

<https://doi.org/10.24060/2076-3093-2025-15-3-282-286>

The Potential of Minimally Invasive Techniques in a Tailored Diagnostic and Therapeutic Strategy for Acute Necrotizing Pancreatitis

Hiwa M.H. Karkhani — Post-graduate Student, Department of General Surgery, orcid.org/0000-0002-2406-2228

Eduard A. Gallyamov — Dr. Sci. (Med.), Prof., Department of General Surgery, orcid.org/0000-0002-6359-0998

Anton B. Shalygin — Cand. Sci. (Med.), orcid.org/0000-0002-3790-5140

Andrei Yu. Emelianov — Cand. Sci. (Med.), Assoc. Prof., Department of General Surgery, orcid.org/0000-0002-9688-4079

Maria V. Shubenok — Surgery Unit, orcid.org/0009-0005-0061-7371

Azimjon A. Yunusov — Surgery Unit, orcid.org/0009-0000-3322-8632

Hiwa M.H. Karkhani^{1,*}, Eduard A. Gallyamov¹, Anton B. Shalygin², Andrei Yu. Emelianov¹, Maria V. Shubenok², Azimjon A. Yunusov²

¹ N.V. Sklifosovskiy Institute of Clinical Medicine, Sechenov First Moscow State Medical University (Sechenov University), Moscow, Russian Federation

² I.V. Davydovsky City Clinical Hospital, Moscow, Russian Federation

* **Correspondence to:** Karkhani Hiwa Mohammed Hassan, e-mail: hewa.karkhani@yandex.ru

Abstract

Introduction. Acute necrotizing pancreatitis (ANP), a severe acute pancreatitis accompanied by necrosis, is associated with high morbidity and mortality. Traditional management has shifted toward minimally invasive multimodal strategies, though a choice of optimal drainage procedures is still being debated and requires evidence-based guidelines. Aim: To analyze ANP outcomes and develop an effective minimally invasive drainage algorithm to reduce complications, mortality, and length of hospitalization. **Materials and methods.** A prospective study (2019–2024) included 136 ANP patients managed according to necrosis score versus 140 historical controls. Necrosis extent was defined using Revised Atlanta Classification: mild ($\leq 30\%$), moderate ($30-60\%$), extensive ($>60\%$). Interventions included ultrasound-guided drainage, laparoscopic necrosectomy, and early open debridement. Conservative treatment comprised antibiotics, prolonged epidural analgesia, enteral feeding. Outcomes were assessed using SAPS, APACHE II/III, MODS, and SOFA scores. Statistical analysis compared frequency of complications, mortality and length of hospitalization. **Results.** Protocol cohort showed significant improvements: Mild necrosis: Infections $\downarrow$ to 11.1 % (vs. 23.6 %; $*p = 0.01$), mortality $\downarrow$ to 1.1 % (vs. 5.2 %; $*p = 0.03$). Moderate necrosis: Laparoscopic necrosectomy reduced sepsis to 37.7 % ($\Delta = 41.1\%$; $*p < 0.001$), mortality $\downarrow$ to 11.4 % (vs. 28.3 %; $*p = 0.002$). Extensive necrosis: Early open debridement $\downarrow$ endotoxemia mortality to 13.7 % (vs. 41.2 %; $*p = 0.007$), overall mortality $\downarrow$ to 34.4 % (vs. 62.1 %; $*p = 0.01$). Overall, protocol adherence $\downarrow$ infections by 65 % (21.7 % vs. 62.8 %; $*p < 0.001$), mortality by 24 % (12.4 % vs. 16.4 %; $*p = 0.03$), and lengths of hospital stays by 22 % (58 vs. 74 days; $*p = 0.002$). **Discussion.** This study validates a necrosis score protocol as superior to historical approaches. Minimally invasive techniques are definitive for mild/moderate necrosis, while early open debridement is critical for extensive necrosis. Key innovations (epidural analgesia, early enteral nutrition, step-up drainage) synergistically reduced systemic inflammation and sepsis. The 65 % infection reduction underscores protocol efficacy, though multicenter validation is warranted. **Conclusion.** A tailored approach significantly improves ANP outcomes, offering a resource-efficient template for management.

Keywords: pancreas, acute necrotizing pancreatitis, minimally invasive surgery, mortality, clinical outcomes, step-up protocol

Conflict of interest. The authors declare no conflict of interest.

Sponsorship data. This work is not funded.

Author contributions. The authors contributed equally to this article.

For citation: Karkhani H.M.H., Gallyamov E.A., Shalygin A.B., Emelianov A.Yu., Shubenok M.V., Yunusov A.A. The potential of minimally invasive techniques in a tailored diagnostic and therapeutic strategy for acute necrotizing pancreatitis. *Creative Surgery and Oncology*. 2025;15(3):282–286. <https://doi.org/10.24060/2076-3093-2025-15-3-282-286>

Received: 18.04.2025

Revised: 18.07.2025

Accepted: 28.07.2025

Возможности малоинвазивных методов лечения при дифференцированной лечебно-диагностической тактике лечения острого деструктивного панкреатита

Х.М.Х. Кархани^{1,*}, Э.А. Галлямов¹, А.Б. Шалыгин¹, А.Ю. Емельянов¹, М.В. Шубенок², А.А. Юнусов²

¹ Институт клинической медицины имени Н.В. Склифосовского, Первый Московский государственный медицинский университет имени И.М. Сеченова (Сеченовский Университет), Россия, Москва

² Городская клиническая больница имени И.В. Давыдовского, Россия, Москва

* **Контакты:** Кархани Хиуа Мохаммед Хассан, e-mail: hewa.karkhani@yandex.ru

Аннотация

Введение. Острый некротизирующий панкреатит (ОНП), тяжелая форма острого панкреатита, характеризующаяся некрозом ткани поджелудочной железы, ассоциирован с высокой заболеваемостью и летальностью. Традиционное лечение эволюционировало в сторону малоинвазивных мультидисциплинарных стратегий, направленных на коррекцию системных осложнений и улучшение исходов. Однако оптимальные алгоритмы применения дренирующих методик остаются предметом дискуссий, что требует разработки доказательных протоколов. **Цель:** проанализировать результаты лечения ОНП и определить эффективный алгоритм применения малоинвазивных дренирующих методик для снижения осложнений, летальности и длительности госпитализации. **Материалы и методы.** Проспективное когортное исследование (2019–2024 гг.) включило 136 пациентов с ОНП, леченных по некроз-стратифицированному протоколу, в сравнении с 140 историческими контролями. Классификация проведена согласно пересмотренной Атлантской классификации: очаговый (некроз $\leq 30\%$), массивный (30–60%), тотальный/субтотальный ($>60\%$). Вмешательства включали ультразвуковое дренирование, лапароскопическую некрэктомию и раннюю открытую санацию. Консервативная терапия: антибиотики, пролонгированная эпидуральная анальгезия, энтеральное питание. Оценка исходов проводилась с использованием шкал SAPS, APACHE II/III, MODS, SOFA. Статистический анализ сравнивал частоту осложнений, летальность и сроки госпитализации. **Результаты.** В группе протокола зафиксировано значительное улучшение показателей: Очаговый некроз: инфекционные осложнения снизились до 11,1% (vs. 23,6% в контроле; $p = 0,01$), летальность — до 1,1% (vs. 5,2%; $p = 0,03$). Массивный некроз: лапароскопическая некрэктомия уменьшила частоту сепсиса до 37,7% ($\Delta = 41,1\%$; $p < 0,001$) и летальность до 11,4% (vs. 28,3%; $p = 0,002$). Тотальный некроз: ранняя открытая санация снизила летальность от эндогенной интоксикации до 13,7% (vs. 41,2%; $p = 0,007$) и общую летальность до 34,4% (vs. 62,1%; $p = 0,01$). Общие исходы: соблюдение протокола уменьшило инфекции на 65% (21,7% vs. 62,8%; $p < 0,001$), летальность — на 24% (12,4% vs. 16,4%; $p = 0,03$), сроки госпитализации — на 22% (58 vs. 74 дня; $p = 0,002$). **Обсуждение.** Некроз-стратифицированный протокол достоверно улучшает исходы ОНП. Малоинвазивные методы эффективны при очаговом/массивном некрозе, тогда как ранняя открытая санация с детоксикацией критична при тотальном поражении. **Заключение.** Данный подход снижает риск сепсиса, летальность и инвалидизацию, предлагая шаблон для ресурсоэффективного лечения ОНП.

Ключевые слова: поджелудочная железа, острый некротизирующий панкреатит, малоинвазивная хирургия, летальность, клинические исходы, поэтапный протокол

Информация о конфликте интересов. Конфликт интересов отсутствует.

Информация о спонсорстве. Данная работа не финансировалась.

Вклад авторов. Все авторы внесли эквивалентный вклад в подготовку публикации.

Для цитирования: Кархани Х.М.Х., Галлямов Э.А., Шалыгин А.Б., Емельянов А.Ю., Шубенок М.В., Юнусов А.А. Возможности малоинвазивных методов лечения при дифференцированной лечебно-диагностической тактике лечения острого деструктивного панкреатита. Креативная хирургия и онкология. 2025;15(3):282–286. <https://doi.org/10.24060/2076-3093-2025-15-3-282-286>

Поступила в редакцию: 18.04.2025

Поступила после рецензирования и доработки: 18.07.2025

Принята к публикации: 28.07.2025

Кархани Хиуа Мохаммед Хассан — аспирант, кафедра общей хирургии, orcid.org/0000-0002-2406-2228

Галлямов Эдуард Абдулхалимович — д.м.н., профессор, кафедра общей хирургии, orcid.org/0000-0002-6359-0998

Шалыгин Антон Борисович — к.м.н., orcid.org/0000-0002-3790-5140

Емельянов Андрей Юрьевич — к.м.н., доцент, кафедра общей хирургии, orcid.org/0000-0002-9688-4079

Шубенок Мария Вячеславовна — хирургическое отделение, orcid.org/0009-0005-0061-7371

Юнусов Азимджон Аслиддинович — хирургическое отделение, orcid.org/0009-0000-3322-8632

INTRODUCTION

Acute destructive pancreatitis (ADP), a severe form of acute pancreatitis (AP), is characterized by significant necrosis of pancreatic tissue and is associated with high morbidity and mortality [1–3]. The management of this disease requires a multidisciplinary approach combining accurate diagnosis, individualized treatment strategies, and careful monitoring to address both local and systemic complications. This thesis provides a comprehensive review of diagnostic and therapeutic approaches for ADP based on recent research findings and clinical guidelines [2,4]. Recent advances in surgical management, including minimally invasive techniques, have contributed to a decline in postoperative mortality rates in Russia: from 15.4% in 2017 to 12.96% in 2018 [3]. This reduction is attributed to a combination of intensive conservative therapy during the early phase of the disease (enzyme toxemia) and minimally invasive surgical interventions in the late phase (sequestration) [3, 5].

The diagnosis of AP is based on clinical, laboratory, and imaging findings. Patients typically present with acute abdominal pain accompanied by elevated serum amylase and lipase levels, which remain the diagnostic gold standard [6–8]. However, in suspected severe or destructive pancreatitis, further assessment of pancreatic necrosis and complications such as infected necrosis or walled-off necrosis is essential [9, 10]. Biomarkers such as serum cytokines and pancreatic amylase show promise in predicting AP severity and identifying high-risk patients, enabling earlier intervention [1, 11]. Imaging modalities, including computed tomography (CT) and magnetic resonance cholangiopancreatography (MRCP), are critical for confirming the diagnosis and assessing severity. CT is particularly valuable for detecting pancreatic necrosis, while MRCP provides detailed visualization of the pancreatic duct [1, 12, 13]. Endoscopic ultrasound (EUS) and endoscopic retrograde cholangiopancreatography (ERCP) are also useful for evaluating pancreatic duct abnormalities, with EUS demonstrating high sensitivity and specificity [12]. Prognostic biomarkers such as C-reactive protein (CRP > 150 mg/L) and procalcitonin are reliable indicators of necrotizing pancreatitis and infected necrosis, respectively [1, 8]. The Revised Atlanta Classification categorizes AP severity into mild, moderately severe, and severe forms based on organ failure and local complications, facilitating early risk stratification [7, 14, 15].

Treatment paradigms for ADP have evolved toward minimally invasive, multidisciplinary, and personalized approaches [16–19]. A step-up strategy for infected pancreatic necrosis begins with endoscopic or percutaneous drainage and escalates to more invasive procedures if necessary [20, 21]. This approach reduces the risk of multiorgan failure and procedural complications [22]. Minimally invasive techniques, including endoscopic transgastric or percutaneous drainage, effectively manage acute peripancreatic fluid collections and walled-off necrosis. For extensive necrosis, minimally invasive necrosectomy is preferred [23, 24]. Meta-analyses confirm that laparoscopic and robotic methods reduce intraoperative blood loss, hospital stay, and surgical site infections compared to open surgery, without increasing mortality [25, 26]. However, these techniques require skilled surgeons and careful patient selection [3, 25].

The aim of this study is to analyze treatment outcomes in patients with acute necrotizing pancreatitis and determine the most effective algorithm for implementing minimally invasive drainage techniques to reduce complication rates, decrease mortality, and improve clinical outcomes.

MATERIALS AND METHODS

This prospective cohort study included 136 patients with destructive acute pancreatitis (AP) admitted to the I.V. Davydovsky City Clinical Hospital (Moscow, Russia) between 2019 and 2024. Patients with biliary or postoperative AP were excluded due to distinct pathophysiological and clinical profiles. A historical control group of 140 patients treated prior to standardized minimally invasive protocols was analyzed for comparative outcomes. The cohort comprised adults aged 22–75 years (mean: 51.0 ± 15.2). All patients with confirmed acute necrotizing pancreatitis (ANP) and fluid collections underwent image-guided closed drainage (ultrasound-guided percutaneous aspiration of pancreatic, retroperitoneal, or lesser sac collections) as first-line intervention. Laparoscopic drainage was performed when ultrasound visualization was inadequate (e.g., due to colonic pneumatosis, obesity, or adhesions), irrespective of disease extent. For localized necrosis ($\leq 30\%$ gland involvement), drainage served as definitive therapy. For necrosis $> 30\%$ (CT-confirmed), drainage preceded laparoscopic necrosectomy with continuous aspiration systems. Open surgery was reserved for anatomically complex cases or failed minimally invasive approaches.

All patients received protocolized conservative care per clinical guidelines, including: Antisecretory therapy (proton pump inhibitors); Aggressive fluid resuscitation; Prophylactic anticoagulation; Broad-spectrum antibiotics (carbapenems/piperacillin-tazobactam); Systemic detoxification (albumin, crystalloids); Metabolic correction (glucose/electrolyte monitoring)

Disease severity was classified using a modified Atlanta criterion:

- **Edematous pancreatitis**
- **Acute necrotizing pancreatitis:** Focal ($\leq 30\%$ necrosis); Massive (30–60%); Total/subtotal ($> 60\%$); Biliary pancreatitis (distal choledochal pathology-associated).

Prognostic Assessment

Physiological scores: SAPS, APACHE II/III, Glasgow Coma Scale

Organ dysfunction: MODS, SOFA

Pancreatic-specific: Ranson, Glasgow, Balthazar CT Severity Index (CTSI)

Systemic inflammation: SIRS criteria

Imaging Protocol

Initial ultrasound: Evaluated pancreatic dimensions, necrosis foci, fluid collections (peripancreatic, pleural, peritoneal), ductal dilatation, and vascular patency (Doppler). Contrast-enhanced CT: Gold standard for diagnosing ANP and complications. Quantified necrosis extent using CTSI (Balthazar score + necrosis percentage). Provided detailed assessment of retroperitoneal involvement and hepatoduodenal anatomy.

Statistical Analysis

Patients were stratified by necrosis extent (Table 1). Continuous variables expressed as mean $\pm$ SD; categorical variables as percentages. Institutional review board approval and informed consent were obtained.

RESULTS

Patient Severity Distribution: At admission, disease severity was stratified as moderate (39.5 %), severe (37.1 %), and critical (23.4 %).

Evolution of Management Protocols (2019–2024): The study period saw enhanced conservative strategies, including:

1. Extracorporeal detoxification (e.g., plasmapheresis, continuous renal replacement therapy).
2. Early enteral nutrition via endoscopic nasojejunal tube placement.
3. Broad-spectrum antibiotics (carbapenems/piperacillin-tazobactam) initiated within 24 hours.
4. Multimodal analgesia anchored by prolonged epidural anesthesia (ropivacaine 0.2 %, 6–8 mL/hr, catheter level Th8–Th9).

Surgical Innovations

- Redefined laparoscopy: Transitioned from purely diagnostic to therapeutic: Enzymatic exudate aspiration from abdominal cavity/lesser sac; Drainage for continuous lavage; Necrosis mapping via laparoscopic pancreatoscopy;
- Step-up minimally invasive approaches: Ultrasound-guided percutaneous drainage for localized collections; Laparoscopic omentobursostomy via mini-ports; Electrosurgical necrosectomy (bipolar/monopolar devices).

Complication Dynamics

- Delayed drainage (>72h): Associated with 23.6 % abscess risk despite antibiotics.
- Focal necrosis (≤ 30 %): Localized abscesses (median onset: days 18–20) managed via image-guided drainage (success rate: 78.4 %).
- Massive necrosis (30–60 %): Required laparoscopic necrosectomy (Δ complications: 37.7 % vs. 11.4 % mortality).

- Total necrosis (>60 %): 73.5 % required early minimally invasive stabilization (laparoscopic lavage $\pm$ closed omentobursostomy).

Table 2 highlights the clinical advantages of the protocol used in Group 2, including reduced infectious complications (21.7 % vs. 62.8 %), mortality (12.4 % vs. 16.4 %), hospital stay (58 ± 9 days vs. 74 ± 12 days), ICU stay (18.8 ± 5 days vs. 25.3 ± 6 days), and disability rate (10.3 % vs. 18.2 %), with all comparisons reaching statistical significance ($p < 0.01$).

Mechanistic Insights

- Epidural analgesia: Correlated with accelerated leukocytosis resolution (days 2–4 vs. 5–7 in controls) and reduced leukocyte intoxication index ($\Delta = 1.8$, $p = 0.007$).
- Early enteral nutrition: Associated with 2.3-day earlier bowel function recovery ($p = 0.03$).
- Laparoscopic step-up: Reduced late-stage sepsis by 4.1-fold (OR = 0.24, 95 % CI 0.12–0.49).

Operative Trends

- Staged necrosectomy: Performed in 67.0 % of severe cases via:
 - Laparoscopic transperitoneal access (84.2 %);
 - Retroperitoneal monoport (15.8 %).
- Reintervention triggers: SOFA score progression ($\Delta \geq 3$), infected necrosis (CT Gas+), or sequestra > 5 cm.

Limitations: Single-center design and heterogeneous necrosis quantification methods may limit generalizability.

DISCUSSION

This study demonstrates that a necrosis-extent-stratified protocol significantly optimizes outcomes in ANP, reducing mortality, infections, and hospitalization. Our findings align with global trends favoring minimally invasive step-up approaches but refine them by emphasizing tailored intervention timing and modality based on objectively quantified necrosis.

Stratification Superiority: The 24 % mortality reduction ($p = 0.03$) highlights that focal necrosis (≤ 30 %) is optimally

Necrosis Extent	Clinical Group 1		Clinical Group 2	
	Abs.	%	Abs.	%
≤ 30 %	75	54	71	52
30–60 %	55	39	56	41
>60 %	10	7	9	7
Total	140	100	136	100

Table 1. Distribution of patients by pancreatic necrosis extent across clinical groups (n/ %) per the Revised Atlanta Classification

Parameter	Group 1 (n = 140)	Group 2 (n = 136)
Infectious complications	62.8 %	21.7 %*
Mortality	16.4 %	12.4 %*
Hospital stay (days)	74 ± 12	58 ± 9 *
ICU stay (days)	25.3 ± 6.0	18.8 ± 5.0 *
Disability rate	18.2 %	10.3 %*

* $p < 0.01$ for all intergroup comparisons

Table 2. Comparative treatment outcomes

managed with percutaneous drainage alone, avoiding unnecessary surgery. This corroborates Gallyamov et al.'s emphasis on less invasive first-line interventions [2, 9]. For massive necrosis (30–60%), staged laparoscopic necrosectomy with continuous lavage reduced sepsis by 41.1% ($p < 0.001$). This supports the “step-up” concept but adds that early laparoscopy (within 72h) mitigates bacterial translocation by preserving peritoneal integrity [23]. Paradoxically, total/subtotal necrosis (>60%) benefited from early open debridement (within 48h), reducing endogenous intoxication mortality by 27.5% ($p = 0.007$). This challenges purely minimally invasive dogma but aligns with Bensman et al., suggesting extensive necrosis requires rapid source control [21].

Adjunct Innovations: Prolonged epidural analgesia accelerated leukocytosis resolution ($\Delta = 3$ days, $p = 0.007$), likely by blunting sympathetic-mediated inflammation. Early enteral nutrition reduced bowel paralysis by 2.3 days ($p = 0.03$), preventing bacterial overgrowth. Ultrasound-guided drainage within 24h prevented abscess formation despite antibiotics (23.6% risk if delayed), underscoring urgency. Our 11.4% mortality in massive necrosis is lower than the 15–20% in recent meta-analyses, attributable to strict necrosis quantification (vs. subjective assessment) and standardized detoxification [24]. The 65% infection reduction exceeds the 40–50% achieved in step-up trials, likely due to our protocol's mandatory early drainage [23]. Limitations and Future Directions: Single-center design and retrospective controls limit generalizability. While necrosis stratification proved robust, inter-rater variability in CTSI scoring requires attention. Multi-center validation (ideally randomized) is needed, particularly for the open approach in total necrosis.

CONCLUSION

This protocol's efficacy stems from precision stratification — minimally invasive techniques for limited necrosis and timely open debridement for extensive disease. Integrating non-surgical adjuncts (epidural analgesia, enteral nutrition) amplifies outcomes. It offers a practical, resource-efficient framework adaptable to diverse settings.

REFERENCES

- Lee P.J., Papachristou G.I. Management of severe acute pancreatitis. *Curr Treat Options Gastroenterol*. 2020;18(4):670–81. DOI: 10.1007/s11938-020-00322-x
- Gallyamov E.A., Agapov M.A., Busyrev Yu.B., Gallyamov E.E., Kakotkin V.V., Allakhverdieva A.R. Comparison of minimal invasive technologies for treatment of infected pancreatic necrosis. *Pirogov Russian Journal of Surgery*. 2020;3:22–8 (In Russ.). DOI: 10.17116/hirurgia202003122
- Revishvili A.Sh., Kriger A.G., Vishnevsky V.A., Smirnov A.V., Berelavichus S.V., Gorin D.S., et al. Current issues in pancreatic surgery. *Pirogov Russian Journal of Surgery*. 2018;9:4–13 (In Russ.). DOI: 10.17116/hirurgia20180915
- Ali-Zade S.G., Nazarov Sh.K., Kholmatov P.K., Dodikhudoev R.A. Complex diagnostics and methods of treatment of the syndrome of enteral insufficiency in patients with acute pancreatitis. *Avicenna Bulletin*. 2019;21(1):136–40 (In Russ.). DOI: 10.25005/2074-0581-2019-21-1-136-140
- Walkowska J., Zielinska N., Tubbs R.S., Podgórski M., Dhubeck-Ruxer J., Olewnik L. Diagnosis and treatment of acute pancreatitis. *Diagnostics*. 2022;12(8):1974. DOI: 10.3390/diagnostics12081974
- Zerem E., Kurtcehajic A., Kunosić S., Zerem Malkočević D., Zerem O. Current trends in acute pancreatitis: diagnostic and therapeutic challenges. *World J Gastroenterol*. 2023;29(18):2747–63. DOI: 10.3748/wjg.v29.i18.2747
- Szatmary P., Grammatikopoulos T., Cai W., Huang W., Mukherjee R., Halloran C., et al. Acute pancreatitis: diagnosis and treatment. *Drugs*. 2022;82(12):1251–76. DOI: 10.1007/s40265-022-01766-4
- Semyonov D.Y., Scherbyuk A.N., Morozov S.V., Lobakov A.I., Unin A.S., Averin A.A., et al. Comparative evaluation of scales to determine severity of acute pancreatitis. *Grekov's Bulletin of Surgery*. 2020;179(1):31–8 (In Russ.). DOI: 10.24884/0042-4625-2020-179-1-31-38
- Gallyamov E.A., Agapov M.A., Lutsevich O.E., Kakotkin V.V. Advanced technologies for treatment of infected pancreatic necrosis: differentiated approach. *Annals of HPB surgery*. 2020;25(1):69–78 (In Russ.). DOI: 10.16931/1995-5464.2020169-78
- García-Rayado G., Cárdenas-Jaén K., de-Madaria E. Towards evidence-based and personalised care of acute pancreatitis. *United European Gastroenterol J*. 2020;8(4):403–9. DOI: 10.1177/2050640620903225
- Timmerhuis H.C., van Dijk S.M., Verdonk R.C., Bollen T.L., Bruno M.J., Fockens P., et al. Various modalities accurate in diagnosing a disrupted or disconnected pancreatic duct in acute pancreatitis: a systematic review. *Digestive Dis Sci*. 2021;66(5):1415–24. DOI: 10.1007/s10620-020-06413-0
- Rudenko V.A., Kakaulina L.N., Verzakova I.V., Karamova I.M. Predicting the severity of acute pancreatitis using ultrasound markers and clinical scales. *Russian Sklifosovsky Journal of Emergency Medical Care*. 2022;11(2):274–9 (In Russ.). DOI: 10.23934/2223-9022-2022-11-2-274-279
- Zhang Z.C., Luo Q.F., Wang W.S., Chen J.H., Wang C.Y., Ma D. Development and future perspectives of natural orifice specimen extraction surgery for gastric cancer. *World J Gastrointest Surg*. 2022;14(11):1198–203. DOI: 10.4240/wjgs.v14.i11.1198
- Smeets X., Bouhouch N., Buxbaum J., Zhang H., Cho J., Verdonk R.C., et al. The revised Atlanta criteria more accurately reflect severity of post-ERCP pancreatitis compared to the consensus criteria. *United Eur Gastroenterol J*. 2019;7(4):557–64. DOI: 10.1177/2050640619834839
- Achkasov E.E., Pugaev A.V., Nabyeva Zh.G., Kalachev S.V. Effect of different nutritional support on pancreatic secretion in acute pancreatitis. *Pirogov Russian Journal of Surgery*. 2018;1(1):14–20 (In Russ.). DOI: 10.17116/hirurgia2018114-20
- Bogdanov S.N., Mukhin A.S., Voloshin V.N., Otdelnov L.A. Issues of acute pancreatitis classification — practical surgeon's point of view. *Perm Medical Journal*. 2020;37(1):102–10 (In Russ.). DOI: 10.17816/pmj371102-110
- Dobszai D., Mátrai P., Gyöngyi Z., Csopor D., Bajor J., Erőss B., et al. Body-mass index correlates with severity and mortality in acute pancreatitis: A meta-analysis. *World J Gastroenterol*. 2019;25(6):729–43. DOI: 10.3748/wjg.v25.i6.729
- Aperstein Y., Cohen L., Bendavid I., Cohen J., Grozovsky E., Rotem T., et al. Improved ICU mortality prediction based on SOFA scores and gastrointestinal parameters. *PLoS One*. 2019;14(9):e0222599. DOI: 10.1371/journal.pone.0222599
- Yelsky I.K., Vasylyev A.A., Smirnov N.L. The efficiency of prognostic scales in stratification of acute pancreatitis. *Literature review. Surgical Practice*. 2020;3(43):17–28 (In Russ.). DOI: 10.38181/2223-2427-2020-3-17-28
- Glabai V.P., Gridnev O.V., Bashankaev B.N., Bykov A.N., Krylov A.V., Kaprin A.I., et al. Surgical strategy for acute biliary pancreatitis. *Pirogov Russian Journal of Surgery*. 2019;11:37–41 (In Russ.). DOI: 10.17116/hirurgia20191137
- Bensman V.M., Savchenko Iu.P., Shcherba S.N., Malysheko V.V., Gnipel A.S., Golikov I.V. Surgical resolutions determining outcomes of infected pancreatic necrosis. *Pirogov Russian Journal of Surgery*. 2018;8:12–8 (In Russ.). DOI: 10.17116/hirurgia2018812
- Myt'nikov A.G., Pan'kov A.G., Churadze B.T., Usachev O.Iu., Shabrin A.V., Shapoval'yants S.G. The abdominal decompression for the treatment of the compartment syndrome in patients with the destructive pancreatitis. *Pirogov Russian Journal of Surgery*. 2012;1:61–6 (In Russ.).
- Purschke B., Bolm L., Meyer M.N., Sato H. Interventional strategies in infected necrotizing pancreatitis: Indications, timing, and outcomes. *World J Gastroenterol*. 2022;28(27):3383–97. DOI: 10.3748/wjg.v28.i27.3383
- Pfister M., Probst P., Müller P.C., Antony P., Klotz R., Kalkum E., et al. Minimally invasive versus open pancreatic surgery: meta-analysis of randomized clinical trials. *BJS Open*. 2023;7(2):zrad007. DOI: 10.1093/bjsopen/zrad007
- Nikitsina K.V. Early respiratory support in patients with acute necrotic pancreatitis. *Novosti Khirurgii*. 2019;27(3):300–6 (In Russ.). DOI: 10.18484/2305-0047.2019.3.300
- Neledova L.A., Mizgiriov D.V., Duberman B.L. Hemorrhagic complications of pancreatitis in surgical practice. *Grekov's Bulletin of Surgery*. 2019;178(1):55–8 (In Russ.). DOI: 10.24884/0042-4625-2019-178-1-55-58

© Karkhani H.M.H., Gallyamov E.A., Shalygin A.B., Emelianov A.Yu., Shubenok M.V., Yunusov A.A., 2025

© Кархани Х.М.Х., Галлямов Э.А., Шалыгин А.Б., Емельянов А.Ю., Шубенок М.В., Юнусов А.А., 2025