Modern strategies for the diagnosis and treatment of acute pancreatitis: prospects for an interdisciplinary approach


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Abstract

The article discusses modern strategies for the diagnosis and treatment of acute pancreatitis with an emphasis on the prospects of an interdisciplinary approach. Acute pancreatitis remains a serious disease with high mortality and a complex clinical course. In recent years, there has been a significant development of diagnostic and treatment methods, including the use of modern educational technologies, drug therapy, surgical techniques and interventional procedures. However, effective treatment of acute pancreatitis requires an integrated approach combining the efforts of various medical specialists – from therapists and gastroenterologists to surgeons and intensive care specialists.

The authors discuss the latest diagnostic methods, such as computed tomography and endoscopic ultrasound diagnostics, as well as innovative treatment approaches, including minimally invasive surgical interventions, etc. Research based on interdisciplinary collaboration helps to reduce mortality from acute pancreatitis and improve the prognosis of patients. The development and implementation of integrated strategies for the diagnosis and treatment of acute pancreatitis using modern technologies are key areas in improving the effectiveness of medical care for patients with this disease.

Keywords

Acute pancreatitis, Diagnosis, Treatment, Innovative methods, Interdisciplinary approach.

INTRODUCTION

Acute pancreatitis remains a serious problem in modern medicine, characterized by high mortality and a complex clinical course. In recent decades, there has been an increase in cases of acute pancreatitis, which requires constant improvement of methods for its diagnosis and treatment.

Modern diagnostic technologies, such as computed tomography and endoscopic ultrasound diagnostics, make it possible to more accurately determine the degree of pancreatic tissue damage and assess the severity of the disease. However, effective treatment of acute pancreatitis requires an integrated approach, including not only drug therapy, but also surgical techniques and interventional procedures.

An interdisciplinary approach is becoming key in the management of patients with acute pancreatitis. The interaction of various specialists, ranging from therapists and gastroenterologists to surgeons and intensive care specialists, allows us to provide comprehensive care and reduce the risk of complications.

The purpose of this article is to consider modern strategies for the diagnosis and treatment of acute pancreatitis with an emphasis on the prospects of an interdisciplinary approach.

MATERIALS AND METHODS

While writing the article, an extensive review of modern and classical scientific articles, reviews, reviews and books on the topic of acute pancreatitis was conducted. Special attention was paid to current research that affected the methods of diagnosis, treat-
ment and the results of such treatment. Diagnostic methods such as molecular genetic and biomarker methods and modern treatment approaches such as intensive care and interventional procedures were considered. The results of clinical studies were also analyzed, which confirmed the effectiveness of certain methods of diagnosis and treatment of acute pancreatitis. Comparative and analytical research methods were used in the processing of materials.

RESULTS

Acute pancreatitis (AP) is an inflammatory disease of the pancreas affecting all age groups, with an annual incidence of 10-50 cases per 100,000 people. The main causes of AP are migration of gallstones and alcohol abuse. Among them, the predominance of one cause over another depends on socio-economic, ethnic and cultural differences[1].

In most patients with AP, the disease is mild and resolves on its own. Conversely, 15-20% of patients with AP develop local or systemic complications, often leading to multiple (respiratory, cardiovascular, renal and hepatic) organ failure (PON) and death. According to the revised Atlantic Classification, the severity of AP is divided into three levels: mild, moderate and severe, depending on organ failure, as well as local and systemic complications [2]. However, the pathophysiological mechanism of AP has not been fully elucidated, and there are several contradictions regarding diagnostic and therapeutic methods due to their effectiveness and complications in the treatment of the disease. These disagreements primarily relate to therapeutic treatment at an early stage of the disease, which includes infusion therapy, including the most appropriate type of liquid to use, as well as the time, volume and speed of administration.

Other disagreements include the time to resume work and the importance of nutritional support, the role of preventive antibiotics, the timing of more aggressive methods, including surgery, as well as the treatment of complications that may negatively affect the prognosis and quality of life of the patient.

There are many causes and pathological conditions potentially associated with AP. It is generally believed that gallstones and alcohol abuse are the cause of about 90% of all cases of AP. The role of gallstones is very important in the etiopathogenesis of AP, and any sign indicating the presence of gallstones in the gallbladder or biliary tract in patients with AP can be classified as the cause of the disease. Therefore, all patients with AP should undergo an ultrasound examination for the presence of cholecystolithiasis, common bile duct stones or diagnose signs of biliary tract obstruction. Alcoholic pancreatitis is more common in young and middle-aged people, in whom idiosyncratic sensitivity to alcohol may exist at alcohol levels exceeding 80 g/dl. Other predisposing factors may be the level of alcohol dehydrogenase activity in the gastric and liver mucosa [3].

OP is mainly an acute inflammatory process in which the pancreatic parenchyma is involved, and in severe forms of the disease other regional tissues or distant organ systems are involved. The pathogenic mechanism of AP is represented by inadequate activation of trypsinogen and destruction of secretory cells, followed by systemic release of cytokines and inflammatory mediators, causing activation of inflammatory cells, fever and PON. Other factors in the pathogenesis of the disease are calcium overload, mitochondrial dysfunction, impaired autophagy, stress of the endoplasmic reticulum and exosomes [4]. Edema of pancreatic and peripancreatic tissues, fatty necrosis are characteristic of all forms of AP (mild, moderate and severe), however, with severe AP (SAP), there is a possibility of hemorrhages in the pancreas.

In the early stages of AP, acute accumulations of pancreatic fluid (pancreas) can occur in the form of accumulations of pancreatic juice rich in amylase and protein, and usually resolve spontaneously. Accumulations of pancreatic fluid that persist for more than 4 weeks are usually caused by rupture of the pancreatic duct (PD) with extravasation of pancreatic juice and are called pancreatic pseudocysts (PPK) or pancreatic necrosis (PN).

The diagnosis of AP is based on the clinical picture, laboratory studies and imaging results and requires the presence of two of the following three criteria: clinical (acute attack of pain in the upper abdomen, spreading to the back), laboratory (serum lipase and/or amylase levels three or more times higher than normal values) and typical imaging results (computer tomography (CT), magnetic resonance imaging, ultrasound), typical for AP. The most common symptoms of the disease are abdominal pain (80-95%), followed by nausea and vomiting (40-80%), soreness, shortness of breath, impaired consciousness with fever, bloating and decreased intestinal sounds [5].

The diagnosis of AP can be confirmed by laboratory tests of serum and urine to clarify its origin. They
usually reflect organ dysfunction and metabolic disorders.

When the clinical picture is typical, but the laboratory parameters are ambiguous or inconclusive, imaging techniques are needed. CT with contrast enhancement is the most frequently performed imaging test and the method of choice for diagnosing PN, determining its degree and diagnosing local complications. However, the full development of PN usually takes several (approximately 4-7) days from the onset of the disease, and before that time, CECT cannot be used to reliably assess the presence and degree of necrosis [6].

Magnetic resonance imaging is a good alternative to contrast-enhanced CT due to its excellent contrast resolution of soft tissues and a better assessment of the gallbladder and BP. This method can also be used as a replacement for endoscopic retrograde cholangiopancreatography (ERCP) in the diagnostic evaluation of AP [7].

Based on the achievements in predicting and diagnosing the severity of AP, CT is considered a diagnostic criterion for assessing AP. However, there is an important situation where contrast CT is contraindicated in patients with renal dysfunction and pregnant women, and it is impossible to repeat subsequent studies due to cost and radiation exposure. In uncomplicated AP, CT is both clinically and biochemically diagnosed as unnecessary; minimizing its overuse will not only reduce healthcare costs, but also reduce radiation exposure to patients [8]. CT on admission to predict the outcome does not seem to have advantages over simpler and more accessible clinical assessment systems. Therefore, a CT scan on the day of hospitalization to assess the severity is not recommended. Improvement measures aimed at limiting the excessive use of early imaging in patients with AP can reduce the amount of excessive imaging, improve the quality of care and reduce losses.

In addition, CT has limitations in assessing the severity of AP, and it is difficult to distinguish necrosis from local effusion in small, non-enlarged areas of the pancreas. Without pancreatic parenchymal necrosis, small organized accumulations of peripancreatic fluid on CT may be mistaken for pseudocysts, which leads to underestimation of extrapancreatic necrosis [9]. These disadvantages limit the use of CT in a number of situations and there is a need to develop other methods that can be used to diagnose and assess the prognosis of AP. In addition, it is recommended that future studies include reliable non-radiological and laboratory classification tests to improve the accuracy of determining and assessing the severity and prognosis of AP, thereby reducing morbidity and mortality associated with post-necrotic pancreatic inflammation [10].

MRI, a non-invasive technology with high tissue contrast and multiple image sequences, effectively helps in determining the diagnosis, complications and severity of AP. When CT gives negative results, but a strong clinical suspicion of AP persists, sequences of T2-weighted or diffusion-weighted imaging with saturated fat turbospin echo can reveal nuances of inflammation of the pancreas and/or peripancreatic canal. MRI plays a key role in the diagnosis of AP and is important in the assessment and characterization of extrapancreatic necrosis, inflammation, splenomegaly and tissue lesions, including vessels, transverse colon, interfascial plane and gastrointestinal tract, in patients with AP. MRI can effectively record the intra-abdominal spread of inflammation that affects mesenteric and omentum fatty areas, this indicates a pathological manifestation of intra-abdominal fatty edema in combination with fatty necrosis resulting from AP [11]. MRI is especially useful for imaging patients with iodine allergy or renal insufficiency, characterizes fluid accumulation, and evaluates abnormalities or disconnections in the pancreatic ducts.

As an alternative diagnostic method, AP MRI shows great potential in clinical application. MRI offers excellent opportunities in the diagnosis of early extrapancreatic necrosis compared to CT without the need for radiation, which makes it suitable for repeated follow-up evaluations. MRI more accurately detects the slightest changes in the AP and can outline the components of mild extrapancreatic inflammatory effusions that may be missed by CT. T2-weighted MRI with saturated fat provides excellent sensitivity in detecting fluid and the absence of liquefied material in extrapancreatic accumulations compared to CT, while T1-weighted MRI is useful for detecting pancreatic or peripancreatic bleeding [12]. In necrotic pancreatitis, MRI provides a higher contrast of soft tissues compared to CT and perfectly visualizes hemorrhages and tissue necrosis. The effectiveness of MRI in determining the progression of inflammatory processes and related vascular changes during treatment has been proven, and early vascular damage detected by MRI can serve as a valuable indicator of the severity of AP.

Ultrasound, endoscopic ultrasound and ERCP are complementary to CTCT and are used to diagnose
gallstone disease, isolated PD, assess the contents of the collection and subsequent visualization. Imaging studies are usually not required in emergency cases, when the clinical picture and laboratory tests correspond to the signs of AP [13].

After the initial diagnosis of AP, it is extremely important to assess the severity of AP in order to predict the likelihood of a severe clinical course, which may include organ failure and even mortality. In addition, this assessment is necessary to determine appropriate initial management and treatment strategies for the future.

The severity of AP is determined by the development of organ failure(s) and local complications, which are mainly classified according to the revised Atlanta Classification. Severe AP, defined as persistent organ failure (lasting > 48 hours), can lead to mortality of up to 43% during the initial attack. Patients with severe AP need to be monitored in the intensive care unit and support for circulatory, lung, kidney, and hepatobiliary function in order to reduce the risk of organ failure consequences.

To predict severe AP in the early stages of the disease, many prognostic models have been developed, including patient-related risk factors, laboratory parameters, and assessment systems. Despite the fact that numerous forecasting tools are available, none of the approaches has proven to be unambiguously superior to others in large-scale comparisons [14]. Among all prognostic tools, systemic inflammatory response syndrome (SIRS) is a widely used and proven predictor that can be as accurate as other more complex indicators, and the absence of SIRS on the first day is associated with a high negative prognostic value. Another easily applicable indicator is the Acute pancreatitis Severity Index (BISAP). A BISAP score of ≥3 was significantly associated with an increased risk of mortality. Recently, an artificial intelligence model called EASY-APP was developed as a web application that can easily identify patients at high risk of severe AP within a few hours after hospitalization. These prognostic parameters should be monitored periodically, especially at the initial stage of AP, to monitor the clinical course and response to treatment.

Recent advances in artificial intelligence (AI) are opening up new possibilities by analyzing huge amounts of clinical and imaging data. Artificial intelligence algorithms can analyze large amounts of clinical and imaging data, identify patterns in the assessment system, and predict the clinical course of the disease [12]. Artificial intelligence-based models have shown promising results in predicting the severity and mortality of AP, but further verification and standardization are needed before their widespread clinical application. In addition, understanding the correlation between these three technologies will help in the development of new methods that can be accurately, sensitively and purposefully used to diagnose, predict the severity and assess the prognosis of AP due to additional advantages.

The application of artificial intelligence to diagnose, predict severity, and evaluate the prognosis of AP represents an exciting development in the field of medicine. However, based on these ongoing studies, we recognize several limitations and potential problems that need to be addressed in order to fully exploit the capabilities of AI in this context. Artificial intelligence algorithms require high-quality, complete and diverse data to build reliable and accurate models. In the context of AP, such datasets may not be available, especially for rare disease subtypes or groups of patients with specific comorbidities. In addition, incomplete or contradictory data can lead to biased or erroneous results. AI models, especially those that use complex algorithms such as deep learning, often work like “black boxes”, providing results without clear and understandable reasons for their decisions. This may limit their acceptance in clinical practice, as medical professionals usually prefer to understand the reason for the diagnosis or prognosis. Standardization: AI algorithms are usually designed and tested on specific datasets. Their applicability to other population groups or medical institutions, especially those that differ significantly from the original context, is not guaranteed. The lack of standardization can lead to contradictory results when models are used in different conditions. Models trained on a specific dataset may not work properly when applied to different datasets, especially if there are demographic or geographical differences. For example, an AI model trained on data from a high-income country may not work as well in a low-income country due to differences in healthcare infrastructure, disease prevalence, and patient characteristics.

The use of patient data to develop and apply artificial intelligence models raises serious concerns about privacy, consent, and data security. It is imperative that these issues are addressed to ensure ethical use...
and maintain public trust. For example, who will be responsible if an artificial intelligence system makes an incorrect diagnosis or prognosis? How is patient data confidentiality ensured? Integration. Successful implementation of AI in medical institutions requires doctors to have a certain level of understanding and trust in this technology. This may not be easy due to the varying levels of digital literacy among healthcare professionals and resistance to change. Considering these issues, the research presented in the literature is crucial for improving the reliability, interpretability and generalizability of AI tools in healthcare, as well as for solving ethical, legal and workflow integration problems associated with their use.

DISCUSSION

AP is a dynamic painful process in which most seizures are mild (mild and moderate forms), AP is a dynamic painful process in which most seizures are mild (mild and moderate forms), with continued recovery after several days of conservative supportive therapy. However, some patients with GLANDERS may develop local and/or systemic complications and PONS. There are two treatment periods for AP: early treatment of an acute attack should be used for both mild and severe forms of AP, whereas later treatment includes treatment of SAP complications [13].

At an early stage of AP, all patients require appropriate conservative treatment and sufficient nutritional support. Most patients with mild or moderate GLANDERS recover with conservative treatment, including correction of hypovolemia and hypoxemia, as well as anesthesia. For a long time, correction of hypovolemia, even with mild AP, was carried out by early aggressive hydration with control of vital constants and diuresis. However, there are conflicting data regarding the fluid management strategy, both in terms of the type of fluid, optimal volume and rate of administration, and in terms of the severity of the AP. Several recent randomized studies have shown that early aggressive infusion therapy in patients with AP resulted in a higher incidence of fluid overload (with a potentially increased risk of acute kidney injury and pulmonary edema) without improving clinical outcomes. In other, also randomized controlled trials, it has been reported that early aggressive intravenous hydration accelerates clinical improvement in patients with AP and that an aggressive infusion strategy is useful, especially for certain subgroups of patients and certain types of AP [14].

Most authors agree that these discrepancies have not been fully elucidated and that future research is needed to find out which infusion therapy strategy is optimal for most patients and which subgroups of patients with AP may benefit from a different fluid replenishment regimen.

Pain control is a very important therapeutic measure at an early stage of AP and can be provided by appropriate intravenous administration of a non-opiate analgesic. opiates can also be prescribed as needed. Some recent systematic reviews and meta-analyses show that epidural anesthesia is safe and effective for reducing pain severity, improving pancreatic perfusion, and reducing mortality during the first 24 hours after AP initiation. However, there is insufficient data to guide the treatment of AP pain, as the data sets in each study are small.

Hypoxemia is a rare phenomenon, but in severe forms of the disease, respiratory failure with hypoxemia, insufficiency of one organ is often observed. Hypoxemia could be avoided by ensuring the patency of the respiratory tract and the additional use of moistened oxygen, which would allow maintaining arterial blood saturation above 95%. With the development of respiratory failure, ventilation with positive exhalation pressure is mandatory [15].

The nutrition management strategy of AP patients has generated intense debate over the past few decades. Oral nutrition should be resumed immediately in patients with preserved gastrointestinal peristalsis, without abdominal pain, nausea, vomiting or signs of intestinal obstruction or intestinal obstruction. Most patients with AP have increased basal energy requirements, pronounced protein catabolism and endogenous gluconeogenesis.

The purpose of nutritional support is to reduce exhaustion, maintain the structure and function of organs and have a positive effect on the clinical course of the disease. In addition, if patients with AP develop paralytic intestinal obstruction as a complication of the disease, it is necessary to maintain the pancreas at rest. Since they require nutritional support to achieve a positive nitrogen balance, parenteral nutrition should be started as early as possible in order to achieve a positive nitrogen balance within the first 72 hours after the onset of the disease [16].

Pancreatic necrosis is defined as the absence of enlargement of the pancreatic parenchyma on CT with contrast, and necrotic pancreatitis manifests itself as
necrosis involving only the pancreas, only extra-pancreatic tissue, or, most often, both. It is important to note that CT with contrast within 48-72 hours after the start of AP cannot exclude the presence of pancreatic necrosis. Therefore, if necrotic pancreatitis is suspected, it should be examined at least three days after its appearance. The exact classification of local fluid accumulations is important, since the treatment and prognosis for necrotic pancreatitis is much more difficult and unfavorable than for intestinal edematous pancreatitis.

In the 1980s, necrotic pancreatitis was mainly treated by surgeons who performed necrectomy within 1-3 days of the onset of the disease [94]. However, the results of the PANTER study, presented in 2010, demonstrated that the minimally invasive “stepwise” approach is better than open necrectomy, with a significant reduction in the incidence of first-time multiple organ failure (12% vs. 40%), postoperative hernia (6% vs. 19%) and first-time diabetes (16% vs. 38%).

The step-by-step approach in the PANTER study was percutaneous drainage followed, if necessary, by minimally invasive retroperitoneal necrectomy (usually after 4 weeks). Interestingly, in the step-by-step approach group, 35% of patients were successfully cured only by percutaneous drainage [17]. The traditional treatment of infected necrosis with pre-surgical treatment has been almost completely replaced by minimally invasive surgical and endoscopic approaches.

Modern treatment strategies for necrotic pancreatitis conceptually consist of four stages: conservative antibiotic treatment; percutaneous or endoscopic transmural drainage; minimally invasive necrectomy, either video-assisted retroperitoneal sanitation (VARS), or endoscopic necrectomy; and open necrectomy. Detailed indications, timing, anatomical features and the choice of each intervention method are discussed below.

Pancreatic necrosis can lead to secondary infection or symptomatic sterile necrosis, which includes obstruction of the intestine or biliary tract, worsening organ failure and persistent poor health of the patient. Both infected necrosis and symptomatic sterile necrosis are generally accepted indications for therapeutic intervention. If signs of infection persist despite taking antibiotics for 48-72 hours, interventional methods of drainage of the cluster should be considered as the next step [18]. Asymptomatic patients with sterile pancreatic necrosis are usually observed, since the risk of iatrogenic complications during the procedure is significantly higher than the risk of spontaneous complications arising from fluid accumulation.

The presence of infected PN is the most important negative indicator and the main cause of morbidity and mortality in GLANDERS. The infectious microorganisms responsible for infection of PN are mainly gram-negative bacteria of intestinal origin, and they can enter PN through a previously damaged barrier of the intestinal mucosa.

The decision on drainage and/or necrectomy in patients with necrotizing pancreatitis is made individually and takes into account various factors such as the patient’s status (hemodynamic stability, symptoms, laboratory data, concomitant diseases, clinical course), features of necrosis (the presence of a mature encapsulated wall, the number of necrotic residues, location, extent and distance from the gastrointestinal tract tract), as well as procedural factors (advantages and disadvantages of each intervention, including endoscopic, percutaneous or surgical, as well as their combinations at the bottom-up approach stage) [19].

Temporary percutaneous catheter drainage can be used as the main method, as an initial procedure with a step-by-step approach, or as bridge therapy even at an early stage of AP up to 4 weeks, when surgical treatment is extremely painful. After 4 weeks, endoscopic drainage is preferable, since the incidence of pancreatic fistulas is significantly lower than percutaneous drainage. Percutaneous drainage is usually used for rescue when endoscopic drainage is ineffective or technically impossible.

In general, the retroperitoneal route is preferred because it avoids intestinal leaks and peritoneal contamination and can be used later for VARS, MIRP or percutaneous endoscopic necrectomy. After installing one or more catheters, the catheter was subjected to intensive manual irrigation with isotonic saline solution, as well as serially enlarged to larger diameter catheters and moved to facilitate the removal of necrotic residues. A systematic review of 11 studies involving 384 patients revealed an overall success rate of 56% when using percutaneous drainage as primary drainage for necrotic pancreatitis. Side effects such as external fistulas were observed in 27% of patients [20].

Broad-spectrum antibiotics capable of penetrating PN should be prescribed only if an infected necrosis is confirmed or strongly suspected. However, some authors advocate the preventive use of antibiotics in AP, believing that they can prevent the development of su-
perinfection in necrotic tissues, which is the only measure of initial treatment of PN, since their development cannot be prevented. Some authors believe that there is a decrease in pancreatic infections in a subgroup of patients treated with broad-spectrum antibiotics, and conclude that additional evidence is needed.

However, numerous prospective randomized placebo-controlled studies and the most important guidelines have demonstrated that routine prophylactic use of broad-spectrum antibiotics in patients with AP has no effect on the development of infected necrosis, systemic complications, the need for surgery, or mortality. In addition, prolonged antibiotic therapy increases the prevalence of fungal infections. There is no evidence confirming the preventive use of antifungal drugs in patients with PN. It is also not recommended to use probiotic prophylaxis to prevent infectious complications in AP [21].

Prevention of recurrent AP begins with the treatment of the current episode. It is necessary to identify potential etiological causes and provide adequate treatment to prevent future recurrence of the disease. This implies an adequate and rapid diagnostic and therapeutic approach to patients with gallstones and sludge, as well as to patients with hyperlipidemia and hypercalcemia [22].

CONCLUSIONS

AP is an inflammatory disease of the pancreas characterized by inadequate activation of trypsinogen and destruction of secretory cells, which leads to activation of inflammatory cells, fever and PON. The diagnosis of AP is based on clinical, laboratory and imaging indicators, which are included in a predictive scoring system designed to predict the severity of the disease. The achievements achieved in establishing diagnostic criteria for the severity and prognosis of AP significantly influenced the therapeutic approach and reduced the mortality rate from the disease.

Early aggressive treatment of AP has been proven to reduce morbidity and mortality. Therefore, early diagnosis and assessment of the severity of AP are extremely necessary, and there is a special need for early technological approaches to assess and predict the progression of AP. In recent years, there has been an increased interest in using visualization technologies, assessment systems, and artificial intelligence to improve diagnosis, severity prediction, and prognosis assessment. Various imaging techniques such as CT, MRI, and ultrasound are used to assess the severity and extent of pancreatic inflammation and identify any complications that may occur. AI is a rapidly developing field capable of revolutionizing the diagnosis and treatment of AP. Artificial intelligence algorithms can be trained to analyze large datasets of imaging and clinical data to predict the severity and prognosis of AP. The integration of visualization technologies, assessment systems and artificial intelligence in diagnosis, prediction of severity and assessment of the prognosis of AP has a number of advantages, such as the ability to make a more accurate diagnosis, improved risk assessment, etc. The combination of imaging technologies, assessment systems and artificial intelligence can provide a more personalized approach to treatment, taking into account the unique circumstances of each patient. Despite these advantages, there are several problems that need to be solved when integrating visualization technologies and assessment systems and artificial intelligence. AP. These challenges include the need for standardized imaging protocols and assessment systems, the need for large sets of images and clinical data to train AI algorithms, as well as ethical and legal issues related to the use of AI in healthcare.

REFERENCES