# DIAGNOSTIC VALUE OF CARDIOMETRY IN THE DETECTION OF SUBCLINICAL CARDITIS IN CHILDREN WITH ACUTE RHEUMATIC FEVER

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***Abstract.*** *Acute rheumatic fever (ARF) in children is a pressing issue due to its high incidence of cardiac damage and the risk of developing chronic rheumatic heart defects. Diagnosing subclinical carditis without obvious clinical or auscultatory manifestations is particularly challenging. The aim of this study was to evaluate the effectiveness of cardiometry in diagnosing subclinical carditis in patients with ARF. A comprehensive patient examination was conducted using echocardiography and cardiometry with a* Cardiocod digital hemodynamic analyzer *. Metabolic (lactate, oxygen) and functional (RV1) cardiometry parameters were found to vary significantly depending on the presence of valvular pathology as determined by echocardiography, while traditional hemodynamic parameters have limited diagnostic value. ROC analysis confirmed the prognostic value of individual cardiometric parameters. Cardiometry can be recommended as an accessible, non-invasive and informative method for early detection of subclinical heart damage in children with ARF.*

***Keywords:*** *acute rheumatic fever, subclinical carditis, children, cardiometry, Cardiocod, lactate, oxygen, RV1, echocardiography.*

***Acute rheumatic fever (ARF) remains a pressing issue in modern pediatrics, particularly in countries with limited healthcare resources, where the incidence and risk of developing chronic rheumatic heart disease remain high. Despite advances in diagnosis and treatment, timely detection of cardiac disease, especially in the subclinical stages, remains a significant challenge.***

Classic clinical and auscultatory signs of carditis are often absent or minimal, leading to underdiagnosis of ARF and delayed treatment. Echocardiography is the "gold standard" for diagnosing carditis; however, its use is limited by inadequate medical facilities, a shortage of qualified specialists, and the impossibility of frequent dynamic monitoring, especially in remote regions.

In this regard, cardiometry is of particular interest as a non-invasive, accessible, and cost-effective method for functional assessment of the cardiovascular system. Cardiometry allows for the simultaneous analysis of hemodynamic, metabolic, and adaptive parameters reflecting early disturbances in the regulation of cardiac activity and myocardial energy metabolism, preceding the structural changes detected by echocardiography.

The insufficient study of the diagnostic and prognostic value of cardiometric parameters in children with acute rheumatic fever, as well as the limited number of studies dedicated to the detection of subclinical carditis using this method, necessitate this study. The data obtained may contribute to improving the effectiveness of early diagnosis, optimizing follow-up care, and reducing the risk of developing chronic rheumatic heart defects.

The aim of the study was to ***evaluate the diagnostic and prognostic effectiveness of cardiometry in identifying subclinical carditis in patients with acute rheumatic fever by comparatively analyzing hemodynamic, metabolic, and functional parameters depending on the presence of valvular changes according to echocardiography data.***

## Materials and methods of research

The study included patients with acute rheumatic fever who were being examined and treated in a hospital setting. All patients were examined using clinical, instrumental, and functional methods.

All patients underwent echocardiography (EchoCG), based on the results of which they were divided into two groups: **Group I** - patients without echocardiographic signs of valvular pathology; **Group II** - patients with identified valvular disorders (mitral regurgitation, tricuspid regurgitation, mitral insufficiency, as well as their combination with tachycardia).

A cardiometric study was conducted using a *Cardiocod digital hemodynamic analyzer* . The following parameters were assessed: stroke volume (SV, ml), lactate level, oxygen content ($O_2$), functional reserve ratio (FR), and myocardial contractility index RV1 (60).

Quantitative indicators were preliminarily assessed for normal distribution using the Shapiro-Wilk test. In the absence of a normal distribution, data are presented as median and interquartile range (Q1–Q3). Comparisons of three or more groups by quantitative indicators were performed using the Kruskal-Wallis test, and post hoc comparisons were performed using Dunn's test with Holm's correction.

Linear and logistic regression methods were used to assess the prognostic significance of cardiometric parameters. The discriminatory power of quantitative parameters was assessed using receiver operating characteristic (ROC) analysis, calculating the area under the curve (AUC), sensitivity, specificity, and positive and negative predictive values.

Quantitative indicators were assessed for compliance with normal distribution using the Shapiro-Wilk test.

In the absence of a normal distribution, quantitative data were described using the median (Me) and the lower and upper quartiles (Q1 - Q3). Comparison of three or more groups by quantitative indicator was performed using the Kruskal-Wallis test, the distribution of which differed from the norm, and post-hoc comparisons were performed using the Dunn test with Holm's correction. A

predictive model describing the dependence of the quantitative variable on the factors was developed using the linear regression method. Construction of a predictive model of the probability of a certain outcome was carried out using the logistic regression method. The Nigelkirk coefficient R2 serves as a measure of accuracy, showing the portion of the variance that can be explained by logistic regression. Differences were considered statistically significant at $p < 0.05$. Categorical data are described indicating absolute values and percentages. 95% confidence intervals for percentages were calculated using the Clopper-Pearson method. Comparison of percentages in the analysis of four-field contingency tables was performed using Fisher's exact test (for expected event values less than 10). When comparing relative indicators, we used the odds ratio with a 95% confidence interval (OR; 95% CI) as a quantitative measure of effectiveness. Comparison of percentages in the analysis of four-field contingency tables was performed using Fisher's exact test (for expected event values less than 10). As a result of the assessment of lactate O2, PV1 (60), statistically significant differences depending on the ECG were revealed (respectively $p = 0.004$, $p = 0.017$, $p < 0.001$) (applied methods: Kruskal-Wallis test). When comparing SV (ml), CrF, no statistically significant differences were found depending on the ECG ($p = 0.448$, $p = 0.253$, respectively) (methods used: Kruskal-Wallis test). When assessing the discriminatory ability of the presence of SV (ml) using ROC analysis, the following curve was obtained

CO (ml) is a statistically significant predictor of mitral regurgitation in echocardiography (AUC = 0.571; 95% CI: 0.409 - 0.732, $p = 0.402$).

The cutoff value for the SV (ml) at the corresponding cutoff point was 20.130, with the Youden index at its maximum. Its existence was predicted when the SV (ml) value was below this value. The sensitivity and specificity of the resulting predictive model were 57.1% and 75.0%, respectively. The following curve was obtained when assessing the discriminatory ability of lactate increases using ROC analysis.

## Results and discussion

In order to evaluate the effectiveness of cardiometry in the diagnosis of subclinical carditis in patients with acute rheumatic fever (ARF), all examined patients were divided into two clinical groups based on echocardiography data.

**Group I (without valvular pathology)** included patients without echocardiographic evidence of valvular heart disease. **Group II (with valvular pathology)** included patients with identified echocardiographic changes, including mitral regurgitation (MR), tricuspid regurgitation (TR), mitral regurgitation (MR), and a combination of regurgitation and tachycardia.

A comparative analysis of cardiometric parameters between the groups is presented in Table 4.2.3.

When assessing stroke volume (SV, ml), no statistically significant differences were found between groups ($p = 0.448$). Despite a tendency for SV to decrease in patients with valvular disorders, this indicator did not demonstrate sufficient diagnostic value in differentiating subclinical carditis.

At the same time, analysis of metabolic parameters revealed significant intergroup differences. Lactate levels differed significantly depending on the echocardiographic pattern ($p = 0.004$). The highest lactate values were recorded in patients with mitral regurgitation ($19.03 \pm 6.61$ conventional units), while in patients without valve pathology, this indicator was $7.36 \pm 1.66$ conventional units. Statistically significant differences were also found between the MR and TR subgroups ($p = 0.024$), indicating different degrees of myocardial metabolic stress in different types of valve lesions.

Analysis of oxygen supply ($O_2$) parameters also demonstrated statistically significant differences between the groups ($p = 0.017$). Minimum oxygen values were observed in patients with mitral regurgitation, while maximum values were observed in patients with tricuspid regurgitation. Significant differences between the TR and tachycardia groups ($p = 0.032$) indicate a decrease in myocardial aerobic capacity in latent carditis.

The CRF indicator did not demonstrate statistically significant differences between the groups ($p = 0.253$), which limits its use as an independent diagnostic criterion for subclinical carditis.

The most significant differences were revealed in the analysis of the RV1 (60) index. In patients without valvular disease, its value was 63.34, while in patients with MR, MR, and a combination of MR and tachycardia, a significant decrease in this index was observed ($p < 0.001$). Multiple post-hoc comparisons confirmed statistically significant differences between the groups without pathology and patients with valvular disorders, indicating a decrease in myocardial contractility even in subclinical carditis.

To evaluate the predictive value of SV (ml) for mitral regurgitation, ROC analysis was performed. The area under the ROC curve was AUC = 0.571 (95% CI: 0.409–0.732; $p = 0.402$), indicating moderate discriminatory ability of this indicator. The optimal SV cutoff value was 20.13 ml, at which the sensitivity and specificity of the model reached 57.1% and 75.0%, respectively.

Thus, the results of the study show that **metabolic (lactate, $O_2$) and functional (RV1) cardiometry parameters have the greatest diagnostic value** in identifying subclinical carditis in patients with ARF, while traditional hemodynamic parameters, such as stroke volume, have limited information content.

Cardiometry can be considered as an effective screening method for early detection of hidden cardiac damage in patients with ARF, especially in conditions of limited availability of echocardiography.

Conclusions. ***Cardiometry is an informative, noninvasive method for detecting subclinical carditis in patients with acute rheumatic fever. Metabolic parameters (lactate and oxygen) vary significantly depending on the presence of valvular pathology, as determined by echocardiography, and reflect the degree of myocardial metabolic stress. The RV1 (60) index has high diagnostic significance and allows for the detection of a decrease in myocardial contractility even in the absence of pronounced clinical manifestations of carditis. Stroke volume (SV, ml)***

***and functional reserve ratio (FR) did not demonstrate statistically significant differences between groups, which limits their independent use for the diagnosis of subclinical carditis.***

## References


1. Gewitz MH, Baltimore RS, Tani LY, et al. Revision of the Jones criteria for the diagnosis of acute rheumatic fever in the era of Doppler echocardiography: a scientific statement from the American Heart Association. Circulation. 2015;131(20):1806-1818. *(Key update to Jones criteria, including subclinical carditis via echocardiography.)*
2. Baevsky RM, Chernikova AG. Heart rate variability analysis: physiological foundations and main methods. Cardiometry. 2017;10:66-76. *(Core reference for Baevsky's stress index and HRV methods.)*
3. Carapetis JR, McDonald M, Wilson NJ. Acute rheumatic fever. Lancet. 2005;366(9480):155-168.
4. Lahiri S, Sanyahumbi A. Acute Rheumatic Fever. Pediatr Rev. 2021;42(5):221-232.
5. Karacan M, Işıkay S, Olgun H, Ceviz N. Heart rate variability in children with acute rheumatic fever. Cardiol Young. 2012;22(3):285-292. *(Direct study on HRV in pediatric ARF, showing sympathetic dominance.)*
6. Reményi B, Wilson N, Steer A, et al. World Heart Federation criteria for echocardiographic diagnosis of rheumatic heart disease—an evidence-based guideline. Nat Rev Cardiol. 2012;9(5):297-309.
7. Figueroa FE, Fernández MS, Valdés P, et al. Prospective comparison of clinical and echocardiographic diagnosis of rheumatic carditis: long term follow up of patients with subclinical disease. Heart. 2001;85(4):407-410.
8. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. Heart rate variability: standards of measurement, physiological interpretation, and clinical use. Circulation. 1996;93(5):1043-1065.

9. Riaz BK, Selvaraj K, Das PK, et al. Heart rate variability in children with rheumatic fever. Indian Pediatr. 2009;46(3):237-240. *(Another study on HRV in pediatric rheumatic fever.)*

10. Zühlke L, Engel ME, Karthikeyan G, et al. Characteristics, complications, and gaps in evidence-based interventions in rheumatic heart disease: the Global Rheumatic Heart Disease Registry (REMEDY). Eur Heart J. 2015;36(18):1115-1122.