tissues

Contrast-enhanced computed tomography criteria:

- Occurs only in the setting of acute necrotizing pancreatitis
- Heterogeneous and non-liquid density of varying degrees in different locations (some appear homogeneous early in their course)
- No definable wall encapsulating the collection
- Location–intrapancreatic and/or extrapancreatic

6. Walled-off necrosis (WON)

A mature, encapsulated collection of pancreatic and/or peripancreatic necrosis that has developed a well-defined inflammatory wall. WON usually occurs >4 weeks after onset of necrotizing pancreatitis.

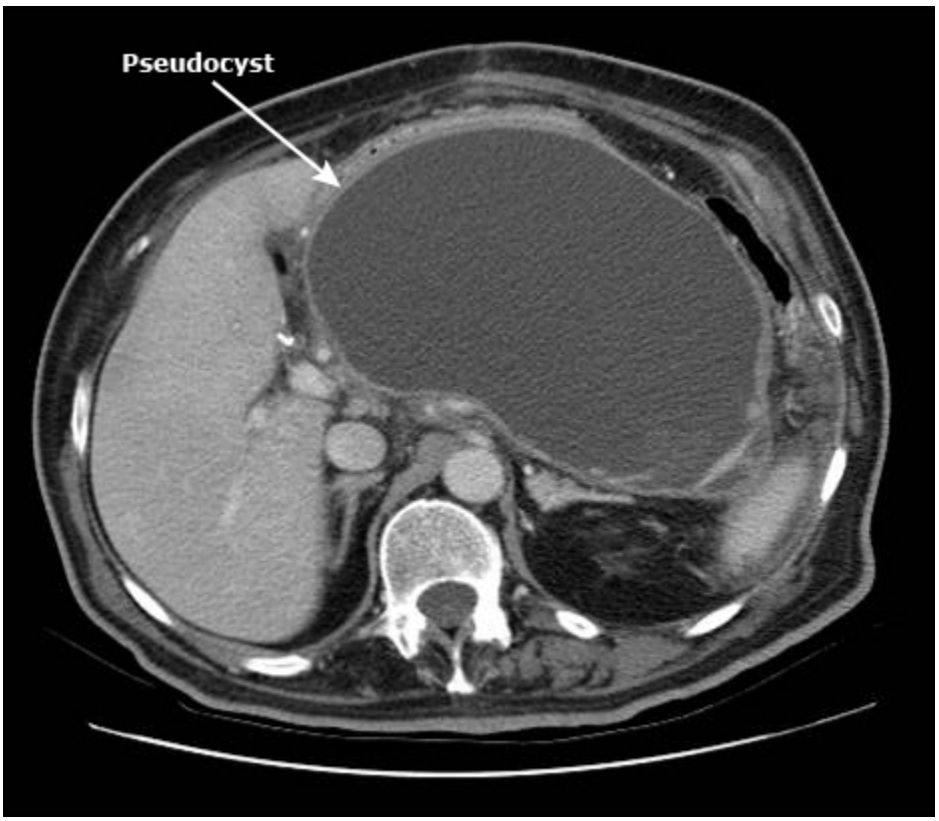
Contrast-enhanced computed tomography criteria:

- Heterogeneous with liquid and non-liquid density with varying degrees of loculations (some may appear homogeneous)
- Well-defined wall, that is, completely encapsulated
- Location–intrapancreatic and/or extrapancreatic
- Maturation usually requires four weeks after onset of acute necrotizing pancreatitis

Reproduced with permission from: Banks PA, Bollen TL, Dervenis C, et al. Classification of acute pancreatitis – 2012: revisions of the Atlanta classification and definitions by international consensus. Gut 2013; 62:102. BMJ Publishing Group Ltd. Copyright © 2013.

Graphic 87683 Version 3.0

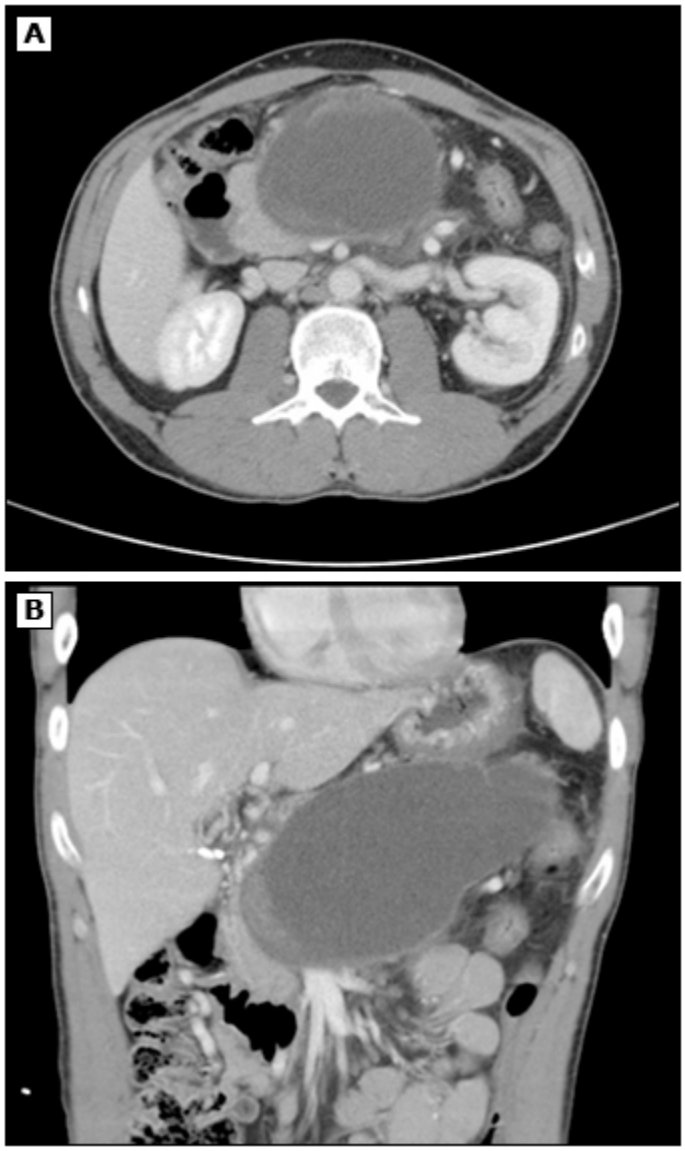
Pancreatic pseudocyst



Computed tomographic scan showing a massive pancreatic pseudocyst compressing the stomach and obliterating the pancreas.

Graphic 80720 Version 5.0

CT scan showing walled-off pancreatic necrosis



Contrast-enhanced CT scan showing walled-off pancreatic necrosis in both axial (A) and coronal (B) projections. This morphologic variant of necrosis is well suited to minimally invasive methods of debridement.

CT: computed tomography.

Graphic 66932 Version 8.0

Antibiotic regimens: Prophylaxis for endoscopic procedures

Procedure	Condition(s)	Antibiotic and dose*	Interval for intraoperative re-dose for prolonged procedure (timed from initiation of preoperative dose)
High-risk endoscopic procedures needing antibiotic prophylaxis¶ Δ			
PEG/PEJ placement	MRSA risk absent	Cefazolin 2 g for patients weighing <120 kg, 3 g for patients weighing ≥120 kg (pediatric dose 30 mg/kg) IV within 60 minutes before procedure. **If penicillin or cephalosporin hypersensitivity:** Clindamycin 900 mg (pediatric dose 10 mg/kg) IV within 60 minutes before procedure.	Cefazolin: four hours Clindamycin: six hours
	MRSA risk present Pre-procedural screening for MRSA and attempted decontamination before feeding tube placement is recommended if practical	Vancomycin 15 mg/kg (maximum 2 g) IV infused over 60 to 90 minutes and beginning within 120 minutes before surgical incision.	Vancomycin: re-dosing is generally not required
ERCP◇	- Biliary obstruction AND cholangitis - Biliary obstruction	Ciprofloxacin 500 mg (pediatric dose 15 mg/kg§) orally given	Ciprofloxacin: re-dosing is generally not required

	unlikely to be successfully drained at ERCP (including malignant hilar obstruction and primary sclerosing cholangitis) - Inadequate biliary drainage following ERCP - Biliary complications following liver transplantation if drainage is unlikely	within 60 to 90 minutes prior to procedure or 400 mg (pediatric dose 10 mg/kg[§]) IV over 60 minutes beginning within 120 minutes prior to procedure **AND/OR**	
		Amoxicillin-clavulanate 1750 mg (pediatric dose 45 mg/kg) orally within 60 minutes prior to procedure or ampicillin-sulbactam 3 grams (pediatric dose 50 mg/kg ampicillin component) IV within 60 minutes prior to procedure **OR**	Amoxicillin-clavulanate: two hours
		Ampicillin 2 grams (pediatric dose 50 mg/kg) IV **plus** gentamicin[¥] 5 mg/kg (pediatric 2.5 mg/kg) IV within 60 minutes before procedure. **If penicillin hypersensitivity:** Substitute vancomycin 15 mg/kg (maximum 2 g) IV infused over 60 to 90 minutes beginning within 120 minutes before procedure plus gentamicin[¥] 5 mg/kg IV (pediatric 2.5 mg/kg) within 60 minutes before procedure.	Ampicillin: two hours Vancomycin: re-dosing is generally not required Gentamicin: single dose only

		ALL above regimens are discontinued post-procedure when drainage is established absent evidence of cholangitis. For antibiotic dosing post-procedure with incomplete drainage, refer to the individual Lexicomp drug information monograph.	
EUS-FNA of cystic lesion(s)‡	- Mediastinal cysts	Ciprofloxacin 500 mg orally (pediatric dose 15 mg/kg§) 60 to 90 minutes prior to procedure or 400 mg IV (pediatric dose 10 mg/kg§) IV given over 60 minutes beginning within 120 minutes prior to procedure. Continue 3 days post-procedure.	Ciprofloxacin: re-dosing is generally not required
Interventional EUS procedures including transmural or transluminal drainage of pancreatic fluid collections	- Mediastinal cysts - Pancreatic cysts - Cysts outside pancreas (excluding solid lesions) - Walled-off pancreatic necrosis	Ciprofloxacin 500 mg orally (pediatric dose 15 mg/kg§) 60 to 90 minutes prior to procedure or 400 mg IV (pediatric dose 10 mg/kg§) IV given over 60 minutes beginning within 120 minutes prior to procedure. Continue 3 days post-procedure.	Ciprofloxacin: re-dosing is generally not required
Natural orifice transluminal endoscopic surgery (NOTES)	Insufficient data to make recommendation. Antibiotic prophylaxis seems reasonable.		

High-risk patients needing antibiotic prophylaxis¶			
All endoscopic procedures with high risk of bacteremia, including procedures not listed above (eg, routine endoscopy with esophageal stricture dilation or endoscopic sclerotherapy); For procedures in the biliary tree (eg, ERCP with drainage or EUS-FNA of any lesion type) in a patient who is at high risk for infection, refer to antibiotic recommendations listed above	- Immunocompromised patients (eg, severe neutropenia [absolute neutrophil count <500 cells/mm^3], advanced hematologic malignancy)† - Cirrhosis with ascites**	Amoxicillin 2 grams (pediatric dose 50 mg/kg) orally within 60 minutes before procedure **OR**	Amoxicillin: two hours
		Ampicillin 2 grams (pediatric dose 50 mg/kg) IV or IM within 60 minutes prior to procedure. **If penicillin hypersensitivity:** Clindamycin 600 mg (pediatric dose 20 mg/kg) orally within 60 minutes before procedure or 900 mg IV (pediatric dose 10 mg/kg IV) within 60 minutes prior to procedure.	Ampicillin: two hours Clindamycin: six hours

The preprocedural antibiotic recommendations presented in this table are generally consistent with those of American Society for Gastrointestinal Endoscopy[1] and the 2013 guidelines developed jointly by the American Society of Health-System Pharmacists and collaborating organizations[2]. A 2009 guideline available from the British Society of Gastroenterology[3] also recommends antibiotic prophylaxis in these conditions, but includes, in some cases, different choices and dosing regimens depending upon specific clinical scenarios. When available, recent culture and sensitivity results should be considered in selecting antibiotic prophylaxis.

PEG: percutaneous endoscopic gastrostomy; MRSA: methicillin-resistant *Staphylococcus aureus*; ERCP: endoscopic retrograde cholangiopancreatography; EUS-FNA: endoscopic ultrasound-guided fine-needle aspiration; GI: gastrointestinal.

* Pediatric dose should generally not exceed adult dose. Doses shown in table are for patients with normal renal function. Dose modification for renal impairment is needed for some agents.

¶ Antibiotic prophylaxis solely to prevent infective endocarditis is **not** recommended in patients undergoing endoscopic procedures. For patients with the highest-risk cardiac conditions (eg, prosthetic heart valve, prior endocarditis) who have ongoing GI or genitourinary tract infection or who are undergoing a procedure for which antibiotic therapy to prevent wound infection or

sepsis is indicated, the American Society for Gastrointestinal Endoscopy (ASGE) and American Heart Association (AHA) suggest an antibiotic regimen that includes an agent active against enterococci (eg, ampicillin, piperacillin-tazobactam, or vancomycin). Refer to topic review of antimicrobial prophylaxis for bacterial endocarditis section on gastrointestinal tract.

Δ A separate table that summarizes the types of procedures and patients needing antibiotic prophylaxis is available in UpToDate. Low-risk endoscopic procedures that do not need routine antibiotic prophylaxis in most patients (eg, routine upper endoscopy, colonoscopy, flexible sigmoidoscopy, others) are listed in that table.

◇ Patients with cholangitis require antibiotic therapy and additional prophylaxis is not required.

§ While fluoroquinolones have been associated with an increased risk of tendinitis/tendon rupture in all ages, use of these agents for single-dose prophylaxis is generally safe.

¥ Gentamicin use for surgical antibiotic prophylaxis should be limited to a single dose given preoperatively. Dosing is based on the patient's actual body weight. For overweight and obese patients (ie, actual weight is greater than 120% of ideal body weight), a dosing weight should be used. A calculator to determine ideal body weight and dosing weight is available in UpToDate.

‡ While antibiotic prophylaxis is recommended by the ASGE for all patients undergoing EUS-FNA of cystic lesions, we generally reserve antibiotic prophylaxis for patients undergoing EUS-FNA of mediastinal lesions and in those who are at high risk for infection. Antibiotic prophylaxis is not required for patients undergoing EUS-FNA of solid lesions.

† Patients at high risk for postprocedural infections may also include those with decreased gastric acidity and motility resulting from malignancy or acid suppression.

** In patients with cirrhosis and upper gastrointestinal bleeding, antibiotics are indicated even if endoscopy is not planned.

References:

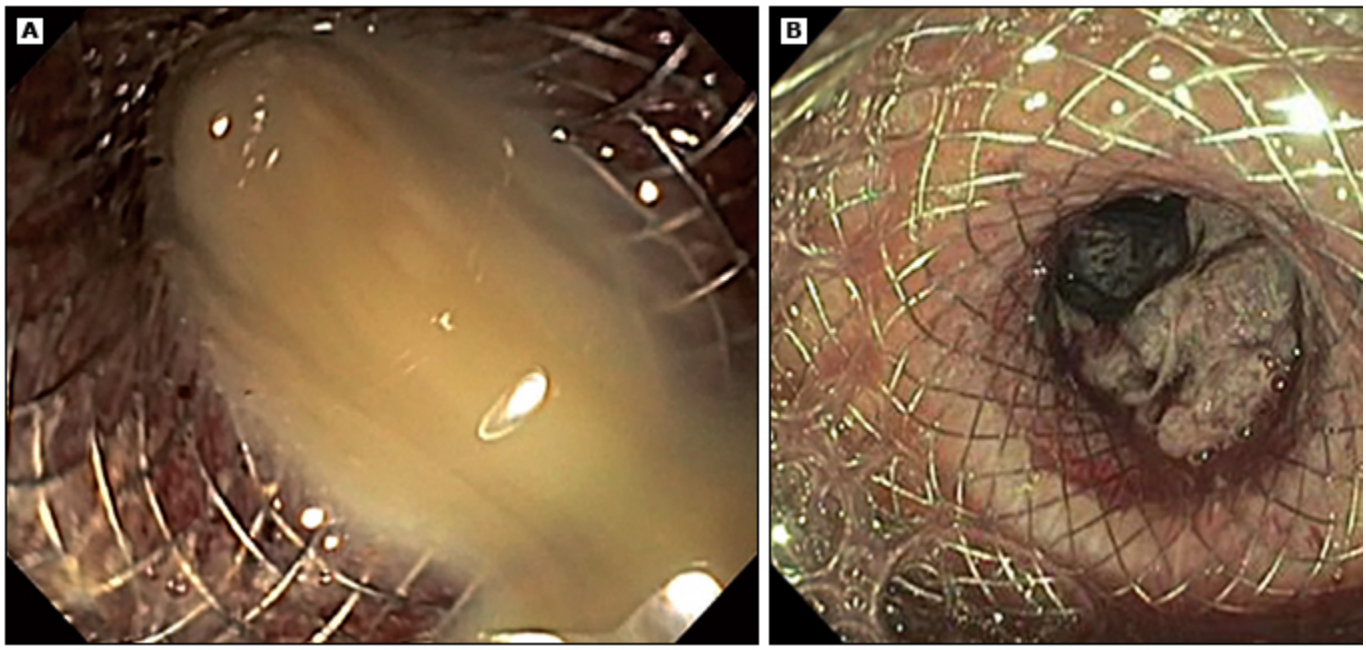
1. *ASGE Standards of Practice Committee, Khashab MA, Chithadi KV, et al. Antibiotic prophylaxis for GI endoscopy. Gastrointest Endosc 2015; 81:81.*
2. *Bratzler DW, Dellinger EP, Olsen KM, et al. Clinical Practice Guidelines for Antimicrobial Prophylaxis in Surgery. Am J Health Syst Pharm 2013; 70:195.*
3. *Allison MC, Sandoe JA, Tighe R, et al. Antibiotic prophylaxis in gastrointestinal endoscopy. Gut 2009; 58:868.*

Additional data from:

1. *Red Book: 2012 Report of the Committee on Infectious Diseases, 29th ed, Pickering LK, ed, Elk Grove Village, IL: American Academy of Pediatrics, 2012, p.808.*

Graphic 54121 Version 9.0

Use of a large-caliber, fully covered, self-expandable metal stent for the man of walled-off pancreatic necrosis

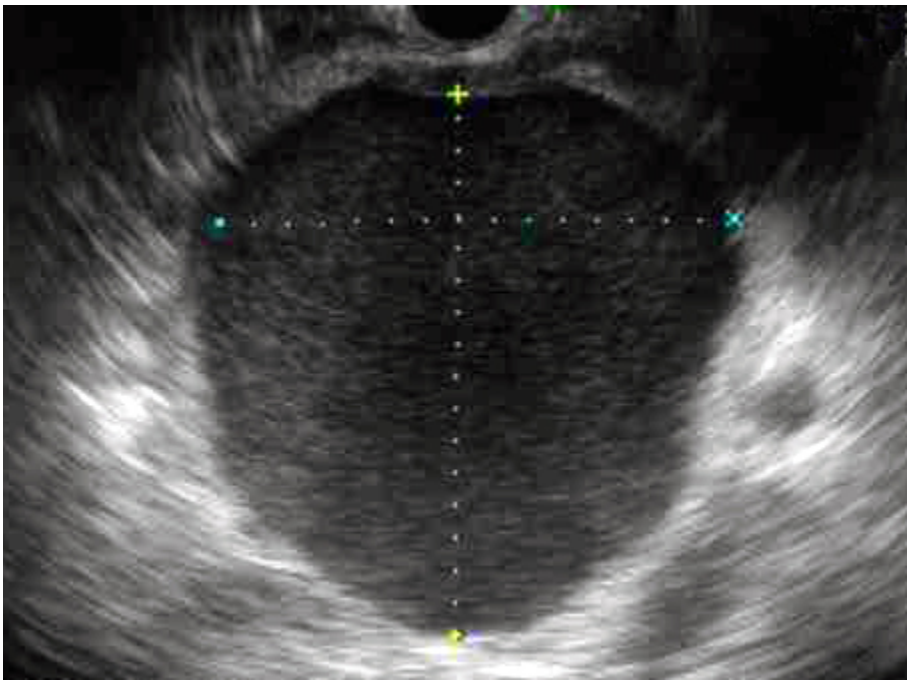


(A) Endoscopic image showing pus originating from walled-off pancreatic necrosis and draining through caliber, fully covered, self-expandable metal stent (AXIOS).

(B) Endoscopic image showing pancreatic fluid draining through a large-caliber, fully covered, self-expan metal stent (AXIOS).

Graphic 114068 Version 1.0

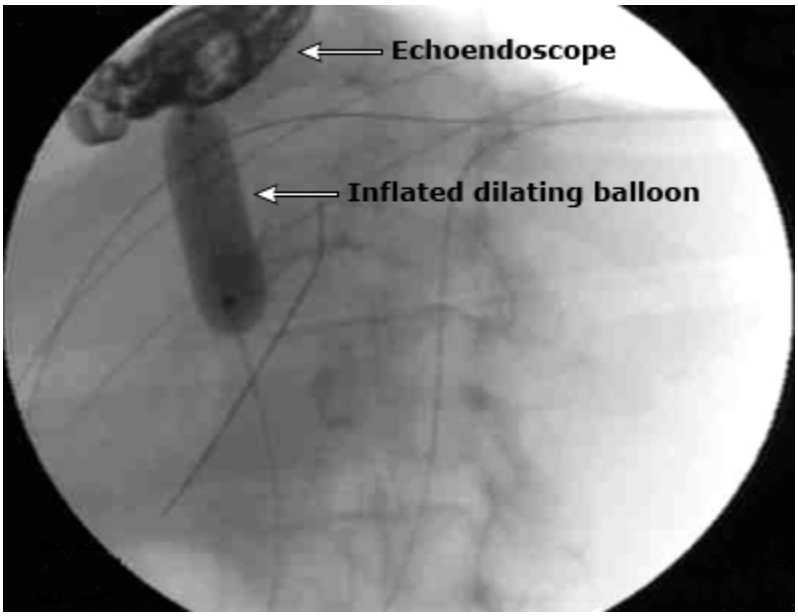
Endoscopic ultrasound (EUS) image of a pancreatic pseudocyst



Courtesy of Dr. Raj J Shah, MD.

Graphic 70020 Version 5.0

Creation of a cystgastrostomy for treatment of a pancreatic pseudocyst



Fluoroscopy view of guidewire exiting the curvilinear array echoendoscope and curling within the pseudocyst. The cystgastrostomy tract is being dilated with a balloon.

Courtesy of Raj J Shah, MD.

Graphic 76019 Version 7.0

Transgastric pigtail stents to drain a pancreatic pseudocyst

Endoscopic view of two 10F transgastric double-pigtail, plastic stents.

Courtesy of Raj J Shah, MD.

Graphic 51572 Version 5.0

Direct endoscopic necrosectomy of walled-off pancreatic necrosis

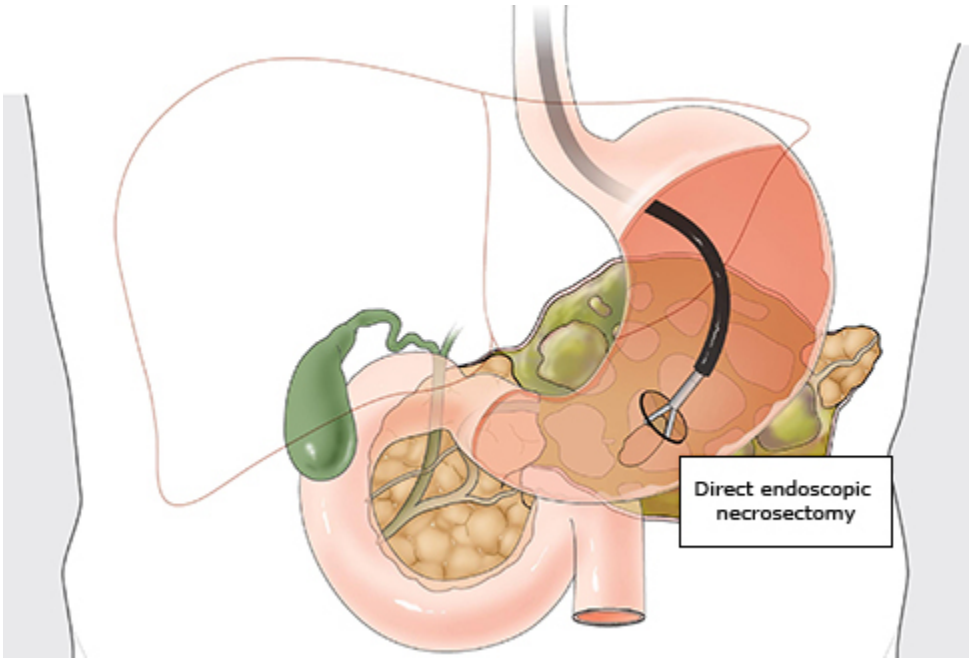


Illustration of direct endoscopic necrosectomy of walled-off pancreatic necrosis. After endoscopically creating a cystgastrostomy or cystenterostomy, the cyst cavity is entered and necrotic material is removed using snares, nets, baskets, and forceps.

Graphic 97914 Version 1.0

Contributor Disclosures

Raj J Shah, MD, MASGE, AGAF, FACG Consultant/Advisory Boards: Boston Scientific [Gastroenterology]. All of the relevant financial relationships listed have been mitigated. **Douglas G Adler, MD, FACG, AGAF, FASGE** Consultant/Advisory Boards: Abbvie [Endoscopy]; Boston Scientific [Endoscopy]; Endorotor [Endoscopy]; Merit [Endoscopy]; Olympus [Endoscopy]. Speaker's Bureau: Abbvie [Pancreatology, general GI]. All of the relevant financial relationships listed have been mitigated. **Kristen M Robson, MD, MBA, FACG** No relevant financial relationship(s) with ineligible companies to disclose.

Contributor disclosures are reviewed for conflicts of interest by the editorial group. When found, these are addressed by vetting through a multi-level review process, and through requirements for references to be provided to support the content. Appropriately referenced content is required of all authors and must conform to UpToDate standards of evidence.

Conflict of interest policy

→