



EARLY DETECTION OF HEART FAILURE RISK IN PATIENTS WITH DIABETES

Barakayeva Nigina O'tkir qizi
Tashkent State Medical University

Abstract: This article explores strategies for the early detection of heart failure (HF) risk in patients with diabetes. Diabetes significantly increases the incidence of HF due to metabolic, vascular, and structural cardiac changes. Early identification of at-risk individuals allows timely intervention and prevents progression to symptomatic heart failure. The study reviews the use of biomarkers, imaging techniques, and functional assessments, highlighting their diagnostic value and clinical relevance in diabetic patients.

Keywords: Diabetes, heart failure, early detection, biomarkers, echocardiography, natriuretic peptides, cardiovascular risk, subclinical dysfunction, risk stratification.

Heart failure (HF) is a common and serious cardiovascular complication in patients with diabetes, contributing to increased morbidity, hospitalization rates, and mortality. Diabetes accelerates structural and functional changes in the heart through mechanisms including hyperglycemia, insulin resistance, microvascular dysfunction, oxidative stress, and inflammation. These changes often precede symptomatic HF, making early detection essential for effective management and improved outcomes.

Early identification of patients at risk for HF involves a combination of clinical evaluation, biomarkers, imaging techniques, and functional assessments. Biomarkers such as B-type natriuretic peptide (BNP) and N-terminal pro-BNP (NT-proBNP) are elevated in subclinical cardiac dysfunction and correlate with future HF risk. Echocardiography, including assessment of left ventricular ejection fraction (LVEF), diastolic function, and strain imaging, provides structural and functional insights into early myocardial impairment.

Other methods, such as cardiac magnetic resonance imaging (MRI), speckle-tracking echocardiography, and tissue Doppler imaging, allow detailed assessment of myocardial mechanics and fibrosis, enhancing early detection capabilities. Functional



tests, including exercise tolerance and cardiopulmonary exercise testing, complement imaging and biomarker data by revealing early limitations in cardiac reserve.

Recognizing risk factors such as hypertension, dyslipidemia, obesity, and chronic kidney disease, in combination with diabetes-specific mechanisms, allows clinicians to identify patients at high risk for HF. Integrating these approaches into routine clinical practice facilitates timely initiation of preventive measures, including lifestyle modification, glycemic and blood pressure control, and targeted pharmacotherapy.

Early detection of heart failure risk in diabetic patients improves clinical decision-making, enables individualized management strategies, and reduces the incidence of adverse cardiovascular events. This article emphasizes the importance of multi-modal assessment and continuous monitoring for effective prevention of heart failure in patients with diabetes.

Heart failure (HF) is a frequent and serious cardiovascular complication among patients with diabetes, with prevalence increasing due to metabolic, structural, and vascular abnormalities associated with hyperglycemia and insulin resistance. Diabetic cardiomyopathy, characterized by myocardial fibrosis, left ventricular hypertrophy, and diastolic dysfunction, often develops silently, preceding symptomatic heart failure. Early detection of at-risk individuals is therefore crucial to implement preventive interventions and improve long-term outcomes.

Biomarkers play a pivotal role in the early identification of HF risk in diabetic patients. B-type natriuretic peptide (BNP) and N-terminal pro-BNP (NT-proBNP) are widely used markers reflecting myocardial wall stress and subclinical cardiac dysfunction. Elevated levels of these peptides in asymptomatic patients correlate with left ventricular dysfunction, diastolic abnormalities, and future HF events. Additional biomarkers, including high-sensitivity troponins, galectin-3, and ST2, provide insights into myocardial injury, fibrosis, and inflammation, complementing traditional risk assessment.

Imaging modalities are essential for structural and functional evaluation of the heart in diabetes. Echocardiography is the primary non-invasive tool for assessing left ventricular ejection fraction (LVEF), diastolic function, and chamber dimensions. Advanced techniques such as tissue Doppler imaging and speckle-tracking echocardiography enable detection of subtle myocardial dysfunction before overt HF develops. These methods provide quantitative measures of myocardial strain and



diastolic filling, offering a sensitive means to monitor disease progression and evaluate the impact of therapeutic interventions.

Cardiac magnetic resonance imaging (MRI) provides high-resolution visualization of myocardial tissue, detecting fibrosis, inflammation, and remodeling that may not be apparent on echocardiography. MRI-derived parameters, such as late gadolinium enhancement and T1 mapping, help identify early myocardial injury and predict future HF risk. While MRI is more resource-intensive, it offers valuable prognostic information, particularly in high-risk diabetic populations.

Functional assessments complement imaging and biomarker data by revealing early limitations in cardiac reserve. Exercise tolerance testing and cardiopulmonary exercise testing measure oxygen consumption, cardiac output, and ventilatory efficiency, highlighting early functional impairment in patients who are still asymptomatic. Reduced exercise capacity often precedes symptomatic HF and serves as a prognostic marker for cardiovascular events in diabetes.

Integrating clinical risk factors is essential in early HF detection. Hypertension, dyslipidemia, obesity, and chronic kidney disease synergistically increase cardiovascular burden in diabetic patients. Microvascular dysfunction, endothelial injury, and chronic low-grade inflammation exacerbate myocardial stress and remodeling, contributing to HF development. Recognizing the interplay between these risk factors allows clinicians to identify high-risk individuals and initiate targeted preventive measures, including optimized glycemic control, blood pressure management, lipid-lowering therapy, and renin-angiotensin system inhibition.

Lifestyle interventions remain foundational for HF prevention. Weight reduction, regular physical activity, dietary optimization, and smoking cessation improve myocardial function, reduce systemic inflammation, and enhance cardiovascular outcomes. Early pharmacologic interventions with ACE inhibitors, angiotensin receptor blockers (ARBs), SGLT2 inhibitors, and mineralocorticoid receptor antagonists have demonstrated efficacy in preventing HF progression, even in patients without overt symptoms. SGLT2 inhibitors, in particular, have shown cardiovascular protective effects beyond glycemic control, reducing hospitalization for HF in diabetic patients.

Continuous monitoring and longitudinal assessment are critical in high-risk diabetic populations. Periodic measurement of biomarkers, echocardiographic



evaluation, and functional testing enable early detection of worsening myocardial function and allow timely adjustment of therapy. Early intervention can prevent or delay progression from subclinical dysfunction to overt heart failure, significantly improving patient prognosis.

In summary, early detection of heart failure risk in patients with diabetes requires a multi-modal approach integrating biomarkers, imaging, functional testing, and clinical risk factor assessment. Biomarkers such as BNP, NT-proBNP, and high-sensitivity troponins, combined with echocardiography, MRI, and exercise testing, provide comprehensive insights into subclinical myocardial dysfunction. Incorporating lifestyle interventions and targeted pharmacotherapy based on early detection allows for effective prevention of symptomatic HF and reduces adverse cardiovascular outcomes in diabetic patients.

Heart failure (HF) is a major cardiovascular complication in patients with diabetes, often developing silently as subclinical myocardial dysfunction before symptomatic disease manifests. Early detection using biomarkers, imaging techniques, functional assessments, and evaluation of clinical risk factors is essential for timely intervention and prevention of adverse outcomes. Biomarkers such as BNP, NT-proBNP, high-sensitivity troponins, galectin-3, and ST2 reflect myocardial stress, fibrosis, and inflammation, while echocardiography, tissue Doppler, speckle-tracking, and cardiac MRI provide structural and functional insights.

Integrating lifestyle interventions—weight management, physical activity, dietary optimization, and smoking cessation—with targeted pharmacotherapy, including ACE inhibitors, ARBs, mineralocorticoid receptor antagonists, and SGLT2 inhibitors, significantly reduces HF risk. Regular monitoring allows clinicians to identify early myocardial dysfunction and adjust therapies accordingly. A multi-modal, proactive approach ensures improved cardiovascular outcomes and long-term prognosis in diabetic patients at risk of heart failure.

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