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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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INDEPENDENT PREDICTORS OF SHORT-TERM MORTALITY IN PATIENTS WITH CHRONIC HEART FAILURE AND ANEMIA

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Abstract.

Background: Anemia is a common comorbidity in patients with chronic heart failure (CHF) and is associated with an unfavorable prognosis. However, the prognostic value of various laboratory biomarkers in patients with CHF and anemia, as well as the contribution of inflammatory mechanisms to adverse clinical outcomes, remains insufficiently understood.

Aim: To identify independent clinical and laboratory predictors of three-month mortality in patients with chronic heart failure (CHF) and anemia.

Materials and Methods: This retrospective study included 162 patients with chronic heart failure (CHF) and anemia. The type of anemia was determined based on a comprehensive assessment of laboratory parameters. Patients were followed for 3 months. Statistical analyses were performed using SPSS software (version 22.0).

Results: Anemia of chronic disease was the most common type of anemia, identified in 104 (64.2%) patients, followed by iron deficiency anemia in 53 (32.7%) patients and macrocytic anemia in 5 (3.1%) patients. Signs of hemodilutional anemia were observed in 89 (54.9%) patients. During the follow-up period, 14 deaths (8.6%) were recorded. In the univariable analysis, hemoglobin level, hematocrit, red blood cell count, white blood cell count, ferritin level, C-reactive protein, and left ventricular ejection fraction were significantly associated with three-month mortality ($p<0.05$). Multivariable analysis identified elevated white blood cell count (OR 1.238, 95% CI 1.094-1.401; p=0.001) and ferritin level (OR 1.003, 95% CI 1.001-1.005; p=0.002) as independent predictors of three-month mortality.

Conclusion: Among patients with CHF and anemia, anemia of chronic disease was the most common type of anemia, while signs of hemodilution were observed in more than half of the study population. Elevated white blood cell count and ferritin levels were identified as independent predictors of three-month mortality. These findings suggest that inflammation-associated laboratory markers may play an important role in determining adverse short-term outcomes in patients with CHF and anemia.

Key words. Chronic heart failure, anemia, anemia of chronic disease, hemodilution, ferritin, white blood cell count, inflammation.

Introduction.

Anemia is a common comorbidity in patients with chronic heart failure (CHF) and is associated with a more severe clinical course, reduced quality of life, and poorer prognosis. According to previous studies, the prevalence of anemia among patients with CHF ranges from 15% to 61% [1,2]. The presence of anemia is associated with an increased risk of mortality and heart failure-related hospitalizations and is considered an important predictor of adverse clinical outcomes [3].

The etiology of anemia in patients with chronic heart failure (CHF) is heterogeneous. In addition to iron deficiency anemia, a substantial proportion of cases is attributable to anemia of chronic disease (inflammatory anemia), hemodilution, and mixed forms. Anemia in CHF is therefore considered a multifactorial condition. In routine clinical practice, the diagnostic evaluation is often limited to measuring hemoglobin levels, which hinders accurate identification of the underlying cause of anemia and may lead to inappropriate iron therapy. Current clinical guidelines emphasize the importance of a comprehensive assessment of iron status, including serum ferritin and transferrin saturation (TSAT), for the diagnosis of iron deficiency in patients with CHF [4].

In recent years, increasing attention has been focused on the role of iron metabolism disorders and systemic inflammation in the pathogenesis of CHF and its associated anemia. It has been shown that both elevated serum ferritin levels, which may reflect inflammatory activation, and reduced transferrin saturation (TSAT) are associated with adverse clinical outcomes. These findings indicate that the interpretation of serum ferritin levels should take into account not only iron stores but also the degree of systemic inflammation [5].

Chronic inflammation plays a pivotal role in the development of anemia in patients with CHF and may contribute to an unfavorable prognosis [6]. At the same time, further investigation is needed to clarify the prognostic value of readily available laboratory markers reflecting inflammatory activity and disturbances in iron metabolism, with the aim of improving risk stratification in patients with CHF and anemia [7].

Therefore, a comprehensive evaluation of anemia subtypes and the identification of independent prognostic markers are essential for accurate risk stratification. The aim of the present study was to identify independent clinical and laboratory predictors of mortality in patients with chronic heart failure and anemia.

Materials and Methods.

A total of 162 patients hospitalized with clinical manifestations of chronic heart failure were retrospectively enrolled in the study

from the Cardiology Department of the Emergency Hospital in Semey.

Inclusion criteria:

1. Patients with confirmed chronic heart failure (CHF), defined as New York Heart Association (NYHA) functional class II-IV, elevated N-terminal pro-B-type natriuretic peptide (NT-proBNP) levels in accordance with the European Society of Cardiology (ESC) guidelines, and available echocardiographic data, including left ventricular ejection fraction (LVEF).
2. Presence of anemia and available laboratory test results allowing assessment of its type.

Exclusion criterion:

Patients with insufficient laboratory data to determine the type of anemia.

Endpoint: all-cause mortality.

The study design was approved by the Local Ethics Committee of Semey Medical University (Protocol No. 2в dated February 4, 2025).

Patients were classified according to the type of anemia:

1. Iron deficiency anemia (IDA) - decreased serum iron and ferritin levels (<100 ng/mL).
2. Anemia of chronic disease (ACD) - normocytic, normochromic anemia associated with chronic inflammation and an elevated C-reactive protein (CRP) level (>5.0 mg/L).
3. Megaloblastic anemia - indirectly assessed based on MCV (>100 fL) and MCH (>34 pg), along with reduced vitamin B12 (<200 pg/mL) and folate (<4 ng/mL) levels.
4. Hemodilutional anemia - defined as a hematocrit level <34%.

Statistical analyses were performed using SPSS software (version 22.0). Continuous variables were compared using the Mann-Whitney U test for independent samples, while associations between categorical variables were assessed using the χ^2 test. Continuous variables are presented as means with standard deviations, and dichotomous variables as frequencies and percentages. Univariable and multivariable binary logistic regression analyses were performed to identify independent predictors of adverse outcomes. Odds ratios (ORs) with corresponding 95% confidence intervals (CIs) were calculated for each factor. Receiver operating characteristic (ROC) curve analysis was used to assess the prognostic value of continuous variables. Optimal cutoff values were determined using the maximum Youden index. Differences were considered statistically significant at $p<0.05$.

Results.

A total of 162 patients hospitalized with CHF and anemia in the Cardiology Department of the Emergency Hospital in Semey between June and August 2025 were included in the study. The mean age of the patients was 68.12 ± 12.0 years, ranging from 36 to 96 years. Of these, 95 (58.6%) were men (mean age, 70.1 ± 11.6 years) and 67 (41.4%) were women (mean age, 65.4 ± 12.0 years). Women were significantly younger than men ($p = 0.016$).

At admission, all patients had NYHA functional class II-IV CHF and were distributed as follows:

- the largest group consisted of patients with NYHA class II CHF, comprising 60 (37.0%) patients;
- patients with NYHA class III accounted for 54 (33.3%) cases, reflecting a substantial proportion of patients with a moderate degree of physical activity limitation;
- the group of patients with NYHA class IV, characterized by severe symptoms at rest, included 48 (29.6%) patients.

Thus, more than 62% of the study population (NYHA class III-IV) consisted of patients with moderate-to-severe and severe CHF, highlighting the high risk of adverse outcomes in this population.

Distribution of anemia subtypes:

Analysis of the distribution of anemia subtypes based on mean corpuscular volume (MCV) demonstrated the following pattern among the 162 patients with chronic heart failure and anemia. The most common subtype was anemia of chronic disease (ACD), which was diagnosed in 104 (64.2%) patients. Iron deficiency anemia (IDA) was the second most prevalent subtype and was identified in 53 (32.7%) patients. Macrocytic anemia (MCV >100 fL), suggesting the possible presence of megaloblastic disorders, was considerably less common and was detected in only 5 (3.1%) patients.

Assessment of the prevalence of hemodilutional anemia, based on the analysis of hemoglobin and hematocrit levels with consideration of the red blood cell count, showed that more than half of the patients had signs of hemodilution. Hemodilutional anemia was identified in 89 of the 162 patients (54.9%), whereas no evidence of hemodilution was observed in 73 (45.1%) patients.

The follow-up period was 3 months, which, according to the accepted time frames (ESC 2021; ACC/AHA 2022), corresponds to the assessment of short-term clinical outcomes. The incidence of the study endpoint (adverse outcomes/all-cause mortality) in the study population was 14 (8.6%).

Table 1 presents a comparative clinical and laboratory characteristics of patients without mortality (n = 148; 91.4%) and with mortality (n = 14; 8.6%).

Continuous variables are presented as median [IQR] (min–max), where IQR denotes the interquartile range and min–max indicates the minimum and maximum values. Categorical variables are presented as absolute numbers and percentages, n (%). *Statistical significance of differences between survivors and non-survivors. LVEF, left ventricular ejection fraction; CRP, C-reactive protein; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin; NYHA, New York Heart Association; CHF, chronic heart failure; NT-proBNP, N-terminal pro-B-type natriuretic peptide.

Univariable regression analysis, which included the above-mentioned variables, identified the following risk factors for an adverse outcome during the three-month follow-up period: hemoglobin level (OR 0.963, 95% CI 0.933-0.994; p=0.018), hematocrit (OR 0.890, 95% CI 0.804-0.985; p=0.025), red blood cell count (OR 0.385, 95% CI 0.173-0.857; p=0.019), white blood cell count (OR 1.234, 95% CI 1.090-1.397; p=0.001), ferritin level (OR 1.003, 95% CI 1.001-1.005; p=0.001), C-reactive protein (OR 1.011, 95% CI 1.002-1.019; p=0.014), and left ventricular ejection fraction (OR 0.960, 95% CI 0.922-1.000; p=0.050).

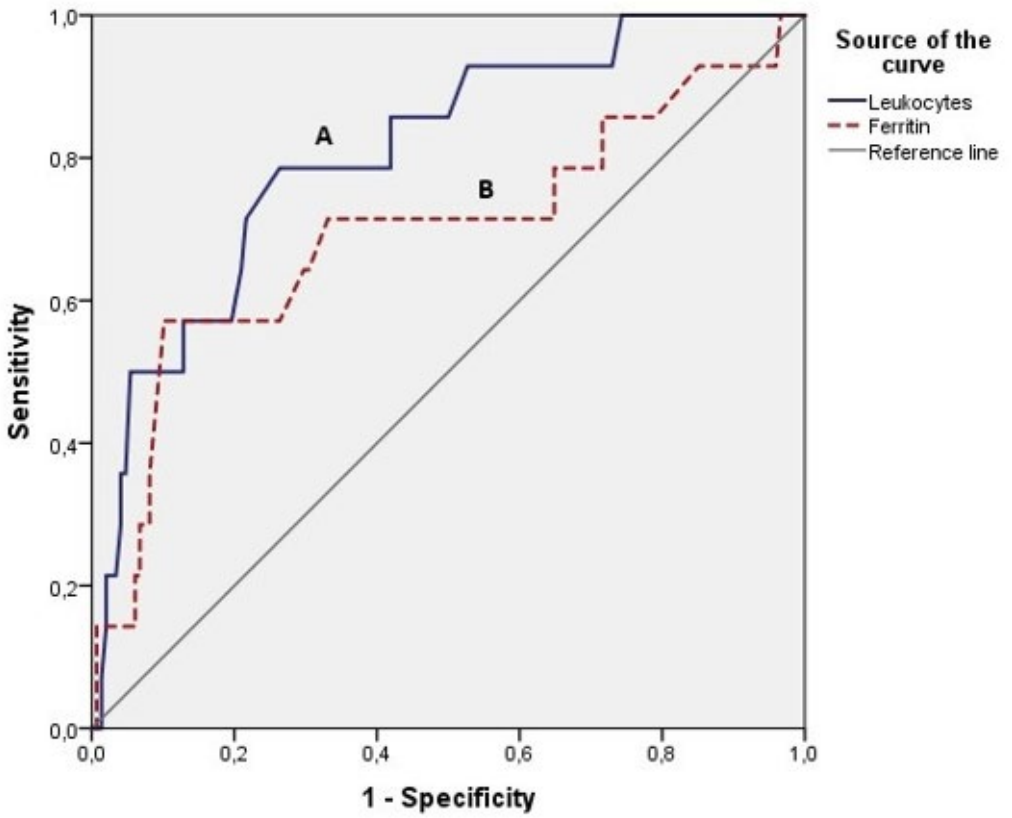


Figure 1. *ROC curves of the variables. A - white blood cell count; B - ferritin level.*

Table 1. *Clinical characteristics of the study population.*

Variable	**All patients (n=162)**	**Survivors (n=148)**	**Non-survivors (n=14)**	**P***
Age, years	69 [14] (36-96)	69 [14] (36-96)	72 [17] (39-91)	0.319
Male sex, n (%)	95 (58.6)	86 (58.1)	9 (64.3)	0.654
CHF according to NYHA				
II	60 (37.0)	59 (39.9)	1 (7.1)	0.007
III	54 (33.3)	47 (31.8)	7 (50.0)	0.234
IV	48 (29.6)	42 (28.4)	6 (42.9)	0.357
LVEF, %	49 [19] (15-70)	50 [18] (15-70)	43 [20] (15-63)	0.034
Laboratory parameters				
Hemoglobin, g/L	108.0 [22] (44-119)	109.0 [21] (44-119)	90.0 [31] (60-116)	0.023
Hematocrit, %	33.0 [6] (16-48)	33.0 [6] (16-48)	30.0 [9] (18-36)	0.024
Red blood cell count, $\times 10^{12}$/L	3.85 [0.7] (1.7-5.6)	3.9 [0.7] (1.7-5.6)	3.4 [1.3] (2.2-4.8)	0.028
White blood cell count, $\times 10^{9}$/L	7.7 [3.3] (1.6-29.0)	7.5 [3.2] (1.6-29.0)	11.7 [6.8] (6.0-21.0)	<0.001
Platelet count, $\times 10^{9}$/L	240.0 [117] (38-639)	243.5 [121] (74-639)	226.5 [97] (38-412)	0.097
MCV, fL	85.5 [12.0] (55-106)	85.0 [12.0] (55-106)	90.5 [19.4] (60-100)	0.208
MCH, pg	27.0 [4.0] (15-34)	27.0 [4.0] (15-33)	28.0 [6.6] (16.2-34)	0.541
Ferritin, ng/mL	131.0 [204] (4-1200)	124 [189] (4-1200)	600 [621] (8-1000)	0.015
Iron, µmol/L	8.15 [7.3] (0.4-47)	8.15 [7.4] (0.4-47)	7.75 [8.5] (1.1-28)	0.603
Vitamin B12, pg/mL	380.0 [185] (50-2200)	377.0 [180] (50-2200)	495.0 [298] (50-800)	0.183
Folate, ng/mL	8.0 [6.0] (4.0-20.0)	8.0 [6.0] (4.0-20.0)	8.0 [6.0] (6.0-20.0)	0.780
C-reactive protein, mg/L	5.9 [19] (1-361)	5.5 [15] (1-361)	45.0 [94] (2-173)	0.004
Creatinine, µmol/L	103.5 [99] (12-873)	102.5 [93] (12-873)	110.5 [196] (41-798)	0.469
NT-proBNP, pg/mL	2603.5 [9676] (65-35000)	2479.0 [9477] (65-35000)	6333.5 [13017] (497-30930)	0.312

Six of the above-mentioned variables that showed a statistically significant association with mortality in the univariable analysis were included in the multivariable analysis. Following stepwise selection, white blood cell count (OR 1.238, 95% CI 1.094-1.401; p=0.001) and ferritin level (OR 1.003, 95% CI 1.001-1.005; p=0.002) remained independent predictors of three-month mortality in the final model.

To determine the optimal cutoff values of the quantitative predictors, receiver operating characteristic (ROC) curve analysis was performed, and the corresponding ROC curves were constructed (Figure 1).

Given the distribution of outcomes in the study population (148 survivors and 14 non-survivors), the cutoff value for the predicted probability was set at 0.086. At this threshold, the combined model demonstrated a sensitivity of 71.4%, a specificity of 84.5%, and an overall accuracy of 83.3%.

According to the area under the ROC curve (AUC) analysis, both markers demonstrated statistically significant predictive ability. The AUC was 0.808 for white blood cell count (95% CI 0.691-0.926; p<0.001) and 0.697 for ferritin (95% CI 0.524-0.870; p=0.015).

In addition, ROC analysis and the Youden index were used to determine individual cutoff values for the key laboratory markers included in the model. The optimal cutoff was 8.95×10^9/L for white blood cell count and 584.0 ng/mL for ferritin.

Discussion.

Anemia is one of the most common comorbid conditions in patients with chronic heart failure (CHF) and is associated with worsening clinical status, an increased risk of mortality, and recurrent hospitalizations [8,9]. Despite the substantial body of evidence available, the mechanisms underlying the unfavorable prognosis in patients with concomitant CHF and anemia remain insufficiently understood.

In the present study, anemia of chronic disease was the most prevalent subtype of anemia, whereas iron deficiency anemia occurred almost twice less frequently. These findings are consistent with current evidence indicating that anemia in patients with CHF more commonly develops in the setting of chronic inflammation and disturbances in iron metabolism [10,11].

Signs of hemodilutional anemia were identified in more than half of the patients, indicating a high prevalence of this mechanism among individuals with CHF. Expansion of plasma volume in heart failure may lead to reduced hemoglobin concentration and hematocrit without a true decrease in red blood cell mass. This phenomenon should be taken into consideration when diagnosing anemia and interpreting laboratory findings [10,12].

The main finding of the present study was the identification of independent predictors of three-month mortality in patients with CHF and anemia. Short-term mortality was significantly associated with elevated white blood cell count and ferritin levels.

Although anemia has traditionally been considered a marker of poor prognosis in patients with CHF, recent studies suggest that, after adjustment for clinical and laboratory parameters, reduced hemoglobin levels do not always retain independent prognostic significance and may instead reflect the overall severity of the patient's condition, including concomitant renal dysfunction, inflammation, and other adverse factors [13,14]. In our study, hemoglobin level, hematocrit, and red blood cell count were significantly associated with short-term mortality in the univariable analysis (p<0.05); however, these parameters did not retain independent prognostic significance after inclusion in the multivariable model. In the study by Arami et al., none of the evaluated red blood cell parameters, including hemoglobin, hematocrit, MCV, and MCH, were independent predictors of rehospitalization or all-cause mortality in the multivariable analysis. The authors noted that although anemia and alterations in red blood cell parameters are associated with an unfavorable clinical profile in patients with heart failure, their prognostic value for short-term adverse cardiovascular outcomes may be limited [15].

In recent years, increasing attention has been focused on the role of systemic inflammation in the pathogenesis of CHF. Experimental and clinical studies have shown that activation of immune-inflammatory mechanisms accompanies disease progression and is associated with an unfavorable prognosis [16,17]. In the present study, elevated white blood cell count and ferritin levels, both laboratory markers associated with inflammatory activity, were identified as independent predictors of three-month mortality. These findings suggest that systemic inflammation may play an important role in adverse short-term outcomes among patients with CHF and anemia.

Among the independent predictors identified, white blood cell count showed the strongest statistical significance (p=0.001). In the TOPCAT-Americas study, an elevated white blood cell count was associated with adverse clinical outcomes in patients with CHF [18]. Increased leukocyte levels in CHF have been attributed to persistent activation of immune-inflammatory pathways, which may occur even in the absence of overt infection [11,19-21]. Under these conditions, an elevated white blood cell count may reflect the intensity of the systemic inflammatory response and can be considered a readily available laboratory marker of poor prognosis.

Despite the availability of contemporary clinical guidelines, the diagnosis of iron deficiency in patients with CHF remains a matter of debate, particularly with regard to the interpretation of serum ferritin levels. This is largely attributable to the limited number of studies comparing the diagnostic performance of serum biomarkers with bone marrow assessment, which remains the reference standard for evaluating iron stores [22,23]. According to current clinical guidelines for the management of patients with CHF, iron deficiency is diagnosed when the serum ferritin concentration is <100 ng/mL or when serum ferritin ranges from 100 to 299 ng/mL in combination with a transferrin saturation (TSAT) <20%. The interpretation of serum ferritin in patients with CHF is challenging because this biomarker reflects not only iron stores but also the degree of systemic inflammation. During inflammatory activation, serum ferritin concentrations may be elevated even in the presence of iron deficiency [24-26].

In the present study, elevated serum ferritin was identified as an independent predictor of short-term mortality (p = 0.002). Given that ferritin is an acute-phase protein, these findings

likely reflect not only alterations in iron metabolism but also the degree of systemic inflammatory activation. Therefore, in this cohort of patients, hyperferritinemia may be considered an integrated marker of disease severity, encompassing both disturbances in iron metabolism and chronic inflammation.

In patients with CHF and anemia, elevated C-reactive protein (CRP) levels were associated with higher short-term mortality in the univariable analysis (p=0.014). In a study of patients hospitalized with acute heart failure, Minami et al. showed that markedly elevated CRP levels at admission were associated with higher short-term cardiac and non-cardiac mortality, whereas moderate CRP elevation was associated with an increased risk of mortality predominantly after 120 days of follow-up [27].

Higher left ventricular ejection fraction (LVEF) was borderline associated with a lower risk of short-term mortality in the univariable analysis (p=0.050); however, LVEF did not retain independent prognostic significance in the multivariable model. In the study by Chairat et al., among patients with CHF and anemia, anemia significantly increased the risk of one-year mortality predominantly in patients with preserved LVEF (p=0.014), whereas no statistically significant effect of anemia on mortality was observed in patients with reduced LVEF. Thus, the prognostic significance of anemia in patients with CHF varied according to the heart failure phenotype, with anemia being associated with a higher risk of mortality in patients with preserved LVEF [28].

Thus, the findings of the present study indicate that short-term prognosis in patients with CHF and anemia may be determined not only by the severity of anemia but also by inflammatory activity. Elevated white blood cell count and ferritin levels were independent predictors of three-month mortality, whereas parameters directly reflecting the severity of anemia did not retain independent prognostic significance after multivariable analysis. These findings broaden the current understanding of risk factors for adverse short-term outcomes in patients with CHF and anemia and support the need for further investigation into the role of inflammatory mechanisms in this patient population.

The limitations of this study include certain characteristics of the study sample. Only patients in whom the type of anemia was established based on additional laboratory testing were included in the analysis. As a result, some male patients with less pronounced reductions in hemoglobin levels were not included, which should be taken into account when interpreting the findings. The small number of deaths may have limited the statistical robustness of the multivariable model. In addition, the follow-up period was limited to three months; therefore, the findings primarily reflect short-term outcomes.

Conclusion.

Thus, among patients with CHF and anemia, anemia of chronic disease was the most common type of anemia, while signs of hemodilution were observed in more than half of the study population. Elevated white blood cell count and ferritin levels were identified as independent predictors of three-month mortality. These findings highlight the prognostic significance of inflammation-associated laboratory markers in adverse short-term outcomes among patients with CHF and anemia and support further investigation into the role of inflammation in this patient population.

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