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Criteria for safe return to sports activity after myocarditis: An analysis of clinical practice

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Abstract
Background: Myocarditis is an inflammatory disease of the myocardium that may lead to ventricular dysfunction, arrhythmias, and sudden cardiac death, especially in athletes engaging in high-intensity exercise. Contemporary guidelines, including the 2025 ESC Guidelines, emphasize that premature return to strenuous activity increases risk of subclinical inflammation, progression to inflammatory cardiomyopathy and malignant arrhythmias.
Objectives: To synthesize up-to-date evidence and recommendations regarding diagnostic evaluation, cardiac rehabilitation, and return-to-sport decision-making after myocarditis, with special focus on athletes and the 2025 ESC myocarditis guidelines.
Methods: A narrative review of major clinical guidelines, key foundational myocarditis literature, and recent studies addressing biomarkers, imaging, athlete-specific risk, COVID-19–related myocarditis in athletes, and rehabilitation strategies was conducted. Evidence was selected for relevance to risk stratification, monitoring, and safe resumption of exercise.
Results: Diagnosis of myocarditis relies on integration of clinical presentation and biomarkers of myocardial injury (troponins) and inflammation (CRP, BNP/NT-proBNP). Echocardiography evaluates ventricular function, while CMR remains the gold standard for tissue characterization, edema detection and quantification of myocardial fibrosis (LGE). Cardiac rehabilitation must begin only after stabilization of symptoms, normalization of biomarkers, and improvement of ventricular function. Initial activity must be low-intensity and progressively increased under multidisciplinary supervision. Return to sport requires all of the following: complete symptom resolution; normalized ventricular systolic function; normal troponin/CRP/BNP; and absence of clinically significant arrhythmias on Holter or stress testing. Repeat CMR is advised if earlier imaging showed edema or fibrosis. Athletes with extensive LGE or persistent LV dysfunction should avoid moderate-tohighintensity sports due to elevated arrhythmia and sudden death risk.
Conclusions: Management of patients after myocarditis—and especially competitive athletes— requires detailed diagnostic evaluation, guided rehabilitation, and strict return-to-play criteria. The 2025 ESC guidelines reinforce individualized decision-making supported by

biomarkers, ECG/Holter monitoring, and advanced imaging such as CMR to minimize risk and ensure a safe return to physical activity. Persistent fibrosis, recurrent inflammation, and arrhythmogenic substrate remain the strongest determinants of long-term risk and eligibility for sport participation.

Key words : myocarditis, return to sport, cardiac rehabilitation, athletes, cardiac magnetic resonance, ESC guidelines 2025, sudden cardiac death

Introduction

Myocarditis refers to an inflammatory condition of the heart muscle that may lead to damage of cardiomyocytes and impairment of cardiac function. This disorder is frequently associated with serious complications such as heart failure, arrhythmias, myocardial scarring, and, in severe cases, cardiogenic shock or sudden cardiac death (SCD). [1] Athletes who have experienced myocarditis constitute a particular group of patients requiring close medical supervision, and the process of rehabilitation as well as the decision regarding a safe return to physical activity should be approached with great caution. The aim of this paper is to present current clinical recommendations and analyze clinical practice — including diagnostic mechanisms, criteria for return to physical activity, and potential long-term consequences — in the context of ensuring a safe return of athletes to training and competition after myocarditis. [2]

Definition of Myocarditis

Myocarditis is an inflammatory condition of the heart muscle characterized by inflammation of the myocardial tissue, which may lead to edema, cardiomyocyte damage, necrosis, and consequently to impaired cardiac function. Its etiology is highly diverse — it may be infectious (most commonly viral) or non-infectious, including autoimmune, toxic, drug-related, or other causes. The new ESC guidelines (2025) introduce the term Inflammatory Myopericardial Syndrome (IMPS) as an umbrella concept encompassing the full spectrum of inflammatory conditions: from isolated myocarditis and isolated pericarditis to mixed forms such as myopericarditis or perimyocarditis. This terminology underscores the potential concurrent or sequential involvement of both the myocardium and the pericardium. [3] The clinical presentation of myocarditis is highly variable — ranging from mild symptoms resembling a viral infection or chest pain of pleuritic character to severe manifestations with heart failure, cardiogenic shock, life-threatening arrhythmias, or even sudden cardiac death. The literature emphasizes that myocarditis — particularly in chronic or insidious forms — may present as so-called “idiopathic” inflammatory cardiomyopathy. [4] Diagnosis is based on a combination of clinical symptoms, laboratory tests, ECG, and echocardiography, depending on the clinical context, while modern imaging — primarily cardiac magnetic resonance (CMR) — plays a central role. In cases of strongly suspected or severe disease, endomyocardial biopsy may be considered for diagnosis or etiological confirmation, although in practice multimodal imaging usually allows the diagnosis to be established. [5]

Causes of Myocarditis

The etiology of myocarditis is diverse and includes both infectious and non-infectious causes. According to available clinical data and reviews, viral infections constitute the most common cause of myocarditis, whereas bacterial, fungal, and parasitic forms occur less frequently. [6] Classical cardiotropic viruses include enteroviruses (such as Coxsackie B virus), adenoviruses, and parvovirus B19. The involvement of other respiratory viruses, influenza viruses, and hepatotropic viruses has also been described. [7] The COVID-19 pandemic brought particular

attention to the association between SARS-CoV-2 infection and myocarditis. Infection with this virus may lead to myocardial injury either through direct viral effects or via the host's inflammatory– immune response. In athletes recovering from COVID-19, cases of myocarditis have been documented, and the incidence of COVID-19–related myocarditis in the athletic population has been estimated at approximately 1–4%, although the overall risk remains low. [8] These findings contributed to the development of specific cardiological evaluation protocols for athletes returning to activity following SARS-CoV-2 infection. Independent of the infection itself, rare cases of myocarditis associated with mRNA COVID-19 vaccination have also been reported. In the literature, these are described as very rare adverse events occurring predominantly in young men, typically within a few days after administration of a subsequent vaccine dose. [9] Proposed mechanisms include an immunologic reaction to vaccine components (including hypersensitivity reactions) and an abnormally heightened inflammatory response. [10]

Autoimmune and inflammatory causes, in which myocarditis forms part of a systemic disease, represent an important etiological group. These include systemic connective tissue diseases and inflammatory vasculitis, in which the immune system attacks self-structures, including cardiomyocytes and other components of the myocardium. [11]

A distinct entity is eosinophilic myocarditis, often associated with drug hypersensitivity, autoimmune disorders, or parasitic infections. In case series of confirmed eosinophilic myocarditis, drug reactions, eosinophilic granulomatosis with polyangiitis and hypereosinophilia were identified as the most common causes, with a considerable proportion of idiopathic cases. [12] Drugs and toxins also play a significant role in the etiology of myocarditis. Among the bestdocumented are modern oncological therapies, especially immune checkpoint inhibitors (ICI), for which myocarditis and pericarditis have been reported as immune-related adverse effects. ESC guidelines also highlight the toxic effects of other substances, including alcohol and certain illicit or psychoactive drugs, which may induce or exacerbate myocardial injury. [13] The new ESC guidelines (2025) emphasize that myocarditis may coexist with genetic predisposition. It has been noted that in some patients myocarditis may unmask or modify the course of latent hereditary cardiomyopathies. Therefore, genetic testing is recommended in patients with a confirmed diagnosis of myocarditis or pericarditis in situations such as a significant family history, suspected inherited cardiomyopathy, severe ventricular arrhythmias, persistent impairment of ejection fraction, or recurrent inflammatory episodes. [3,14]

In summary, the current understanding of myocarditis etiology — reflected in the latest ESC guidelines — encompasses a broad spectrum of infectious (predominantly viral, including SARSCoV-2), immunologic (autoimmune and drug-induced), toxic, and genetic causes, while in a subset of patients the disease remains idiopathic despite comprehensive diagnostic evaluation. [3,15]

Epidemiology of Myocarditis

In recent years, it has been estimated that the global number of new myocarditis cases reached approximately 1.27 million in 2019, representing a 62.2% increase compared with 1990. According to data from the general population, the annual incidence of acute myocarditis is estimated at approximately 4–14 cases per 100,000 persons per year. [16,17] In a national registry from Poland, covering the period 2009– 2020, the incidence among hospitalized patients with suspected myocarditis ranged between 1.15 and 14 per 100,000, with the highest rate observed in the 16–

20year age group. In the general population, the disease more commonly affects young adults, and men constitute the dominant group. In the MYO-PL registry (Poland), as many as 74% of hospitalizations with a diagnosis of myocarditis involved male patients. [18]

Regarding severe outcomes, the European Society of Cardiology (ESC) in its latest guidelines (2025) notes that although population-level data on the prevalence of myocarditis and pericarditis remain limited, one registry study indicates an incidence of acute myocarditis of 6.3–8.6 per 100,000 persons per year. Among young adults undergoing autopsy, deaths attributed to myocarditis accounted for 1.1% to 12% of all sudden cardiac deaths (SCD). [3] In the context of athletic populations, particularly after COVID-19 infection, available data demonstrate variable rates of myocarditis detection. In a cohort of 1,597 U.S. collegiate athletes, myocarditis (clinical or subclinical) was identified in 37 individuals (2.3%) based on imaging studies (CMR). [19] Other reviews report that the overall frequency of cardiac complications (including myocarditis) in this group ranges from 0.4% to 15.4%. However, more rigorous and widespread post-COVID-19 screening suggests that the proportion of individuals with confirmed myocarditis is relatively small
— for example, approximately 0.9% in certain studies. [20,21]

In summary, although myocarditis is not among the most common medical conditions, its epidemiology shows substantial variability depending on the population studied, diagnostic method used, and age. The disease occurs more frequently in younger individuals, particularly males; in athletic populations following COVID-19 infection, subclinical cases are possible, underscoring the importance of thorough diagnostic evaluation and long-term follow-up. [22]

Summary

Myocarditis is a serious condition with a complex etiology, primarily involving infectious causes (mainly viral, including SARS-CoV-2 infection), but also autoimmune, drug-induced, toxic mechanisms, and genetic factors predisposing to the development of inflammatory cardiomyopathy. Epidemic increases in myocarditis cases observed in connection with the COVID-19 pandemic, as well as reports of rare cases of myocarditis following mRNA vaccination, have drawn particular attention to the need for monitoring heart health, especially in young, physically active individuals and athletes. [23]

In this context, early diagnosis and determination of the possible cause of the disease using modern diagnostic methods, such as cardiac magnetic resonance (CMR) and, in selected cases, endomyocardial biopsy, in accordance with current ESC guidelines, are of key importance. Properly conducted diagnostics and appropriately selected treatment form the basis for safely planning a return to physical activity and sports, particularly in young men and athletes, in whom the risk of myocarditis and its complications (including sudden cardiac death) is relatively higher. [3,24]

Diagnosis of Myocarditis

The diagnosis of myocarditis is multi-step and requires the integration of clinical, laboratory, electrocardiographic, and imaging data. In the latest European Society of Cardiology (ESC) guidelines, an approach based on early identification of patients with suspected inflammatory myopericardial syndrome (IMPS) has been proposed, including comprehensive clinical assessment, biomarker measurement, ECG examination, and echocardiography as first-line tools. [3,5] The starting point in the diagnosis of myocarditis is a detailed medical history and physical examination, taking into account symptoms such as chest pain, dyspnea, palpitations, or flu-like symptoms, as well as information on past viral infection, vaccination, autoimmune disease, or exposure to potentially cardiotoxic drugs. [25] Biomarkers of myocardial injury (high-sensitivity troponins – hs-TnT/hs-TnI, CK-MB), inflammatory markers (CRP, ESR), and, if necessary, natriuretic peptides (BNP/NTproBNP) play a key role in the assessment of heart failure. Elevated troponin levels support the diagnosis of cardiomyocyte injury; however, normal values do not exclude myocarditis, as emphasized in documents from the ACC and ESC. [26,27]

Standard 12-lead ECG is recommended for all patients with suspected myocarditis. Recordings may show nonspecific changes, including ST-T segment disturbances, low QRS amplitude,

atrioventricular block, supraventricular or ventricular tachyarrhythmias. At the same time, it is emphasized that a normal ECG does not exclude myocarditis. [3,15,28]

Transthoracic echocardiography is recommended as a basic first-line imaging method. It allows assessment of chamber size and function, global and regional contractility abnormalities, pericardial effusion, and indirect signs of pulmonary hypertension. This examination is particularly important in differentiating from other causes of acute chest pain and heart failure, such as acute coronary syndrome or pulmonary embolism. [29]

Cardiac magnetic resonance (CMR) is currently a key non-invasive diagnostic method for the assessment of myocarditis. The ESC 2025 guidelines recommend performing CMR in patients with suspected myocarditis who present clinical, laboratory (biomarker), electrocardiographic, or echocardiographic abnormalities. CMR allows detailed tissue characterization of the myocardium – assessment of edema (T2weighted sequences), changes in extracellular volume (ECV), necrosis, and fibrosis (late gadolinium enhancement, LGE). The application of updated Lake Louise criteria (combined T1 and T2 criteria) allows the diagnosis of "definite myocarditis" in the presence of typical imaging features in the appropriate clinical context. It is also noted that the highest diagnostic sensitivity of CMR is achieved when the examination is performed within the first few weeks from symptom onset. [3,30]

Despite advances in imaging methods, endomyocardial biopsy (EMB) remains the reference method for histopathological confirmation of myocarditis and identification of its subtype (e.g., lymphocytic, eosinophilic, giant cell) and potential presence of viral genetic material in the myocardium. [31]

Current ESC guidelines recommend considering EMB particularly in patients with severe clinical course (severe heart failure, cardiogenic shock, malignant ventricular arrhythmias), lack of response to standard treatment, suspicion of specific forms of myocarditis (e.g., giant cell or eosinophilic), and in situations where the biopsy result may directly impact treatment selection (e.g., initiation of immunosuppression). [3]

Clinical Symptoms of Myocarditis

The clinical presentation of myocarditis is heterogeneous and may include both mild, nonspecific complaints and severe symptoms of heart failure or hemodynamic instability. Guidelines emphasize that the spectrum of clinical presentations includes chest pain, signs of congestive heart failure, palpitations, arrhythmias and syncope, while in some patients the disease may be subclinical or oligosymptomatic. The most common symptom is chest pain, which may be "infarct-like," with STsegment elevation or other ECG changes, making differentiation from acute coronary syndrome challenging. [32] The ESC 2025 guidelines highlight so-called clinical "red flags," including a recent viral infection or flu-like symptoms, infarct-like chest pain, palpitations, and signs of heart failure. [3] Dyspnea (at rest or exertional) and reduced exercise tolerance are common manifestations of myocardial involvement and developing ventricular dysfunction. Systematic reviews have described that patients with myocarditis may report dyspnea, easy fatigability, orthopnea, and peripheral edema in the course of heart failure. Fatigue and general weakness are often preceded by symptoms of viral infection, such as fever, cough, myalgia, or malaise, which has been repeatedly reported in the context of viral myocarditis, including cases related to
SARS-CoV-2. [33]

Arrhythmias occupy an important place in the clinical picture. The literature reports both supraventricular and ventricular tachyarrhythmias, bradyarrhythmias, and conduction disturbances (e.g., atrioventricular block), as well as palpitations, syncope, and episodes of sudden cardiac death as possible first manifestations of the disease. In athletes, particular emphasis is placed on the risk of severe arrhythmias and sudden cardiac death in the context of high-intensity physical exertion. Symptoms may also be nonspecific, described as palpitations, chronic fatigue, reduced exercise capacity, myalgia, tachycardia, and complaints resembling

upper respiratory tract infections. In the athletic population, it is noted that often the only signals may be subtle changes in exercise tolerance, a feeling of "poor form," or unexplained resting or exertional tachycardia. [34]

An important aspect highlighted in reviews and guidelines is that myocarditis may be asymptomatic or present with very mild symptoms, which complicates early diagnosis. This also applies to patients after SARS-CoV-2 infection, in whom changes consistent with myocardial inflammation or post-inflammatory scarring were detected solely on imaging studies, despite the absence of overt clinical symptoms. Therefore, in young physically active individuals and athletes, particular clinical vigilance is recommended in the presence of new or atypical cardiopulmonary complaints, especially following viral infections. [35]

Laboratory Tests and Biomarkers in the Diagnosis of Myocarditis

Laboratory tests play a key role in the diagnosis of myocarditis, enabling assessment of the degree of myocardial injury, the activity of the inflammatory process, and the severity of heart failure. According to current ESC guidelines, biomarker assessment should be part of the basic diagnostic work-up for every patient with suspected myocarditis. [3]

The primary biomarker used to detect cardiomyocyte injury is cardiac troponin (highsensitivity troponin T or I – hs-TnT, hs-TnI). Elevated levels reflect myocardial injury regardless of etiology and are often observed in acute myocarditis. ESC guidelines emphasize that abnormal troponin values should prompt further investigation into the cause of myocardial injury using imaging studies, such as echocardiography and cardiac magnetic resonance (CMR). At the same time, it is noted that normal troponin values do not exclude myocarditis, particularly in mild or subacute cases. Therefore, troponin interpretation should always be considered in the clinical context and alongside other investigations. [3,36]

C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR) are nonspecific markers of inflammation that may be elevated in myocarditis, particularly of infectious or immunologic etiology. Elevated CRP supports the diagnosis of active inflammation; however, its absence does not exclude the disease. Publications on COVID-19– associated myocarditis and myocarditis after mRNA vaccination noted that some patients exhibited simultaneous elevation of both troponin and inflammatory markers. [37]

Natriuretic peptides (BNP, NT-proBNP) are used to assess the degree of heart failure and volume overload. In myocarditis, especially in cases with impaired left ventricular systolic function, BNP/NT-proBNP levels may be significantly elevated. These biomarkers are useful both for diagnosis and for monitoring treatment response and risk stratification. [38]

Current ESC guidelines on myocarditis and pericarditis emphasize that no single biomarker is sufficient for the diagnosis of myocarditis. It is recommended to interpret troponin, CRP, and BNP/NT-proBNP in conjunction with the clinical picture, ECG findings, echocardiography, and, if indicated, CMR and endomyocardial biopsy. [3] Documents addressing athletes post–COVID-19 additionally highlight the importance of biomarker dynamics – sequential measurements of troponin and inflammatory markers may support assessment of disease course and return to physical activity. Thus, laboratory tests are an integral part of myocarditis diagnostics, providing information on myocardial injury, inflammatory activity, and heart failure, but their diagnostic value is greatest when combined with other diagnostic methods. [39]

Electrocardiographic (ECG) Studies

Electrocardiography is one of the basic and widely available tools used in the diagnosis of myocarditis. As reported by ESC guidelines, the ECG in patients with suspected myocarditis may show a wide range of changes, from nonspecific deviations to severe rhythm disturbances, reflecting the variable clinical nature of this condition. [3] The most commonly observed ECG changes include cardiac rhythm disturbances, including sinus tachycardia, which is a common but nonspecific sign of an inflammatory process in the myocardium. In some cases, conduction disturbances may also occur, including atrioventricular (AV) blocks, resulting from

involvement of the conduction system by the inflammatory process. Another frequently reported group of changes involves ventricular repolarization abnormalities, including ST-segment changes and T-wave abnormalities, which may indicate cardiomyocyte irritation or injury. These changes are nonspecific and may also occur in other heart diseases, emphasizing the need to interpret the ECG in conjunction with other diagnostic elements, such as cardiac biomarkers and imaging studies. [28] In more severe forms of myocarditis, clinically significant arrhythmias may occur, including ventricular arrhythmias, which are associated with an increased risk of sudden cardiac death. Therefore, ECG plays an important role not only in diagnosis but also in assessing complication risk and monitoring patients, particularly young individuals and athletes returning to physical activity after viral infection. [40] ESC guidelines emphasize that despite the frequent occurrence of ECG changes, ECG alone is not sufficient for the diagnosis of myocarditis. In some patients, especially those with mild or subclinical disease, the ECG may be normal. Therefore, electrocardiography should be regarded as a component of a multi-step diagnostic process. [3] **Imaging Studies**

Imaging studies play a key role in the diagnosis of myocarditis, allowing assessment of cardiac structure and function, detection of features of inflammation, edema, and fibrosis of the myocardium, as well as concomitant pericardial involvement. The ESC 2025 guidelines on inflammatory myopericardial syndromes (IMPS) emphasize the importance of multimodal imaging, with echocardiography as the first-line examination and cardiac magnetic resonance (CMR) as the primary method for tissue characterization. [3,5]

Transthoracic echocardiography is one of the most commonly used imaging modalities in suspected myocarditis. ESC guidelines indicate that it should be performed in all patients with suspected inflammatory myocardial disease, as it allows evaluation of cardiac chamber size, systolic and diastolic function, and the presence of concomitant pericardial effusion.

In the course of myocarditis, echocardiography may reveal:

Enlargement of the cardiac chambers, particularly the left ventricle, associated with impaired systolic function,

Global or regional left ventricular contractility abnormalities,

Reduced left ventricular ejection fraction,

Pericardial effusion, indicating concomitant pericardial involvement (myopericarditis). Echocardiographic studies have also demonstrated the value of more advanced techniques, such as strain echocardiography (speckle tracking), which can detect subclinical impairment of systolic function even with preserved ejection fraction. In patients with biopsy-confirmed myocarditis, reduced global longitudinal strain has been observed, correlating with the presence of myocardial inflammation. Echocardiography is also used to monitor disease course and treatment response, including assessment of improvement in ventricular systolic function and changes in pericardial effusion. [41]

Cardiac magnetic resonance (CMR) is currently recognized as the leading noninvasive imaging method in the diagnosis of myocarditis. ESC 2025 guidelines, as well as ACC expert statements, emphasize that CMR using the updated Lake Louise criteria (2018) constitutes the primary tool for the diagnosis and characterization of inflammatory myocardial changes. CMR allows:

Assessment of myocardial edema (T2-weighted sequences),

Detection of myocardial injury and fibrosis using late gadolinium enhancement (LGE),

Evaluation of extracellular volume (ECV) and T1-mapping parameters, reflecting inflammation, necrosis, or fibrosis,

Analysis of ventricular systolic function and volumes, as well as concomitant pericardial effusion. [42,43]

According to the revised Lake Louise criteria, the diagnosis of myocarditis on CMR requires at least one T2-based criterion (edema) and one T1-based criterion (non-infarct myocardial injury – abnormal T1 mapping, increased ECV, or LGE) in the appropriate clinical context. Validation

studies have demonstrated high sensitivity and specificity of the updated criteria in the diagnosis of acute myocarditis. [43]

Guidelines and review studies emphasize that CMR allows not only diagnosis but also prognostic assessment – the extent and location of LGE and persistence of changes during follow-up are associated with the risk of adverse cardiac events, including ventricular arrhythmias and sudden cardiac death. CMR is particularly useful in cases where echocardiography does not show definitive abnormalities or when precise assessment of inflammatory activity and post-inflammatory scarring is required, including in athletes evaluating readiness to return to physical activity. [44]

Diagnostic Criteria for Myocarditis

The diagnosis of myocarditis is based on the integration of clinical, laboratory, and imaging data according to current European Society of Cardiology (ESC) guidelines and expert recommendations. ESC guidelines on inflammatory myopericardial syndromes (IMPS, 2025) emphasize that the diagnosis of myocarditis requires the combination of at least one clinical criterion and one objective criterion confirming inflammation, after excluding other potential causes. [3]

Clinical criteria include symptoms suggestive of myocardial involvement by the inflammatory process. The most commonly reported in the literature are:

Chest pain, which may be inflammatory or mimic angina,

Exertional or resting dyspnea,

Cardiac rhythm disturbances, including palpitations, syncope, or loss of consciousness,

Signs of heart failure. [45]

The presence of biomarkers of myocardial injury constitutes one of the key criteria for confirmation. Elevated troponin levels are considered a crucial indicator of acute cardiomyocyte injury. In addition, inflammatory markers such as CRP and heart failure markers, including BNP, may be helpful. [46]

Electrocardiographic changes may include nonspecific but important abnormalities, such as:

Cardiac rhythm disturbances,

Conduction abnormalities (e.g., atrioventricular blocks),

Repolarization changes in the ST segment and T wave. [28]

These changes support the diagnosis, although they are not decisive on their own. Cardiac magnetic resonance (CMR) is a key tool for noninvasive confirmation of myocarditis. According to the Lake Louise criteria (2018), recognized by ESC and ACC, the diagnosis of myocarditis requires at least one criterion indicating myocardial edema and one criterion reflecting tissue injury (e.g., presence of LGE, abnormal focal T1 values, or ECV). CMR is indicated in cases with inconclusive echocardiography results and in athletes where precise determination of inflammatory activity is necessary. [24]

Echocardiography, as a first-line examination, may reveal impaired left ventricular systolic function, global or regional contractility abnormalities, chamber enlargement, and pericardial effusion, particularly in cases of myopericarditis. [41]

Principles of Cardiac Rehabilitation after Myocarditis

Cardiac rehabilitation after myocarditis is a key component of the treatment process, aimed at safely and gradually restoring patients to normal physical activity, including sports. Contemporary approaches to cardiac rehabilitation take into account the individual needs of patients, health monitoring, and assessment of the severity and extent of cardiac inflammation. Cardiac rehabilitation focuses on improving cardiac function while minimizing the risk of cardiovascular complications, such as heart failure, arrhythmias, or other rhythm disturbances. The goal of rehabilitation after myocarditis is to enable the patient to gradually return to physical activity and improve quality of life through the implementation of appropriate therapeutic programs. [47] It should be initiated during the stable phase of the disease, after

excluding severe complications and advanced cardiac damage. Cardiac rehabilitation after myocarditis is a multistage process, including different phases tailored to the individual needs of the patient. Indications for rehabilitation must be strictly determined by specialists, taking into account symptom severity, diagnostic test results, and the overall health status of the patient. [48] In the initial stage of rehabilitation, the patient must undergo a period of clinical stabilization. During this time, cardiac function is monitored, and any symptoms such as chest pain, dyspnea, or rhythm disturbances must be controlled. The patient should be monitored using ECG and other biomarker tests (e.g., troponin, BNP) to ensure that myocarditis does not cause further cardiac damage. [3,47] After patient stabilization, rehabilitation progresses to a stage of gradual return to physical activity. Guidelines published by the AHA (2021) and ESC (2025) indicate that patients may begin cardiac rehabilitation only after full resolution of clinical symptoms of myocarditis and after imaging studies show no significant structural cardiac damage. Moderate physical activity is recommended, most often in the form of aerobic exercises, which help improve cardiac performance. The rehabilitation program should be supervised by a cardiologist and physiotherapist to ensure patient safety. [2,3,47]

Once the patient achieves physical stability and obtains favorable results from cardiac monitoring, more intensive rehabilitation may begin, bringing the patient closer to full sports activity. At this stage, exercise intensity is increased, with a greater number of repetitions and loads. The patient should undergo an assessment of physical capacity before being allowed to engage in more intensive exertion to ensure that the heart does not show signs of overload. [3]

Role of Monitoring and Safety in Cardiac Rehabilitation

Patient safety is a crucial aspect of cardiac rehabilitation after myocarditis. Monitoring is essential at every stage of rehabilitation to minimize the risk of adverse events, such as arrhythmias or acute cardiac dysfunction. Regular ECG examinations are important to detect potential rhythm disturbances that may occur during exercise. Cardiac biomarkers should also be monitored. Troponin and BNP levels should be checked to detect any changes in myocardial function that may suggest new injury or exacerbation of the inflammatory process. Exercise testing, such as cardiopulmonary exercise tests, allows assessment of patient fitness and helps adjust exercise intensity at each stage of rehabilitation after myocarditis. [49]

Return to Sports Activity after Cardiac Rehabilitation

After completing rehabilitation and achieving appropriate physical fitness, the patient may be gradually allowed to return to sports activity. According to ESC guidelines (2025), return to sport after myocarditis requires meeting several criteria, including:

Absence of clinical symptoms – the patient must be free from chest pain, dyspnea, or palpitations.

Favorable imaging results – cardiac magnetic resonance (CMR) and echocardiography should show no signs of myocardial damage or structural abnormalities.

No indications for ongoing pharmacological therapy – the patient should not require anticoagulants or other substances that may affect cardiac function.

ESC guidelines indicate that once these criteria are met, the patient may be gradually allowed to engage in light to moderate physical activity, progressively increasing exercise intensity until full return to competitive sports, if health status permits. [2,47] Cardiac rehabilitation after myocarditis is a multi-stage process that should be tailored to the individual needs of the patient. Monitoring the patient's health status, controlling exercise intensity, and assessing cardiac function at each stage of rehabilitation are essential. Properly conducted cardiac rehabilitation allows a safe return to physical activity, including sports, minimizes the risk of complications, and improves patient quality of life. [50]

Risks Associated with Early Return to Physical Activity after Myocarditis

Returning to physical activity after myocarditis is a critical stage in the rehabilitation process of patients. However, if this process is not conducted responsibly and under proper supervision, it can be associated with significant risks to both cardiovascular function and the patient's overall health. Myocarditis is a serious condition that can lead to structural cardiac damage, arrhythmias, heart failure, and other cardiovascular complications. Therefore, an early return to physical activity without appropriate medical supervision and rehabilitation may result in deterioration of health and, in some cases, life-threatening events.[47]

One of the most common and serious risks associated with premature resumption of physical exertion after myocarditis is the occurrence of arrhythmias. Myocardial damage caused by inflammation may lead to disturbances in the conduction of electrical impulses in the heart, resulting in arrhythmias. In particular, increasing the intensity of physical activity before full resolution of inflammation may trigger tachyarrhythmias or bradyarrhythmias, which can be dangerous and, in some cases, lead to sudden cardiac arrest. Therefore, physicians recommend careful monitoring of patients during rehabilitation and the use of advanced diagnostic techniques, such as Holter ECG or echocardiography, to detect early signs of arrhythmia. Patient education regarding potential complications from non-adherence to recommendations is also crucial. [2,49] Another important issue related to premature resumption of exertion is the risk of worsening cardiac function. In myocarditis, the myocardial structure may be damaged, reducing the heart's ability to pump blood effectively. Engaging in intensive exercise during this period may exceed the heart's adaptive capacity, resulting in functional deterioration. Patients who have not undergone complete rehabilitation may experience symptoms such as dyspnea, fatigue, and edema, indicating the onset of heart failure. [51]

According to ESC guidelines, return to physical activity should be delayed until cardiac function has been fully assessed, and imaging results indicate complete stability. Cardiac function should be monitored using echocardiography and cardiac magnetic resonance (CMR), which allow accurate assessment of myocardial damage and cardiac performance before deciding on return to sport. [3] One of the most serious hazards of early exertion after myocarditis is the possibility of sudden cardiac arrest. This may occur as a result of arrhythmias, which are unpredictable and often appear during intensive exercise.

A major challenge in post-myocarditis rehabilitation is ensuring that the patient engages in an appropriate level of physical activity, which on one hand does not overload the heart, but on the other allows improvement in physical performance. Studies emphasize the importance of an individualized approach to each patient and close collaboration with the medical team, including cardiologists, physiotherapists, and personal trainers, to optimally tailor the rehabilitation plan to the patient's health status. [52]

Recommendations for Return to Physical Activity

After an acute episode of myocarditis, it is recommended to limit physical activity— both sport and recreational—for at least 3–6 months. The latest ESC 2025 guidelines emphasize the need for an individualized approach to the decision to resume activity, depending on disease severity, left ventricular function, and CMR findings for each patient. During active inflammation or when imaging shows inflammatory infiltrates, fibrosis, or functional abnormalities, sport and intensive physical activity are contraindicated. [3,23]

The decision to return to sport should follow a comprehensive reassessment of cardiac status. Literature and guidelines indicate that return to activity, including competitive sport, may be considered if all the following conditions are met simultaneously:

Absence of clinical symptoms (chest pain, dyspnea, palpitations);

Normalized left ventricular systolic function (ejection fraction) assessed by echocardiography and/or CMR;

Normal levels of myocardial injury and inflammatory markers (troponin, inflammatory biomarkers);
No significant arrhythmias (especially ventricular) on 24-/48-hour Holter monitoring and/or exercise testing.
In cases where CMR during the acute phase revealed abnormalities (edema, late gadolinium enhancement—LGE), repeat CMR is recommended before making decisions about return to sport. [2,47,49]
According to ESC 2025 recommendations, resumption of physical activity should be gradual after a period of inactivity. Once approved by a physician, initial activity should be light and low-intensity (walking, stationary cycling), and then gradually increase load and intensity if the patient remains asymptomatic, according to physiological response. If symptoms occur during rehabilitation or return to activity (fatigue, palpitations, chest pain, dyspnea), activity should be halted, and cardiac reassessment performed. [3]
Post-myocarditis patients remain at increased risk due to potential disease recurrence, subclinical inflammation, or myocardial scarring (fibrosis), which can predispose to arrhythmias and sudden cardiac death. Periodic follow-up—including annual imaging, biochemical tests, ECG/Holter monitoring—is recommended, especially in patients with detected LGE, even if systolic function is normal and the patient is asymptomatic. [53] For athletes, the risk associated with returning to intensive physical activity after myocarditis requires particular caution. Decisions should follow a shared decision-making approach between the medical team and the patient, considering examination results, recurrence risk, presence of scarring, type of sport, and level of engagement. Athletes with extensive myocardial scarring (e.g., LGE >20% of myocardial mass) and persistent left ventricular dysfunction are advised to avoid moderate- or high-intensity sports. [54]
Clinical Practice – Analysis of Current Guidelines
Guidelines for managing patients after myocarditis are essential for ensuring the safe return to physical activity, including sports. Current recommendations are based on the best available scientific evidence and aim to minimize the risk of complications associated with premature exertion. According to the latest ESC guidelines (2025), before undertaking any physical activity, the patient must undergo detailed cardiological diagnostics, including assessment of cardiac function and inflammatory status of the myocardium. The basis for evaluating a patient's health after myocarditis involves the use of diagnostic methods such as echocardiography or cardiac magnetic resonance (CMR), considered the "gold standard" for diagnosing and monitoring treatment outcomes in patients with myocarditis. [2,3]
Monitoring troponin and BNP (B-type natriuretic peptide) levels allows assessment of the presence of inflammation and cardiac injury, as well as close control of rehabilitation progress. According to ESC guidelines (2025), cardiac rehabilitation is a key element of the treatment process for patients after myocarditis. It should be conducted in close cooperation with a medical team, including a cardiologist, physiotherapist, and a specialist in cardiac rehabilitation. There are strictly defined principles for introducing physical activity aimed at gradually loading the heart safely for the patient. [3, 23] Rehabilitation after myocarditis should start with minimal physical exertion, gradually increasing intensity. This process should follow the following principles: in the initial phase, after symptoms have subsided, the patient begins with low-intensity exercises such as treadmill walking or stationary cycling to improve aerobic capacity. Then, intensity should be gradually increased. As the patient's health improves, exercise intensity should be progressively raised. It is important that this process is monitored, and the patient is evaluated for clinical symptoms and diagnostic test results. Rehabilitation is recommended to last at least 3–6 months, depending on the patient's health status and the degree of cardiac damage. For patients with more advanced myocardial damage, the rehabilitation

process may be longer, with particular caution. Meanwhile, the patient should undergo regular follow-up examinations to monitor cardiac status and exclude potential complications. [2,3]
For athletes who have experienced myocarditis, the decision to return to competitive sports should only be made after full stabilization of health status and obtaining positive diagnostic results. ESC guidelines (2025) indicate that during the initial phase of rehabilitation, athletes should avoid intensive physical activity and sports competition. Return to competitive sports is only possible if the patient completes all stages of rehabilitation and diagnostic tests confirm that the heart shows no structural or functional abnormalities. In competitive sports, return to competition should be phased, as the patient achieves appropriate physical fitness and experiences no concerning cardiac symptoms. [2,3]
It is also important to note that each patient is different, and decisions regarding return to physical activity should be made individually, based on detailed diagnosis and health assessment. For example, a patient whose myocarditis was mild and did not cause significant cardiac damage may return to physical activity sooner, while those with more advanced inflammatory changes will require a longer rehabilitation period.

Conclusions
Based on the analysis of current guidelines and scientific literature regarding myocarditis and safe return to physical activity after it, the following conclusions can be drawn:
1.Detailed diagnostics before returning to physical activity are crucial in preventing complications.
2.A key element of cardiac rehabilitation is the gradual introduction of physical activity.
3.Monitoring the patient's condition during rehabilitation is essential to ensure the safe progression of return to physical activity.
4.The risk associated with early resumption of physical activity is high; therefore, patient education about potential complications is important.
5.Return to competitive sports for athletes and physically active individuals is possible only after comprehensive cardiac evaluation and full stabilization of the patient's health.
6.Multidisciplinary team involvement—including cardiologists, physiotherapists, and specialized cardiac rehabilitation trainers—plays a vital role in preventing complications during postmyocarditis rehabilitation.
Summary
Safe return to physical activity after myocarditis is critical for patient health and requires close monitoring and adherence to medical guidelines. Before starting rehabilitation, the patient should undergo comprehensive cardiological diagnostics, and rehabilitation should proceed gradually, considering the individual capacity of the patient's heart. Early return to physical activity carries significant risk of complications; therefore,
decisions regarding resumption of sports, especially competitive sports, should be made after thorough risk assessment. A multidisciplinary approach in rehabilitation and adherence to ESC, ACC, and other professional guidelines are essential to ensure patient safety and optimize the process of returning to full physical fitness.

Disclosure

Author's contribution

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