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ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

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GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman** (**Кириллица**), для текста на грузинском языке следует использовать **AcadNusx.** Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - http://www.spinesurgery.ru/files/publish.pdf и http://www.nlm.nih.gov/bsd/uniform_requirements.html
В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректура авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or compu-ter-printed on a single side of standard typing paper, with the left margin of **3** centimeters width, and **1.5** spacing between the lines, typeface - **Times New Roman** (**Cyrillic**), print size - **12** (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf
In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

Articles that Fail to Meet the Aforementioned Requirements are not Assigned to be Reviewed.

ავტორთა საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

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SERUM BIOMARKERS FOR EARLY SEVERITY STRATIFICATION IN ACUTE PANCREATITIS: A NARRATIVE REVIEW

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Abstract.

Background: Acute pancreatitis (AP) is an inflammatory disorder with an unpredictable course, ranging from mild self-limiting forms to necrotizing pancreatitis with multiple organ failure. Despite advances in imaging and scoring systems, early severity prediction remains a major challenge. Circulating biomarkers have gained attention as tools for improving diagnostic precision and patient risk stratification.

Aim: To summarize and ccomprehensively evaluate current literature on serum biomarkers used or proposed for predicting acute pancreatitis severity and complications, and to determine their prognostic and clinical value for potential integration into existing scoring systems.

Materials and Methods: A comprehensive search of PubMed, Scopus, Google Scholar, and The Cochrane Library identified retrospective and prospective studies assessing diagnostic and prognostic performance of biomarkers - C-reactive protein (CRP), procalcitonin, lipase, angiopoietins (ANG-1, ANG-2), fibrinogen-like proteins (FGL1, FGL2) and interleukins (IL-6, IL-38).

Results: Classical biomarkers (CRP, procalcitonin, nitrogen, protein, and electrolyte indicators) retain diagnostic relevance but show limited specificity. Emerging markers (angiopoietin-2, FGL1, FGL2, cytokines, D-dimer) demonstrate higher sensitivity and prognostic accuracy for organ failure and necrosis, though clinical use remains limited by cost and lack of multicenter validation.

Conclusion: Serum biomarkers hold significant potential for improving early severity prediction in AP. Integrating novel and traditional markers with scoring systems may enhance diagnostic accuracy and guide timely intervention. Further multicenter studies are required for clinical validation and implementation.

Key words. Acute pancreatitis, prognostic biomarkers, C-reactive protein, procalcitonin, angiopoietin-2, interleukin-6, fibrinogen-like protein 2 (FGL2), D-dimer, and risk prediction.

Introduction.

Acute pancreatitis is the most common pancreatic disease worldwide. Severe pancreatitis occurs in 20% of patients, driven by the increasing prevalence of obesity and comorbidities. Data from the US National Center for Health Statistics (NCHS) indicate that 275,000 hospitalizations due to acute pancreatitis are recorded annually in the United States, with healthcare costs amounting to $2.5 billion. A retrospective analysis in the US over a ten-year period (2002–2012) also found a 13.2% ($p < 0.001$) increase in hospitalizations due to acute pancreatitis, highlighting the growing epidemiological significance of this disease [1-4].

Clinical manifestations of acute pancreatitis (AP) differ markedly from mild forms, as evidenced by pancreatic necrosis, the development of multiple organ failure, and other life-threatening complications, leading to death. Treatment affects the development of pancreatic necrosis, particularly during the development of pancreatic necrosis, representing one of the unsolved problems in clinical surgery. The mortality rate for severe acute pancreatitis reaches 20%, and for infected pancreatic necrosis, 25% [5].

Timely assessment of the severity of the disease is of key importance, especially in the first 24 hours, as this period is considered a "window of opportunity" for preventing pancreatic necrosis. Various clinical scales, such as Ranson, APACHE II, and BISAP, as well as biomarkers of inflammation and pancreatic injury, are used to assess the severity of AP [6]. The term "biomarker" was defined by the US National Institutes of Health as "a characteristic that is objectively measured and evaluated as an indicator of normal biological processes, pathological changes, or pharmacological response to therapy." Biomarkers are an important component in the diagnosis and prognosis of the inflammatory process in the pancreas. Existing studies of existing biomarkers in acute pancreatitis do not have sufficient accuracy and specificity, which dictates the study and implementation of new serum markers [7-9].

The novelty of this study lies in the fact that while traditional biomarkers such as C-reactive protein and procalcitonin have already proven their clinical value in assessing the severity of acute pancreatitis, the role of new indicators-angiopoietin-2, fibrinogen-like proteins, cytokines, and D-dimer - remains debated and requires further clinical validation. The practical significance of this analysis lies in the fact that comparing traditional and promising markers allows us to identify the most informative indicators for the early prediction of complications. This literature review presents the results of recent studies, providing a basis for the development of combined prognostic models and their implementation in clinical practice.

Aim.

To provide a comprehensive narrative synthesis of serum biomarkers with distinct pathogenetic mechanisms involved in acute pancreatitis and to evaluate their prognostic value in stratifying disease severity and predicting complications.

Materials and Methods.

This structured narrative review summarizes published studies on serum biomarkers that predict the severity of acute pancreatitis. The literature was searched in PubMed, Scopus, The Cochrane Library, and Google Scholar databases. This allowed the inclusion of both early and recent research related to diagnostic and prognostic aspects of acute pancreatitis.

The search was performed using the following keywords: acute pancreatitis, prognostic biomarkers, C-reactive protein, procalcitonin, angiopoietin-2, interleukin-6, fibrinogen-like protein 2 (FGL2), D-dimer, and risk prediction. Reference lists of selected articles were reviewed to identify additional relevant publications.

We included retrospective and prospective human studies that evaluated the prognostic accuracy of serum biomarkers, such as CRP, procalcitonin, angiopoietins, cytokines, pancreatic enzymes, and coagulation markers. Studies that compared biomarker performance with clinical scoring systems (APACHE II, BISAP, Ranson) or

reported correlations between biomarker levels and disease outcomes were also included.

We excluded studies with participants under 18 years of age, experimental work on animals, conference abstracts, editorials, and articles without peer review or without data on the prognostic value of biomarkers.

Results were organized by biomarker category - inflammatory, vascular, enzymatic, and emerging markers - to provide a logical overview of their role in predicting the severity of acute pancreatitis.

Results and Discussion.

In the course of the literature review, we examined classical biomarkers of systemic inflammation, including C-reactive protein (CRP) and procalcitonin, along with parameters reflecting electrolyte balance, protein and nitrogen metabolism, hematological indices, and pancreatic enzyme activity. In addition, emerging biomarkers such as cytokines, D-dimer, angiopoietins, and fibrinogen-like proteins were analyzed for their potential diagnostic and prognostic significance.

Biomarkers of systemic inflammation.

C-reactive protein (CRP): Currently, CRP is the only standard biochemical marker for predicting the severity of AP [10]. Studies show that an increase in CRP above 150 mg/L on the third day from the onset of the disease is a significant indicator of severe AP [11]. CRP measured 48 hours after hospitalization demonstrated high prognostic accuracy for severe acute pancreatitis (SAP), pancreatic necrosis, and in-hospital mortality. The area under the curve (AUC) values were 0.81 for SAP, 0.77 for pancreatic necrosis, and 0.79 for in-hospital death. The optimal cutoff values of CRP for predicting SAP and pancreatic necrosis were 190 mg/L, and for in-hospital death – 170 mg/L, making this indicator key for early prediction of complications of acute pancreatitis [12]. However, this marker is not specific and may be elevated in other inflammatory processes.

Procalcitonin:

Procalcitonin is a simple and practical marker that can be used for early diagnosis and monitoring of prognosis of severe acute pancreatitis [13]. According to the results of a multicenter study, a procalcitonin value of ≥3.5 ng/ml for 2 days with a sensitivity of 93% and a specificity of 88% corresponds to an assessment of the risk of infected necrosis with multiple organ failure syndrome or mortality [14]. The use of procalcitonin in acute pancreatitis may contribute to the rational use of antibiotic therapy [15]. Also, procalcitonin levels on admission correlate with the length of hospital stay and the need for intensive care, exceeding CRP levels in prognostic significance. A cutoff value for plasma procalcitonin >2 ng/ml was found to be 100% sensitive and 100% specific [16]. However, despite its high prognostic efficacy, procalcitonin is not widely used in clinical surgery [17].

Indicators of nitrogen metabolism.

Creatinine: In the early stages of AP, hemodynamic changes often occur, which can lead to acute kidney injury and dynamic fluctuations in serum creatinine levels [18]. Creatinine and estimated glomerular filtration rate measured on admission ($p < 0.001$, $p < 0.001$, respectively) and after 48 hours ($p = 0.001$, $p < 0.001$, respectively) were significantly associated with the presence of pancreatic necrosis [19]. Although creatinine is widely used in clinical practice, it has limitations: its level depends not only on glomerular filtration, but also on tubular secretion, which can be influenced by external factors, including drugs [20].

Urea: Blood urea nitrogen, as a surrogate marker of intravascular volume, is used to assess the response to fluid therapy in acute pancreatitis [21]. An increase in blood urea nitrogen levels at 24 hours was the only significant predictor of mortality ($p = 0.000$; OR: 12.7; 95% CI: 4.1–38.2) [22]. BUN threshold of 7.8 mg/dL on admission was associated with an increased risk of mortality (OR = 2.9), whereas a decrease in the level by ≥5 mg/dL at 24 hours reduced the risk of mortality to 0%–3.2% [23]. A large cohort study showed that serial measurement of blood urea nitrogen levels is the most informative routine test for predicting mortality in AP [24].

Indicators of electrolyte balance.

Sodium (Na): Despite the availability of laboratory sodium measurement in hospital settings, its role in predicting outcomes remains poorly understood. Hyponatremia (sodium <133 mmol/L) is significantly associated with an increased risk of mortality compared with levels ≥133 mmol/L ($p = 0.013$) [25]. This issue clearly requires further research.

Potassium (K): Serum potassium is one of the standard and widely used laboratory parameters in clinical practice. However, there are no studies establishing an optimal cutoff value of serum potassium for assessing the severity of acute pancreatitis. Some experimental studies have explored potassium transport and homeostasis in pancreatic cells [26,27], but their findings remain basic and not directly applicable to clinical prognostication.

Calcium (Ca): Unlike Na and K, the pathophysiological aspects of calcium as a biomarker have been studied in more detail. Dysregulation of Ca^{2+} homeostasis in acute pancreatitis leads to the loss of mitochondrial integrity and cell necrosis [28]. Disease triggers induce either excessive release of acinar Ca^{2+} or failure of the mechanisms that maintain its low basal concentration, which leads to calcium toxicity, a key trigger in the pathogenesis of acute pancreatitis [29,30]. Serum calcium showed independent prognostic value for disease severity in logistic analysis (HR 0.21; 95% CI: 0.08–0.58; $p = 0.002$); A threshold of 1.97 mmol/L predicted POF with an AUC of 0.888, a sensitivity of 89.7%, and a specificity of 74.8% [31].

Hemogram parameters.

Red blood cell distribution width (RDW): RDW has been proposed as an early prognostic marker associated with increased mortality in various pathophysiological conditions [32]. A retrospective cohort study showed a proportional relationship between RDW and mortality in septic shock, confirming its role in assessing the systemic inflammatory response and predicting AP outcomes [33]. RDW = 14.2 (CI 95%), the sensitivity and specificity for predicting mortality were 75.0% and 89.8%, and Kaplan-Meier analysis demonstrated an increased likelihood of death with high RDW values [34]. This simple routine parameter is already available upon patient admission [35]. However, due to the weakness of the existing studies due to limited sample sizes, further well-designed studies with larger sample sizes and different endpoints are needed to rigorously evaluate the prognostic value of RDW in AP [36].

Hematocrit: Hemoconcentration is an important factor influencing the progression of severe acute pancreatitis [37]. Hematocrit is a simple and accessible test used to predict the severity of AP [38]. Studies conducted in 2004 and 2006 reached similar conclusions that the prognostic utility of hematocrit as an independent biomarker remains controversial. Hematocrit on admission (≥44%) demonstrated low sensitivity (52.9%) in predicting necrosis, and its failure to normalize in the first 24 hours did not predict the development of severe pancreatitis [39,40]. Studies conducted in 2005 and 2024 also confirmed the unreliability of hematocrit as a prognostic marker and indicated that, given the approximately 75% prevalence of mild acute pancreatitis, admission hematocrit does not provide additional prognostic value and is not a significant independent predictor of disease severity [41,42]. Multicenter studies with large samples are needed to obtain more accurate conclusions.

Neutrophil to lymphocyte ratio (NLR):

NLR is an easily accessible and simple routine parameter that can be rapidly calculated using a complete blood count [43]. This parameter is

superior to total white blood cell count in predicting adverse outcomes in acute pancreatitis [44]. An elevated NLR in the first 48 hours after admission is associated with severe disease and is an independent negative prognostic factor [45]. The optimal cutoff level remains controversial, demonstrating significant variability between studies. The Spearman correlation coefficient was -0.109 (p = 0.763), indicating no cutoff effect. The sensitivity (61.6%) and specificity (93.8%) confirm the heterogeneity of the data. Further studies using subgroup analysis and meta-regression are needed to clarify the sources of heterogeneity [46].

Pancreatic enzymes.

Serum amylase: Serum amylase levels have traditionally been used to diagnose AP [47]. Over the past 20 years, numerous comparative studies have been conducted evaluating the efficacy of lipase and amylase in diagnosing this disease. One such study found that the sensitivity of serum lipase was 96.6% and the specificity was 99.4%, while for amylase these figures were 78.6% and 99.1% [48]. Similar results have been noted in other studies, demonstrating the advantage of lipase as a diagnostic marker.

Despite the widespread use of amylase, its level correlates poorly with the severity of the disease [49]. Based on the results of a retrospective multicenter study was proposed to use the ratio of the amylase level on the second day to its level on the first day. With a threshold value of 0.3, this ratio achieved a sensitivity of 92.0% and a specificity of 33.8%. Based on these data, it is recommended to transfer patients with a ratio >0.3 to the intensive care unit. However, the authors note that 48 hours are required to calculate this indicator, which limits its use as a predictor of TAP in the first 24 hours after patient admission [50]. Furthermore, the serum amylase levels 3 hours after endoscopic retrograde cholangiopancreatography (ERCP) can serve as a marker for predicting procedure-associated acute pancreatitis. Moreover, the optimal amylase threshold values differ by gender: 357 U/L for women and 436 U/L for men [51].

Serum lipase: Despite the recognition of lipase as a more sensitive and specific test internationally, amylase remains a routine test [52]. The sensitivity of serum lipase in AP varies from 82 to 100% [53]. Serum lipase levels >10,000 U/L at the time of patient admission are a marker of biliary etiology of AP and virtually exclude alcoholic pancreatitis [54]. However, none of the enzyme tests are informative for assessing the severity and have prognostic value for the development of complications [55]. Cases of AP with normal serial levels of lipase, serum amylase, and urinary amylase have also been described [56].

Thus, serum pancreatic enzymes are not informative enough for timely prediction of the development of complications and effective assessment of the severity of organ damage.

Protein metabolism marker.

Albumin: Hypoalbuminemia within the first 24 hours of hospitalization, as a risk factor, was independently associated with an increased risk of persistent organ failure and mortality in AP [57]. Hypoalbuminemia also correlated with the presence of pleural effusion and mortality (P = 0.000) [58]. The RDW-albumin ratio and albumin-bilirubin ratio were described as promising prognostic indicators of TOP, comparable in performance to the Ranson, BISAP, SOFA, SAPS-II and APACHE-II scales [59,60]. Thus, the level of serum albumin as a prognostic marker of organ failure and the development of complications in acute pancreatitis is significant with hypoalbuminemia below 25 g/l, which allows the use of this indicator in predicting the outcome of pancreatic damage [61].

Promising markers under study for predicting the severity of acute pancreatitis.

D dimer:

D-dimer plays a significant role in the impairment of the blood coagulation system associated with the severity of the disease. A 1.5-fold increase in D-dimer levels indicates a severe form of AP [62]. A D-dimer value of 414.00 μg/L at admission showed the best performance in predicting AP with a sensitivity of 90% and a specificity of 89% [63]. The risk of death in patients with AP and a mean D-dimer level of 0.4–0.8 mg/L was 11.2 times higher compared to patients with a mean D-dimer level of 0.2–0.4 mg/L at admission [64]. Furthermore, D-dimer can be used to predict the incidence of infectious complications of AP [65].

Thus, D-dimer measurement is a simple, accessible and inexpensive method for early prediction of the severity and complications of TOP [66].

Cytokines (Tumor Necrosis Factor (TNF) and Interleukins): Tumor necrosis factor (TNF-α) is a pleiotropic cytokine that plays a key role in the progression of the systemic inflammatory response with the development of dysfunction of vital organs [67]. TNF-α initiates and propagates almost all the consequences of the systemic inflammatory response syndrome, which enhances the inflammatory process [68]. A study by Surbatovic Maja and co-authors (Serbia, 2013) showed that TNF-α is a significant prognostic marker in TOP. TNF-α levels below 7.95 pg/ml are associated with a 3.2-fold increased risk of developing multiple organ dysfunction syndrome, while levels above 10.5 pg/ml increase the likelihood of survival by 4.8 times. The sensitivity and specificity of these indicators are approximately 83% and 73–77%, respectively [69].

Interleukins are a marker of inflammation and an important tool for predicting the severity and monitoring patients with AP. Since cytokine concentrations increase earlier than acute phase proteins, many clinical studies have been conducted to evaluate the usefulness of cytokines such as interleukin (IL)-1, IL-6, IL-8, IL-10, and IL-18 [70]. TNF-α and IL-1 are known to stimulate the release of IL-6 and IL-8 [71]. IL-6, IL-8, IL-10, and CRP were evaluated to predict outcomes of acute pancreatitis. An IL-6 level ≥28.90 pg/ml, measured within the first 48 hours of disease onset, with a sensitivity of 62.8%, specificity of 80%, and a positive predictive value of 95.6%, demonstrated the best result among the studied biomarkers for predicting the progression of severe pancreatitis [72]. The binomial logistic regression was performed to evaluate the Ranson criteria, as well as the levels of IL-6, IL-8, and IL-10 (measured upon admission and after 48 hours). It was found that the best predictor of the severity of acute pancreatitis was the IL-6 level measured 48 hours after admission (AUC = 0.84) [73].

However, the use of cytokines in routine clinical practice is limited by their low availability and high cost. Furthermore, many cytokine studies were conducted in animal models and were not included in this review.

Angiopoietins (ANG-1, ANG-2):

Angiopoietin-1 (Ang-1) and angiopoietin-2 (Ang-2) are autocrine peptides that regulate endothelial permeability. Ang-1 reduces vascular permeability and protects against vascular leakage, while Ang-2, conversely, promotes its increase. A 2010 collaborative study conducted across the United States and Germany demonstrated that elevated Ang-2 levels are a reliable marker of multiple organ failure. In patients with severe AP, Ang-2 levels remained significantly higher than in patients with mild AP during the first 7 days of illness. Ang-1 levels did not differ significantly between groups [74]. Ang-1 and Ang-2 act as an agonist-antagonist pair, mediating capillary endothelial leakage. The Ang-2/Ang-1 ratio is used as an indicator of capillary endothelial damage: the higher this ratio, the more severe the damage [75]. Ang-2 is associated with various diseases, including inflammatory disorders. It is found in endothelial cells at sites of vascular remodeling, where its autocrine action attenuates endothelial cell interactions with pericytes and other surrounding cells [76]. Early plasma Ang-2 levels are an accurate predictor of acute myocardial infarction, multiple organ failure, and infectious complications [77].

In addition, Ang-2 can differentiate patients with systemic organ failure from those with mild AP (AUC = 0.88, 95% CI 0.78–0.94)

and those with moderately severe AP (MSAP, AUC = 0.74, 95% CI 0.63–0.83) [78]. In the studies of Qing Huang et al. (China, 2020), it was noted that Ang-2 has proven itself as a promising predictor of the severity of acute pancreatitis [79].

Thus, the most accurate biomarker for predicting the risk of complications of acute pancreatitis is Ang-2, which indicates the possibility of its use in clinical practice.

Fibrinogen-like proteins:

Fibrinogen-like protein 1 (FGL1) is a novel hepatokine belonging to the fibrinogen family. FGL1 induces hepatocyte proliferation and promotes liver injury repair by activating epidermal growth factor receptor (EGFR) and SRC-dependent signaling pathways [80].

Most studies on the efficacy of FGL1 have been conducted in animal models (rats), while human data are still limited. FGL1 and procalcitonin (PCT) showed similar sensitivity (83.33%) in predicting severe acute pancreatitis (SAP), while the specificity of FGL1 was higher than that of PCT (94.12% vs. 88.24%). The combined use of these indicators proved to be more accurate (AUC: 0.96; sensitivity - 91.67%; specificity - 98.04%). In infectious pancreatic necrosis, CRP demonstrated higher sensitivity compared to FGL1 (100% vs. 77.78%), but the specificity of CRP was lower (79.63% vs. 87.04%) [81]. FGL1 requires further study using larger sample sizes as it is a novel immune checkpoint molecule with potential for clinical application, especially in the field of immunotherapy [82]. Fibrinogen-like protein 2 (FGL2), a member of the fibrinogen family, can exist in two forms: a membrane-bound protein with coagulation activity or a secreted form (sFGL2) [83]. sFGL2 is known to be primarily secreted by regulatory T cells (Treg) and has potent immunosuppressive activity [84]. Serum soluble FGL2 levels are independent predictors of delirium in acute pancreatitis. Using ROC analysis, it was found that serum soluble FGL2 >244.6 ng/mL predicted the development of delirium with a sensitivity of 79.6% and a specificity of 66.7% [85].

Most studies on the efficacy of FGL2 in acute pancreatitis have been conducted in animal models (mice and rats), and its clinical significance as a prognostic marker remains poorly understood. Further research is needed to elucidate the mechanisms of FGL2 and its clinical significance. This will deepen our understanding of the role of FGL2 in inflammatory diseases and aid in the development of new therapeutic strategies [86].

Conclusion.

This narrative review presents structured data on serum biomarkers involved in the development of acute pancreatitis (AP), including markers with different pathogenetic mechanisms - from systemic inflammation and vascular permeability to immune response and coagulation. The review emphasizes the multidimensional nature of biomarker research and their potential to improve early prediction of disease severity and complications in acute pancreatitis.

Classical biomarkers, including C-reactive protein (CRP), procalcitonin, creatinine, urea, albumin, and electrolyte parameters (sodium, potassium, calcium), remain essential tools in clinical practice due to their availability and diagnostic reliability. CRP continues to serve as the benchmark for rapid, reliable, and cost-effective assessment of disease severity.

Modern biomarkers, such as angiopoietins (Ang-1, Ang-2), fibrinogen-like proteins (FGL1, FGL2), cytokines (TNF-α, interleukins), and D-dimer, demonstrate high prognostic value for early detection of severe pancreatitis, organ failure, and infectious complications. However, their broader clinical application is currently limited by insufficient multicenter validation and the high cost of laboratory testing.

The presented synthesis confirms that the integration of modern biomarkers with traditional indicators can significantly enhance early risk stratification and support evidence-based decision-making in the management of acute pancreatitis. Further multicenter studies are needed to develop and validate standardized biomarker panels for clinical use.

Conflict of Interest.

The authors declare no conflict of interest.

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Author Contributions.

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REFERENCES

1. Bhatia R.K, Wong F.L, Cao Ya, et al. Pathophysiology of Acute Pancreatitis. Pancreatology. 2005;5:132-144.
2. Tonsi A.F, Bacchion M, Crippa S, et al. Acute pancreatitis at the beginning of the 21st century: The state of the art. WJG. 2009;15:2945-2959.
3. Yadav D, Lowenfels A.B. The Epidemiology of Pancreatitis and Pancreatic Cancer. Gastroenterology. 2013;144:1252-1261.
4. Sepúlveda E.V.F, Guerrero-Lozano R. Acute pancreatitis and recurrent acute pancreatitis: an exploration of clinical and etiologic factors and outcomes. J. Pediatr. 2019;95:713-719.
5. Pitchumoni C.S, Nayan P, Prasanna Sh. Factors Influencing Mortality in Acute Pancreatitis: Can We Alter Them? WJGS. 2022;14:798-814.
6. Chan K.S, Shelat V.G. Diagnosis, severity stratification and management of adult acute pancreatitis–current evidence and controversies. WJGS. 2022;14:1179-1197.
7. Wajda J, Dumnicka P, Maraj M, et al. Potential Prognostic Markers of Acute Kidney Injury in the Early Phase of Acute Pancreatitis. IJMS. 2019;20.
8. Comprehensive Toxicology. McQueen Ch.A., editor. 2nd ed. Elsevier Press; 2010.
9. Strimbu K. Tavel J.A. What are biomarkers? Curr. Opin. HIV AIDS. 2010;5:463.
10. Papachristou G.I, Whitcomb D.C. Inflammatory markers of disease severity in acute pancreatitis. Clin. Lab. Med. 2005;25:17-37.
11. Staubli S.M, Oertli D, Nebiker Ch.A. Laboratory markers predicting severity of acute pancreatitis. Crit Rev Clin Lab Sci. 2015;52:273-283.
12. Cardoso F.S, Ricardo L.B, Oliveira A.M, et al. C-reactive protein prognostic accuracy in acute pancreatitis: timing of measurement and cutoff points. Eur J Gastroenterol Hepatol. 2013;25:784-789.
13. Bülbüller N, Doğru O, Ayten R, et al. Procalcitonin is a predictive marker for severe acute pancreatitis. Ulus Travma Acil Cerrahi Derg. 2006;12:115-120.
14. Rau B.M, Kemppainen E.A, Gumbs A.A, et al. Early Assessment of Pancreatic Infections and Overall Prognosis in Severe Acute Pancreatitis by Procalcitonin (PCT): A Prospective International Multicenter Study. Ann Surg. 2007;245:745-754.

15. Siriwardena A.K, Jegatheeswaran S, Mason J.M. A procalcitonin-based algorithm to guide antibiotic use in patients with acute pancreatitis (PROCAP): a single-centre, patient-blinded, randomised controlled trial. Lancet Gastroenterol Hepatol. 2022;7:913-921.
16. Dias B.H, Rozario A.P, Olakkengil S.A, et al. Procalcitonin Strip Test as an Independent Predictor in Acute Pancreatitis. Indian J Surg. 2015;77:1012-1017.
17. Staubli S.M, Oertli D, Nebiker C.A. Laboratory markers predicting severity of acute pancreatitis. Crit Rev Clin Lab Sci. 2015;52:273-283.
18. Sinha S.S, Singh A.K, Sharma P.K. Acute Changes in Serum Creatinine and Kinetic Glomerular Filtration Rate Estimation in Early Phase of Acute Pancreatitis. J Clin Med. 2022;11:59-61.
19. Lipinski M, Rydzewski A, Rydzewska G. Early changes in serum creatinine level and estimated glomerular filtration rate predict pancreatic necrosis and mortality in acute pancreatitis: Creatinine and eGFR in acute pancreatitis. Pancreatology. 2013;13:207-211.
20. Wajda J, Dumnicka P, Maraj M, et al. Potential Prognostic Markers of Acute Kidney Injury in the Early Phase of Acute Pancreatitis. 2019;20.
21. Wu B.U, Bakker O.J, Papachristou G.I, et al. Blood Urea Nitrogen in the Early Assessment of Acute Pancreatitis: An International Validation Study. Arch. Intern. Med. 2011;171:669-676.
22. Pando E, Alberti P, Mata R, et al. Early Changes in Blood Urea Nitrogen (BUN) Can Predict Mortality in Acute Pancreatitis: Comparative Study between BISAP Score, APACHE-II, and Other Laboratory Markers – A Prospective Observational Study. Can. J. Gastroenterol. Hepatol. 2021;2021.
23. Lin S, Hong W, Basharat Z, et al. Blood Urea Nitrogen as a Predictor of Severe Acute Pancreatitis Based on the Revised Atlanta Criteria: Timing of Measurement and Cutoff Points. Can. J. Gastroenterol. Hepatol. 2017;2017.
24. Wu B.U, Johannes R.S, Sun X, et al. Early Changes in Blood Urea Nitrogen Predict Mortality in Acute Pancreatitis. Gastroenterology. 2009;137:129-135.
25. Song L, Tang W, Feng M, et al. Hyponatremia Is Associated with Mortality in Acute Pancreatitis Patients. Dig Dis Sci. 2024;69:3436-3441.
26. Venglovecz V, Rakonczay Z, Gray M, et al. Potassium channels in pancreatic duct epithelial cells: their role, function and pathophysiological relevance. Pflügers Arch. 2015;467:625-640.
27. Hayashi M, Novak I. Molecular basis of potassium channels in pancreatic duct epithelial cells. Channels. 2013;7:432-441.
28. Booth D.M, Mukherjee R, Sutton R, et al. Calcium and Reactive Oxygen Species in Acute Pancreatitis: Friend or Foe? Antioxid. Redox Signal. 2011;15:2683-2698.
29. Petersen O.H, Gerasimenko O.V, Tepikin A.V, et al. Aberrant Ca^{2+} signalling through acidic calcium stores in pancreatic acinar cells. Cell Calcium. 2011;50:193-199.
30. Frick T.W. The role of calcium in acute pancreatitis. Surgery. 2012;152:157-163.
31. Peng T, Peng X, Huang M, et al. Serum calcium as an indicator of persistent organ failure in acute pancreatitis. Am J Emerg Med. 2017;35:978-982.
32. Zhang T, Liu H, Wang D, et al. Predicting the Severity of Acute Pancreatitis with Carboxyhemoglobin. Shock. 2018;49:525-531.
33. O'Connell R.M, Boland M.R, O'Driscoll J, et al. Red cell distribution width and neutrophil-to-lymphocyte ratio in predicting severity of acute pancreatitis. Int J Surg. 2018;55:124128.
34. Yao J, Lv G. Association between red cell distribution width and acute pancreatitis: a cross-sectional cohort study. BMJ Open. 2014;4.
35. Gravito-Soares M, Gravito-Soares E, Gomes D, et al. Red cell distribution width and red cell distribution width to total serum calcium ratio as major predictors of severity and mortality in acute pancreatitis. BMC Gastroenterology. 2018;18:108.
36. Goyal H, Awad H, Hu Zh.-D. Prognostic value of admission red blood cell distribution width in acute pancreatitis: a systematic review. ATM. 2017;5:342.
37. Mao E, Fei J, Peng Yi, et al. Rapid hemodilution is associated with increased sepsis and mortality among patients with severe acute pancreatitis. CMJ. 2010;123:1639-1644.
38. Bidari S.K, Dhungana M, Panthi R.Ch, et al. The Role of Hematocrit Levels in Diagnosing the Severity of Acute Pancreatitis: A Cross-Sectional Study at a Tertiary Care Center in Nepal. Cureus. 2024;16:e68527.
39. Gardner T.B, Olenec Ch.A, Chertoff J.D, et al. Hemoconcentration and Pancreatic Necrosis: Further Defining the Relationship. Pancreas. 2006;33:169-173.
40. Gan S.I, Romagnuolo J. Admission Hematocrit: A Simple, Useful and Early Predictor of Severe Pancreatitis. DDS. 2004;49:1946-1952.
41. Bidari S.K, Dhungana M, Panthi R.Ch, et al. The Role of Hematocrit Levels in Diagnosing the Severity of Acute Pancreatitis: A Cross-Sectional Study at a Tertiary Care Center in Nepal. Cureus. 2024;16:e68527.
42. Remes-Troche J.M, Duarte-Rojo A, Morales G, et al. Hemoconcentration is a poor predictor of severity in acute pancreatitis. WJG. 2005;11:7018-7023.
43. Kokulu K, Günaydın Ya.K, Akıllı N.B, et al. Relationship between the neutrophil-to-lymphocyte ratio in acute pancreatitis and the severity and systemic complications of the disease. TJG. 2018;29:684-691.
44. Azab B, Jaglall N, Atallah J.P, et al. Neutrophil-Lymphocyte Ratio as a Predictor of Adverse Outcomes of Acute Pancreatitis. Pancreatology. 2011;11:445-452.
45. Suppiah A, Malde D, Arab T, et al. The Prognostic Value of the Neutrophil–Lymphocyte Ratio (NLR) in Acute Pancreatitis: Identification of an Optimal NLR. J Gastrointest Surg. 2013;17:675-681.
46. Kong W, He Yu, Bao H, et al. Diagnostic Value of Neutrophil-Lymphocyte Ratio for Predicting the Severity of Acute Pancreatitis: A Meta-Analysis. Dis Markers. 2020;2020:9731854.
47. Hong W, Geng W, Chen B, et al. Predictors of acute pancreatitis with low elevation of serum amylase. Ther Clin Risk Manag. 2017;13:1577-1584.
48. Gomez D, Addison A, De Rosa A, et al. Retrospective study of patients with acute pancreatitis: is serum amylase still required? BMJ Open. 2012;2:e001471.

49. Yadav D, Agarwal N, Pitchumoni C.S. A Critical Evaluation of Laboratory Tests in Acute Pancreatitis. Am J Gastroenterol. 2002;97:1309-1318.
50. Hong W, Zheng L, Lu Ya, et al. Non-linear correlation between amylase day 2 to day 1 ratio and incidence of severe acute pancreatitis. Front Cell Infect Microbiol. 2022;12:910760.
51. Lv Z.-H, Kou D.-Q, Guo Sh.-B. Three-hour post-ERCP amylase level: a useful indicator for early prediction of post-ERCP pancreatitis. BMC Gastroenterology. 2020;20:118.
52. Hofmeyr S, Meyer C, Warren B.L. Serum lipase should be the laboratory test of choice for suspected acute pancreatitis. S Afr J Surg. 2014;52.
53. Yadav D, Agarwal N, Pitchumoni C.S. A critical evaluation of laboratory tests in acute pancreatitis. Am J Gastroenterol. 2002;97:1309.
54. Cornett D.D, Spier B.J, Eggert A.A, et al. The Causes and Outcome of Acute Pancreatitis Associated with Serum Lipase >10,000 U/L. Dig Dis Sci. 2011;56:3376-3381.
55. Yadav D, Agarwal N, Pitchumoni C.S. A Critical Evaluation of Laboratory Tests in Acute Pancreatitis. Am J Gastroenterol. 2002;97:1309-1318.
56. Vashishtha V, Kulkarni S.V, Srivastava V.L, et al. Normal Lipase Acute Pancreatitis: A Case Series Analysis. Indian J Surg. 2024.
57. Hong W, Lin S, Zippi M, et al. Serum Albumin Is Independently Associated with Persistent Organ Failure in Acute Pancreatitis. Can J Gastroenterol Hepatol. 2017;2017:5297143.
58. Amri F, Rahaoui M, Aissaoui H, et al. Is serum albumin a pivotal biomarker in anticipating acute pancreatitis outcomes? BMC Gastroenterology. 2024;24:234.
59. Wang X, Zhu L, Tao K, et al. Red cell distribution width to serum albumin ratio as an early prognostic marker for severe acute pancreatitis: A retrospective study. Arab J Gastroenterol. 2022;23:206-209.
60. Shi L, Zhang D, Zhang J. Albumin-bilirubin score is associated with severity and mortality in acute pancreatitis. Eur J Gastroenterol Hepatol. 2020;32:1051-1057.
61. Gonzálvez-Gascha A, de Casasolab G.G, Martínb R.B, et al. A simple prognostic score for risk assessment in patients with acute pancreatitis. Eur J Gastroenterol Hepatol. 2009;20:E43-E48.
62. Salomone T, Tosi P, Palareti G, et al. Coagulative Disorders in Human Acute Pancreatitis: Role for the D-Dimer. Pancreas. 2003;26:111-116.
63. Radenkovic D, Bajec D, Ivancevic N, et al. d-Dimer in Acute Pancreatitis: A New Approach for an Early Assessment of Organ Failure. Pancreas. 2009;38:655-660.
64. He Q, Ding J, He S, et al. The predictive value of procalcitonin combined with C-reactive protein and D dimer in moderately severe and severe acute pancreatitis. Eur J Gastroenterol Hepatol. 2022;34:744-750.
65. Zhang G.-Q, Wang G, Li L, et al. Plasma D-Dimer Level Is an Early Predictor of Severity of Acute Pancreatitis Based on 2012 Atlanta Classification. Med Sci Monit. 2019;25:9019-9027.
66. Kumar A, Kothagattu R. D-dimer levels in predicting the severity of acute pancreatitis. Int Surg J. 2017;4.
67. Malleo G, Mazzon E, Siriwardena A.K, et al. Role of tumor necrosis factor-α in acute pancreatitis: From biological basis to clinical evidence. Shock. 2007;28:130-140.
68. Pereda J, Sabater L, Aparisi L, et al. Interaction Between Cytokines and Oxidative Stress in Acute Pancreatitis. Curr Med Chem. 2006;13:2775-2787.
69. Surbatovic M, Radakovic S. Tumor Necrosis Factor-α Levels Early in Severe Acute Pancreatitis: Is There Predictive Value Regarding Severity and Outcome? J Clin Gastroenterol. 2013;47:637-643.
70. Khanna A.K, Meher S, Prakash S, et al. Comparison of Ranson, Glasgow, MOSS, SIRS, BISAP, APACHE-II, CTSI Scores, IL-6, CRP, and Procalcitonin in Predicting Severity, Organ Failure, Pancreatic Necrosis, and Mortality in Acute Pancreatitis. HPB Surgery. 2013;2013:367581.
71. Al Mofleh I.A. Severe acute pancreatitis: Pathogenetic aspects and prognostic factors. World J Gastroenterol. 2008;14:675-684.
72. Rao S.A, Kunte A.R Interleukin-6: An Early Predictive Marker for Severity of Acute Pancreatitis. Indian J Crit Care Med. 2017;21:424-428.
73. Ćeranić D.B, Zorman M, Skok P. Interleukins and inflammatory markers are useful in predicting the severity of acute pancreatitis. Bosn J Basic Med Sci. 2020;20:99-105.
74. Whitcomb D.C, Muddana V, Langmead C.J, et al. Angiopoietin-2, a Regulator of Vascular Permeability in Inflammation, Is Associated with Persistent Organ Failure in Patients with Acute Pancreatitis from the United States and Germany. Am J Gastroenterol. 2010;105:2287-2292.
75. Fang Y, Li C, Shao R, et al. Prognostic significance of the angiopoietin-2/angiopoietin-1 and angiopoietin-1/Tie-2 ratios for early sepsis in an emergency department. Critical Care. 2015;19:367.
76. Sporek M, Dumnicka P, Gala-Bladzinska A, et al. Angiopoietin-2 Is an Early Indicator of Acute Pancreatic-Renal Syndrome in Patients with Acute Pancreatitis. Mediators Inflamm. 2016;2016:5780903.
77. Buddingh K.T, Koudstaal L.G, van Santvoort H.C, et al. Early Angiopoietin-2 Levels after Onset Predict the Advent of Severe Pancreatitis, Multiple Organ Failure, and Infectious Complications in Patients with Acute Pancreatitis. J Am Coll Surg. 2014;218:26-32.
78. Zhang Y.-P, Liu C, Ye L, et al. Early Prediction of Persistent Organ Failure by Serum Angiopoietin-2 in Patients with Acute Pancreatitis. Dig Dis Sci. 2016;61:3584-3591.
79. Huang Q, Wu Z, Chi C, et al. Angiopoietin-2 Is an Early Predictor for Acute Gastrointestinal Injury and Intestinal Barrier Dysfunction in Patients with Acute Pancreatitis. Dig Dis Sci. 2020;66:114-120.
80. Wu H.-T, Chen S.-C, Fan K.-C, et al. Targeting fibrinogen-like protein 1 is a novel therapeutic strategy to combat obesity. FASEB J. 2019;34:2958-2967.
81. Sui Y, Zhao Z, Zhang Y, et al. Fibrinogen-like Protein 1 as a Predictive Marker for the Incidence of Severe Acute Pancreatitis and Infectious Pancreatic Necrosis. Medicina. 2022;58:1753.
82. Qian W, Zhao M, Wang R, et al. Fibrinogen-like protein 1 (FGL1): the next immune checkpoint target. J Hematol Oncol. 2021;14:147.

83. Hu J, Yan J, Rao G, et al. The Duality of Fgl2 - Secreted Immune Checkpoint Regulator Versus Membrane-Associated Procoagulant: Therapeutic Potential and Implications. Int Rev Immunol. 2016;35:325-339.
84. Ji W, Wang W, Li P, et al. sFgl2 gene-modified MSCs regulate the differentiation of CD4+ T cells in the treatment of autoimmune hepatitis. Stem Cell Res Ther. 2023;14:316.
85. Xu W.-B, Hu Q.-H, Wu C.-N, et al. Serum soluble fibrinogen-like protein 2 concentration predicts delirium after acute pancreatitis. Brain Behav. 2019;9:01261.
86. Fu L, Liu Z, Liu Y. Fibrinogen-like protein 2 in inflammatory diseases: A future therapeutic target. Int Immunopharmacol. 2023;116:109799.

რეზიუმე

ფონი: მწვავე პანკრეატიტი (AP) წარმოადგენს პანკრეასის ანთებით დაავადებას არაპროგნოზირებადი მიმდინარეობით, რომელიც მერყეობს მსუბუქ თვითშეზღუდვად ფორმებსა და ნეკროზულ პანკრეატიტს შორის მრავალორგანული უკმარისობით. მიუხედავად ვიზუალიზაციისა და შეფასების სისტემების განვითარებისა, დაავადების სიმძიმის ადრეული პროგნოზირება კვლავ სერიოზულ კლინიკურ გამოწვევად რჩება. ბოლო წლებში ცირკულირებადი ბიომარკერები მოიპოვებს მზარდ ყურადღებას, როგორც დიაგნოსტიკური სიზუსტისა და პაციენტთა რისკის სტრატიფიკაციის გაუმჯობესების ინსტრუმენტი.

მიზანი: მიმოხილვის მიზანია შეაჯამოს და კრიტიკულად შეაფასოს არსებული ლიტერატურა სისხლის შრატის ბიომარკერებზე, რომლებიც გამოიყენება ან ახლადაა შემოთავაზებული მწვავე პანკრეატიტის სიმძიმისა და გართულებების პროგნოზირებისთვის, და განისაზღვროს მათი კლინიკური და პროგნოზული მნიშვნელობა არსებული შეფასების სისტემებში ინტეგრაციის პერსპექტივით.

მასალები და მეთოდები: PubMed-ში, Scopus-ში, Google Scholar-ში და The Cochrane Library-ში მოიცავდა რეტროსპექტული და პროსპექტული კვლევების იდენტიფიცირებას, რომლებიც აფასებდნენ ბიომარკერების დიაგნოსტიკურ და პროგნოსტიკურ მნიშვნელობას — C-რეაქტიული ცილა (CRP), პროკალციტონინი, ლიპაზა, ანგიოპოეტინები (ANG-1, ANG-2), ფიბრინოგენთან მსგავსი ცილები (FGL1, FGL2) და ინტერლეიკინები (IL-6, IL-38).

შედეგები: ტრადიციულ ბიომარკერებს (CRP, procalcitonin, აზოტის, ცილის და ელექტროლიტების მაჩვენებლები) კვლავ აქვთ დიაგნოსტიკური მნიშვნელობა მათი ხელმისაწვდომობისა და დაბალი ღირებულების გამო, თუმცა სპეციფიკურობა შეზღუდულია. პერსპექტიული ბიომარკერები (angiopoietin-2, FGL1, FGL2, cytokines, D-dimer) აჩვენებენ უფრო მაღალ მგრძნობელობასა და პროგნოზულ სიზუსტეს ორგანოთა უკმარისობისა და ნეკროზის შემთხვევაში, თუმცა მათი კლინიკური გამოყენება ჯერაც შეზღუდულია მაღალი ღირებულებისა და მრავალცენტრული ვალიდაციის არარსებობის გამო.

დასკვნა: სისხლის შრატის ბიომარკერები წარმოადგენს მნიშვნელოვან მიმართულებას მწვავე პანკრეატიტის სიმძიმის ადრეული პროგნოზირების გასაუმჯობესებლად. კლასიკური და ახალი ბიომარკერების ინტეგრაცია არსებული შეფასების სისტემებთან შეიძლება გააუმჯობესოს დიაგნოსტიკური სიზუსტე და ხელი შეუწყოს დროულ ჩარევას. საჭიროა დამატებითი მრავალცენტრული კვლევები ამ მონაცემების დასადასტურებლად და კლინიკურ პრაქტიკაში მათი დანერგვისთვის.

საკვანძო სიტყვები: მწვავე პანკრეატიტი, პროგნოსტიკური ბიომარკერები, C-რეაქტიული ცილა, პროკალციტონინი, ანგიოპოეტინ-2, ინტერლეიკინ-6, ფიბრინოგენთან მსგავსი ცილა 2 (FGL2), D-დიმერი და რისკის პროგნოზირება.

Аннотация

Введение: Острый панкреатит (ОП) представляет собой воспалительное заболевание поджелудочной железы с непредсказуемым течением, варьирующим от лёгких самоограничивающихся форм до некротического панкреатита с развитием полиорганной недостаточности. Несмотря на достижения в визуализационных и оценочных методах, раннее прогнозирование тяжести заболевания остаётся серьёзной клинической проблемой. В последние годы циркулирующие биомаркеры привлекают всё большее внимание как инструмент для повышения точности диагностики и стратификации риска пациентов.

Цель: Обобщить и комплексно оценить современную литературу о сывороточных биомаркерах, применяемых или недавно предложенных для прогнозирования тяжести острого панкреатита и его осложнений, а также определить их клиническое и прогностическое значение с точки зрения возможной интеграции в существующие системы оценки тяжести заболевания.

Материалы и методы: В результате комплексного поиска в PubMed, Scopus, Google Scholar и Cochrane Library были выявлены ретроспективные и проспективные исследования, оценивающие диагностическую и прогностическую эффективность биомаркеров- С-реактивного белка (СРБ), прокальцитонина, липазы, ангиопоэтинов (ANG-1, ANG-2), фибриногеноподобных белков (FGL1, FGL2) и интерлейкинов (IL-6, IL-38).

Результаты: Традиционные биомаркеры (CRP, прокальцитонин, показатели азотистого, белкового и электролитного обмена) сохраняют диагностическую значимость благодаря доступности и низкой стоимости, однако характеризуются ограниченной специфичностью. Перспективные биомаркеры (angiopoietin-2, FGL1, FGL2, цитокины, D-dimer) демонстрируют более высокую чувствительность и прогностическую точность в отношении органной недостаточности и некроза, однако их клиническое применение пока ограничено высокой стоимостью и отсутствием многоцентровой валидации.

Заключение: Сывороточные биомаркеры представляют собой перспективное направление для совершенствования раннего прогнозирования тяжести острого панкреатита. Интеграция классических и новых биомаркеров в существующие системы оценки может повысить точность диагностики и своевременность лечебных решений. Необходимы дополнительные многоцентровые исследования для подтверждения этих данных и внедрения наиболее информативных маркеров в клиническую практику.

Ключевые слова: Острый панкреатит, прогностические биомаркеры, С-реактивный белок, прокальцитонин, ангиопоэтин-2, интерлейкин-6, фибриногеноподобный белок 2 (FGL2), D-димер и прогнозирование риска.