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CHRONIC HEART SHORTAGE WITH SICK INSTRUMENTAL EXAMINATION OF PATIENTS EFFICIENCY AND PATHOMORPHOLOGICAL ANALYSIS

Khalilov Azizbek Ma'rufjanovich
Mansurov Asadbek Qurbonali o'g'li
Central Asian Medical University

Abstract. This scientific work chronic heart in the diagnosis of deficiency (SYUYE) applicable modern instrumental technologies comparative efficiency learns. In the article electrocardiography[1,2,3], echocardiography all modes (B- mode, Doppler, Speckle Tracking), cardiac MRI, MSCT and blue crack cage radiography diagnostic opportunities analysis Also myocardial systolic and diastolic functions instrumental indicators in the assessment relay, cardiorenal syndrome monitoring and lungs to simmer visualization methods statement The 2026 International protocols and statistic information instrumental diagnostics based on death indicator in reduction role proven.

Key words: Systolic dysfunction, ejection fraction, cardiomegaly, interstitial edema, gadolinium with contrast, global longitudinal deformation (GLS), cardiomycytes hypoxia, hemodynamic monitoring.

INTRODUCTION

Chronic heart failure (CHF) remains one of the most significant global health problems of modern medicine. According to recent epidemiological studies, more than 64.3 million people worldwide are currently living with chronic heart failure, and this number continues to increase annually due to population aging, the rising prevalence of cardiovascular risk factors, and improved survival rates after acute cardiovascular events[4,5,6]. Data published in the 2025 reports of the World Health Organization (WHO) and the European Society of Cardiology (ESC) indicate that CHF is responsible for a substantial proportion of hospital admissions among adults over the age of 60.

Despite advances in pharmacological therapy and interventional cardiology, CHF continues to be associated with high morbidity and mortality. The one-year mortality rate among patients hospitalized with chronic heart failure ranges from 20% to 25%, while the five-year survival rate remains comparable to that of several malignant diseases. In addition, CHF significantly reduces patients' quality of life, leading to decreased exercise tolerance, frequent hospitalizations, and increased healthcare expenditures[7,8].

Modern cardiology emphasizes the importance of early detection and risk stratification, particularly during the A and B stages of heart failure according to the ACC/AHA classification. At these stages, patients may not yet demonstrate obvious clinical symptoms; however, structural or functional cardiac abnormalities are already present. Identifying such changes early allows clinicians to initiate preventive therapy and delay or prevent the progression to symptomatic heart failure.

In this context, instrumental diagnostic methods play a crucial role. These techniques provide objective and reproducible data about myocardial structure, cardiac function, hemodynamic status, and extracardiac complications associated with CHF[9,10]. Instrumental diagnostics not only facilitates early diagnosis but also enables clinicians to evaluate disease severity, monitor treatment response, and predict clinical outcomes.

Among the most commonly used diagnostic tools are electrocardiography, echocardiography, cardiac magnetic resonance imaging, multislice computed tomography, and chest radiography. Each of these methods provides complementary information regarding myocardial contractility, chamber dimensions, valvular function, coronary circulation[11,12], and pulmonary hemodynamics. When applied in a comprehensive diagnostic algorithm, these techniques significantly increase diagnostic accuracy and improve clinical decision-making.

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In recent years, the role of instrumental diagnostics has expanded further with the introduction of advanced imaging technologies, including Speckle Tracking echocardiography, tissue Doppler imaging, cardiac MRI with T1 mapping, and coronary CT angiography[13,14]. These methods allow the detection of subclinical myocardial dysfunction, diffuse myocardial fibrosis, microvascular ischemia, and early structural remodeling, which may occur long before clinical manifestations appear.

Furthermore, instrumental examinations are indispensable for monitoring the effectiveness of modern pharmacological therapies[15,16]. Contemporary treatment strategies for CHF include medications such as angiotensin receptor–neprilysin inhibitors (ARNI), sodium-glucose cotransporter-2 inhibitors (SGLT2 inhibitors), beta-blockers, mineralocorticoid receptor antagonists, and diuretics. The effectiveness of these therapies is frequently assessed through changes in ejection fraction, ventricular volumes, myocardial strain parameters, pulmonary artery pressure, and biomarkers such as NT-proBNP.

Instrumental diagnostics also plays an essential role in identifying complications and associated syndromes, including cardiorenal syndrome, pulmonary hypertension, arrhythmias, and structural cardiac remodeling. Timely detection of these conditions enables physicians to adjust treatment strategies and prevent further clinical deterioration[17].

Another important aspect is the development of remote monitoring technologies, which allow continuous assessment of hemodynamic parameters outside the hospital setting. Implantable sensors measuring pulmonary artery pressure, telemetric ECG monitoring, and portable echocardiographic devices provide clinicians with real-time information about a patient’s cardiovascular status. Studies have shown that such monitoring systems can reduce hospital readmission rates by more than 40% and significantly improve long-term prognosis.

Therefore, the integration of modern instrumental diagnostic technologies into routine clinical practice represents a key strategy for improving the management of patients with chronic heart failure. Early detection, accurate assessment of disease severity, and continuous monitoring of therapeutic effectiveness contribute to reducing mortality, improving quality of life, and optimizing healthcare resources.

For these reasons, investigating the diagnostic efficiency and clinical significance of instrumental examinations in patients with chronic heart failure remains an important and relevant scientific task in contemporary cardiology.

The diagnostic process in patients with chronic heart failure (CHF) requires a systematic approach. First, the effectiveness of electrocardiography (ECG) should be considered. Although ECG does not directly confirm CHF, its negative predictive value exceeds 90%. In other words, if a patient's ECG parameters are completely normal, the probability of CHF is less than 10%.

Detection of left ventricular hypertrophy on ECG (Sokolow–Lyon index >35 mm) indicates chronic myocardial overload. In addition, a complete left bundle branch block (QRS duration >130 ms) leads to asynchronous cardiac contraction, which worsens systolic heart failure by approximately 40%.

Statistical data show that QT interval prolongation on ECG increases the risk of sudden arrhythmic death by 2.5 times in patients with CHF.

The next and most important stage is echocardiography (EchoCG). The effectiveness of this method lies in its non-invasiveness and its ability to visualize cardiac anatomy in real time. Modern cardiology is no longer limited to evaluating ejection fraction (EF) alone.

Statistics indicate that nearly 50% of patients with CHF have preserved EF (HFpEF) but still present diastolic dysfunction. This can be effectively detected using Tissue Doppler Imaging (TDI). An E/e' ratio greater than 14 indicates increased left atrial pressure and confirms diastolic heart failure with 92% accuracy.

In recent years, Speckle Tracking technology has demonstrated that determining Global Longitudinal Strain (GLS) is more sensitive than EF. A GLS value lower than −18% indicates subclinical myocardial damage, even when EF remains around 55%.

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Table 1. Changes in instrumental diagnostic indicators according to CHF stages (average statistical data)

Indicator	Stage A (Risk group)	Stage B (Structural changes)	Stage C (Clinical symptoms)	Stage D (Terminal)
EF (%)	>55	45–55	30–45	<25
Left atrial volume (ml/m²)	<28	28–34	34–48	>50
Pulmonary artery pressure (mmHg)	<25	25–35	35–55	>60
NT-proBNP level (pg/ml)	<125	125–450	450–2000	>5000

To evaluate the condition of the pulmonary circulation in chronic circulatory disorders, chest radiography is widely used. Radiography is particularly effective in identifying acute decompensation.

Morphologically, pulmonary venous congestion manifests in four stages:

1. Stage 1: Enlargement of upper lobe vessels (cephalization)
2. Stage 2: Interstitial edema and Kerley B lines
3. Stage 3: Alveolar edema (“butterfly wing” appearance)
4. Stage 4: Pleural effusion (hydrothorax)

According to statistical data, 75% of patients admitted with CHF decompensation show clear signs of venous congestion on chest radiography.

Cardiac magnetic resonance imaging (MRI) currently plays the role of a “visual biopsy” in studying myocardial morphology. Its effectiveness lies in identifying fibrosis and necrotic areas using Late Gadolinium Enhancement (LGE).

If fibrosis is subendocardial, it suggests ischemic CHF, whereas intramural localization indicates cardiomyopathy or myocarditis. MRI measures myocardial mass with an error of less than 5%, while echocardiography may have an error rate of 15–20%.

Research published in 2026 demonstrates that T1 mapping parameters detected by MRI enable early identification of diffuse myocardial fibrosis, leading to changes in treatment strategy in 40% of cases.

Multislice computed tomography (MSCT) is mainly used to evaluate coronary arteries and exclude ischemic causes of CHF. MSCT angiography is safer than invasive coronary angiography and has a negative predictive value of 99%. This means that if coronary vessels appear normal on MSCT, ischemic heart disease can be ruled out with 99% probability.

Instrumental examinations in CHF are not limited to the heart. Ultrasound examinations of the kidneys and liver are important in diagnosing cardiorenal and cardiohepatic syndromes.

Due to venous congestion, the diameter of the inferior vena cava (IVC) increases (normally <2.1 cm), and its collapse during inspiration decreases. If the IVC diameter exceeds 2.5 cm and collapses less than 50% during inspiration, it indicates right atrial pressure above 15 mmHg and severe systemic venous congestion.

Table 2. Complementary characteristics of instrumental methods

Clinical condition	First-line method	Complementary method
Valvular defects	Echocardiography	Cardiac MRI / MSCT
Suspected myocarditis	MRI with LGE	Biomarkers (Troponin)
Pericarditis (fluid)	Echocardiography/ Ultrasound	MSCT (pericardial thickness)
Coronary atherosclerosis	MSCT angiography	Stress echocardiography

Statistical analyses demonstrate that combined use of instrumental diagnostic methods significantly improves survival rates in patients with CHF. For example, performing MRI before

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implantation of pacemakers or implantable cardioverter-defibrillators (ICD) reduces the risk of sudden cardiac death by 35%.

In addition, remote hemodynamic monitoring at home (such as sensors measuring pulmonary artery pressure) has been shown to reduce hospitalizations by 42%.

CONCLUSION

The effectiveness of instrumental examinations in chronic heart failure depends not only on modern technologies but also on their timely and proper combination.

- Echocardiography is the leading method for evaluating functional cardiac status.
- Cardiac MRI provides detailed assessment of myocardial structure.
- Chest radiography is essential for identifying hemodynamic complications.

According to modern clinical practice in 2026, every patient with chronic heart failure should undergo comprehensive instrumental screening at least once a year. This approach not only improves quality of life but also optimizes healthcare system expenditures.

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