



Canadian Journal of Cardiology ■ (2022) 1–4

## Training/Practice Contemporary Issues in Cardiology Practice

# COVID-19, Inflammatory Heart Disease, and Vaccination in the Athlete and Highly Active Person: An Update and Further Considerations

Nathaniel Moulson, MD,<sup>a</sup> Kim A. Connelly, MBBS, PhD,<sup>b</sup> Paul Dorian, MD,<sup>b</sup> Anne Fournier, MD,<sup>c</sup> Jack M. Goodman, PhD,<sup>b</sup> Nicholas Grubic, BScH,<sup>d</sup> Saul Isserow, MBBCh,<sup>a</sup> Amer M. Johri, MD,<sup>d</sup> François Philippon, MD,<sup>e</sup> Andrew Pipe, MD,<sup>f</sup> Paul Poirier, MD, PhD,<sup>e</sup> Ryan Quinn, MD,<sup>g</sup> Taryn Taylor, MD,<sup>h</sup> Jane Thornton, MD, PhD,<sup>i</sup> Mike Wilkinson, MBBCh,<sup>a</sup> and James McKinney, MD, MSc<sup>a</sup>

<sup>a</sup> University of British Columbia, Vancouver, British Columbia, Canada

<sup>b</sup> University of Toronto, Toronto, Ontario, Canada

<sup>c</sup> University of Montréal, Montréal, Québec, Canada

<sup>d</sup> Queen's University, Kingston, Ontario, Canada

<sup>e</sup> Institut universitaire de cardiologie et de pneumologie de Québec, Université Laval, Québec City, Québec, Canada

<sup>f</sup> University of Ottawa, Ottawa, Ontario, Canada

<sup>g</sup> McMaster University, Hamilton, Ontario, Canada

<sup>h</sup> Carleton Sport Medicine Clinic, Ottawa, Ontario, Canada

<sup>i</sup> Western University, London, Ontario, Canada

**Members of the Community and Athletic Cardiovascular Health Network (CATCHNet) and the writing group for the Canadian Cardiovascular Society/Canadian Heart Rhythm Society Joint Position Statement on the Cardiovascular Screening of Competitive Athletes provided previous guidance on the cardiovascular return-to-play (RTP) recommendations for athletes and highly active persons following COVID-19 infection.<sup>1</sup> A significant accumulation of evidence has occurred, and the pandemic has evolved with new variants and the availability of highly effective vaccinations. This document aims to provide an update to these previous recommendations for the sports clinician regarding cardiovascular RTP and new guidance on vaccination.**

### Background

Initial concern stemming from uncertain cardiac effects of the SARS-CoV-2 virus (COVID-19) resulted in the recommendation for cardiac screening RTP protocols for athletes and highly active persons (hereafter referred to as “athletes”) before resumption of sport after infection.<sup>1,2</sup> The rationale for initial protocols was the observed cardiac injury, defined in terms of elevated cardiac troponin (cTn) levels or cardiac imaging abnormalities, in nonathlete populations following predominately moderate to severe disease, and the concern this represented an increased risk for the development of myocarditis, even after asymptomatic or mild infection. The extent of recommended RTP cardiac screening varied significantly across organizations, with extensive screening inclusive of cardiac magnetic resonance (CMR) imaging in select populations. This working group recommended a pragmatic approach of initial restriction from moderate- to high-intensity exercise for at least 7 days, followed by medical evaluation and clinically indicated cardiac testing.<sup>1</sup> These recommendations were largely based on expert opinion. Since publication, robust observational data detailing the prevalence of cardiac involvement and—to a lesser extent—outcomes, have been reported.<sup>2</sup> Furthermore, changes in the dominant variant, widespread vaccination, and reduced quarantine

Received for publication March 8, 2022. Accepted May 11, 2022.

Corresponding author: Dr James McKinney, SportsCardiologyBC, 2211 Wesbrook Mall, Vancouver, British Columbia C V6K 2V8, Canada.

E-mail: [james.mckinney@ubc.ca](mailto:james.mckinney@ubc.ca)

See page 4 for disclosure information.

<https://doi.org/10.1016/j.cjca.2022.05.019>

0828-282X/© 2022 Canadian Cardiovascular Society. Published by Elsevier Inc. All rights reserved.

requirements have changed the pandemic landscape, necessitating updated guidance.

### COVID-19 Cardiac Involvement in Athletes

Several large registries of collegiate and professional athletes undergoing dedicated RTP cardiac screening have demonstrated a prevalence of reported cardiac involvement ranging from 0.6% to 0.7% in those without primary CMR screening and up to 2.3% to 3.0% in those with a primary screening CMR performed.<sup>S1-S3</sup> This cardiac involvement, defined predominately by CMR tissue abnormalities, with or without the presence of established clinical criteria for myocarditis, remains of uncertain clinical significance. Importantly, no adverse cardiac events definitively related to COVID-19 have been reported in competitive athletes. The presence of cardiopulmonary symptoms, particularly chest pain, on return to exercise may increase the likelihood of cardiac involvement. Overall, nonsevere COVID-19 in young otherwise healthy athletic populations appears to be associated with a low risk of cardiac involvement. Cardiac abnormalities identified in athletes undergoing systematic RTP screening regardless of symptom status require further evaluation to determine their clinical significance. This includes comparison with appropriate athletic controls and against other common viral illnesses.

### Updated RTP Cardiovascular Screening Recommendations

We continue to recommend against the need for routine cardiac testing or screening before returning to exercise after COVID-19 infection (Fig. 1). This recommendation is supported by observational data from large athlete registries.<sup>S1-S3</sup> Athletes whose initial infectious course is uncomplicated and without cardiac or other symptoms that would otherwise warrant evaluation may return to sport without medical evaluation or clearance. Cardiac symptoms as part of acute infection that are suggestive of a clinical diagnosis of inflammatory heart disease (ie, pericarditis or myocarditis) require detailed medical evaluation and clinically indicated cardiac testing before returning to exercise.

### Return to Exercise Post-COVID

Previous recommendation was to avoid moderate- to high-intensity exercise after COVID-19 infection for 7 days, regardless of the presence of symptoms or severity of symptoms. The high reported prevalence of asymptomatic or mildly symptomatic athletes, in addition to a low reported prevalence of inflammatory heart disease, and an increased infectivity rate of novel variants, such as Omicron, suggest that a shorter duration of restriction may suffice. Furthermore, public health guidance in many Canadian jurisdictions has reduced quarantine requirements after a positive test. Pragmatically, athletes may be advised to avoid moderate- to high-intensity exercise for the duration of quarantine if asymptomatic or mildly symptomatic. Upon the completion of quarantine, assuming their symptoms—apart from anosmia or ageusia—have resolved, athletes may return to exercise in a graded fashion, accounting for the duration of time away from sport and severity of COVID-19 symptoms (Fig. 1). Athletes

should be made aware of potential concerning symptoms and instructed to self-monitor throughout the RTP process. Medical evaluation should be undertaken for those with initial cardiopulmonary symptoms suggestive of inflammatory heart disease and for those who develop cardiopulmonary symptoms in the RTP period. Resumption of group training or competitive activities, along with the need for repeat negative COVID-19 testing, will be organization dependent and with testing requirements presumably based on availability.

### Cardiac Evaluation for the Symptomatic Post-COVID Athlete

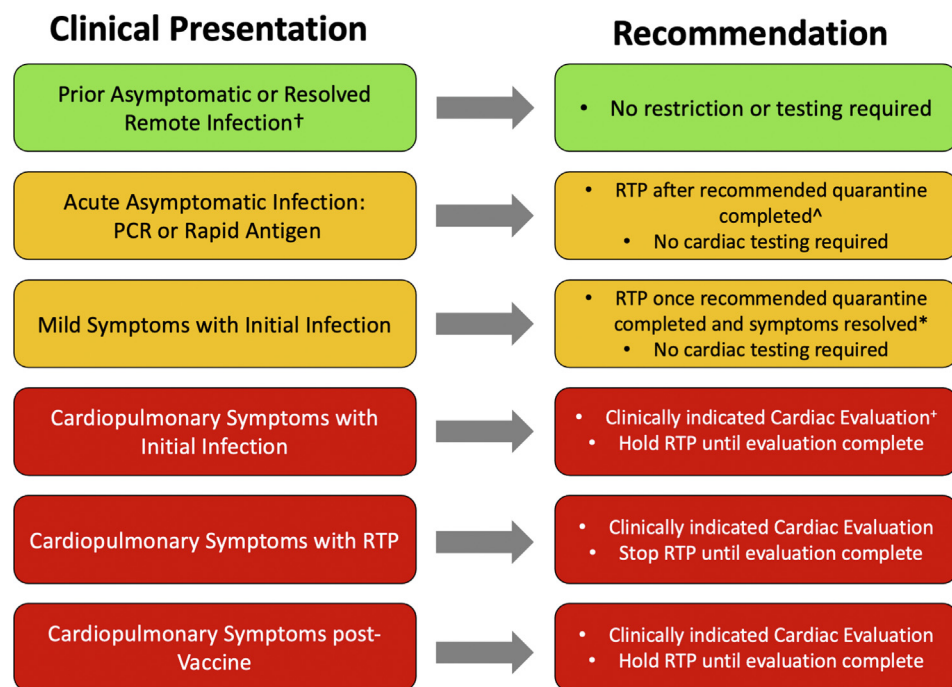
The presence of symptoms suggestive of inflammatory heart disease should prompt appropriate cardiac evaluation (Box 1). Athletes with such symptoms should refrain from vigorous- intensity exercise until evaluation can be completed. A detailed history and physical examination should be the first step. In athletes for whom clinical concern for inflammatory heart disease exists, appropriate initial testing may include a 12-lead electrocardiogram (ECG), inflammatory or cardiac biomarkers, and cardiac imaging with transthoracic echocardiography as the first line. CMR should be considered in athletes with suggestive cardiac testing abnormalities or in those with a high index of clinical suspicion based on symptoms but with unremarkable initial cardiac testing. CMR abnormalities should be interpreted within the context of the updated imaging criteria.<sup>3</sup> Exercise testing, in the form of maximal-effort exercise stress test or cardiopulmonary exercise test, may be considered in those with exertional symptoms for whom overt inflammatory heart disease has been ruled out. Exercise testing may assist in the diagnostic evaluation by provoking potential causative cardiac abnormalities such as exercise-induced arrhythmias or ischemia, depending on the age of the athlete.

### Postacute Sequelae of SARS-CoV-2 in Athletes

Prolonged or chronic multisystem effects of COVID-19, defined as postacute sequelae of SARS-CoV-2 infection (PASC), appear relatively infrequently in young competitive athletes.<sup>4</sup> The prevalence is poorly characterized in other groups such as Masters athletes. However, when present, symptoms may be debilitating and heterogeneous in nature. Potential PASC-related cardiovascular symptoms, defined by the absence of objective abnormalities on standard diagnostic testing, include—but are not limited to—exercise intolerance, dyspnea, and tachycardia.<sup>2</sup> Symptoms lasting more than 1 month since onset of acute infection require further clinical evaluation, particularly if these symptoms are impairing athletic performance. Athletes with PASC should be referred to appropriate multidisciplinary PASC clinics for evaluation and ongoing management.

### Vaccination and Vaccine-Associated Myocarditis in Young Athletes

Myocarditis is a rare complication following COVID-19 mRNA vaccination. Although no data on the risk of vaccine-associated myocarditis exist in the athlete population specifically, there appears to be an increased incidence in young persons, particularly in the male population, receiving



**Figure 1.** Return-to-play (RTP) and cardiac testing recommendations based on clinical presentation. PCR, polymerase chain reaction. <sup>†</sup> Remote asymptomatic infection refers to positive SARS-CoV-2 antibodies with no history of symptoms and resolved remote infection refers to  $\geq 3$  months since infection. <sup>^</sup> Duration of quarantine period, in concordance with local health-authority recommendations. <sup>\*</sup> Apart from anosmia or ageusia. <sup>†</sup> Clinically indicated cardiac evaluation should include a detailed history and physical evaluation and may include 12-lead electrocardiogram, inflammatory and cardiac biomarkers, and transthoracic echocardiography as first-line testing with cardiac magnetic resonance used in those with abnormalities on initial cardiac testing or in those with a continued high index of suspicion despite unremarkable first-line testing.

the mRNA vaccines.<sup>5</sup> This risk is present for both doses but higher after the second dose. The reported incidence in the young male population (aged 12 to 29 years) is  $\sim 1$  in 10,000 to 25,000, and in young female population (aged 12 to 29 years) is  $\sim 1$  in 90,000 to 240,000. Existing data on the risk of vaccine-associated myocarditis, compared with myocarditis related to COVID-19 infection, suggest that the relative risk is lower with the Pfizer mRNA vaccine but may be similar with the Moderna mRNA vaccine in those below the age of 40

years.<sup>S4-S7</sup> However, the absolute risk of vaccine-associated Q6 myocarditis is low, and the majority of cases appear to be mild and self-limited. Furthermore, despite false reports circulating online, there have been no documented cases of vaccine-related sudden cardiac arrest in athletes. The benefit of COVID-19 vaccination in terms of reduction of hospitalization, admission to intensive care units, mortality, and cases of multisystem inflammatory syndrome in children (MIS-C) continues to outweigh the risk of vaccine-associated myocarditis. Furthermore, preliminary data suggest that vaccination may reduce symptoms of PASC in infected. Q7

No cardiac evaluation is required for RTP following COVID-19 vaccination. Athletes who develop clinical signs suggestive of vaccine-induced myocarditis should undergo appropriate cardiovascular evaluation and follow contemporary RTP guidelines, which include 3 to 6 months of exercise restriction during the acute inflammatory phase. Myocarditis after immunization is a reportable adverse event and should be reported to the appropriate public health authority.

### Summary and Guidance

Based on the current state of knowledge, we suggest the following pragmatic guidance for medical practitioners involved in the cardiovascular care of athletes and highly active persons:

- Athletes should avoid moderate- to high-intensity exercise during their quarantine period, in concordance of their local health authority recommendations, and

### Box 1. Cardiopulmonary symptoms of concern

#### Cardiopulmonary symptoms of concern

- Presyncope or syncope
- Chest pain or pressure, particularly with exertion
- Excessive shortness of breath at rest or with exertion
- Palpitations
- Reduction in fitness out of proportion to the severity of illness or duration away from training

#### Practical guidance

- The development of any cardiopulmonary symptom should prompt—at minimum—a medical evaluation to characterize the symptom in question
- Symptoms of deconditioning are common following COVID-19 and may be more pronounced compared with other viral illnesses<sup>2</sup>
- A high index of clinical suspicion should be applied to athletes presenting with new cardiopulmonary symptoms after COVID-19

may return to sports upon completion of quarantine, assuming their symptoms—apart from anosmia or ageusia—have resolved.

- Athletes with suspected or confirmed COVID-19 infection who are asymptomatic or mildly symptomatic, and without cardiopulmonary symptoms, do not require routine cardiac screening or testing.
- The presence of symptoms suggestive of inflammatory heart disease that occur either with initial infection or during RTP should prompt an appropriate cardiac evaluation, and athletes should be advised to avoid moderate- to high-intensity exercise until evaluation is complete.
- Evaluation of athletes with symptoms concerning for inflammatory heart disease should include a detailed history and physical evaluation, 12-lead ECG, inflammatory and cardiac biomarkers, and transthoracic echocardiography. CMR should be used in those with abnormalities on initial cardiac testing or in those with a continued high index of suspicion despite unremarkable first-line testing
- COVID-19 vaccination is recommended in all athletes, as the benefit of vaccination exceeds the risks, including that of vaccine-associated myocarditis.
- Athletes diagnosed with myocarditis, related either to COVID-19 infection or vaccination, should be restricted from moderate- to high-intensity exercise and follow contemporary sports cardiology myocarditis recommendations regarding further evaluation and RTP.
- In all sport settings, cardiac safety of participants is optimized by the implementation of an appropriate emergency action plan or protocol ensuring rapid access to defibrillators and training specific to the management of cardiac emergencies in such environments.

### Acknowledgements

These recommendations were created on behalf of the COVID-19 Subcommittee of the Community and Athletic Cardiovascular Health Network, an umbrella group with expertise in sports cardiology, electrophysiology, exercise physiology, primary care and emergency medicine, and cardiac imaging interested in the reduction of sudden cardiac death in the athlete, supported by the Heart and Stroke Foundation, Canadian Cardiovascular Society, and Canadian

Institute of Health Research. The subcommittee is undertaking further national investigative work to enhance general and COVID-19-related cardiovascular health of active persons. The recommendations presented herein are not intended to replace established screening procedures but rather to provide a framework for health professionals evaluating return to play for exercisers and highly active persons with COVID-19.

### Funding Sources

No funding was provided for this article.

### Disclosures

The authors have no conflicts of interest to disclose.

### References

1. McKinney J, Connelly KA, Dorian P, et al. COVID-19 myocarditis and return to play: reflections and recommendations from a Canadian Working Group. *Can J Cardiol* 2021;37:1165-74.
2. Gluckman TJ, Bhavne NM, Allen LA, et al. 2022 ACC expert consensus decision pathway on cardiovascular sequelae of COVID-19 in adults: myocarditis and other myocardial involvement, post-acute sequelae of SARS-CoV-2 infection, and return to play: a report of the American College of Cardiology Solution Set Oversight Committee. *J Am Coll Cardiol* 2022;79:1717-56.
3. Ferreira VM, Schulz-Menger J, Holmvang G, et al. Cardiovascular magnetic resonance in nonischemic myocardial inflammation: expert recommendations. *J Am Coll Cardiol* 2018;72:3158-76.
4. Petek BJ, Moulson N, Baggish AL, et al. for the ORCCA Investigators. Prevalence and clinical implications of persistent or exertional cardiopulmonary symptoms following SARS-CoV-2 infection in 3597 collegiate athletes: a study from the Outcomes Registry for Cardiac Conditions in Athletes (ORCCA). *Br J Sports Med* 2021. <https://doi.org/10.1136/bjsports-2021-104644>.
5. Oster ME, Shay DK, Su JR, et al. Myocarditis cases reported after mRNA-based COVID-19 vaccination in the US from December 2020 to August 2021. *JAMA* 2022;327:331-40.

### Supplementary Material

To access the supplementary material accompanying this article, visit the online version of the *Canadian Journal of Cardiology* at [www.onlinecjc.ca](http://www.onlinecjc.ca) and at <https://doi.org/10.1016/j.cjca.2022.05.019>.