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DISTRIBUTION OF PATIENTS INTO GROUPS DEPENDING ON THE SEVERITY OF CHF

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Introduction. Chronic heart failure (CHF) is one of the most significant problems of modern healthcare, causing high morbidity, frequency of hospitalizations and mortality among the adult population. According to the World Health Organization (WHO) and recent epidemiological studies, the prevalence of CHF in the world ranges from 1 to 3% among adults and increases to 10-15% among people over 70 years of age. Despite significant progress in therapy, the prevalence and mortality in CHF remain consistently high, which indicates the need to improve early diagnosis and prevention methods.

In order to clinically assess the significance of bioimpedance analysis (NICaS) and determine the severity of latent or overt heart failure, all examined patients (n = 120) were stratified into three groups based on: clinical data (symptoms, complaints, anamnesis), bioimpedance analysis results (CI, CO, TPRI, CrAD, CPI, GGI), EchoCG parameters (PV, chamber sizes, signs of remodeling), laboratory markers (GFR, glucose, fibrinogen). All bioimpedance measurements were performed on NICaS certified equipment in stationary conditions, in compliance with registration standards (before and after rest, with stable parameters of temperature and body position). 2-4 consecutive measurements were performed for each patient with an assessment of variability. The stratification was carried out taking into account the following parameters: Complaints (shortness of breath, fatigue, edema) Left Ventricular Ejection fraction (LVEF), Indicators CI (Cardiac Index), TPRI (Total Peripheral Resistance Index) and IDA (Mean Arterial Pressure), Structural changes in echocardiography (hypertrophy, dilation), Objective signs of stagnation (increased BCC, increased vascular resistance). Group A (n = 38, 31.8%) — patients with reduced EF The presence of CHF symptoms (shortness of breath, swelling, fatigue) NICaS decrease in pumping function: CI < 2.2 l/min/m2 Elevated TPRI > 3000 u × s·m2/ml SAD > 110 mmHg LV < 50% or marked LV changes by EchoCG Group B (n = 65, 54.5%) — Retained PV Inclusion criteria:

Absence of obvious CHF symptoms Reduction of CI in the range of 2.2–2.6 l/min/m2 Elevated TPRI (> 3000) and MAP > 105 mmHg. Possible structural changes in EchoCG (diastolic dysfunction, LVH) Group C (n=17, 13.6%) — Control (relatively healthy or compensated patients) Inclusion criteria: Absence of CHF symptoms CI > 2.6 l/min/m2 TPRI < 3000 u × s·m2/ml, MAP < 105 mmHg. Normal EchoCG values (EF ≥ 55%, without remodeling) In order to assess the differences in the hemodynamic profile between the studied groups of patients, a comparative analysis of key parameters obtained by noninvasive bioimpedance monitoring was carried out. The following indicators were included in the study: cardiac output Index (CI), minute volume of blood circulation (Cardiac Output, CO), Total Peripheral Resistance Index (TPRI), Mean Arterial Pressure (MAP), heart pumping efficiency Index (Cardiac Power Index, CPI), as well as the Global Gearing Index (GGI) index of energy efficiency of cardiac activity. The results of the analysis demonstrate significant differences between the groups in all the studied indicators. In particular, there was a progressive increase in CI and CO from group A to group C ($p < 0.001$ and $p = 0.003$, respectively), indicating an improvement in the pumping function of the heart. The decrease in TPRI and MAP values in the same groups ($p < 0.001$ for both indicators)

reflects a decrease in peripheral vascular resistance and probably characterizes the transition from a vasoconstrictor to a vasodilation hemodynamic profile. Additionally, a statistically significant increase in CPI ($p = 0.002$) and GGI ($p < 0.001$) was found, indicating an increase in pumping and energy efficiency of the heart, respectively. Based on the totality of the data, the following hemodynamic types can be distinguished: • Group A is characterized by low CI and CO values with elevated TPRI and MAP, as well as low CPI and GGI, which may reflect a hypodynamic type of blood circulation with compensatory vasoconstriction. This condition may be associated with chronic heart failure or hypovolemia. • Group B shows intermediate values, which makes it possible to interpret it as a transitional phase between decompensation and compensation of hemodynamics. • Group C is characterized by high cardiac output, low peripheral resistance, and relatively low MAP with high pumping and energy efficiency of the heart. Such a hemodynamic pattern can be interpreted as a hyperdynamic type of blood circulation, observed, in particular, in septic or hypermetabolic conditions. Thus, the results obtained indicate a pronounced differentiation of hemodynamic parameters between patient groups, which emphasizes the need for a personalized approach to the interpretation of monitoring data and to the choice of therapy tactics aimed at optimizing cardiovascular activity. In order to clarify the nature of the differences between the studied groups of patients, a paired comparative analysis of hemodynamic parameters was performed using the Student's t-test for independent samples. To quantify the clinical significance of the identified differences, the effect size (Cohen's d) was additionally calculated. According to generally accepted interpretation criteria, values of $d > 0.8$ indicate a high clinical significance of the differences. The table shows the analysis results for key hemodynamic parameters: cardiac output index (CI), minute circulation volume (CO), total peripheral resistance Index (TPRI), mean blood pressure (MAP), heart Pumping Efficiency Index (CPI) and global Energy Efficiency Index (GGI). The analysis showed that there are the most pronounced differences between groups A and C in almost all the estimated parameters, which is confirmed by both statistical significance ($p < 0.001$) and a very high effect size (for example, Cohen's $d = 3.5$ for CI and 2.8 for TPRI). These differences indicate the presence of fundamentally different hemodynamic conditions in these groups. A vs B comparison showed a statistically significant decrease in CI ($d = 2.0$) and CPI ($d = 1.3$) in group A, reflecting its less favorable hemodynamic profile. In the B vs C pair, a moderate but clinically significant decrease in CI and an increase in MAP were found in group B compared with group C ($d = 1.5$ and 1.7, respectively). GGI values are also significantly lower in group A compared to group C ($d = 2.1$), which indicates a significant decrease in the energy efficiency of cardiac activity in this category of patients.The results obtained confirm the presence of large effects (Cohen's $d > 0.8$) in most paired comparisons, which indicates not only the statistical, but also the high clinical significance of the differences between the groups.

Conclusion. These data strengthen the argument in favor of using hemodynamic monitoring as an objective tool for stratifying patients and choosing individualized treatment tactics. In particular, the marked differences between groups A and C require additional clinical analysis in order to identify the underlying causes of such a different state of central and peripheral hemodynamics. Thus, the intergroup differences in key hemodynamic parameters confirm the validity of the stratification and indicate the possibility of using the BIM profile as a quantitative criterion for assessing the functional state of the cardiovascular system.

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