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Nutrition management in acute pancreatitis: Clinical practice consideration

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Abstract

Acute pancreatitis (AP) is a common gastrointestinal disease and the leading cause of hospital admission and healthcare burden among gastrointestinal disorders in many countries. Patients can present with varying degrees of inflammation and disease severity, ranging from self-limiting mild AP to devastating and fatal severe AP. Many factors contribute to malnutrition in AP, especially abnormal metabolism and catabolism related to inflammation. The concept of "pancreatic rest" is not evidence-based. There is however, emerging evidence that supports the use of oral or enteral nutrition to improve nutrition status and to reduce local and systemic inflammation, complications, and death. In mild disease, patients are generally able to initiate solid oral diet and do not require specialized nutrition care such as enteral or parenteral nutrition. In contrast, nutrition interventions are imperative in moderately severe and severe AP. The current article aims to review the latest evidence and suggest practical nutrition interventions in patients with AP, including nutrition requirements, routes of nutrition treatment, types of formula, and the role of nutritional supplements, such as glutamine, probiotics, omega-3 fatty acids, and antioxidants.

Key words: Acute pancreatitis; Nutrition management; Enteral nutrition; Parenteral nutrition; Nutritional supplement; Nutrition assessment

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Core tip: Nutrition intervention helps prevent malnutrition and is a key to reduce inflammation, complications, and death in acute pancreatitis. Current evidence supports the benefits of early enteral nutrition in severe pancreatitis. Gastric and jejunal feeding are equally effective, and polymeric formula is safe, compared to peptide-based formula. Parenteral nutrition should be considered in patients who cannot tolerate enteral

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nutrition. According to recent data, nutritional supplements, including glutamine, probiotics, omega-3 fatty acids, and antioxidants, may contribute to positive outcomes. While intravenous glutamine shows promising benefits in patients receiving total parenteral nutrition, further studies in other nutritional supplements are needed.

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INTRODUCTION

Acute pancreatitis (AP) is an acute inflammatory process of pancreas with variable involvement of other regional tissues and remote organ systems. The diagnosis is based on two of the following three criteria: (1) Abdominal pain consistent with pancreatitis; (2) A serum amylase or lipase greater than 3 times upper normal limit; and (3) Characteristic findings from abdominal imaging^[1]. The two most common etiologies of AP are gallstones (40%-70%) and alcohol (25%-35%). Other causes include medications, infectious diseases, and metabolic causes such as hypercalcemia and hypertriglyceridemia^[2].

The incidence of AP varies between 4.9 and 73.4 cases per 100000 worldwide^[3,4]. The overall mortality ranges from 5%-20%, depending on severity of pancreatitis. The severity of this disease is classified as mild, moderately severe, or severe, according to the 2012 revised Atlanta classification^[5]. While the mortality rate is very low in mild pancreatitis (1%), there is a dramatic 30% increase in mortality in severe pancreatitis. Additionally, mortality can be up to 50% in extensive pancreatic necrosis and as high as 80% in patients with sepsis^[6]. AP is associated with a hospital length of stay of about 30 d and annual health-care cost of 2.6 billion in the United States^[7,8].

There are two distinctive phases of AP: (1) Early phase (within 1 wk), characterized by both local pancreatic inflammation, the systemic inflammatory response syndrome, and/or organ failure; and (2) Late phase (> 1 wk), characterized by local complications and/or persistent organ failure^[2]. Hence, prevention and management of systemic inflammatory response syndrome, organ failure, and complications are imperative in order to decrease morbidity and mortality in this potentially fatal disorder. Nowadays, there are no specific medications found to effectively treat AP, and therefore management is focused on supportive interventions such as fluid resuscitation and nutrition intervention. Nutrition management has demonstrated necessity not only in prevention and treatment of malnutrition but also in obviating systemic inflammation, reduction of complications, and therefore modifying the course of the disease^[9,10].

This article aims to review the latest evidence and recommend an evidence-based practical approach to nutrition management in AP, which includes patient evaluation, nutrition management in mild, moderately severe, and severe pancreatitis, and pancreatic exocrine insufficiency (PEI) in AP.

PATHOPHYSIOLOGY OF MALNUTRITION AND NUTRIENT METABOLISM IN AP

Multiple factors are able to deteriorate nutrition status in AP, and one of the most important factors is inflammation. Inflammatory cytokines (tumor necrosis factor alpha, interleukins 1 and 6) and stress hormones (cortisol, catecholamines, and glucagon), released during pancreatitis, result in abnormal metabolism which is similar to sepsis^[11].

Resting energy expenditure (REE) in patients with pancreatitis is generally higher than healthy individuals because of inflammation-induced hypermetabolism and/or septic complications. REE measured by indirect calorimetry (IC) increased in 61% of patients with AP and 82% in pancreatitis complicated by infection. $m \pm SD$ of measured REE was $111\% \pm 15\%$ in mild pancreatitis, $126\% \pm 10\%$ in severe pancreatitis, and $120\% \pm 11\%$ in pancreatic sepsis, compared to predicted REE by Harris-Benedict equation^[12]. Nutrition support may help restore energy balance and

prevent malnutrition in this circumstance.

Severe inflammation leads to protein catabolism. Amino acids released from protein breakdown provide substrates for the production of acute-phase protein. This was found in 80% of patients with severe necrotizing pancreatitis^[11]. Nitrogen balance can be negative up to 20-40 g/d^[13,14] and patients with a negative balance had a ten-fold higher death rate than those with normal balance^[15]. Muscle mass and function, measured by grip strength and respiratory muscle strength, rapidly declined within 5 d without nutrition support in healthy men suffering from AP^[16].

Regarding carbohydrate metabolism, hyperglycemia is often found in patients with pancreatitis. It is a result of insulin resistance, increased glucose production from liver (gluconeogenesis), and impaired insulin secretion caused by beta-cell damage^[17]. Hyperglycemia is related with pancreatic necrosis and infectious complications. As a result, blood glucose should be monitored and controlled in all patients^[18].

Hypertriglyceridemia is common, and can be either a cause or a consequence of pancreatitis. Lipid catabolism and impaired lipid clearance, resulting from decreased insulin secretion, contribute to elevated serum triglycerides^[18]. In the absence of gallstones and significant alcohol consumption, severe hypertriglyceridemia (serum triglycerides > 11.3 mmol/L) can be considered as a cause of AP^[2,19]. Serum triglycerides level should be monitored, especially in those who receive intravenous lipid emulsions (ILEs).

Malnutrition in AP can arise from decreased oral intake as a result of anorexia, abdominal pain, vomiting, ileus, gastroparesis, gastric outlet obstruction, and inappropriate fasting for pancreatic rest^[20]. In addition, pancreatic exocrine dysfunction leads to maldigestion of nutrients and may persist up to 6-18 mo after acute attack^[21].

Micronutrient abnormalities are common in AP. Chronic alcohol consumption frequently leads to micronutrient deficiencies due to inadequate intake, decreased absorption, and impaired storage and utilization of nutrients. In patients with alcoholism, biochemical data demonstrate several micronutrient deficiencies including vitamin B1, B2, B3, B12, C, A, folic acid, and zinc^[22,23]. Moreover, the risk of deficiencies increases in patients with severe complicated pancreatitis, requiring prolonged admission. The etiology is multifactorial including decreased intake, maldigestion, and increased demand from severe inflammation. Hypocalcemia can occur in 40%-60% of patients. The underlying causes of hypocalcemia may be related to saponification of calcium, hypomagnesemia, decreased parathyroid hormone release, and increased calcitonin levels^[24,25].

FALL OF THE “PANCREATIC REST” CONCEPT

Nutrients delivered to gastrointestinal tract proximal to mid-jejunum (around 40 cm distal to ligament of Trietz) stimulate pancreatic enzyme secretion. Traditional thinking was that this may lead to increased pancreatic autodigestion and worsening of pancreatitis. As a result, the concept of “pancreatic rest” has formerly been used to guide management of AP since the 1970s. This concept states that enteral nutrition (EN) should only be started when abdominal pain has completely resolved and the pancreatic enzymes have normalized. Based on this concept, strategies are used to minimize pancreatic stimulation such as parenteral nutrition (PN), elemental formula, and a stepwise introduction of oral diet, beginning with clear fluid. However, this concept is based on only physiologic assumption and is not supported by good scientific evidence and indeed, may result in worsening of nutritional status and poor outcomes^[7,26].

Further studies have found that pancreatic enzyme secretion is significantly reduced in AP and the secretion was inversely related to the severity of pancreatitis. A lower secretion of trypsin (16-fold), amylase (22-fold), and lipase (102-fold) was found in severe pancreatitis^[27]. In addition, early EN use resulted in clinically significant exacerbation of symptoms in only 4% of cases^[28]. These data suggest that the injured acinar cells cannot fully respond to physiologic stimuli, and may explain why enteral feeding is safe and does not worsen autodigestion during an attack of pancreatitis.

Since the 1990s, several randomized controlled trials (RCT) and meta-analyses have demonstrated safety and benefits of enteral nutrients in terms of mortality, multiorgan failure, infection, complications, and surgical intervention^[29-32]. This evidence supports the administration of EN to stimulate and maintain gut function, which is opposite to “pancreatic rest” that may give rise to gut dysfunction and worse clinical outcomes. Enteral nutrients help maintain gut integrity, gut-associated lymphoid tissue, and gut microbiota composition. This strategy reduces bacterial, endotoxin, and pancreatic enzyme translocation, which may attenuate systemic

inflammation, multiorgan failure, infection, and disease severity in AP^[26,33-35]. Based on this evidence, the gastrointestinal tract should be considered as an important organ in pancreatitis patients.

PATIENT EVALUATION

The principal aim of patient evaluation is: (1) To plan nutrition support according to the severity of pancreatitis; (2) To evaluate nutrition status; and (3) To identify risk groups that require special nutrition needs^[22].

Since AP has a vast spectrum of disease severity, the approach to nutritional management is different between mild, self-limited disease and severe, fulminant pancreatitis. Thus, it is useful to evaluate disease severity before deciding on a plan for nutrition treatment. The revised Atlanta 2012 classification (Table 1) defines three degrees of severity: Mild, moderately severe, severe pancreatitis according to organ failure (modified Marshall score ≥ 2 , Table 2), and local or systemic complications.

Preexisting malnutrition was found in 30% of cases at the time of the initial attack. The risk groups of malnutrition include chronic alcoholism and elderly^[22]. Malnutrition is associated with negative outcomes (complications, higher morbidity, and prolonged hospital stay)^[13,36], and therefore nutrition status should be evaluated by validated nutrition screening and assessment tools especially in high risk population.

Patients with chronic alcoholism require special attention to evaluate clinical signs and/or biochemical levels of the micronutrients (vitamin B1, B2, B3, B12, C, A, folic acid, and zinc)^[22]. Obese patients may be considered and managed as at risk of severe pancreatitis. Meta-analyses demonstrated a significantly higher rate of severe pancreatitis [Odds ratio (OR) = 2.9, 95% confidence interval (CI): 1.8-4.6], local complications (OR = 3.8, 95% CI: 2.4-6.6), systemic complications (OR = 2.3, 95% CI: 1.4-3.8), and death (OR = 2.89, 95% CI: 1.1-7.36) in obese patients^[37,38]. The pathophysiology may be associated with unregulated lipolysis of visceral fat around pancreas, which inhibits mitochondrial complex I and V, leading to pancreatic necrosis and poor outcomes^[39].

NUTRITION MANAGEMENT IN MILD AP

Mild AP is reported in 75%-85% of all AP episodes. It is transient, self-limiting, and therefore specialized nutrition care (EN and/or PN), is not generally required^[7]. Patients can consume oral diet when abdominal pain, nausea, and vomiting are improved. A full caloric, solid diet can be started safely and a stepwise introduction of oral diet, beginning with clear liquids, is unnecessary. Randomized trials comparing a clear liquid diet and a solid diet in mild pancreatitis illustrated that initiating oral feeding with a solid diet was safe, well-tolerated, and could decrease length of hospital stay by 2 d compared with a liquid diet^[40-42]. As for dietary composition, even though a low fat diet (< 30% of total energy) has been used in previous studies^[40,42], this diet does not support by good scientific evidence and may lead to inadequate energy intake. Tube feeding is only recommended when oral nutrition is not feasible for more than 5 d^[13]. An example of this is patients with poor oral intake resulting from persistent nausea, vomiting, and abdominal pain.

NUTRITION MANAGEMENT IN MODERATELY SEVERE AND SEVERE AP

Nutrition support has been well-documented in its benefits in moderately severe and severe pancreatitis. The following aspects should be considered in this group of patients.

Nutrient requirements

Energy requirement should be estimated with IC if possible, or 25 kcal/kg/d may be used as energy goal. Many non-static variables affect energy expenditure in severe pancreatitis, such as body temperature, volume status, and medications. These variables result in the poor accuracy of predictive equations. IC is the goal standard to determine energy expenditure, and thus IC measurement may help prevent over- or underfeeding. Energy requirement, whether by calorimetry or predictive equation, should be reevaluated more than once per week in order to reach appropriate energy balance. Estimated protein requirements are higher than healthy individuals (1.2-1.5

Table 1 The revised Atlanta 2012 classification for grading severity of acute pancreatitis

Grade of severity	Criteria
Mild	No organ failure No local or systemic complications
Moderately severe	Organ failure that resolves within 48 h (transient organ failure) and/or Local or systemic complications without persistent organ failure
Severe	Persistent organ failure (> 48 h) Single organ failure Multiple organ failure

Local complications include acute peripancreatic fluid collection, pancreatic pseudocyst, acute necrotic collection and walled-off necrosis. Systemic complications include exacerbation of pre-existing co-morbidity, such as coronary artery disease or chronic lung disease, precipitated by the acute pancreatitis.

g/kg/d). This may improve nitrogen balance and is related to a decrease in 28-d mortality in critically ill patients^[43]. Mixed source of energy from carbohydrate, fat, and protein should be provided^[20,44].

A daily dose of multivitamins and trace elements is recommended especially in patients receiving total PN^[44]. Micronutrients should be supplemented in patients with confirmed or suspected deficiencies.

Route of nutrition support

EN: Enteral feeding should be considered as a preferred route of nutrition support^[2,13,45]. A 2018 meta-analysis of 5 RCTs (348 patients) demonstrated that EN, when compared to PN, was associated with a significant reduction in death with risk ratio (RR) of 0.36 (95%CI: 0.20-0.65) and multiple organ failure with RR of 0.39 (95%CI: 0.21-0.73)^[31]. These benefits were confirmed in a recent meta-analysis of 11 studies including 562 patients. The results showed that EN significantly decreased mortality rate (RR = 0.43; 95%CI: 0.23-0.78), the risk of complications (RR = 0.53; 95%CI: 0.39-0.71), and mean length of hospital stay (mean difference = -2.93, 95%CI: -4.52 to -1.34)^[32]. Local complications (necrosis, fistulas, ascites, and pseudocyst) are not contraindications for enteral feeding^[13].

EN should be started after adequate resuscitation and stable hemodynamic status. Many studies have shown advantages of early enteral feeding in severe pancreatitis. Meta-analyses illustrated that early EN within 48 h of admission was associated with significant reductions in mortality, infectious complications, multi-organ failure, surgical intervention, and length of hospitalization^[46,47]. In contrast, early EN may not be better than on-demand oral diet at 72 h. A multicenter RCT in 205 patients compared early EN within 24 h *vs* on-demand oral diet 72 h, with tube feeding provided at day 4 if the oral diet was not tolerated. There was no significant difference between two groups in the rate of major infection or death, and tube feeding could be prevented in 69% of patients in on-demand group^[48]. Over 80% of the patients in this study were admitted to medical ward and only 18% required intensive care unit (ICU) admission, which indicates that most of them may actually have moderately severe pancreatitis. This result suggests that, in non-ICU patients, on-demand oral diet may be tried for 3 d and tube feeding should be initiated at day 4 if the oral diet is unsuccessful. However, more data are required before a recommendation can be made about this issue.

In patients who need tube feeding, continuous feeding is recommended over bolus feeding by current guidelines^[2,13]. Better feeding tolerance and fewer interruptions of EN delivery due to elevated residuals and vomiting were found in continuous infusion compared with bolus group^[49,50].

Given that pancreatic enzymes stimulated by enteral nutrients may lead to pancreatic autodigestion, the role of antisecretory agents, including somatostatin and its analogues (octreotide), has been investigated in several studies. However, the result remains inconclusive. A RCT and recent Cochrane review revealed no benefit among treatment group with respect to mortality, complications, and duration of pain^[51,52]. This may be due to a dramatic decrease in pancreatic secretion during AP.

Gastric *vs* small bowel feeding: Traditionally, it is believed that small bowel feeding was associated with less pancreatic stimulation and autodigestion. Nevertheless, a meta-analysis found that nasogastric feeding was not inferior to nasojejunal feeding in terms of exacerbation of pain (RR = 0.94; 95%CI: 0.32-2.70), aspiration (RR = 0.46; 95%CI: 0.14-1.53), meeting energy balance (RR = 1.00; 95%CI: 0.92-1.09), and mortality

Table 2 Modified Marshall scoring system for organ dysfunction

Organ system	Score				
	0	1	2	3	4
Respiratory (PaO ₂ /FiO ₂)	> 400	301-400	201-300	101-200	≤ 100
Renal ¹					
Serum Cr (μmol/L)	≤ 134	134-169	170-310	311-439	> 439
Serum Cr (mg/dL)	< 1.4	1.4-1.8	1.9-3.6	3.6-4.9	> 4.9
Cardiovascular (SBP, mm Hg) ²	> 90	< 90, fluid responsive	< 90, not fluid responsive	< 90, pH < 7.3	< 90, pH < 7.2

¹A score for patients with pre-existing chronic renal failure depends on the extent of further deterioration of baseline renal function. No formal correction exists for a baseline serum creatinine ≥ 134 μmol/L or ≥ 1.4 mg/dL.

²Off inotropic support. A score of 2 or more in any system defines the presence of organ failure. Cr: Creatinine; SBP: Systolic blood pressure.

(RR = 0.69; 95%CI: 0.37-1.29)^[53]. This is predicated by lack of impact on pancreatic secretion regardless of feeding route during AP. Initiating EN in the stomach is technically easier, cheaper, and may reduce the time to start EN while small bowel feeding generally requires special technique and takes more time for tube placement. For these reasons, nasogastric tube may be used as a first line therapy in order to achieve benefits of early EN in patients with severe pancreatitis.

Jejunal feeding should be considered in patients who cannot tolerate gastric feeding. It may be necessary in those with severe gastroparesis or partial gastric outlet obstruction either from pancreatic edema or pseudocysts^[54]. An intraoperative jejunostomy tube may be placed for postoperative feeding in patients undergoing surgery from other indications^[13].

Polymeric vs elemental/semi-elemental formulas: Elemental and semi-elemental formulas are thought to induce less pancreatic stimulation, require less digestion, and are readily absorbed into small intestine. A physiological study in healthy subjects found that pancreatic enzyme secretion reduced by 50% when polymeric formula was changed to elemental formula^[55]. Thus, semi-elemental and elemental formulas have been used in many studies on AP. Even though few studies directly compare between elemental/semi-elemental formulas and polymeric formula, there are one RCT and one retrospective cohort study showing elemental and semi-elemental formulas were not superior over polymeric formula in terms of feeding tolerance, diarrhea, and infectious complications^[56,57]. Additionally, a meta-analysis of 10 RCTs using indirect adjusted method illustrated that the use of semi-elemental or elemental formula did not result in a significant difference in feeding intolerance (RR = 0.62; 95%CI: 0.10-3.97), infection (RR = 0.48; 95%CI: 0.06-3.76), and death (RR = 0.63; 95%CI: 0.04-9.86)^[58]. Furthermore, the weekly cost for semi-elemental formula is 7-fold higher than polymeric formula^[7]. Hence, the use of polymeric formula may be effective and practical in severe pancreatitis.

PN: PN is indicated when patients cannot tolerate EN. Some patients develop intestinal failure type I or II from systemic or local complications such as severe ileus and duodenal obstruction from pancreatic edema or pseudocyst. When PN is required, a mixed fuel solution (carbohydrate, protein, and lipids) is recommended. Glucose should not be more than the maximal level of glucose oxidation (4-7 mg/kg/min or 5-6 g/kg/d), and a target blood glucose range of 7.7-10 mmol/L is recommended^[59,60]. ILEs can be safely started and the recommended dose is 0.8-1.5 g/kg/d^[20,44]. ILEs dose may need to be reduced or discontinued if serum triglyceride concentrations greater than 4.5 mmol/L^[18,61]. PN initiation may need to be delayed until after 5-7 d of admission^[20,59]. Because initiating PN at this point may be associated with better outcomes, including decreased mortality, overall complication, and length of hospitalization^[62]. Further studies are needed to confirm appropriate time and clinical benefits of PN in AP with intestinal failure. The recommended route of nutrition support is summarized in **Figure 1**.

Role of nutritional supplements

Glutamine: Glutamine is considered a conditionally essential amino acid with antioxidative effects that improves immune function and intestinal integrity. Its depletion has been demonstrated in critically ill patients because of the increased demand during metabolic stress^[63]. Glutamine supplementation may play a role in critical illnesses, including severe pancreatitis^[10].

A meta-analysis of 12 RCTs demonstrated that glutamine was associated with

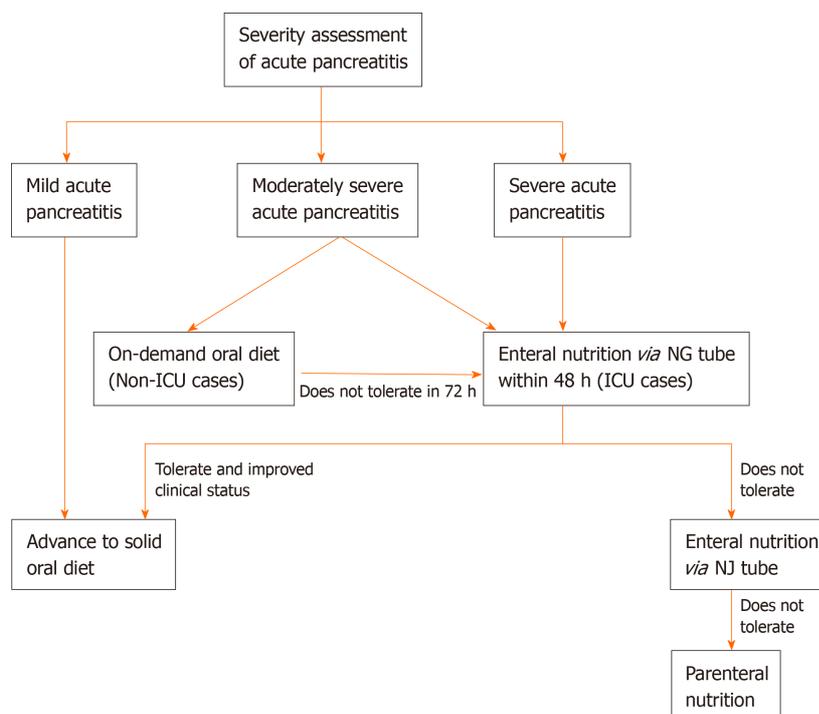


Figure 1 Route of nutrition treatment in acute pancreatitis. ICU: Intensive care unit; NG: Nasogastric tube; NJ: Nasojejunal tube.

lower infectious complications (RR = 0.58; 95% CI: 0.39-0.87) and mortality (RR = 0.30; 95% CI: 0.15-0.60). In this study, only patients receiving total PN but not EN showed statistically significant benefits^[64]. Another meta-analysis confirmed these findings and, again, intravenous glutamine was related with more advantages^[65]. A recent RCT of enteral glutamine showed improvement in organ failure score without significant benefits in infected necrosis and mortality^[66]. Overall, intravenous glutamine seems to give benefits in patients with total PN while the beneficial effects of enteral glutamine needs to be investigated in the future. The recommended dose of glutamine supplementation is between 0.3-0.5 g/kg/d.

Probiotics: Intestinal barrier dysfunction may induce bacterial translocation and infected necrosis, being the major cause of morbidity and mortality in severe pancreatitis. Probiotics may help improve gut integrity and immune function, and thus prevent bacterial translocation^[67,68]. *Lactobacillus plantarum* decreased intestinal permeability, infectious complications, systemic inflammation, and multiorgan failure, but did not improve mortality rate in small RCTs^[69-71]. In contrast, a multispecies probiotic preparation did not reduce infection and was associated with an increased mortality (RR = 2.53; 95% CI: 1.22-5.25)^[72]. These data suggest the potential benefits of single strain probiotic (*Lactobacillus plantarum*) in severe pancreatitis; however, further validated studies are needed before its advantages could be confirmed.

Omega-3 fatty acids: Omega-3 fatty acids have shown beneficial anti-inflammatory effects and may improve systemic inflammation, multiorgan failure, and clinical outcomes in severe pancreatitis. A meta-analysis of 8 small RCTs demonstrated that the administration of omega-3 fatty acids was beneficial for reducing mortality, infectious complications, and length of hospital stay, especially when received parenterally. Nonetheless, large and rigorously designed RCTs are required to elucidate the efficacy of omega-3 fatty acid supplement in severe pancreatitis^[73].

Antioxidants: Antioxidants (vitamin A, vitamin C, vitamin E, selenium, and N-acetyl cysteine) may reduce inflammation and improve outcomes in severe pancreatitis. Nevertheless, few small studies with varied dose and duration of antioxidants led to mixed outcomes^[10]. Larger and well-designed clinical trials are needed to confirm potential benefits of antioxidants in this disorder.

PEI IN AP

Although no data supports routine use of pancreatic enzymes during the first 5-10 d of AP, the evidence supports that some patients experience exocrine dysfunction for a period of time after acute attack of pancreatitis^[74,75]. A meta-analysis in 2018, containing 32 studies (1495 patients), showed that the prevalence of PEI after pancreatitis was 27.1%. This condition is directly related to the degree of pancreatic parenchymal injury and is more common in alcoholic pancreatitis (22.7%), severe pancreatitis (33.4%), and necrotizing pancreatitis (32%)^[76]. Patients should be monitored for symptoms of maldigestion (diarrhea, steatorrhea) and/or non-invasive pancreatic function tests (*e.g.*, fecal fat and fecal elastase)^[77] for at least 6-18 mo after AP, especially in alcoholic, severe, and necrotizing pancreatitis. Pancreatic enzyme supplement should be started as indicated^[75].

CLINICAL VIGNETTE

Case 1

A 48 years old woman presented with acute onset of severe epigastric pain with nausea, and vomiting. She had no significant past medical history and denied alcohol drinking. Her body weight was stable and her body mass index was 24 kg/m². Initial laboratory results showed lipase 560 U/L (0-60 U/L). Abdominal ultrasound demonstrated several gallstones with normal bile duct. She had no organ failure at admission, and therefore mild acute gallstones pancreatitis was diagnosed. Her abdominal pain and nausea were improved after receiving analgesia and antiemetic medications. What is the most appropriate nutrition management in this patient?

Comment: The patient presented with classic acute gallstone pancreatitis. Given that her disease severity was mild, and her abdominal pain and nausea were improved, solid oral diet should be initiated. Stepwise approach starting from clear fluid is unnecessary and may be associated with longer length of hospital stay in this patient.

Case 2

A 55 years old man presented with acute severe epigastric pain, accompanied by alteration of consciousness, vomiting, and fever. He had history of chronic alcohol drinking 100 g/d for more than 20 years. His body weight was stable with body mass index of 22 kg/m². Initial laboratory results demonstrated lipase 720 U/L (0-60 U/L) and creatinine 180 µmol/L (50-120 µmol/L). He was intubated in order to protect airway and was admitted to intensive care unit. Initial management included intravenous crystalloid solution and symptomatic treatment. On day 2 of admission, his creatinine was rising to 190 µmol/L. Severe acute alcoholic pancreatitis was diagnosed. What is the most appropriate nutrition treatment in this patient?

Comment: This patient was diagnosed with acute alcoholic pancreatitis with persistent organ failure. He was intubated and was admitted to intensive care unit. Therefore, early EN should be initiated after adequate resuscitation. Nasogastric tube can be used to achieve early EN. A standard polymeric formula may be initiated at the rate of 20 ml per hour and should be titrated to meet protein and energy requirements (1.2-1.5 g/kg/d and 25 kcal/kg/d, respectively). Given the history of chronic alcoholism, micronutrient levels, including vitamin B1, B2, B3, B12, C, A, folic acid, and zinc may be evaluated and treatment should be initiated if there is an evidence of micronutrient deficiencies.

Case progression

On day 5 of admission, he still had fever and severe abdominal pain required around the clock intravenous opioid injection. Physical examination revealed hypotension, absent bowel sound, marked abdominal distension, and generalized abdominal tenderness. He could not tolerate enteral feeding due to vomiting. Computer tomography demonstrated extensive pancreatic necrosis with gas at body and tail of pancreas, and generalized small and large bowel dilatation. Vasopressor agents and antibiotics were initiated and surgical debridement was planned. What is the most appropriate nutrition treatment according to his clinical status?

Comment: The patient was complicated by infected pancreatic necrosis with septic shock. He could not tolerate EN due to severe ileus. As a result, PN was indicated in this case. ILEs can be given if serum triglycerides levels was less than 4.5 mmol/L, and the dose should be 0.8-1.5 g/kg/d. Blood glucose should be monitored and controlled in range 7.7-10 mmol/L. In this case, intravenous glutamine may be

considered with the dose 0.3-0.5 g/kg/d.

CONCLUSION

AP is a common gastrointestinal disease with varying degree of disease severity ranging from self-limiting mild AP to devastating and fatal severe AP. At present, disease-specific treatment remains obscure and supportive care, including nutrition intervention, are crucial. Nutrition treatment not only helps prevent malnutrition, but it is also a key to reduce systemic inflammation, complications, and death. Severity assessment is the first step to guide nutrition intervention. In mild pancreatitis, patients are generally able to initiate solid oral diet and do not require specialized nutrition care. In moderately severe or severe pancreatitis, gut should be considered as an important organ, and early EN should be given to maintain gut function and achieve positive clinical outcomes. Gastric and jejunal feeding are equally effective in severe pancreatitis. Polymeric formula is safe and inexpensive, compared to elemental formula. PN should be administered only in patients who cannot tolerate EN. Some nutritional supplements, such as intravenous glutamine in patients with total PN, may lead to positive outcomes. However, further studies are still needed in the others. [Table 3](#) summarizes all recommendations and areas that need future study in AP.

Table 3 Summary of nutrition management in severe acute pancreatitis and areas for future research

Recommendation	Areas for future research
Energy requirement should be measured by IC, or 25 kcal/kg/d may be used	Role of on-demand oral diet
Protein requirements are 1.2-1.5 g/kg/d	Polymeric formula <i>vs</i> elemental/semi- elemental formula
Early EN within 48 h is recommended	Timing and benefits of PN in intestinal failure type I or II
Gastric or Jejunal feeding is acceptable	Role of enteral glutamine, probiotics, omega-3 FAs, antioxidants
Intravenous glutamine may be considered in patients with TPN	
PEI should be monitored, especially in alcoholic, severe, and necrotizing pancreatitis	

EN: Enteral nutrition; IC: Indirect calorimetry; TPN: Total parenteral nutrition; PEI: Pancreatic exocrine insufficiency; FAs: Fatty acids.

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