


## REVIEW ARTICLE

## Update on Sports Participation for Athletes with Implantable Cardioverter Defibrillators

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### Abstract

Prior statements have recommended restriction from competitive sports participation for all athletes with ICDs. Recent data, however, suggests that many athletes can participate in sports without adverse events. In the ICD Sports Registry, 440 athletes, aged 8-60 years, 77 of which were high-level interscholastic athletes, who had continued to practice sports, were prospectively followed for 4 years, with no deaths or failures to defibrillate during practice, and no injuries related to arrhythmia or shock during sports. Shocks did occur, for ventricular and supraventricular arrhythmias. While more athletes received shocks during physical activity than at rest, there were no differences between competition or practice, versus other physical activity. Programming with higher rate cut-offs and longer durations was associated with fewer inappropriate shocks, with no increase in syncope. Based on this study, current recommendations now state that returning to competition may be considered for an athlete with an ICD. In considering this decision, the underlying disease and type of sport should be discussed, and shared decision-making between doctor, patient, and often family, is critical.

### Introduction

The number of athletes diagnosed with cardiovascular disease placing them at risk for sudden death, whether

through presentation with symptoms such as syncope or cardiac arrest, or through screening efforts, will likely continue to increase. In Europe, ECG screening of athletes is recommended by professional societies<sup>1</sup> and while consensus statements in the US continue to support pre-participation evaluation (PPE) with just history and physical examination,<sup>2</sup> these too may diagnose life-threatening cardiac conditions, and many universities in the US have added ECG to the PPE.<sup>3</sup> Furthermore, family cascade screening increases the rate of diagnosis of asymptomatic family members after presentation of a symptomatic proband.<sup>4,5</sup> Many of these symptomatic and asymptomatic athletes will receive defibrillators, raising the question of the safety of returning to practice.

### Historical perspective

Until recently, consensus statements from the American College of Cardiology and European Society for Cardiology<sup>6-8</sup> advised that patients with ICDs should not participate in sports more vigorous than the "IA" class, low-dynamic/low-static activities such as bowling or golf. The basis for these recommendations were postulated risks, based on the consensus of experts, of failure to defibrillate, injury caused by loss of control due to arrhythmia-related syncope and/or shock, or damage to the ICD system. However, restriction from sports also has downsides, as the psychological as well as physiological benefits of exercise and sports are well-

### Keywords

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known. Restriction from sports, for any reason, has been shown to decrease both physical and emotional quality of life for athletes.<sup>9</sup> For many adolescents with ICDs, restriction from sports was the biggest factor impacting their quality of life.<sup>10</sup>

Further, a 2006 retrospective survey of Heart Rhythm Society physician-members,<sup>11</sup> suggested that many ICD patients were participating in sports, despite the consensus recommendations, and the survey respondents did not describe adverse events. While survey results are limited by selection and recall bias, these results suggested that a prospective registry of athletes with ICDs was feasible, ethical, and necessary. Feasible, as many ICD patients were participating in sports. Ethical, as study participants were already practicing sports and were not asked to perform activities of which safety was unknown. Necessary, as if the risks were as high as hypothesized, those participating needed to know, while if the risks were not so high, others might choose to participate. Based on the preliminary results provided by this survey, the ICD Sports Safety Registry, a multinational, prospective, observational registry, was established to identify and quantify risks associated with sports participation for ICD patients.

### The ICD sports registry

In this study, of which two-year results were published in 2013 and four-year results in 2017,<sup>12,13</sup> 440 athletes with ICDs, aged 10-60 years, 2/3 males, 46% with a history of ventricular arrhythmia (secondary prevention) who had chosen to continue competing in sports higher than Class "IA" regarding static/dynamic intensity, were prospectively followed. Participants were contacted regularly during the follow-up, and ICD records obtained, and rhythms adjudicated for shocks received at any time. The most common cardiac diagnoses were LQTS, HCM, and CAD, and the most common sports, running, soccer, and basketball. Among the twenty athletes participating at the university interscholastic level, diagnoses were similar, and the sports included soccer, basketball, lacrosse, and others.<sup>14</sup>

Over a median follow-up of 44 months, there were no occurrences of the primary endpoints—no failures of the ICD to defibrillate or externally resuscitated arrests, and no injuries due to syncopal arrhythmia or loss of control following shock. The 95% confidence interval for the occurrence of adverse events based on 376 participants

followed for at least 2 years was 0% to 0.9% and based on 167 participants followed for at least 4 years, it was 0% to 2.2%. Many participants received shocks, with forty-six (10%) receiving appropriate shocks (for VT/VF) during competition or practice, a rate of 3 per 100 person-years. While more athletes received shocks during some form of physical activity than during rest, there was no difference between competition/practice and other physical activities.<sup>13</sup> In this population, older athletes were more likely to receive shocks during sports than those under 18 years old.

While the ICD Registry demonstrated that it is safe for many athletes with ICDs to continue competing, whether ventricular arrhythmias requiring shock for termination are more common in competitive athletes is yet to be determined. A subanalysis of the ICD Registry which compared the primary population with a subpopulation of intensive recreational athletes enrolled in Europe<sup>15</sup> (and not described in the papers focused on competitive athletes) suggested that arrhythmias with physical activity were more common in those competing. However, there were differences between the European and US athletes. In the general population, the "paradox of exercise" is well-described.<sup>16</sup> While overall, sudden death is less common in those who exercise vigorously, the risk of an event is higher during exercise. While often considered a "paradox", this is likely explained by the role of the autonomic nervous system in arrhythmogenesis. Catecholamines are known to promote arrhythmias.<sup>17</sup> For well-conditioned individuals, catecholamines will be at the highest levels when they are vigorously exercising. Whether a similar "paradox of exercise" exists in the most common genetic cardiovascular diseases in the athlete-ICD population, is unknown. An ongoing observational study, the "Exercise in Genetic Cardiovascular Disease" (NIH # R01 HL125918-01) is currently enrolling individuals with HCM and LQTS (in two parallel studies, Lifestyle and Exercise in HCM (LIVE-HCM) and Lifestyle and Exercise in LQTS (LIVE-LQTS) at all levels of exercise, both with and without ICDs, to determine whether arrhythmic endpoints are more or less frequent in patients who exercise when compared to those who do not (<http://www.livehcm.org/> and <http://livelqts.org/>).

The impact of shocks on quality of life was not measured in the ICD Sports Registry. ICD shocks decrease quality of life, as shown in many studies.<sup>18</sup> However, while about one-third of those athletes who received shocks during sports stopped playing one or

all sports for a period of time, most returned to sports later on, suggesting that the beneficial impacts of sports participation on quality of life outweighed the negative impact of shocks for most athletes.

### Programming the ICD in the athlete

A recent subanalysis<sup>19</sup> has focused on the appropriate programming to minimize the likelihood of inappropriate shocks in this population. In the ICD Sports Study, those athletes whose ICDs were programmed with higher rate-cut-offs for the first therapy zone (greater than 200bpm), and those programmed with detection-duration greater than the nominal settings, were less likely to receive inappropriate shocks, and those with both these settings, the least likely.<sup>19</sup> Programming was not prescribed in this study, but findings were similar to large randomized controlled studies in the general ICD population.<sup>20</sup> There was no increase in syncope prior to shock in those athletes with higher rate-cut-off/longer duration. While two athletes had ventricular tachycardia below the rate cut-off and thus not treated, the arrhythmias were minimally symptomatic, presenting as palpitations. There was no difference in shock-rates based on dual-versus-single chamber device, or number of therapy zones.

Based on data from the ICD Sports Registry, in the updated "Eligibility and Disqualification Recommendations for Competitive Athletes With Cardiovascular Abnormalities: Task Force 9: Arrhythmias and Conduction Defects: A Scientific Statement From the American Heart Association and American College of Cardiology",<sup>21</sup> competitive sports participation for patients with an ICD no longer carries a blanket restriction, but rather, a "IIB" recommendation, i.e., "may be considered".

### Factors in the decision-making process around return to play: importance of the underlying disease

What factors need to be considered in the decision-making process around return to play for an athlete with an ICD? The most important one is the underlying disease. The ICD Sports Registry has not evaluated if or to what degree vigorous exercise may exacerbate the progression of cardiomyopathies. While in that study the ICD was always successful at converting ventricular arrhythmias in patients with arrhythmogenic right ventricular cardiomyopathy (ARVC,) these were the patients most likely to experience both single and

storms of ventricular arrhythmias during sports. Furthermore, there are increasing data in both animals<sup>22,23</sup> and human patients<sup>24,25</sup> that high-level exercise may accelerate cardiomyopathy progression in this disorder. For patients with ARVC, the disease process, rather than the ICD itself, should guide the risk-evaluation of sports participation.

How exercise may impact the myopathic process in HCM is yet to be clarified. In a murine model of HCM, exercise was actually beneficial. In animals who had not yet developed the HCM phenotype, exercise prevented fibrosis and myocyte disarray, and in animals who had already developed HCM, exercise led to disarray regression and to improvements in the apoptotic signaling pathway components.<sup>26</sup> In a recent study of controlled increases in moderate exercise in sedentary HCM patients,<sup>27</sup> physical conditioning improved, there were no arrhythmias, and no changes in echo parameters, although this was a short intervention, and did not include maximal vigorous exercise.

Catecholaminergic polymorphic VT (CPVT) is unique in that an ICD is not nearly as successful at converting an arrhythmia as it is in other arrhythmogenic conditions.<sup>28</sup> ICD shocks increase catecholamines, even in a sedated patient<sup>17</sup> and this can create a vicious cycle of arrhythmia recurrence for a patient with CPVT. One small series has described appropriately-treated CPVT patients, mostly without ICDs, participating in sports.<sup>29</sup> In one series of 15 CPVT patients with ICDs, 6 were treated for ventricular arrhythmias. Two died of VT refractory to ICD treatment, including one whose VT was triggered by an inappropriate shock for AF.<sup>28</sup> In the ICD Sports Registry, another subset of patients with ventricular arrhythmias requiring multiple shocks for termination were those with "idiopathic VF". As CPVT is electrically silent at rest, it is highly possible that some "idiopathic VF" may represent undiagnosed CPVT. Treadmill testing is imperative to evaluate CPVT, and genetic testing should be considered.

### Factors in decision-making: sports

The type of sports should also be taken into consideration. In the ICD Sports Registry, there were few athletes engaged in high-level contact sports. Basketball and soccer, which are considered "contact sports" by the American Academy of Pediatrics,<sup>30</sup> comprised a significant proportion of the sports practiced by the athletes, but there were very few engaged in sports in

which violent contact was an intrinsic and purposeful part of the practice, such as American football or hockey. In the ICD Sports Registry, lead malfunction rates were similar to those reported in unselected populations,<sup>31</sup> but whether the risk of damage to the ICD system is higher during the practice of the more violent contact sports remains undetermined.

### Importance of shared decision-making

Finally, the most important consideration is the athlete's values and preferences, and often his or her family's, and a shared decision-making approach is imperative.<sup>32</sup> Shared decision-making, termed the "pinnacle of patient-centered care",<sup>33</sup> requires the physician to explain the risks and benefits of options and to help patients understand how to reconcile these options with their personal preferences and values. This means full discussion with the patients, and often with their families--What are the risks? What data do we have, and how does this patient compare to the patients in the studies? For instance, for a hockey player, it is important to explain that system damage may be greater. What data are lacking? For instance, as mentioned above, while we know that shocks occur during sports, whether shocks would be less likely with the discontinuation of sports is still unknown. Furthermore, while there has been no adverse events described in the 440 patients in the ICD Sports Registry over four years, this study is not large enough to declare that the risk is zero. What do the professional society guidelines recommend? What does this patient and family think about risk in general? For instance, some families allow their children to climb Mount Everest, while others would not allow them to play American football. This shared decision-making approach requires a combination of knowledge of the data, and willingness to engage the patients (and often

their families) as partners in the decision-making process. Most importantly, we need to stress that we do not have all the answers, while providing a framework for decision-making.

### Author contributions

Acquisition of data: Lampert R. Analysis and interpretation of the data: Lampert R. Obtaining financing: Lampert R. Writing of the manuscript: Lampert R. Critical revision of the manuscript for intellectual content: Lampert R.

### Potential Conflict of Interest

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### Study Association

This study is not associated with any thesis or dissertation work.

### Ethics approval and consent to participate

This study was approved by the Ethics Committee of the Yale Human Investigation Committee under the protocol number 0608001736. All the procedures in this study were in accordance with the 1975 Helsinki Declaration, updated in 2013. Informed consent was obtained from all participants included in the study.

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