

Pancreatic necrosis: Complications and changing trend of treatment

Mamoon Ur Rashid, Ishtiaq Hussain, Sundas Jehanzeb, Waqas Ullah, Saeed Ali, Akriti Gupta Jain, Neelam Khetpal, Sarfraz Ahmad

ORCID number: Mamoon Ur Rashid (0000-0002-3843-4352); Ishtiaq Hussain (0000-0002-2574-9156); Sundas Jehanzeb (0002-0002-8974-6639); Waqas Ullah (0000-0002-4850-0309); Saeed Ali (0000-0003-4967-1385); Akriti Gupta Jain (0000-0002-7238-9241); Neelam khetpal (0000-0002-3436-0173); Sarfraz Ahmad (0000-0002-5180-0409).

Author contributions: All authors equally contributed to this paper with conception and design of the study, literature review and analysis, drafting and critical revision and editing, and final approval of the final version.

Conflict-of-interest statement: No potential conflicts of interest. No financial support.

Open-Access: This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

Manuscript source: Unsolicited manuscript

Received: March 12, 2019

Peer-review started: March 15, 2019

Mamoon Ur Rashid, Saeed Ali, Akriti Gupta Jain, Neelam Khetpal, Department of Internal Medicine, Advent Health Graduate Medical Education, Orlando, FL 32804, United States

Ishtiaq Hussain, Sundas Jehanzeb, Department of Gastroenterology, Cleveland Clinic, Weston, FL 33326, United States

Waqas Ullah, Internal Medicine, Abington Hospital, Abington, PA 19001, United States

Sarfraz Ahmad, Department of Gynecologic Oncology, Advent Health Cancer Institute, Orlando, FL 32804, United States

Corresponding author: Mamoon Ur Rashid, MBBS, MD, Doctor, Medical Resident, Department of Internal Medicine, Advent Health Graduate Medical Education, 2501 North Orange Avenue, Orlando, FL 32804, United States. mamoon.rashid.md@adventhealth.com

Telephone: +1-407-3122766

Fax: +1-407-3032435

Abstract

Incidence of acute pancreatitis seems to be increasing in the Western countries and has been associated with significantly increased morbidity. Nearly 80% of the patients with acute pancreatitis undergo resolution; some develop complications including pancreatic necrosis. Infection of pancreatic necrosis is the leading cause of death in these patients. A significant portion of these patients needs surgical interventions. Traditionally, the "gold standard" procedure has been the open surgical necrosectomy, which is now being completed by the relatively lesser invasive interventions. Minimally invasive surgical (MIS) procedures include endoscopic drainage, percutaneous image-guided catheter drainage, and retroperitoneal drainage. This review article discusses the open and MIS interventions for pancreatic necrosis with each having its own respective benefits and disadvantages are covered.

Key words: Pancreatic necrosis; Necrosectomy; Open surgery; Minimally invasive surgery; Complications; Treatment; Review article

©The Author(s) 2019. Published by Baishideng Publishing Group Inc. All rights reserved.

Core tip: Pancreatic necrosis is one of the serious complications of acute pancreatitis. A significant portion of these patients needs surgical interventions. Traditionally, the "gold standard" procedure has been the open surgical necrosectomy, which is now being completed by the relatively lesser invasive interventions which include endoscopic

First decision: April 13, 2019
Revised: April 19, 2019
Accepted: April 23, 2019
Article in press: April 23, 2019
Published online: April 27, 2019

P-Reviewer: Memeo R, Quesada BM

S-Editor: Ji FF

L-Editor: A

E-Editor: Wu YXJ



drainage, percutaneous image-guided catheter drainage, and retroperitoneal drainage which are discussed in detail in this review article. However, no single modality is optimal for the treatment, and a multi-modal approach is needed. The mainstay of the management is now shifting to a “Step-up approach” from the most non-invasive towards the most invasive techniques in a step-up manner as the indications arise.

Citation: Rashid MU, Hussain I, Jehanzeb S, Ullah W, Ali S, Jain AG, Khetpal N, Ahmad S. Pancreatic necrosis: Complications and changing trend of treatment. *World J Gastrointest Surg* 2019; 11(4): 198-217

URL: <https://www.wjgnet.com/1948-9366/full/v11/i4/198.htm>

DOI: <https://dx.doi.org/10.4240/wjgs.v11.i4.198>

INTRODUCTION

In the Western countries, acute pancreatitis is responsible for significant morbidity, high health care resources utilization and expenses. An unexplained increase in the incidence of acute pancreatitis has been noted in the past few decades in number of Western countries; ranging from 5 to 70 per 100000 persons per year^[1-3]. The rate of hospitalization has gone up reaching 0.7 per 1000 persons over the same period^[4]. Cholelithiasis and excessive alcohol intake are the leading predisposing risk factors, which collectively are responsible for nearly 2/3rd of the reported cases^[3,5-8].

Although majority of the patients (approximately 80%) with acute pancreatitis undergo resolution of symptoms, a minority of these cases (*i.e.*, approximately 20%) run an advance complicated course resulting in pancreatic tissue and/or peri-pancreatic tissue necrosis, which is accountable for considerable mortality and morbidity rates (reaching up to 27%)^[9]. Among these patients with necrotizing pancreatitis, infection of the necrotic tissue is the leading cause of death, which is a poor prognostic factor: pancreatic necrosis without infection has nearly 15% mortality rate while it is up to 30%-39% in those with infected necrosis. In approximately 1/3rd of the patients, the pancreatic necrosis gets infected at some stage of the clinical course^[10-12].

Bradley *et al*^[13] proposed, in the beginning of 1990s, that several patients with sterile pancreatic necrosis gets better without surgical intervention. Subsequently, the medical treatment of necrotizing pancreatitis was widely followed by the specialty. Despite this, a significant proportion of patients with pancreatic necrosis still need intervention. Open surgical necrosectomy was the traditional intervention for these patients, which is a highly invasive surgery resulting in 43%-89% complication rates and 9%-39% mortality rate^[14-19]. The “gold standard” intervention for infected pancreatic necrosis was open necrosectomy previously, which is now being competed and challenged by the relatively lesser invasive interventions. These minimal access interventions can minimize the surgical stress and hence its adverse effects on the patients’ outcomes. Comparatively lesser morbidity and mortality were observed in several case series of minimally invasive surgical (MIS) interventions for necrotizing pancreatitis, but these might be confounded by the inherent selection bias favoring the MIS approach^[20-23]. Three types of MIS interventions are used in necrotizing pancreatitis that included: (1) percutaneous image-guided catheter drainage (PCD); (2) endoscopic drainage (ED); and (3) retroperitoneal necrosectomy (RN). Percutaneous drainage (PCD) is the most frequently used first-line intervention in the management of necrotizing pancreatitis. In 55.7% of patients with necrotizing pancreatitis, PCD was the only and definitive intervention^[24]. RN has two fundamental types: (1) video-assisted retroperitoneal debridement (VARD); and (2) minimal access retroperitoneal pancreatic necrosectomy.

Treatment of necrotizing pancreatitis is evolving continuously. The open surgical approach (commonly used previously) is now being replaced by the MIS techniques, but the evidence supporting the superiority of these techniques is still insufficient and therefore further studies are needed to support the superiority claims.

Classification of acute pancreatitis

The Revised Atlanta Classification 2012 classifies acute pancreatitis in three forms as: mild acute pancreatitis characterized by no local/systemic complications (necrosis or pseudocyst) and organ failure (pulmonary/renal failure), moderate acute pancreatitis is characterized by temporary organ failure less than 24 h duration or local

complications, severe acute pancreatitis is described as the persistence of organ failure greater than 24 h^[25].

The absence of pancreatic tissue necrosis or peripancreatic necrosis on imaging study defines interstitial edematous pancreatitis. Necrotizing pancreatitis is grouped into three types as: (1) pancreatic necrosis; (2) extra-pancreatic necrosis; or (3) combination of both. All three types can be sterile or get infected.

Acute peripancreatic fluid collection: Fluid collection around the pancreatic tissue without any encapsulated wall or necrosis either parenchymal/peri-pancreatic on imaging studies within the first 4-wk of acute pancreatitis is called acute peripancreatic fluid collection.

Pancreatic pseudocyst: It is the persistence of APFC for 4-wk with the formation of a well-defined wall.

Acute necrotic collection: It is defined as the collection of fluid combined with the parenchymal or peri-pancreatic tissue necrosis within the first 4-wk of the disease.

Walled-off necrosis: It is the persistence of acute necrotic collection (ANC): over 4-wk with the development of a well-defined wall^[25]. A simplified version of the above facts is shown below:

APFC -----> 4-wk + Walled-off -----> PP
 APN -----> 4-wk + Walled-off + Necrosis -----> walled-off necrosis (WON)

Necrotizing pancreatitis complications and their treatment

Management of necrotizing pancreatitis complications depends on the severity, which is determined based on Revised Atlanta Classification, and the type of complications such as pancreatic pseudocyst (PP), infection, hemorrhage, abscess, fistulas^[25]. A multidisciplinary approach is mandatory for the treatment of complications with the implementation of either a conservative, interventional, or surgical approach.

Infection: Superimposed infection of the pancreatic necrosis is a serious complication and the major cause of increased death rates in severe acute pancreatitis. It has been found out that almost 80% of the deaths associated with acute pancreatitis are due to infected pancreatic necrosis^[26]. Infection of pancreatic necrosis heightens between 2-4 wk of the presentation; but may occur at any stage of the disease course. The commonly causative pathogens are the Gram-negative bacteria but other pathogens such as Gram-positive bacteria and multi-resistant pathogens have been found to be increasing in the incidence^[27]

Several clinical features and laboratory findings are indicative of infected pancreatic necrosis; new-onset fever, tachycardia, and elevating leukocytes. It is also associated with septicemia, systemic inflammatory response syndrome (SIRS) and organ dysfunction as disease progresses^[28,29]. Although detection of infection in the pancreatic necrotic tissue is very vital for the selection of appropriate treatment approach, it is quite hard to recognize the infection. The detection of gas due to gas-producing pathogens or a fistula to the stomach, small intestine, large bowel on the imaging studies is greatly indicative of the presence of infection but only detected in a small proportion of patients. Moreover, the existence of gas is not mandatory to label as infected necrosis^[30].

Prophylaxis: Meta-analysis by Wittau *et al*^[31] showed that prophylactic antibiotics are not effective in the prevention of pancreatic necrosis infection or decreasing the mortality, and thus, not recommended. On the other hand, mortality rate is lowered with prophylaxis, but no effect has been noticed on the incidence of pancreatic necrosis infection rates. Beta-lactam antibiotics are shown to decrease both the infection and mortality rates as compared to imidazole plus quinolone combination.

Bleeding: The enzymatic destruction of pancreatic and extra-pancreatic tissue occurs in necrotizing pancreatitis, which leads to the destruction of blood vessels and formation of pseudoaneurysms^[32]. This is responsible for the bleeding complication in NP, usually in the later stages of the disease. About 1% to 6.2% of NP patients are affected by this complication^[33,34]. Bleeding complications should be suspected when there is a sudden development of hemodynamic instability with the falling hemoglobin levels or formation of a new mass or bloody output from the pancreatic tissue drainage. Embolization of the vessels with angiography is the first-line treatment option while surgical intervention is only done in case of first-line treatment failure^[35]. Splenic vein thrombosis is also responsible for variceal hemorrhage in a minority (4%-12.6%) of patients^[35].

Acute compartment syndrome: Acute necrotizing pancreatitis (ANP) can result in extravasation and accumulation of fluid resulting in acute compartment syndrome (ACS)^[36]. The ACS affects 27% of ANP patients, with a mortality rate of 50%-75% despite the reasonable treatment and monitoring^[37]. Therefore, it is prudent and rather mandatory to keep a track of the intra-visceral pressures during the management of acute pancreatitis. An intra-vesical pressure greater than 20 cmH₂O accompanied by renal insufficiency or respiratory failure should prompt a suspicion for the ACS diagnosis^[38,39].

The ACS is a surgical emergency and urgent surgical decompression with laparotomy is required. This approach has been shown in an experimental porcine model, to improve the hemodynamics, renal and respiratory status of the patient with statistical significance^[40]. It must be performed within 6 h to achieve better outcomes^[40]. Initially, the ACS is managed medically through fluid restriction, intestinal decompression, improving abdominal compliance *via* curarization. In some cases, with high intra-vesical pressure greater than 25 mmHg associated with new-onset organ dysfunction, refractoriness to medical therapy and nasogastric and rectal decompression, in such cases the percutaneous drainage is mandatory^[41].

The minimally invasive techniques of decompression were shown to be superior to laparotomy in terms of mortality and complication rates in a retrospective study^[42]. The study found a lower rate of mortality in the ACS or early ANP-treated with minimally invasive drainage techniques vs. laparotomy (19% vs 53%, $P < 0.001$); and complication rates of 41 % vs 80% ($P < 0.001$). Anyhow these results should be interpreted carefully as the study groups were not comparable^[42].

Vacuum-assisted open abdomen has shown variable results; but bias is present due to the low ACS incidence in acute pancreatitis resulting in confusion about the various severity grades. The samples included in this meta-analysis were relatively small with inherent methodological faults, which did not allow the authors to devise any clear recommendations for the optimal timing and the appropriate invasive method to use.

The DECOMPRESS trial (ClinicalTrials.gov, NCT00793715) is going on to evaluate the laparotomy with transient abdominal closure in comparison to the minimally invasive drainages without any surgery in the ACS patients. The sample size is going to be 100 enrolling at five different hospitals.

Gastrointestinal ischemia with perforation: Nearly 10% ANP is complicated gastrointestinal necrosis. A study of autopsy findings revealed 27% ischemic colitis in 48 patients with ANP. The diagnosis is made by contrast enhanced computed tomography (CT) of the abdomen and pelvis on suspicion which shows the absence of enhancement or even perforated wall. These perforations are the result of microvascular thrombosis that occurs due to the peri-pancreatic inflammatory response involving the microvasculature accelerated further by the ACS. A re-opening at 24-48 h after the initial surgery can be justified based on the risk for ischemia and perforation^[43].

The treatment for ischemia or perforation is surgical which is not clearly codified. Stoma is highly recommended in the after surgical resection. A lateral protective ileostomy is shown to avoid the resection when intestinal viability is doubtful. Ileostomy was found to prevent ischemia and its complications in a series of 30 patients^[44].

Clinical course of acute pancreatitis

Acute pancreatitis progresses to severe acute pancreatitis in two stages. *First stage* which occurs over 1-2 wk, is characterized by an inflammatory reaction leading to a SIRS, which is mostly sterile (*i.e.*, without any sepsis or infection). The SIRS is usually without any organ failure but may cause multi-organ dysfunction (MOD), if severe. The usual timing of pancreatic necrosis in severe acute pancreatitis is within the first 4-d and progresses over the next 2-wk^[45]. Earlier in the disease course, the SIRS may not be accompanied by pancreatic necrosis; but once organ failure develops, most of the patients have pancreatic necrosis as shown by the imaging studies^[46,47].

In the second stage or late-phase, which occurs after 2-wk, an anti-inflammatory state develops which promotes the development of infection due to the increased passage of bacterial pathogens through the intestinal wall leading to infected pancreatic and extra-pancreatic tissue and fluid collections. Mortality is increased at two-stages, early rise is due to the severe SIRS causing organ failure while the second rise occurs due to infection in the pancreatic necrosis and the fluid collections^[48-51].

DIAGNOSIS

Contrast-enhanced computed tomography

Contrast-enhanced computed tomography (CECT) is principally used in the management of acute pancreatitis after 3-4 d when the necrosis starts developing and the local complications which were not present on the initial presentation may start to develop. Its main purpose is the detection of pancreatic necrosis and the degree of its extension, and detection of complications like venous thrombosis and pseudoaneurysms^[45].

The CECT is not a very good predictor of the severity of acute pancreatitis so its use at the presentation is limited to situations where another differential needs to be ruled out. Other clinical and biochemical features are more reliably predictive of the severity^[52]. The CECT is the imaging study of choice for acute pancreatitis. The Revised Atlanta Criteria is profoundly dependent on the morphological features for the description of sequelae of acute pancreatitis and hence CECT is vital for it^[53,54].

Success of treatment is assessed by CT after percutaneous, endoscopic, or operative interventions. Side effects of the CECT are contrast induced kidney injury, radiation exposure and low sensitivity in the detection of necrosis in the setting of acute necrotic collection or WON^[52].

Magnetic resonance imaging

Magnetic resonance imaging (MRI) is a good substitution for the CECT for detection of pancreatic necrosis^[52,55,56]. The MRI is used in cases where the CECT is not capable of detecting the gall stones in the common bile duct and to detect any solid necrotic debris in the fluid collections^[57]. Non-liquified components of the collections appear as homogeneous or heterogeneous on the CECT. MRI was the imaging study used in patients with a contraindication to the CECT, *e.g.*, allergic to intravenous (IV) contrast or pregnant patients^[58].

Non-contrast MRI is shown to be superior to non-contrast CT for the detection of pancreatic necrosis in patients with severe renal disease having glomerular filtration rate < 35 mL/min. The MRI is more sensitive and specific in detecting pancreatic necrosis as shown by Arvanitakis *et al*^[59]. The CECT is the imaging study of choice in majority of the institutions, but there are some institutions which opt for the MRI^[60]. The MRI has some other benefits such as non-ionizing radiations which are useful in the patients who are pregnant or need long-term surveillance^[56].

MANAGEMENT

Medical management

The medical management of pancreatic necrosis is primarily employed in the acute and sub-acute phases of the condition^[61]. The aggressiveness of the interventions depends upon the severity of the pancreatitis. Different scoring systems have been used to assess the severity of pancreatitis. These include, but are not limited to, Ranson's Criteria, SIRS response, and bedside index for the severity of pancreatitis score^[62,63]. Patients most at risk of developing necrosis are the ones who have a higher score on these indices. Based on the SIRS criteria, a patient presenting with SIRS response with concomitant renal dysfunction would need aggressive fluid replacement. The patient's overall clinical status should also be kept in view besides the clinical criteria.

Fluid replacement: In the acute phase of pancreatitis, body fluids should be replenished aggressively. Some evidence supports the use of ringer lactate as compared to normal saline in the early phase^[64]. Another review states that crystalloids and colloids have the same effect^[65]. Therefore, care should be taken during the replacement because the patient can have effusions on the imaging. The severity of the pancreatitis can be assessed by the amount of fluid required. Adequate fluid replenishment is associated with an improvement in the SIRS response in these patients^[66]. Measures of improvement can be assessed from the improvement of the vitals and urine output.

Alimentation: There is increased rate of catabolism in severe form of pancreatitis. Early nourishment is necessary to tackle malnutrition. The route of nutritional support in pancreatitis has been an area of interest for long-time. Studies have been conducted comparing alimentation through the parenteral, enteral and oral routes^[67]. There are concerns that oral intake leads to increased exocrine secretion of the pancreas. Generally, oral nutrition can be given in the absence of nausea, vomiting, and progressively rising pain in the abdomen. Diet low in fat should be used^[68]. Studies have shown that enteral nourishment by means of nasojejunal tubes do not lead to stimulation of exocrine secretions in the pancreas^[69]. Furthermore, enteral

nutrition helps maintain the gut barrier^[70]. There can also be benefit to the use of probiotic supplements^[71].

Supportive management: Patients with severe acute pancreatitis may have to be put on a ventilator. Pain should be managed with narcotics through the IV route. Mobilization, physical therapy, and changing positions are the valuable components of the supportive care.

Invasive treatment approaches for infected necrosis

Settings in which intervention is indicated: Timing of intervention is crucial to the effective and safe treatment of infected pancreatic necrosis. Pseudocyst must be differentiated from the walled-off pancreatic necrosis since their management and prognosis widely differs. Necrotic debris are better detected by the MRI and endoscopic ultrasound (EUS) as compared to the CT scan^[45]. Pseudocysts are fluid filled cysts outside the pancreas while the pancreatic necrosis contains cyst within the pancreatic parenchyma which contains solid debris.

Acute fluid collections do not require any intervention in most cases of the early stages while in the later stages, it may require intervention if symptomatic (*i.e.*, causing pain or intestinal obstruction). Infected necrotic collections need to be preferably drained radiologically or endoscopically in order to avoid or delay surgical intervention^[45].

WON needs no intervention if asymptomatic with any size and progression. They are likely to resolve without any intervention. In case of symptoms due to infection, pain or visceral/bile duct obstruction, intervention is needed.

Infected pancreatic necrosis: Intervention either endoscopic or surgical is only indicated in the first couple of weeks of acute pancreatitis onset, if infected pancreatic necrosis is detected in association with the worsening clinical condition and septicemia. However, no intervention is indicated in case of aseptic necrosis with the worsening clinical condition even with maximum medical treatment, unless infection is detected. The outcomes in these patients are rather poor with or without surgical intervention^[72,73]. Therefore, the recommendations are to delay the intervention up to 3-wk. Earlier debridement before 3-wk is associated with adverse outcomes. Several reasons are described for this approach. Firstly, the risk of bleeding is increased. Secondly, the necrosis becomes more prominent at the delayed stage, which helps in identifying the necrotic tissues during debridement, and thus minimize damage to the normal pancreatic parenchyma. This is responsible for long-term improved outcomes with respect to the endocrine and exocrine pancreatic functions as well as lesser post-operative complications^[71,74,75]. The most important thing to take care of at this stage is the detection of pancreatic necrosis, which in turn, will guide the further treatment line.

CT with contrast is now becoming the recommendation for the diagnosis of pancreatic necrosis and its timing is important. As compared to earlier CT imaging previously, the new recommendations are that CT with IV contrast should be delayed^[76]. There are a couple of reasons behind this approach. Firstly, this delayed CT is not only cost effective, but avoids radiation side effects. Secondly, CT with contrast accurately identifies patients who are likely candidates for the intervention. CT shows the extent of necrosis, which in turn, predicts the probability of getting infected, and thus, helps in stratifying patients for the intervention. Likelihood of infection decreases with 30% or less area of necrosis while the probability is higher for 50% or greater area of necrosis involved^[77].

Numerous studies have confirmed the benefits of delayed surgical intervention in the management of pancreatic necrosis^[78,79]. The International Association of Pancreatology Guidelines recommend delaying of the surgical treatment for 3-4 wk. A lower rate of mortality and morbidity has resulted from this approach as compared to the earlier intervention^[78]. A randomized controlled trial by Mier *et al*^[75] demonstrated higher mortality and morbidity incidence with early necrotic tissue resection within 3-4 d as compared to delaying to 12 d after the acute pancreatitis onset. Early surgical intervention is a non-partisan indicator of adverse sequel^[79].

Clinically stable patients with infected necrosis can be managed with non-invasive medical treatment (*i.e.*, antibiotics alone). This has been well demonstrated in a series of studies by different investigators^[80-84].

Different approaches for the invasive interventions

Two main approaches for the intervention are: Open surgical and minimally access techniques. The open surgical includes laparotomic trans-peritoneal or retro-peritoneal approach while the minimally invasive approach comprise of percutaneous, laparoscopic, retro-peritoneal, endoscopic transmural, or combined.

Delay before performing surgery

It is best to wait for a period of 4-wk before performing the surgery so that the infection and collection walls-off to an extent. Failure to do so, may lead to peritonitis, thus potentially affecting the morbidity and mortality^[75]. One study included 167 patients, who underwent necrosectomy^[15]. The mortality rate for the patients who underwent surgery more than 28-days after the onset of symptoms was compared with the patients who had the operation in the first 4-wk. The mortality rate was 5% for the former group *vs* 20% for the latter^[15]. It is therefore recommended to wait for 4-wk in the current guidelines^[24,79].

Open necrosectomy

Historical perspective: Historically, the surgical treatment of pancreatic necrosis was proposed in 1886 by Senn suggesting that beneficial outcomes for the patients undergoing removal of pancreatic and peri-pancreatic necrotic tissue^[85]. Since then, surgical treatment of pancreatic necrosis remained the standard, and the surgical techniques kept evolving during this time-period until 1990s when Bradley and Allen^[13] proposed that recovery is seen in several patients with aseptic necrotic pancreatic tissue treated with non-surgical treatment only. This led to the adoption of medical treatment as a general approach with surgical intervention reserved only for the individuals with infected necrosis^[13]. Debridement and drainage are most beneficial in cases of pancreatic necrosis, which have been secondarily infected and have been confirmed by performing bacterial cultures or suspected strongly^[12].

Approaches for necrosectomy: Necrotic tissue debridement *via* open surgical approach has long been the standard of care for infected pancreatic necrosis. This approach permits the scrutiny of the abdominal cavity to identify the necrotic lesions and clean them up as much as possible at the expense of considerable morbidity and mortality of 34%-95% and 11%-39%, respectively^[86]. Either a midline or bilateral subcostal approach is used while a transmesocolic approach can be used as a substitute in case of trouble. These approaches allow revelation of the lesser sac and pancreas. Care must be taken during the debris clean-up to avoid any compromise of the nearby structures^[87]. Several samples for bacterial cultures are vital to take. A suggestion by several authors is that in order to avoid abdominal compartment syndrome and to make the repeated debridement easier after the surgical intervention, leaving the abdomen opened might help. In case of abdominal closure, two approaches are proposed: (1) "Close Packing technique" in which the abdomen is packed closed with a drain placed that permits the repeated reopening for debridement; and (2) "Extended Irrigation technique" which is achieved by abdominal closure with the placement of draining catheters for continuous irrigation in the lesser sac, retroperitoneal location, and posterior to the colon^[45].

Which technique is better? Several studies have shown the superiority of the closed packing technique, which was introduced by the Fernandez del Castillo *et al*^[88] in 1998. They showed that post-operative closure with packing and irrigation technique is associated with lower mortality and morbidity rates and the need for repeated reopening. A series proved these findings in 2008^[15,88]. The Werner *et al*^[89] review explained the lower incidence of morbidity and the need for re-visiting the operating room for re-laparotomies. A retrospective study ($n = 244$) showed superiority of the drainage/lavage in terms of decreased mortality^[90]. In spite of these studies, the superiority of these techniques over the repeated laparotomies approach is based on the limited evidence^[45].

Disadvantages of open necrosectomy: Open necrosectomy is associated with high morbidity and mortality^[86]. Complications that could occur in the early post-operative period are perforation of viscus, organ dysfunction, bleeding, and wound infection. The late post-operative complications include: fistulas (pancreaticocutaneous and enterocutaneous), pancreatic insufficiency and hernias of the abdominal wall. Repeated laparotomies intensify the local and systemic injuries and has unfavorable impact on the hemodynamic status and the systemic inflammatory response. Abstaining from the surgical re-interventions lowers the morbidity but has no effect on the mortality rate^[75].

Advantages of open necrosectomy: Open necrosectomy has several advantages. Firstly, it facilitates the access to all the regions of the abdominal cavity with the necrotic tissues. Secondly, it permits the simultaneous cholecystectomy and choledocholithiasis management. Lastly, feeding jejunostomy could also be performed.

Necrosectomy via retroperitoneal approach

Although due to the difficult surgical pathway, retroperitoneal open necrosectomy is infrequently performed. It is the preferred technique for the patients requiring repeated operations and is associated with lower mortality rates in comparison with the anterior approach. Its main limitation is inability to give access to most of the peritoneal cavity^[91].

A 10-15 cm long incision along the length of the 12th rib in the left lateral sub-costal region is given with the patient in the right lateral decubitus position. In order to reach the pancreatic bed, dissection is performed posteriorly to the colon and mesocolon and anteriorly to the kidney to reach the Toldt fascia. The different pancreatic and peri-pancreatic regions are then cleaned-up blindly of the necrotic debris. Drain is placed to perform the repeated lavages^[92].

Trans-peritoneal laparoscopic necrosectomy

This approach was suggested by Parekh^[93] in 2006. Four of the 18 patients who underwent laparoscopic necrosectomy subsequently needed open surgical intervention. In this study, 11% mortality and 58% morbidity rates were observed^[93].

Due to the infrequent application of this approach, its comparison with other approaches is rather difficult. Lower complication rates were observed in a retrospective study evaluating the laparoscopic approach with open surgical approach favoring laparoscopic approach in terms of the occurrence of post-operative pancreatic fistula, blood loss, and average hospital length-of-stay (LOS) post-operatively^[94]. Recently, a series by Mathew *et al*^[95] showed that laparoscopic necrosectomy is a potentially safe and promising intervention having all the advantages of the minimally access approaches with a lower incidence of morbidity and mortality in contrast to the open surgical approaches.

Trans-peritoneal laparoscopic enteric drainage is performed by developing an anastomotic connection between the WON and the stomach or small intestine. This intervention is a single operation mostly; but recommended to be performed by the expert minimally invasive surgeons and a distinct WON near the stomach or the small bowel must be present^[96].

Minimally invasive interventions

Necrotizing pancreatitis is now approached with a changing treatment strategy favoring delayed surgical intervention whenever possible^[72]. Development of MIS approaches such as percutaneous, endoscopic techniques and other MIS interventions are providing substitutes for the morbid approaches like open surgery for necrotizing pancreatitis and walled-off pancreatic necrosis^[97-103].

Minimally invasive retroperitoneal approach

An endoscope or a laparoscope is passed into the retroperitoneal space through a radiologically-guided percutaneous tract into the necrotic tissue collection. This is followed by the necrotic debridement and lavage. A series by van Santvoort *et al*^[98] showed that no more than three interventions were required, peri-procedural complications lower than 5%, with the morbidity and mortality rates of 10%-20% and 0-20%, respectively. Another series involving 400 patients noted a reduction in the rates of organ dysfunction and intensive care requirement after this procedure.

Radiologic percutaneous drainage

Radiologic percutaneous catheter drainage (PCD) was introduced in 1998 with the aim of obtaining fluid and tissue samples for bacteriologic culture and to drain the fluid collection in the necrotic area^[97]. The CT scan can determine the extent of area involved by the necrosis and can give precise details about the exact site, amount, possible communication and structures in the proximity. High resolution contrast enhancement MRI through its ability to define the composition of the necrotic collection (liquid content, necrotic sediment, clotted blood, big size debris) is useful to select the best technique for the drainage, and hence, increases the chances of effective drainage^[104]. The MRI is 67% sensitive and 97% specific in detecting the presence of a superimposed infection in the pancreatic fluid collections, which gives a weaker diffusion coefficient ($P = 0.031$).

It is performed in two ways: trans-peritoneal or retro-peritoneal. The retroperitoneal has the advantage of preventing peritoneal infection *via* contamination and enteric seepage^[97,98]. This technique is used either as a primary intervention or as an adjuvant technique with other modalities^[45]. Percutaneous technique is highly advantageous for the unresolved collections, sepsis control, initial intervention prior to the endoscopic or surgical interventions and post-invasive treatments to drain the left-over fluid collections^[45]. The drainage should be enhanced in case of no resolution after 72 h. Optimization of drainage is done by increasing the drains caliber to 30F, using additional drains or using continuous drainage^[105,106].

Radiologic percutaneous technique has been shown to be effective primary intervention by a systematic review conducted by van Baal *et al.*^[24]. It was found to be effective in 55.7% of the patients with 15.4% mortality rate. No surgical intervention was needed in the successfully drained patients^[24]. The Dutch Pancreatitis Study Group evaluated percutaneous drainage in a randomized control trial (RCT), which showed 35% success rate^[107]. External fistulae developed in 27% of cases^[21,107]. **Table 1** includes literature report on PCD demonstrating complications and mortality in different studies.

VARD

The VARD usually follows percutaneous radiological drainage, performed through the same tract^[108]. A 5 cm incision is given in the 12th or 11th intercostal space after placing the patient in supine position. The location of incision is the same as that of the percutaneous radiological drainage. A lung grasper and a suction device are utilized for the necrotic debridement. Laparoscope is introduced retroperitoneally *via* the incision, which is followed by the insertion of two drains (large bore) *via* the incision with skin closure in between the drains.

Gastrointestinal fistulas, and peritoneal infection due to seeding during the dissection and bleeding complications are possible in these patients. A cohort of 639 patients with ANP were evaluated prospectively, which demonstrated a lower incidence of mortality and complications rate in the minimally access RN group as compared to the open necrosectomy wing (19% *vs* 38%, and 55% *vs* 81%, respectively)^[79]. Nearly 20% risk of the long-term pancreaticocutaneous fistula was found with the risk of progression to chronic fistula^[109].

Endoscopic necrotic debridement

In 1985, Ghebarth^[110] described per-oral trans-gastric endoscopic approach to PP drainage in. Subsequently, in 1996, Baron *et al.*^[111] explained the walled-off pancreatic necrosis irrigation *via* a nasocystic catheter introduced through the wall. In 2000, Seifert *et al.*^[112] performed the first endoscopic necrotic debridement of WON^[113].

Complications of retro-peritoneal approach, especially the pancreaticocutaneous fistula and the advancements in the endoscopic techniques are the reasons behind the increased attention towards the endoscopic approach. Endoscopic approach is preceded by a trans-gastric approach like the radiologic drainage before the retroperitoneal approach. In case of inefficiency of the endoscopic technique, surgery should be performed^[114].

Technique: The necrotic cavity is accessed *via* the insertion of endoscope through the mouth and then *via* the stomach wall to perform necrosectomy. The point of entrance through the gastric wall is identified from the bump produced by the necrotic collection from the outside in 50%-60% of the patients^[45]. In some cases, the bump is not visible due to different reasons such as the small sized collections, low serum levels of albumin, and collections in proximity to pancreatic tail. In such cases, in order to avoid damage to the structures in the proximity, EUS is used to identify the collection, determine its nature and guide the access. The benefits of EUS-guided endoscopic technique were evaluated in the RCTs by Varadarajulu *et al.*^[115] and Park *et al.*^[116], which showed higher success rate in the EUS-guided technique (> 95% *vs* 33%-66%) and low adverse events incidence (0%-4% *vs* 13%-15%)^[11,115].

The trans-gastric opening formed is dilated *via* a balloon followed by the insertion of two large bore double pigtail catheters. Necrosectomy and lavage is performed *via* a few instruments such as the basket dormia, forceps, and balloons, *etc.*, requiring 3-6 sessions to achieve a complete removal of debris.

Evidence supporting endoscopic necrotic debridement: Endoscopic necrotic debridement has shown promising outcomes. A systematic review by Haghshenasskashani *et al.*^[117] found that fully resolved collections resulted in 76% of patients with 27% morbidity and 5% mortality rates. In this systematic analysis study, characteristics of the patients were different in the series evaluated^[117]. The PENGUIN trial conducted by the Dutch Pancreatitis Study Group evaluated endoscopic trans-gastric debridement in comparison to the video-assisted RN in patients with infected necrosis. Lower rates of MOD (0% *vs* 50%, $P = 0.03$) and pancreatic fistula (10% *vs* 70%) with no change in mortality rate were observed. The number of interventions needed were greater in the endoscopic group (3 *vs* 1, $P = 0.007$). These results should be considered with caution as the sample size was small ($n = 20$), different C-reactive protein (CRP) levels between the groups and an unusually greater mortality rate of 40%.

A systematic review by Mowery *et al.*^[118] recommended endoscopic or radiologic drainage as initial intervention before proceeding to surgery in patients with infected

Table 1 Peer-reviewed literature reports on the clinical outcomes of patients undergoing percutaneous catheter drainage

Author/year/country	Ref.	No. of patients	Mortality	Complications	Mortality
Jones/2016/ United States	[123]	69	PCD	N/A	6.5%
Navarrete/2016/Chile	[124]	17	PCD	1 = stent fracture, 1 = leak, 4, 2 = bleeding, 1 = pseudoaneurysm, 1 = venous oozing	0%
Sugimoto/2016/United States	[125]	39	PCD	New onset organ failure 0 ¹ , 5 ² , enterocutaneous fistula 4 ¹ , 6 ²	16%
Russell/2017/New Zealand	[126]	85	PCD	N/A	12%
Sleeman/2011/United States	[99]	63	PCD	Internal fistula <i>n</i> = 14 (23%), bleeding <i>n</i> = 2	8%
Ross/2010/United States	[127]	15	PCD	Immediate post-procedure complications; tachycardia and hypotension (<i>n</i> = 2), late complication, parenchymal infection (<i>n</i> = 1)	0%
Van Santvoort/2010/The Netherlands	[98]	88	PCD	Organ failure <i>n</i> = 5 (12%) ¹ , <i>n</i> = 18 (40%) ² , systemic complication <i>n</i> = 0 ¹ , <i>n</i> = 1 (2%) ² , nterocutaneous fistula/perforation <i>n</i> = 6 (14%) ¹ , <i>n</i> = 10 (22%) ² , pancreatic fistula <i>n</i> = 12 (28%) ¹ , <i>n</i> = 17(38%) ² , incisional hernia <i>n</i> = 3 (7%) ¹ , <i>n</i> = 11 (24%) ² , new onset diabetes <i>n</i> = 7 (16%) ¹ , <i>n</i> = 17 (38%) ² , pancreatic enzyme needed <i>n</i> = 3 (7%) ¹ , <i>n</i> = 15 (33%) ² , intraabdominal bleed <i>n</i> = 7 (16%) ¹	19%
Rocha/2009/United States	[128]	64	PCD	Infection 27% ¹ , 35% ² , 71% ³ , single organ failure 36% ¹ , 12% ² , 14% ³ . MOSF 64% ¹	12%
Becker/2009/Germany	[129]	7	PCD	Spontaneous duodenal perforation (1/7), pancreatico-colonic fistula (1/7), fistula to the retroperitoneal space (1/7), spontaneous gastric bleeding (1/7), exocrine insufficiency (2/7)	0
Bruennler/2008/United Kingdom	[130]	18	PCD	N/A	22%
Cheung/2005/Hong Kong	[131]	8	PCD	Intestinal fistula to abscess cavity (4/8), left subphrenic fluid collection (1/8)	12.5%
Risse/2004/France	[132]	6	PCD	1/6 ¹ Post-operative peritonitis, 1/6 ¹ 40 °C fever 24 h, 1/6 ¹ insulin dependent DM, 1/6 ¹ Psuedocyst	0
Carter/2000/Scotland	[23]	10	PCD	N/A	20%
Freeny/1998/United States	[97]	34	PCD	N/A	N/A
Echenique/1988/United States	[133]	20	PCD	12/20 (renal failure × 2, bowel fistula × 10)	0

¹Indicates PCD associated variables.²Indicates surgical procedure associated variables.³Indicates endovascular approach associated variables. PCD: Percutaneous drainage; N/A: Not available; MOSF: Multiple organ system failure; DM: Diabetes mellitus.

collections (level III evidence). Another systematic review by Luigiano *et al*^[119] concluded that higher success rates with lower morbidity and mortality rates were found for the endoscopic techniques in comparison to the percutaneous and surgical approaches. A meta-analysis by Gurusamy *et al*^[120] concluded that very-low quality evidence exists in support of the endoscopic minimally access techniques over the video-assisted retroperitoneal approaches in terms of the lower adverse events in the former group; but the mortality rate remained unchanged. Another meta-analysis by Puli *et al*^[121] showed that endoscopic trans-mural necrosectomy is safe and effective in the drainage of WON but decision should be made by the advanced/expert endoscopist.

Currently, the TENSION trial is in progress, which is evaluating the “all endoscopic approach”, *i.e.*, endoscopic trans-gastric drainage followed by the endoscopic necrotic debridement (if necessary) in comparison to the “step-up approach” which consists of the percutaneous drainage followed by the VARD^[122].

Disadvantages: There are several limitations to this approach because more than one procedure is required, which are performed under sedation or general anesthesia, failure to quantify and manage greater quantity of necrotic tissue and the limited ability to debride deep retroperitoneal extension and the left-sided distal necrotic collections^[98]. Other technical limitations are the non-availability of the dedicated instruments, difficulty in suturing or stapling the bowel lumen with cavity, risk of damaging nearby vascular structures^[98]. The endoscopic necrosectomy is a risk-free and effective technique only in the setting of experienced endoscopists in the specialized centers.

Therefore, the conclusions of the above noted studies in favor of endoscopic necrosectomy are promising, and although no clear consensus exists, it should be the intervention of choice in setting of favorable anatomy, skilled and highly experienced endoscopists since it has lower morbidity rate and risk of chronic pancreaticocutaneous fistula. **Table 2** includes various studies on endoscopic transluminal necrosectomy and mentions clinical outcomes, complications and mortality.

Step-up approach

The latest approach that is under evaluation for the treatment of necrotizing pancreatitis is the “step-up approach”. This approach came into practice because surgical intervention was associated with high morbidity and mortality rates, and various newer approaches such as the radiologic and endoscopic techniques became the components of this approach. Step-up approach is the step-wise introduction of different techniques when one technique fails to be effective for at-least 72 h. Indicators of positive response are the normalization of the organ dysfunction or betterment of at-least 10% in any of the two parameters such as: white cell count, body temperature, and CRP levels. Each step is managed by multidisciplinary coordination between the endoscopists, radiologists, surgeons, and intensive care specialists who put their efforts to delay the proceeding to the next step and lower the mortality at each step.

Evidence supporting the “step-up approach”: In 2010, a sample of 88 patients was evaluated in a multicenter randomized controlled trial named the PANTER trial^[98]. In these patients, retroperitoneal drainage preferably percutaneous radiologic drainage or second-line endoscopic technique was performed as the first-step. This was followed by the video-assisted RN in the setting of failure. Open surgery with continuous post-operative lavage was performed as the third-step in case of failure. The “Step-up group” was significantly better in the outcomes in terms of morbidity (40% *vs* 69%), new onset organ dysfunction (12% *vs* 42%), incisional hernias (7% *vs* 24%), and diabetes mellitus new-onset (16% *vs* 38%), respectively. Further, 35% participants in the “Step-up group” did not need necrosectomy. However, no difference in the mortality was found between the two groups^[98]. The authors concluded that the “step-up approach” reduced complications by lowering down the surgical insult in the weaker and debilitated patients. Removal of infected fluid was enough with no need for necrosectomy if the condition of the patient was improving, in fact 35% of patients needed percutaneous drainage alone^[98].

The “step-up approach” is summed up as the “3D’s approach” (*i.e.*, Delay, Drain,

Table 2 Peer-reviewed literature reports on the clinical outcomes of patients undergoing endoscopic transluminal necrosectomy

Author/year/country	Ref.	No. of patients	Modality	Complications	Overall successrate (%)	Mortality
Jones/2016/United States	[123]	69	ETN	N/A	N/A	6.5%
Oh/2016/Japan	[134]	25	ETN	20% (5/24), 4 self-limited abdominal pain, 1 minor bleeding	100% pain score improvement, $p = 0.001$	N/A
Sharaiha/2016/United States	[135]	124	ETN	Suprainfection $n = 3$, stent occlusion $n = 2$, stent migration $n = 4$, hemorrhage $n = 1$	N/A	0%
Huggett/2015/United Kingdom	[136]	19	ETN	Stent migration after necrosectomy 2/19, abdominal pain 1/19	N/A	26%
Schmidt/2015/Denmark	[137]	81	ETN	Death 1 (1%), bleeding from necrosis cavity 4 (5%), bleeding from transmural tract 4 (5%), pneumoperitoneum 4 (5%)	N/A	11%
Smoczynsk/2016/Poland	[138]	56	ETN	Transmural stent displacement $n = 1$ ¹ , GI perforation $n = 1$ ¹	N/A	0%
Siddiqui/2015/United States	[139]	68	ETN	Infection $n = 4$, bleeding $n = 5$	N/A	0%
Kumar/2014/United States	[103]	24	ETN	0/12 vs 8/12 (bleeding, enterocutaneous fistula and infection)	N/A	0
Smith/2014/United States	[140]	17	ETN	Bleeding $n = 1$, sepsis $n = 1$	N/A	5.8%
Saxena/2014/United States	[141]	5	ETN	Pseudocyst $n = 1$, stent displacement $n = 1$	N/A	0%
Rische/2013/Germany	[142]	31	ETN	Perforation of colon ($n = 2$); stent dislocation to jejunum ($n = a$), bleeding ($n = 1$)	83%	9.6%
Siddiqui/2013/United States	[143]	14	ETN	3/14 (perforation, pneumoperitoneum, bacteremia)	N/A	7.1%
Ardengh/2013/Brazil	[144]	15	ETN	4 patients experienced bleeding (entry side ($n = 3$), inside cavity ($n = 1$), and worsening of infection (33.3%))	N/A	13.3%
Yasuda/2013/Japan	[145]	57	ETN	Bleeding ($n = 5$), perforation ($n = 3$), air embolism ($n = 1$)	75%	11%

Gardner/2011/United States	[116]	104	ETN	14/104 (Bacteremia, infected collection, moderate bleeding at puncture site, <i>C. diff colitis</i> , retrogastric perforation × 2, pneumoperitoneum × 3, balloon dilatation in retroperitoneum, massive bleeding during dilatation, periprocedural hypotension and cardiac arrest, anoxic brain injury, PEG site infection. bleeding (19/104)	N/A	5.7%
Varadarajulu/2011/United States	[146]	60	ETN	5/60	N/A	5%
Becker/2009/Germany	[129]	7	ETN	Spontaneous duodenal perforation (1/7), pancreatico-colonic fistula (1/7), fistula to the retroperitoneal space (1/7), spontaneous gastric bleeding (1/7), exocrine insufficiency (2/7)	N/A	0
Seifert/2009/Germany	[22]	93	ETN	Pseudocyst <i>n</i> = 11, bleeding <i>n</i> = 13, perforation <i>n</i> = 5, fistula <i>n</i> = 2, air embolism <i>n</i> = 2, multiorgan failure <i>n</i> = 2	80% Fairly satisfied	15.5%
Mathew/2008/United States	[95]	6	ETN	N/A	100%	N/A
Voermans/2007/The Netherlands	[147]	25	ETN	7/25 (bleeding). 1/25 (perforation of wall)	N/A	0
Schrover/2007/The Netherlands	[148]	8	ETN	Bleeding <i>n</i> = 1	N/A	12.5%
Charnley/2006/United Kingdom	[149]	13	ETN	N/A	N/A	15.3%
Bakker/2005/The Netherlands	[100]	20	ETN	New-onset diabetes 2 (22%) ¹ 3 (50%) ² , use of pancreatic enzymes 0 (0%) ¹ , 3 (50%) ² persisting fluid collections 2 (22%) ¹ 3 (50%) ² , pancreatic fistula 1 (10%) ¹ 7 (70%) ² , enterocutaneous fistula 0 (0%) ¹ 2 (20%) ¹ , new-onset multiple organ failure 5 (50%) ¹ 0 (0%) ²	N/A	10%

¹Indicates ETN associated variables.²Indicates surgical procedure associated variables. ETN: Endoscopic transluminal necrosectomy; N/A: Not available; PEG: Percutaneous endoscopic gastrostomy.

and Debride). The primary goal of the step-up approach is infection control either with or without the removal of the necrotic parenchyma. Patients presenting with severe ANP are diagnosed and treated with endoscopic or radiologic drainage of the infected necrosis. The intervention is selected based on the extent of collection and the expertise of the center. Necrosectomy is done in case of failure. The difference in the

operators and instruments at different centers has led to the recommendation that the technique with which the team feels most comfortable should be adopted.

CONCLUSION

The management of ANP is continuously evolving from the early open surgical intervention to the delayed surgical intervention, and now to minimally invasive techniques becoming the first-line interventions. However, no single modality is optimal for the treatment, and a multi-modal approach involving interventional radiology, interventional endoscopy, surgery, and nutrition is the mainstay currently. The mainstay of the management is now shifting to a “step-up approach” from the most non-invasive towards the most invasive techniques in a step-up manner as the indications arise. Therefore, the first-line intervention should be either radiologic or trans-gastric endoscopic approach while early surgery is avoided to prevent the adverse functional consequences. At the same time, an indication for emergency surgery should not be missed as this may potentially lead to increased mortality and morbidity.

REFERENCES

- 1 **Shaddique S**, Cahill RA, Watson RG, O'Connor J. Trends in the incidence and significance of presentations to the emergency department due to acute pancreatitis. *Eur J Emerg Med* 2006; **13**: 209-213 [PMID: 16816584 DOI: 10.1097/01.mej.0000209062.90826.e7]
- 2 **Yadav D**, Lowenfels AB. Trends in the epidemiology of the first attack of acute pancreatitis: a systematic review. *Pancreas* 2006; **33**: 323-330 [PMID: 17079934 DOI: 10.1097/01.mpa.0000236733.31617.52]
- 3 **Sandzén B**, Rosenmüller M, Haapamäki MM, Nilsson E, Stenlund HC, Oman M. First attack of acute pancreatitis in Sweden 1988 - 2003: incidence, aetiological classification, procedures and mortality - a register study. *BMC Gastroenterol* 2009; **9**: 18 [PMID: 19265519 DOI: 10.1186/1471-230X-9-18]
- 4 **Fagenholz PJ**, Fernández-del Castillo C, Harris NS, Pelletier AJ, Camargo CA. National study of United States emergency department visits for acute pancreatitis, 1993-2003. *BMC Emerg Med* 2007; **7**: 1 [PMID: 17241461 DOI: 10.1186/1471-227X-7-1]
- 5 **Spanier BW**, Dijkgraaf MG, Bruno MJ. Epidemiology, aetiology and outcome of acute and chronic pancreatitis: An update. *Best Pract Res Clin Gastroenterol* 2008; **22**: 45-63 [PMID: 18206812 DOI: 10.1016/j.bpg.2007.10.007]
- 6 **Lindkvist B**, Appelros S, Manjer J, Borgström A. Trends in incidence of acute pancreatitis in a Swedish population: is there really an increase? *Clin Gastroenterol Hepatol* 2004; **2**: 831-837 [PMID: 15354285 DOI: 10.1016/S1542-3565(04)00355-6]
- 7 **Andersson R**, Andersson B, Haraldsen P, Drewsen G, Eckerwall G. Incidence, management and recurrence rate of acute pancreatitis. *Scand J Gastroenterol* 2004; **39**: 891-894 [PMID: 15513389 DOI: 10.1080/00365520410007061]
- 8 **Lankisch PG**, Breuer N, Bruns A, Weber-Dany B, Lowenfels AB, Maisonneuve P. Natural history of acute pancreatitis: a long-term population-based study. *Am J Gastroenterol* 2009; **104**: 2797-2805; quiz 2806 [PMID: 19603011 DOI: 10.1038/ajg.2009.405]
- 9 **de Beaux AC**, Palmer KR, Carter DC. Factors influencing morbidity and mortality in acute pancreatitis; an analysis of 279 cases. *Gut* 1995; **37**: 121-126 [PMID: 7672660 DOI: 10.1136/gut.37.1.121]
- 10 **Banks PA**, Freeman ML; Practice Parameters Committee of the American College of Gastroenterology. Practice guidelines in acute pancreatitis. *Am J Gastroenterol* 2006; **101**: 2379-2400 [PMID: 17032204 DOI: 10.1111/j.1572-0241.2006.00856.x]
- 11 **Frossard JL**, Steer ML, Pastor CM. Acute pancreatitis. *Lancet* 2008; **371**: 143-152 [PMID: 18191686 DOI: 10.1016/S0140-6736(08)60107-5]
- 12 **Petrov MS**, Shanbhag S, Chakraborty M, Phillips AR, Windsor JA. Organ failure and infection of pancreatic necrosis as determinants of mortality in patients with acute pancreatitis. *Gastroenterology* 2010; **139**: 813-820 [PMID: 20540942 DOI: 10.1053/j.gastro.2010.06.010]
- 13 **Bradley EL**, Allen K. A prospective longitudinal study of observation versus surgical intervention in the management of necrotizing pancreatitis. *Am J Surg* 1991; **161**: 19-24; discussion 24-25 [PMID: 1987854 DOI: 10.1016/0002-9610(91)90355-H]
- 14 **Reddy M**, Jindal R, Gupta R, Yadav TD, Wig JD. Outcome after pancreatic necrosectomy: trends over 12 years at an Indian centre. *ANZ J Surg* 2006; **76**: 704-709 [PMID: 16916387 DOI: 10.1111/j.1445-2197.2006.03835.x]
- 15 **Rodriguez JR**, Razo AO, Targarona J, Thayer SP, Rattner DW, Warshaw AL, Fernández-del Castillo C. Debridement and closed packing for sterile or infected necrotizing pancreatitis: insights into indications and outcomes in 167 patients. *Ann Surg* 2008; **247**: 294-299 [PMID: 18216536 DOI: 10.1097/SLA.0b013e31815b6976]
- 16 **Göttinger P**, Sautner T, Kriwanek S, Beckerhinn P, Barlan M, Armbruster C, Wamser P, Függer R. Surgical treatment for severe acute pancreatitis: extent and surgical control of necrosis determine outcome. *World J Surg* 2002; **26**: 474-478 [PMID: 11910483 DOI: 10.1007/s00268-001-0252-8]
- 17 **Olakowski M**, Dranka-Bojarowska D, Szlachta-Swiatkowska E, Lekstan A, Lampe P. Management of necrotizing pancreatitis: flexible approach depending on intra-operative assessment of necrosis. *Acta Chir Belg* 2006; **106**: 172-176 [PMID: 16761472 DOI: 10.1080/00015458.2006.11679865]
- 18 **Howard TJ**, Patel JB, Zyromski N, Sandrasegaran K, Yu J, Nakeeb A, Pitt HA, Lillemoe KD. Declining morbidity and mortality rates in the surgical management of pancreatic necrosis. *J Gastrointest Surg* 2007; **11**: 43-49 [PMID: 17390185 DOI: 10.1007/s11605-007-0112-4]
- 19 **Madenci AL**, Michailidou M, Chiou G, Thabet A, Fernández-del Castillo C, Fagenholz PJ. A contemporary series of patients undergoing open debridement for necrotizing pancreatitis. *Am J Surg*

- 2014; **208**: 324-331 [PMID: 24767969 DOI: 10.1016/j.amjsurg.2013.11.004]
- 20 **Mortelé KJ**, Girshman J, Szejnfeld D, Ashley SW, Erturk SM, Banks PA, Silverman SG. CT-guided percutaneous catheter drainage of acute necrotizing pancreatitis: clinical experience and observations in patients with sterile and infected necrosis. *AJR Am J Roentgenol* 2009; **192**: 110-116 [PMID: 19098188 DOI: 10.2214/AJR.08.1116]
- 21 **Horvath K**, Freeny P, Escallon J, Heagerty P, Comstock B, Glickerman DJ, Bulger E, Sinanan M, Langdale L, Kolokythas O, Andrews RT. Safety and efficacy of video-assisted retroperitoneal debridement for infected pancreatic collections: a multicenter, prospective, single-arm phase 2 study. *Arch Surg* 2010; **145**: 817-825 [PMID: 20855750 DOI: 10.1001/archsurg.2010.178]
- 22 **Seifert H**, Biermer M, Schmitt W, Jürgensen C, Will U, Gerlach R, Kreitmair C, Meining A, Wehrmann T, Rösch T. Transluminal endoscopic necrosectomy after acute pancreatitis: a multicentre study with long-term follow-up (the GEPARD Study). *Gut* 2009; **58**: 1260-1266 [PMID: 19282306 DOI: 10.1136/gut.2008.163733]
- 23 **Carter CR**, McKay CJ, Imrie CW. Percutaneous necrosectomy and sinus tract endoscopy in the management of infected pancreatic necrosis: an initial experience. *Ann Surg* 2000; **232**: 175-180 [PMID: 10903593 DOI: 10.1097/0000658-200008000-00004]
- 24 **van Baal MC**, van Santvoort HC, Bollen TL, Bakker OJ, Besselink MG, Gooszen HG; Dutch Pancreatitis Study Group. Systematic review of percutaneous catheter drainage as primary treatment for necrotizing pancreatitis. *Br J Surg* 2011; **98**: 18-27 [PMID: 21136562 DOI: 10.1002/bjs.7304]
- 25 **Sarr MG**, Banks PA, Bollen TL, Dervenis C, Gooszen HG, Johnson CD, Tsiotos GG, Vege SS. The new revised classification of acute pancreatitis 2012. *Surg Clin North Am* 2013; **93**: 549-562 [PMID: 23632143 DOI: 10.1016/j.suc.2013.02.012]
- 26 **Maher MM**, Lucey BC, Gervais DA, Mueller PR. Acute pancreatitis: the role of imaging and interventional radiology. *Cardiovasc Intervent Radiol* 2004; **27**: 208-225 [PMID: 15024494 DOI: 10.1007/s00270-003-1907-7]
- 27 **Schmidt PN**, Roug S, Hansen EF, Knudsen JD, Novovic S. Spectrum of microorganisms in infected walled-off pancreatic necrosis - impact on organ failure and mortality. *Pancreatol* 2014; **14**: 444-449 [PMID: 25266641 DOI: 10.1016/j.pan.2014.09.001]
- 28 **Rau BM**, Bothe A, Kron M, Beger HG. Role of early multisystem organ failure as major risk factor for pancreatic infections and death in severe acute pancreatitis. *Clin Gastroenterol Hepatol* 2006; **4**: 1053-1061 [PMID: 16843734 DOI: 10.1016/j.cgh.2006.05.030]
- 29 **Lee HS**, Lee SK, Park DH, Lee SS, Seo DW, Kim MH, Chong YP. Emergence of multidrug resistant infection in patients with severe acute pancreatitis. *Pancreatol* 2014; **14**: 450-453 [PMID: 25458666 DOI: 10.1016/j.pan.2014.10.003]
- 30 **Shyu JY**, Sainani NI, Sahni VA, Chick JF, Chauhan NR, Conwell DL, Clancy TE, Banks PA, Silverman SG. Necrotizing pancreatitis: diagnosis, imaging, and intervention. *Radiographics* 2014; **34**: 1218-1239 [PMID: 25208277 DOI: 10.1148/rg.345130012]
- 31 **Wittau M**, Mayer B, Scheele J, Henne-Bruns D, Dellinger EP, Isenmann R. Systematic review and meta-analysis of antibiotic prophylaxis in severe acute pancreatitis. *Scand J Gastroenterol* 2011; **46**: 261-270 [PMID: 21067283 DOI: 10.3109/00365521.2010.531486]
- 32 **Flati G**, Andrén-Sandberg A, La Pinta M, Porowska B, Carboni M. Potentially fatal bleeding in acute pancreatitis: pathophysiology, prevention, and treatment. *Pancreas* 2003; **26**: 8-14 [PMID: 12499910 DOI: 10.1097/00006676-200301000-00002]
- 33 **Sharma PK**, Madan K, Garg PK. Hemorrhage in acute pancreatitis: should gastrointestinal bleeding be considered an organ failure? *Pancreas* 2008; **36**: 141-145 [PMID: 18376304 DOI: 10.1097/MPA.0b013e318158466e]
- 34 **Andersson E**, Ansari D, Andersson R. Major haemorrhagic complications of acute pancreatitis. *Br J Surg* 2010; **97**: 1379-1384 [PMID: 20564308 DOI: 10.1002/bjs.7113]
- 35 **Fitzpatrick J**, Bhat R, Young JA. Angiographic embolization is an effective treatment of severe hemorrhage in pancreatitis. *Pancreas* 2014; **43**: 436-439 [PMID: 24622075 DOI: 10.1097/MPA.000000000000051]
- 36 **Jaipuria J**, Bhandari V, Chawla AS, Singh M. Intra-abdominal pressure: Time ripe to revise management guidelines of acute pancreatitis? *World J Gastrointest Pathophysiol* 2016; **7**: 186-198 [PMID: 26909242 DOI: 10.4291/wjgp.v7.i1.186]
- 37 **Chen H**, Li F, Sun JB, Jia JG. Abdominal compartment syndrome in patients with severe acute pancreatitis in early stage. *World J Gastroenterol* 2008; **14**: 3541-3548 [PMID: 18567084 DOI: 10.3748/wjg.14.3541]
- 38 **Cheatham ML**, Malbrain ML, Kirkpatrick A, Sugrue M, Parr M, De Waele J, Balogh Z, Leppäniemi A, Olvera C, Ivatury R, D'Amours S, Wendon J, Hillman K, Wilmer A. Results from the International Conference of Experts on Intra-abdominal Hypertension and Abdominal Compartment Syndrome. II. Recommendations. *Intensive Care Med* 2007; **33**: 951-962 [PMID: 17377769 DOI: 10.1007/s00134-007-0592-4]
- 39 **Malbrain ML**, Cheatham ML, Kirkpatrick A, Sugrue M, Parr M, De Waele J, Balogh Z, Leppäniemi A, Olvera C, Ivatury R, D'Amours S, Wendon J, Hillman K, Johansson K, Kolkman K, Wilmer A. Results from the International Conference of Experts on Intra-abdominal Hypertension and Abdominal Compartment Syndrome. I. Definitions. *Intensive Care Med* 2006; **32**: 1722-1732 [PMID: 16967294 DOI: 10.1007/s00134-006-0349-5]
- 40 **Ke L**, Ni HB, Tong ZH, Li WQ, Li N, Li JS. The importance of timing of decompression in severe acute pancreatitis combined with abdominal compartment syndrome. *J Trauma Acute Care Surg* 2013; **74**: 1060-1066 [PMID: 23511145 DOI: 10.1097/TA.0b013e318283d927]
- 41 **Working Group IAP/APA Acute Pancreatitis Guidelines**. IAP/APA evidence-based guidelines for the management of acute pancreatitis. *Pancreatol* 2013; **13**: e1-15 [PMID: 24054878 DOI: 10.1016/j.pan.2013.07.063]
- 42 **Peng T**, Dong LM, Zhao X, Xiong JX, Zhou F, Tao J, Cui J, Yang ZY. Minimally invasive percutaneous catheter drainage versus open laparotomy with temporary closure for treatment of abdominal compartment syndrome in patients with early-stage severe acute pancreatitis. *J Huazhong Univ Sci Technolog Med Sci* 2016; **36**: 99-105 [PMID: 26838748 DOI: 10.1007/s11596-016-1549-z]
- 43 **Aldridge MC**, Francis ND, Glazer G, Dudley HA. Colonic complications of severe acute pancreatitis. *Br J Surg* 1989; **76**: 362-367 [PMID: 2655821 DOI: 10.1002/bjs.1800760416]
- 44 **Borie D**, Frileux P, Tiret E, Berger A, Wind P, Levy E, Nordlinger B, Cugnenc PH, Parc R. [Diverting loop ileostomy, effective prevention of colonic complications in necrotizing acute pancreatitis]. *Ann Chir*

- 1992; **46**: 51-58 [PMID: 1550319 DOI: 10.1016/j.cccn.2005.03.011]
- 45 **Freeman ML**, Werner J, van Santvoort HC, Baron TH, Besselink MG, Windsor JA, Horvath KD, vanSonnenberg E, Bollen TL, Vege SS; International Multidisciplinary Panel of Speakers and Moderators. Interventions for necrotizing pancreatitis: summary of a multidisciplinary consensus conference. *Pancreas* 2012; **41**: 1176-1194 [PMID: 23086243 DOI: 10.1097/MPA.0b013e318269c660]
- 46 **Buter A**, Imrie CW, Carter CR, Evans S, McKay CJ. Dynamic nature of early organ dysfunction determines outcome in acute pancreatitis. *Br J Surg* 2002; **89**: 298-302 [PMID: 11872053 DOI: 10.1046/j.0007-1323.2001.02025.x]
- 47 **Beger HG**, Bittner R, Block S, Büchler M. Bacterial contamination of pancreatic necrosis. A prospective clinical study. *Gastroenterology* 1986; **91**: 433-438 [PMID: 3522342 DOI: 10.1016/0016-5085(86)90579-2]
- 48 **Beger HG**, Rau BM. Severe acute pancreatitis: Clinical course and management. *World J Gastroenterol* 2007; **13**: 5043-5051 [PMID: 17876868 DOI: 10.3748/wjg.v13.i38.5043]
- 49 **Beger HG**, Rau B, Mayer J, Pralle U. Natural course of acute pancreatitis. *World J Surg* 1997; **21**: 130-135 [PMID: 8995067 DOI: 10.1007/s002689900204]
- 50 **Tenner S**, Sica G, Hughes M, Noordhoek E, Feng S, Zinner M, Banks PA. Relationship of necrosis to organ failure in severe acute pancreatitis. *Gastroenterology* 1997; **113**: 899-903 [PMID: 9287982 DOI: 10.1016/S0016-5085(97)70185-9]
- 51 **Besselink MG**, van Santvoort HC, Boermeester MA, Nieuwenhuijs VB, van Goor H, Dejong CH, Schaapherder AF, Gooszen HG; Dutch Acute Pancreatitis Study Group. Timing and impact of infections in acute pancreatitis. *Br J Surg* 2009; **96**: 267-273 [PMID: 19125434 DOI: 10.1002/bjs.6447]
- 52 **Morgan DE**. Imaging of acute pancreatitis and its complications. *Clin Gastroenterol Hepatol* 2008; **6**: 1077-1085 [PMID: 18928934 DOI: 10.1016/j.cgh.2008.07.012]
- 53 **Bae KT**. Intravenous contrast medium administration and scan timing at CT: considerations and approaches. *Radiology* 2010; **256**: 32-61 [PMID: 20574084 DOI: 10.1148/radiol.10090908]
- 54 **Weisbrod AB**, Kitano M, Thomas F, Williams D, Gulati N, Gesuwan K, Liu Y, Venzon D, Turkbey I, Choyke P, Yao J, Libutti SK, Nilubol N, Linehan WM, Kebebew E. Assessment of tumor growth in pancreatic neuroendocrine tumors in von Hippel Lindau syndrome. *J Am Coll Surg* 2014; **218**: 163-169 [PMID: 24440063 DOI: 10.1016/j.jamcollsurg.2013.10.025]
- 55 **Balthazar EJ**. Acute pancreatitis: assessment of severity with clinical and CT evaluation. *Radiology* 2002; **223**: 603-613 [PMID: 12034923 DOI: 10.1148/radiol.2233010680]
- 56 **Pamuklar E**, Semelka RC. MR imaging of the pancreas. *Magn Reson Imaging Clin N Am* 2005; **13**: 313-330 [PMID: 15935314 DOI: 10.1016/j.mric.2005.03.012]
- 57 **Türkvan A**, Erden A, Seçil M, Türkoğlu MA. Fluid collections associated with acute pancreatitis: a pictorial essay. *Can Assoc Radiol J* 2014; **65**: 260-266 [PMID: 24650871 DOI: 10.1016/j.carj.2013.08.003]
- 58 **Zaheer A**, Singh VK, Qureshi RO, Fishman EK. The revised Atlanta classification for acute pancreatitis: updates in imaging terminology and guidelines. *Abdom Imaging* 2013; **38**: 125-136 [PMID: 22584543 DOI: 10.1007/s00261-012-9908-0]
- 59 **Arvanitakis M**, Delhay M, De Maertelaere V, Bali M, Winant C, Coppens E, Jeanmart J, Zalcmn M, Van Gansbeke D, Devière J, Matos C. Computed tomography and magnetic resonance imaging in the assessment of acute pancreatitis. *Gastroenterology* 2004; **126**: 715-723 [PMID: 14988825 DOI: 10.1053/j.gastro.2003.12.006]
- 60 **Busireddy KK**, AlObaidy M, Ramalho M, Kalubowila J, Baodong L, Santagostino I, Semelka RC. Pancreatitis-imaging approach. *World J Gastrointest Pathophysiol* 2014; **5**: 252-270 [PMID: 25133027 DOI: 10.4291/wjgp.v5.i3.252]
- 61 **Cochior D**, Constantinoiu S, Copăescu C, Șerbănoiu D, Birlă R, Boeriu M. Clinical importance of the determinant-based classification of acute pancreatitis severity. *Chirurgia (Bucur)* 2013; **108**: 631-642 [PMID: 24157105 DOI: 10.1097/SLA.0b013e318256f778]
- 62 **Thandassery RB**, Yadav TD, Dutta U, Appasani S, Singh K, Kochhar R. Dynamic nature of organ failure in severe acute pancreatitis: the impact of persistent and deteriorating organ failure. *HPB (Oxford)* 2013; **15**: 523-528 [PMID: 23750495 DOI: 10.1111/j.1477-2574.2012.00613.x]
- 63 **Park JY**, Jeon TJ, Ha TH, Hwang JT, Sinn DH, Oh TH, Shin WC, Choi WC. Bedside index for severity in acute pancreatitis: comparison with other scoring systems in predicting severity and organ failure. *Hepatobiliary Pancreat Dis Int* 2013; **12**: 645-650 [PMID: 24322751 DOI: 10.1016/S1499-3872(13)60101-0]
- 64 **Baron TH**. Managing severe acute pancreatitis. *Cleve Clin J Med* 2013; **80**: 354-359 [PMID: 23733900 DOI: 10.3949/ccjm.80gr.13001]
- 65 **Chang YS**, Fu HQ, Zou SB, Yu BT, Liu JC, Xia L, Lv NH. [The impact of initial fluid resuscitation with different ratio of crystalloid-colloid on prognosis of patients with severe acute pancreatitis]. *Zhonghua Weizhongbing Jijiu Yixue* 2013; **25**: 48-51 [PMID: 23611098 DOI: 10.3760/cma.j.issn.2095-4352.2013.01.013]
- 66 **Anand N**, Park JH, Wu BU. Modern management of acute pancreatitis. *Gastroenterol Clin North Am* 2012; **41**: 1-8 [PMID: 22341246 DOI: 10.1016/j.gtc.2011.12.013]
- 67 **Singh N**, Sharma B, Sharma M, Sachdev V, Bhardwaj P, Mani K, Joshi YK, Saraya A. Evaluation of early enteral feeding through nasogastric and nasojejunal tube in severe acute pancreatitis: a noninferiority randomized controlled trial. *Pancreas* 2012; **41**: 153-159 [PMID: 21775915 DOI: 10.1097/MPA.0b013e318221c4a8]
- 68 **Thomas T**, Mah L, Barreto SG. Systematic review of diet in the pathogenesis of acute pancreatitis: a tale of too much or too little? *Saudi J Gastroenterol* 2012; **18**: 310-315 [PMID: 23006458 DOI: 10.4103/1319-3767.101124]
- 69 **Nathens AB**, Curtis JR, Beale RJ, Cook DJ, Moreno RP, Romand JA, Skerrett SJ, Stapleton RD, Ware LB, Waldmann CS. Management of the critically ill patient with severe acute pancreatitis. *Crit Care Med* 2004; **32**: 2524-2536 [PMID: 15599161 DOI: 10.1097/01.CCM.0000148222.09869.92]
- 70 **Hughes SJ**, Papachristou GI, Federle MP, Lee KK. Necrotizing pancreatitis. *Gastroenterol Clin North Am* 2007; **36**: 313-323, viii [PMID: 17533081 DOI: 10.1016/j.gtc.2007.03.012]
- 71 **Plaudis H**, Pupelis G, Zeiza K, Boka V. Early low volume oral synbiotic/prebiotic supplemented enteral stimulation of the gut in patients with severe acute pancreatitis: a prospective feasibility study. *Acta Chir Belg* 2012; **112**: 131-138 [PMID: 22571076 DOI: 10.1080/00015458.2012.11680811]
- 72 **Besselink MG**, Verwer TJ, Schoenmaeckers EJ, Buskens E, Ridwan BU, Visser MR, Nieuwenhuijs VB, Gooszen HG. Timing of surgical intervention in necrotizing pancreatitis. *Arch Surg* 2007; **142**: 1194-1201

- [PMID: 18086987 DOI: 10.1001/archsurg.142.12.1194]
- 73 **Papachristou GI**, Takahashi N, Chahal P, Sarr MG, Baron TH. Peroral endoscopic drainage/debridement of walled-off pancreatic necrosis. *Ann Surg* 2007; **245**: 943-951 [PMID: 17522520 DOI: 10.1097/01.sla.0000254366.19366.69]
- 74 **Bhansali SK**, Shah SC, Desai SB, Sunawala JD. Infected necrosis complicating acute pancreatitis: experience with 131 cases. *Indian J Gastroenterol* 2003; **22**: 7-10 [PMID: 12617444]
- 75 **Mier J**, León EL, Castillo A, Robledo F, Blanco R. Early versus late necrosectomy in severe necrotizing pancreatitis. *Am J Surg* 1997; **173**: 71-75 [PMID: 9074366 DOI: 10.1016/S0002-9610(96)00425-4]
- 76 **Sheu Y**, Furlan A, Almusa O, Papachristou G, Bae KT. The revised Atlanta classification for acute pancreatitis: a CT imaging guide for radiologists. *Emerg Radiol* 2012; **19**: 237-243 [PMID: 22160496 DOI: 10.1007/s10140-011-1001-4]
- 77 **Bollen TL**, Singh VK, Maurer R, Repas K, van Es HW, Banks PA, Mortele KJ. Comparative evaluation of the modified CT severity index and CT severity index in assessing severity of acute pancreatitis. *AJR Am J Roentgenol* 2011; **197**: 386-392 [PMID: 21785084 DOI: 10.2214/AJR.09.4025]
- 78 **Uhl W**, Warshaw A, Imrie C, Bassi C, McKay CJ, Lankisch PG, Carter R, Di Magno E, Banks PA, Whitcomb DC, Dervenis C, Ulrich CD, Satake K, Ghaneh P, Hartwig W, Werner J, McEntee G, Neoptolemos JP, Büchler MW; International Association of Pancreatology. IAP Guidelines for the Surgical Management of Acute Pancreatitis. *Pancreatol* 2002; **2**: 565-573 [PMID: 12435871 DOI: 10.1159/000071269]
- 79 **van Santvoort HC**, Bakker OJ, Bollen TL, Besselink MG, Ahmed Ali U, Schrijver AM, Boermeester MA, van Goor H, Dejong CH, van Eijck CH, van Ramshorst B, Schaapherder AF, van der Harst E, Hofker S, Nieuwenhuijs VB, Brink MA, Kruyt PM, Manusama ER, van der Schelling GP, Karsten T, Hesselink EJ, van Laarhoven CJ, Rosman C, Bosscha K, de Wit RJ, Houdijk AP, Cuesta MA, Wahab PJ, Gooszen HG; Dutch Pancreatitis Study Group. A conservative and minimally invasive approach to necrotizing pancreatitis improves outcome. *Gastroenterology* 2011; **141**: 1254-1263 [PMID: 21741922 DOI: 10.1053/j.gastro.2011.06.073]
- 80 **Oláh A**, Belágyi T, Bartek P, Pohárnok L, Romics L. Alternative treatment modalities of infected pancreatic necrosis. *Hepatogastroenterology* 2006; **53**: 603-607 [PMID: 16995471 DOI: 10.1136/gut.2006.094680]
- 81 **Runzi M**, Niebel W, Goebell H, Gerken G, Layer P. Severe acute pancreatitis: nonsurgical treatment of infected necroses. *Pancreas* 2005; **30**: 195-199 [PMID: 15782093 DOI: 10.1097/01.mpa.0000153613.17643.b3]
- 82 **Sivasankar A**, Kannan DG, Ravichandran P, Jeswanth S, Balachandar TG, Surendran R. Outcome of severe acute pancreatitis: is there a role for conservative management of infected pancreatic necrosis? *Hepatobiliary Pancreat Dis Int* 2006; **5**: 599-604 [PMID: 17085350]
- 83 **Garg PK**, Sharma M, Madan K, Sahni P, Banerjee D, Goyal R. Primary conservative treatment results in mortality comparable to surgery in patients with infected pancreatic necrosis. *Clin Gastroenterol Hepatol* 2010; **8**: 1089-1094.e2 [PMID: 20417724 DOI: 10.1016/j.cgh.2010.04.011]
- 84 **Wysocki AP**, McKay CJ, Carter CR. Infected pancreatic necrosis: minimizing the cut. *ANZ J Surg* 2010; **80**: 58-70 [PMID: 20575882 DOI: 10.1111/j.1445-2197.2009.05177.x]
- 85 **Chang YC**. Is necrosectomy obsolete for infected necrotizing pancreatitis? Is a paradigm shift needed? *World J Gastroenterol* 2014; **20**: 16925-16934 [PMID: 25493005 DOI: 10.3748/wjg.v20.i45.16925]
- 86 **van Brunschot S**, Bakker OJ, Besselink MG, Bollen TL, Fockens P, Gooszen HG, van Santvoort HC; Dutch Pancreatitis Study Group. Treatment of necrotizing pancreatitis. *Clin Gastroenterol Hepatol* 2012; **10**: 1190-1201 [PMID: 22610008 DOI: 10.1016/j.cgh.2012.05.005]
- 87 **Beger HG**, Büchler M, Bittner R, Block S, Nevalainen T, Roscher R. Necrosectomy and postoperative local lavage in necrotizing pancreatitis. *Br J Surg* 1988; **75**: 207-212 [PMID: 3349326 DOI: 10.1002/bjs.1800750306]
- 88 **Fernández-del Castillo C**, Rattner DW, Makary MA, Mostafavi A, McGrath D, Warshaw AL. Débridement and closed packing for the treatment of necrotizing pancreatitis. *Ann Surg* 1998; **228**: 676-684 [PMID: 9833806 DOI: 10.1007/978-3-540-28656-1_23]
- 89 **Werner J**, Feuerbach S, Uhl W, Büchler MW. Management of acute pancreatitis: from surgery to interventional intensive care. *Gut* 2005; **54**: 426-436 [PMID: 15710995 DOI: 10.1136/gut.2003.035907]
- 90 **Branum G**, Galloway J, Hirschowitz W, Fendley M, Hunter J. Pancreatic necrosis: results of necrosectomy, packing, and ultimate closure over drains. *Ann Surg* 1998; **227**: 870-877 [PMID: 9637550 DOI: 10.1097/0000658-199806000-00010]
- 91 **Fagniez PL**, Rotman N, Kracht M. Direct retroperitoneal approach to necrosis in severe acute pancreatitis. *Br J Surg* 1989; **76**: 264-267 [PMID: 2720323 DOI: 10.1002/bjs.1800760316]
- 92 **Berne TV**, Donovan AJ. Synchronous anterior celiotomy and posterior drainage of pancreatic abscess. *Arch Surg* 1981; **116**: 527-533 [PMID: 7235945 DOI: 10.1001/archsurg.1981.01380170023004]
- 93 **Parekh D**. Laparoscopic-assisted pancreatic necrosectomy: A new surgical option for treatment of severe necrotizing pancreatitis. *Arch Surg* 2006; **141**: 895-902; discussion 902-3 [PMID: 16983033 DOI: 10.1001/archsurg.141.9.895]
- 94 **Tan J**, Tan H, Hu B, Ke C, Ding X, Chen F, Leng J, Dong J. Short-term outcomes from a multicenter retrospective study in China comparing laparoscopic and open surgery for the treatment of infected pancreatic necrosis. *J Laparoendosc Adv Surg Tech A* 2012; **22**: 27-33 [PMID: 22217005 DOI: 10.1089/lap.2011.0248]
- 95 **Mathew MJ**, Parmar AK, Sahu D, Reddy PK. Laparoscopic necrosectomy in acute necrotizing pancreatitis: Our experience. *J Minim Access Surg* 2014; **10**: 126-131 [PMID: 25013328 DOI: 10.4103/0972-9941.134875]
- 96 **Melman L**, Azar R, Beddow K, Brunt LM, Halpin VJ, Eagon JC, Frisella MM, Edmundowicz S, Jonnalagadda S, Matthews BD. Primary and overall success rates for clinical outcomes after laparoscopic, endoscopic, and open pancreatic cystgastrostomy for pancreatic pseudocysts. *Surg Endosc* 2009; **23**: 267-271 [PMID: 19037696 DOI: 10.1007/s00464-008-0196-2]
- 97 **Freeny PC**, Hauptmann E, Althaus SJ, Traverso LW, Sinanan M. Percutaneous CT-guided catheter drainage of infected acute necrotizing pancreatitis: techniques and results. *AJR Am J Roentgenol* 1998; **170**: 969-975 [PMID: 9530046 DOI: 10.2214/ajr.170.4.9530046]
- 98 **van Santvoort HC**, Besselink MG, Bakker OJ, Hofker HS, Boermeester MA, Dejong CH, van Goor H, Schaapherder AF, van Eijck CH, Bollen TL, van Ramshorst B, Nieuwenhuijs VB, Timmer R, Laméris JS, Kruyt PM, Manusama ER, van der Harst E, van der Schelling GP, Karsten T, Hesselink EJ, van Laarhoven CJ, Rosman C, Bosscha K, de Wit RJ, Houdijk AP, van Leeuwen MS, Buskens E, Gooszen HG; Dutch

- Pancreatitis Study Group. A step-up approach or open necrosectomy for necrotizing pancreatitis. *N Engl J Med* 2010; **362**: 1491-1502 [PMID: 20410514 DOI: 10.1056/NEJMoa0908821]
- 99 **Sleeman D**, Levi DM, Cheung MC, Rahnemai-Azar A, Parisek S, Casillas V, Echenique A, Yrizarri J, Guerra JJ, Levi JU, Livingstone AS. Percutaneous lavage as primary treatment for infected pancreatic necrosis. *J Am Coll Surg* 2011; **212**: 748-52; discussion 752-4 [PMID: 21463827 DOI: 10.1016/j.jamcollsurg.2010.12.019]
- 100 **Bakker OJ**, van Santvoort HC, van Brunschot S, Geskus RB, Besselink MG, Bollen TL, van Eijck CH, Fockens P, Hazebroek EJ, Nijmeijer RM, Poley JW, van Ramshorst B, Vleggaar FP, Boermeester MA, Gooszen HG, Weusten BL, Timmer R; Dutch Pancreatitis Study Group. Endoscopic transgastric vs surgical necrosectomy for infected necrotizing pancreatitis: a randomized trial. *JAMA* 2012; **307**: 1053-1061 [PMID: 22416101 DOI: 10.1001/jama.2012.276]
- 101 **Kulkarni S**, Bogart A, Buxbaum J, Matsuoka L, Selby R, Parekh D. Surgical transgastric debridement of walled off pancreatic necrosis: an option for patients with necrotizing pancreatitis. *Surg Endosc* 2015; **29**: 575-582 [PMID: 25055889 DOI: 10.1007/s00464-014-3700-x]
- 102 **Gardner TB**, Chahal P, Papachristou GI, Vege SS, Petersen BT, Gostout CJ, Topazian MD, Takahashi N, Sarr MG, Baron TH. A comparison of direct endoscopic necrosectomy with transmural endoscopic drainage for the treatment of walled-off pancreatic necrosis. *Gastrointest Endosc* 2009; **69**: 1085-1094 [PMID: 19243764 DOI: 10.1016/j.gie.2008.06.061]
- 103 **Kumar N**, Conwell DL, Thompson CC. Direct endoscopic necrosectomy versus step-up approach for walled-off pancreatic necrosis: comparison of clinical outcome and health care utilization. *Pancreas* 2014; **43**: 1334-1339 [PMID: 25083997 DOI: 10.1097/MPA.0000000000000213]
- 104 **Borens B**, Arvanitakis M, Absil J, El Bouchaibi S, Matos C, Eisendrach P, Toussaint E, Deviere J, Bali MA. Added value of diffusion-weighted magnetic resonance imaging for the detection of pancreatic fluid collection infection. *Eur Radiol* 2017; **27**: 1064-1073 [PMID: 27300193 DOI: 10.1007/s00330-016-4462-8]
- 105 **Segal D**, Mortelet KJ, Banks PA, Silverman SG. Acute necrotizing pancreatitis: role of CT-guided percutaneous catheter drainage. *Abdom Imaging* 2007; **32**: 351-361 [PMID: 17502982 DOI: 10.1007/s00261-007-9221-5]
- 106 **Bello B**, Matthews JB. Minimally invasive treatment of pancreatic necrosis. *World J Gastroenterol* 2012; **18**: 6829-6835 [PMID: 23239921 DOI: 10.3748/wjg.v18.i46.6829]
- 107 **Büchler MW**, Gloor B, Müller CA, Friess H, Seiler CA, Uhl W. Acute necrotizing pancreatitis: treatment strategy according to the status of infection. *Ann Surg* 2000; **232**: 619-626 [PMID: 11066131 DOI: 10.1097/0000658-200011000-00001]
- 108 **Horvath KD**, Kao LS, Wherry KL, Pellegrini CA, Sinanan MN. A technique for laparoscopic-assisted percutaneous drainage of infected pancreatic necrosis and pancreatic abscess. *Surg Endosc* 2001; **15**: 1221-1225 [PMID: 11727105 DOI: 10.1007/s004640080166]
- 109 **Boerma D**, Rauws EA, van Gulik TM, Huijbregtse K, Obertop H, Gouma DJ. Endoscopic stent placement for pancreaticocutaneous fistula after surgical drainage of the pancreas. *Br J Surg* 2000; **87**: 1506-1509 [PMID: 11091237 DOI: 10.1046/j.1365-2168.2000.01573.x]
- 110 **Gebhardt C**. [Therapeutic strategy in acute pancreatitis (II). Surgical procedure]. *Fortschr Med* 1984; **102**: 215-217 [PMID: 6706277]
- 111 **Baron TH**, Thaggard WG, Morgan DE, Stanley RJ. Endoscopic therapy for organized pancreatic necrosis. *Gastroenterology* 1996; **111**: 755-764 [PMID: 8780582 DOI: 10.1053/gast.1996.v111.pm8780582]
- 112 **Seifert H**, Wehrmann T, Schmitt T, Zeuzem S, Caspary WF. Retroperitoneal endoscopic debridement for infected peripancreatic necrosis. *Lancet* 2000; **356**: 653-655 [PMID: 10968442 DOI: 10.1016/S0140-6736(00)02611-8]
- 113 **Gardner TB**, Coelho-Prabhu N, Gordon SR, Gelrud A, Maple JT, Papachristou GI, Freeman ML, Topazian MD, Attam R, Mackenzie TA, Baron TH. Direct endoscopic necrosectomy for the treatment of walled-off pancreatic necrosis: results from a multicenter U.S. series. *Gastrointest Endosc* 2011; **73**: 718-726 [PMID: 21237454 DOI: 10.1016/j.gie.2010.10.053]
- 114 **Isayama H**, Nakai Y, Rerknimitr R, Khor C, Lau J, Wang HP, Seo DW, Ratanachu-Ek T, Lakhtakia S, Ang TL, Ryozaawa S, Hayashi T, Kawakami H, Yamamoto N, Iwashita T, Itokawa F, Kuwatani M, Kitano M, Hanada K, Kogure H, Hamada T, Ponnudurai R, Moon JH, Itoi T, Yasuda I, Irisawa A, Maetani I. Asian consensus statements on endoscopic management of walled-off necrosis Part 1: Epidemiology, diagnosis, and treatment. *J Gastroenterol Hepatol* 2016; **31**: 1546-1554 [PMID: 27044023 DOI: 10.1111/jgh.13394]
- 115 **Varadarajulu S**, Christein JD, Tamhane A, Drelichman ER, Wilcox CM. Prospective randomized trial comparing EUS and EGD for transmural drainage of pancreatic pseudocysts (with videos). *Gastrointest Endosc* 2008; **68**: 1102-1111 [PMID: 18640677 DOI: 10.1016/j.gie.2008.04.028]
- 116 **Park DH**, Lee SS, Moon SH, Choi SY, Jung SW, Seo DW, Lee SK, Kim MH. Endoscopic ultrasound-guided versus conventional transmural drainage for pancreatic pseudocysts: a prospective randomized trial. *Endoscopy* 2009; **41**: 842-848 [PMID: 19798610 DOI: 10.1055/s-0029-1215133]
- 117 **Haghshenas-kashani A**, Laurence JM, Kwan V, Johnston E, Hollands MJ, Richardson AJ, Pleass HC, Lam VW. Endoscopic necrosectomy of pancreatic necrosis: a systematic review. *Surg Endosc* 2011; **25**: 3724-3730 [PMID: 21656324 DOI: 10.1007/s00464-011-1795-x]
- 118 **Mowery NT**, Bruns BR, MacNew HG, Agarwal S, Enniss TM, Khan M, Guo WA, Cannon JW, Lissauer ME, Duane TM, Hildreth AN, Pappas PA, Gries LM, Kaiser M, Robinson BRH. Surgical management of pancreatic necrosis: A practice management guideline from the Eastern Association for the Surgery of Trauma. *J Trauma Acute Care Surg* 2017; **83**: 316-327 [PMID: 28452889 DOI: 10.1097/TA.0000000000001510]
- 119 **Luigiano C**, Pellicano R, Fusaroli P, Iabichino G, Arena M, Lisotti A, Consolo P, Morace C, Opocher E, Caletti G, Fagoonee S, Cennamo V, Fabbri C. Pancreatic necrosectomy: an evidence-based systematic review of the levels of evidence and a comparison of endoscopic versus non-endoscopic techniques. *Minerva Chir* 2016; **71**: 262-269 [PMID: 27152629]
- 120 **Gurusamy KS**, Belgaumkar AP, Haswell A, Pereira SP, Davidson BR. Interventions for necrotising pancreatitis. *Cochrane Database Syst Rev* 2016; **4**: CD011383 [PMID: 27083933 DOI: 10.1002/14651858.CD011383.pub2]
- 121 **Puli SR**, Graumlich JF, Pamulaparthy SR, Kalva N. Endoscopic transmural necrosectomy for walled-off pancreatic necrosis: a systematic review and meta-analysis. *Can J Gastroenterol Hepatol* 2014; **28**: 50-53 [PMID: 24212912 DOI: 10.1155/2014/539783]
- 122 **van Brunschot S**, van Grinsven J, Voermans RP, Bakker OJ, Besselink MG, Boermeester MA, Bollen TL,

- Bosscha K, Bouwense SA, Bruno MJ, Cappendijk VC, Consten EC, Dejong CH, Dijkgraaf MG, van Eijck CH, Erkelens GW, van Goor H, Hadithi M, Haveman JW, Hofker SH, Jansen JJ, Laméris JS, van Lienden KP, Manusama ER, Meijssen MA, Mulder CJ, Nieuwenhuis VB, Poley JW, de Ridder RJ, Rosman C, Schaapherder AF, Scheepers JJ, Schoon EJ, Seerden T, Spanier BW, Straathof JW, Timmer R, Venneman NG, Vleggaar FP, Witteman BJ, Gooszen HG, van Santvoort HC, Fockens P; Dutch Pancreatitis Study Group. Transluminal endoscopic step-up approach versus minimally invasive surgical step-up approach in patients with infected necrotizing pancreatitis (TENSION trial): design and rationale of a randomised controlled multicenter trial [ISRCTN09186711]. *BMC Gastroenterol* 2013; **13**: 161 [PMID: 24274589 DOI: 10.1186/1471-230X-13-161]
- 123 **Jones JD**, Matrachisia J, French JB, Case D, Clark CJ, Mishra G, Pawa R. Mo1413 Analysis of the Step-Up Approach in the Management of Walled off Pancreatic Necrosis (WOPN) in a Large Cohort of Patients at a United States Academic Medical Center. *Gastroenterology* 2016; **150**: S705 [DOI: 10.1016/S0016-5085(16)32404-0]
- 124 **Navarrete C**, Richter H, Osorio J, Castillo C, Valdivieso E, Harz C. Mo2033 Wide Percutaneous Access to Retroperitoneal Pancreatic Necrosis Through Fully Covered Self-Expandable Metal Stent. *Gastrointest Endosc* 2016; **83**: AB502 [DOI: 10.1016/j.gie.2016.03.724]
- 125 **Sugimoto M**, Sonntag DP, Flint GS, Boyce CJ, Kirkham JC, Harris TJ, Carr SM, Nelson BD, Bell DA, Barton JG, Traverso LW. Better Outcomes if Percutaneous Drainage Is Used Early and Proactively in the Course of Necrotizing Pancreatitis. *J Vasc Interv Radiol* 2016; **27**: 418-425 [PMID: 26806694 DOI: 10.1016/j.jvir.2015.11.054]
- 126 **Russell PS**, Mittal A, Brown L, McArthur C, Phillips AJR, Petrov M, Windsor JA. Admission, management and outcomes of acute pancreatitis in intensive care. *ANZ J Surg* 2017; **87**: E266-E270 [PMID: 27018076 DOI: 10.1111/ans.13498]
- 127 **Ross A**, Gluck M, Irani S, Hauptmann E, Fotoohi M, Siegal J, Robinson D, Crane R, Kozarek R. Combined endoscopic and percutaneous drainage of organized pancreatic necrosis. *Gastrointest Endosc* 2010; **71**: 79-84 [PMID: 19863956 DOI: 10.1016/j.gie.2009.06.037]
- 128 **Rocha FG**, Benoit E, Zinner MJ, Whang EE, Banks PA, Ashley SW, Mortele KJ. Impact of radiologic intervention on mortality in necrotizing pancreatitis: the role of organ failure. *Arch Surg* 2009; **144**: 261-265 [PMID: 19289666 DOI: 10.1001/archsurg.2008.587]
- 129 **Becker V**, Huber W, Meining A, Prinz C, Umgelter A, Ludwig L, Bajbouj M, Gaa J, Schmid RM. Infected necrosis in severe pancreatitis--combined nonsurgical multi-drainage with directed transabdominal high-volume lavage in critically ill patients. *Pancreatology* 2009; **9**: 280-286 [PMID: 19407483 DOI: 10.1159/000212093]
- 130 **Bruennler T**, Langgartner J, Lang S, Zorger N, Herold T, Salzberger B, Feuerbach S, Schoelmerich J, Hamer OW. Percutaneous necrosectomy in patients with acute, necrotizing pancreatitis. *Eur Radiol* 2008; **18**: 1604-1610 [PMID: 18357453 DOI: 10.1007/s00330-008-0928-7]
- 131 **Cheung MT**, Ho CN, Siu KW, Kwok PC. Percutaneous drainage and necrosectomy in the management of pancreatic necrosis. *ANZ J Surg* 2005; **75**: 204-207 [PMID: 15839965 DOI: 10.1111/j.1445-2197.2005.03366.x]
- 132 **Risse O**, Auguste T, Delannoy P, Cardin N, Bricault I, Létoublon C. Percutaneous video-assisted necrosectomy for infected pancreatic necrosis. *Gastroenterol Clin Biol* 2004; **28**: 868-871 [PMID: 15523223 DOI: 10.1016/S0399-8320(04)95150-0]
- 133 **Echenique AM**, Sleeman D, Yrizarry J, Scagnelli T, Guerra JJ, Casillas VJ, Huson H, Russell E. Percutaneous catheter-directed debridement of infected pancreatic necrosis: results in 20 patients. *J Vasc Interv Radiol* 1998; **9**: 565-571 [PMID: 9684824 DOI: 10.1016/S1051-0443(98)70323-9]
- 134 **Oh D**, Park DH, Cho MK, Nam K, Song TJ, Lee SS, Seo DW, Lee SK, Kim MH. Feasibility and safety of a fully covered self-expandable metal stent with antimigration properties for EUS-guided pancreatic duct drainage: early and midterm outcomes (with video). *Gastrointest Endosc* 2016; **83**: 366-373.e2 [PMID: 26324387 DOI: 10.1016/j.gie.2015.07.015]
- 135 **Sharaiha RZ**, Tyberg A, Khashab MA, Kumta NA, Karia K, Nieto J, Siddiqui UD, Waxman I, Joshi V, Benias PC, Darwin P, DiMaio CJ, Mulder CJ, Friedland S, Forcione DG, Sejal DV, Gonda TA, Gress FG, Gaidhane M, Koons A, DeFilippis EM, Salgado S, Weaver KR, Poneris JM, Sethi A, Ho S, Kumbhari V, Singh VK, Tieu AH, Parra V, Likhitsup A, Womeldorph C, Casey B, Jonnalagadda SS, Desai AP, Carr-Locke DL, Kahaleh M, Siddiqui AA. Endoscopic Therapy With Lumen-apposing Metal Stents Is Safe and Effective for Patients With Pancreatic Walled-off Necrosis. *Clin Gastroenterol Hepatol* 2016; **14**: 1797-1803 [PMID: 27189914 DOI: 10.1016/j.cgh.2016.05.011]
- 136 **Huggett MT**, Oppong KW, Pereira SP, Keane MG, Mitra V, Charnley RM, Nayar MK. Endoscopic drainage of walled-off pancreatic necrosis using a novel self-expanding metal stent. *Endoscopy* 2015; **47**: 929-932 [PMID: 26126156 DOI: 10.1055/s-0034-1392413]
- 137 **Schmidt PN**, Novovic S, Roug S, Feldager E. Endoscopic, transmural drainage and necrosectomy for walled-off pancreatic and peripancreatic necrosis is associated with low mortality--a single-center experience. *Scand J Gastroenterol* 2015; **50**: 611-618 [PMID: 25648776 DOI: 10.3109/00365521.2014.946078]
- 138 **Kleiman K**. Cardiac involvement in progressive systemic sclerosis (scleroderma). *Minn Med* 1983; **66**: 313, 333 [PMID: 6865888 DOI: 10.5114/wiitm.2015.55677]
- 139 **Siddiqui AA**, Adler DG, Nieto J, Shah JN, Binmoeller KF, Kane S, Yan L, Laique SN, Kowalski T, Loren DE, Taylor LJ, Munigala S, Bhat YM. EUS-guided drainage of peripancreatic fluid collections and necrosis by using a novel lumen-apposing stent: a large retrospective, multicenter U.S. experience (with videos). *Gastrointest Endosc* 2016; **83**: 699-707 [PMID: 26515956 DOI: 10.1016/j.gie.2015.10.020]
- 140 **Smith IB**, Gutierrez JP, Ramesh J, Wilcox CM, Mönkemüller KE. Endoscopic extra-cavitary drainage of pancreatic necrosis with fully covered self-expanding metal stents (fcSEMS) and staged lavage with a high-flow water jet system. *Endosc Int Open* 2015; **3**: E154-E160 [PMID: 26135660 DOI: 10.1055/s-0034-1391481]
- 141 **Saxena P**, Singh VK, Messallam A, Kamal A, Zaheer A, Kumbhari V, Lennon AM, Canto MI, Kalloo AN, Baron TH, Khashab MA. Resolution of walled-off pancreatic necrosis by EUS-guided drainage when using a fully covered through-the-scope self-expandable metal stent in a single procedure (with video). *Gastrointest Endosc* 2014; **80**: 319-324 [PMID: 25034838 DOI: 10.1016/j.gie.2014.04.041]
- 142 **Rische S**, Riecken B, Degenkolb J, Kayser T, Caca K. Transmural endoscopic necrosectomy of infected pancreatic necroses and drainage of infected pseudocysts: a tailored approach. *Scand J Gastroenterol* 2013; **48**: 231-240 [PMID: 23268585 DOI: 10.3109/00365521.2012.752029]
- 143 **Siddiqui AA**, Easler J, Strongin A, Slivka A, Kowalski TE, Muddana V, Chennat J, Baron TH, Loren DE,

- Papachristou GI. Hydrogen peroxide-assisted endoscopic necrosectomy for walled-off pancreatic necrosis: a dual center pilot experience. *Dig Dis Sci* 2014; **59**: 687-690 [PMID: 24282052 DOI: 10.1007/s10620-013-2945-x]
- 144 **Ardengh JC**, Baron TH, Kemp R, Taglieri E, Micelli-Neto O, Orsini ET, Dos Santos JSS. Su1570 Programmed EUS-Guided Necrosectomy for Infected Walled-off Pancreatic Necrosis After Severe Acute Pancreatitis. *Gastrointest Endosc* 2013; **77**: AB371 [DOI: 10.1016/j.gie.2013.03.1223]
- 145 **Yasuda I**, Nakashima M, Iwai T, Isayama H, Itoi T, Hisai H, Inoue H, Kato H, Kanno A, Kubota K, Irisawa A, Igarashi H, Okabe Y, Kitano M, Kawakami H, Hayashi T, Mukai T, Sata N, Kida M, Shimosegawa T. Japanese multicenter experience of endoscopic necrosectomy for infected walled-off pancreatic necrosis: The JENIPaN study. *Endoscopy* 2013; **45**: 627-634 [PMID: 23807806 DOI: 10.1055/s-0033-1344027]
- 146 **Varadarajulu S**, Phadnis MA, Christein JD, Wilcox CM. Multiple transluminal gateway technique for EUS-guided drainage of symptomatic walled-off pancreatic necrosis. *Gastrointest Endosc* 2011; **74**: 74-80 [PMID: 21612778 DOI: 10.1016/j.gie.2011.03.1122]
- 147 **Voermans RP**, Veldkamp MC, Rauws EA, Bruno MJ, Fockens P. Endoscopic transmural debridement of symptomatic organized pancreatic necrosis (with videos). *Gastrointest Endosc* 2007; **66**: 909-916 [PMID: 17963877 DOI: 10.1016/j.gie.2007.05.043]
- 148 **Schrover IM**, Weusten BL, Besselink MG, Bollen TL, van Ramshorst B, Timmer R. EUS-guided endoscopic transgastric necrosectomy in patients with infected necrosis in acute pancreatitis. *Pancreatology* 2008; **8**: 271-276 [PMID: 18497540 DOI: 10.1159/000134275]
- 149 **Charnley RM**, Lochan R, Gray H, O'Sullivan CB, Scott J, Oppong KE. Endoscopic necrosectomy as primary therapy in the management of infected pancreatic necrosis. *Endoscopy* 2006; **38**: 925-928 [PMID: 16981111 DOI: 10.1055/s-2006-944731]



Published By Baishideng Publishing Group Inc
7041 Koll Center Parkway, Suite 160, Pleasanton, CA 94566, USA
Telephone: +1-925-2238242
Fax: +1-925-2238243
E-mail: bpgoffice@wjgnet.com
Help Desk: <https://www.f6publishing.com/helpdesk>
<https://www.wjgnet.com>

