Cureus
Part of SPRINGER NATURE

Open Access Case Report

# De Winter Is Coming: A Rare ST-Segment Elevation Myocardial Infarction (STEMI) Equivalent in an Ironman Competitor

**Review began** 05/13/2026
**Review ended** 05/25/2026
**Published** 05/30/2026

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**DOI:** 10.7759/cureus.109942

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## Abstract

De Winter's electrocardiogram (ECG) pattern, defined as upsloping ST-segment depression >1 mm at the J point with tall, symmetric T waves in the precordial leads, represents a rare acute ST-segment elevation myocardial infarction (STEMI) equivalent. Seen in only 2%-3% of proximal left anterior descending (LAD) occlusions, it is often missed by automated interpretation systems yet carries mortality similar to classic STEMI and mandates urgent reperfusion. We present the case of a 56-year-old male who collapsed during an Ironman triathlon after developing severe chest pain. Initial ECG showed hyperacute T waves in V2-V3, consistent with de Winter's pattern; high-sensitivity troponin was elevated. The patient underwent urgent catheterization, which revealed an acute mid-LAD occlusion and high-grade stenosis of the second diagonal branch. Primary percutaneous revascularization was performed with restoration of flow. Postprocedural echocardiography demonstrated moderately reduced left ventricular function, and the patient was discharged on guideline-directed medical therapy (GDMT) with an uncomplicated recovery. This case underscores the importance of recognizing de Winter's ECG pattern as a STEMI equivalent to facilitate rapid intervention and improve outcomes.

**Categories:** Cardiology, Emergency Medicine, Internal Medicine
**Keywords:** acute coronary syndrome, de winter pattern, electrocardiography (ecg), left anterior descending artery occlusion, pci (percutaneous coronary intervention), stemi-equivalent

## Introduction

This case was previously presented as a meeting abstract at the 2026 American College of Cardiology (ACC) conference on March 30, 2026.

Acute ST-segment elevation myocardial infarction (STEMI) remains a leading cause of cardiovascular morbidity and mortality, with timely recognition and reperfusion therapy serving as the cornerstone of management [1,2]. While the classic electrocardiographic (ECG) criteria for STEMI are well established, a significant minority of patients with acute coronary artery occlusion present with atypical ECG patterns (so-called "STEMI equivalents") that may be seen in 10% to 25% of patients with acute coronary occlusion requiring urgent percutaneous coronary intervention (PCI) [3]. Among these, the de Winter ECG pattern is a rare but critical finding, first described by de Winter et al. in 2008 as upsloping ST-segment depression >1 mm at the J point with tall, symmetric T waves in the precordial leads, typically accompanied by subtle ST-segment elevation in lead aVR [4]. This pattern is observed in approximately 2% of patients with proximal left anterior descending (LAD) coronary artery occlusion [5].

Despite its classification as a STEMI equivalent by both the 2022 ACC Expert Consensus Decision Pathway and the 2025 ACC/AHA Acute Coronary Syndrome Guideline, the de Winter pattern is frequently missed by both automated ECG interpretation systems and clinicians because it does not meet traditional STEMI criteria [1,6-8]. The pattern is characteristically transient, typically evolving to overt ST-segment elevation within a median of 114 minutes, creating a narrow diagnostic window during which recognition is critical [5,8].

Although the de Winter pattern has been increasingly reported in the literature, a 2024 systematic review by Felicioni et al. identified only 66 published case reports with LAD-related lesions exhibiting this pattern [9]. The majority of reported cases involve young males, with a low prevalence of prior coronary artery disease, presenting in emergency departments and prehospital settings. Published cases have described the pattern in varied contexts, including after ventricular fibrillation cardiac arrest, as a transient phenomenon, and in atypical or delayed presentations [5,8,9].

Exercise-related acute cardiovascular events are a recognized complication of endurance sports. Among over 9 million triathlon participants, the incidence of sudden cardiac death has been reported at 1.74 per 100000

participants, with atherosclerotic coronary artery disease identified as a leading cause at autopsy [10]. Middle-aged males are disproportionately affected, and clinically silent cardiovascular disease is present in a substantial proportion of victims [10,11]. This case describes a de Winter ECG pattern presenting during an Ironman triathlon in a middle-aged male with minimal traditional cardiovascular risk factors, highlighting the importance of recognizing this rare STEMI equivalent across all clinical settings, including field-side and prehospital environments.

## Case Presentation

A 56-year-old male with a history of prediabetes and dyslipidemia collapsed at mile 32 of an Ironman triathlon after developing severe chest pain radiating to the left arm, accompanied by dyspnea, nausea, and diaphoresis. On arrival at the emergency department, the patient was diaphoretic and hypertensive with ongoing chest pain.

A 12-lead ECG was obtained and demonstrated upsloping ST-segment depression at the J point in the precordial leads (V2-V3) with tall, symmetric T waves, consistent with the de Winter ECG pattern (Figure *1*). Notably, the ECG did not meet traditional STEMI criteria. High-sensitivity troponin was elevated at 48.4 ng/L. The tall, symmetric T waves and elevated troponin initially raised concern for other conditions such as hyperkalemia and non-ST-elevation myocardial infarction (NSTEMI). However, the patient's sudden exertional chest pain, autonomic symptoms, normal electrolyte levels, and unremarkable renal function made the findings more consistent with the de Winter pattern. The patient received aspirin, ticagrelor, and unfractionated heparin, and the cardiac catheterization laboratory was emergently activated.

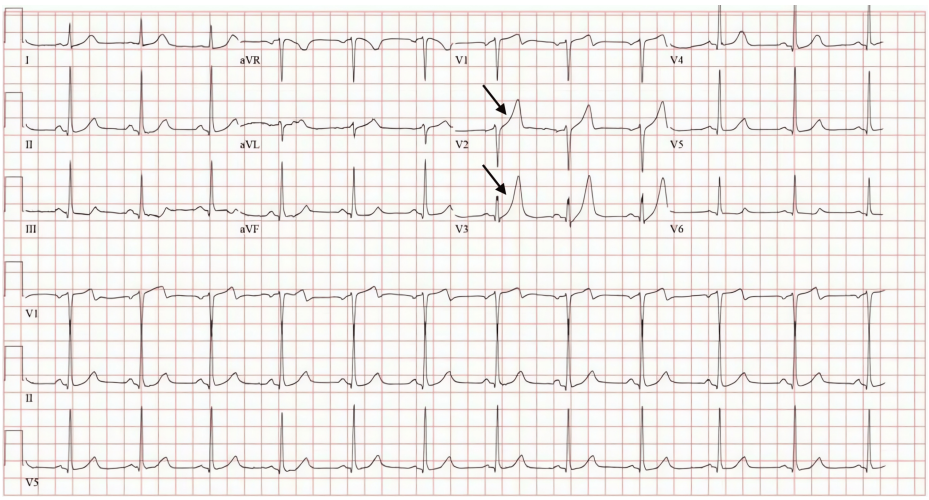



**FIGURE 1: Twelve-lead ECG demonstrating the de Winter pattern with upsloping ST-segment depression at the J point in leads V2-V3 and tall, symmetric T waves (black arrows)**

ECG: electrocardiogram

Coronary angiography revealed an acute mid-LAD occlusion with high-grade stenosis of the second diagonal branch (Figure *2*). Primary PCI was performed with stent placement across both lesions, resulting in successful restoration of coronary flow (Figure *3*). The patient's chest pain resolved following the procedure, and post-PCI transthoracic echocardiography revealed a left ventricular ejection fraction (LVEF) of 40%-45%. The patient had an uncomplicated postprocedural course and was discharged on guideline-directed medical therapy (GDMT), dual antiplatelet therapy, and high-intensity statin therapy, with referral to cardiac rehabilitation.

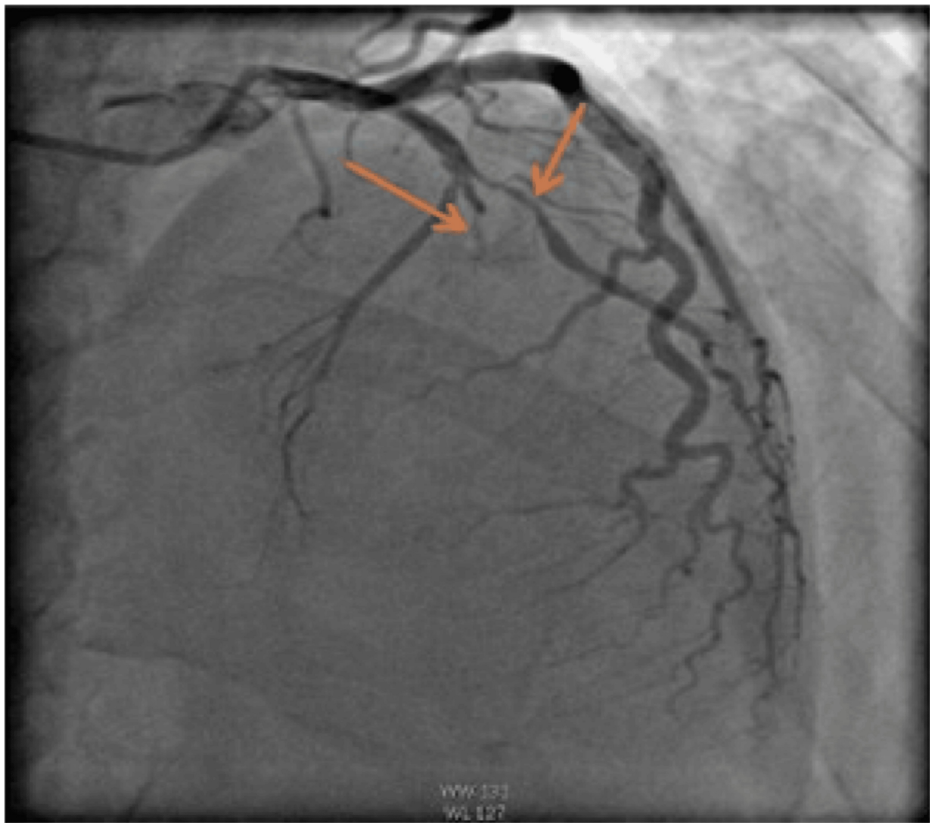


**FIGURE 2: Coronary angiography revealing acute occlusion of the mid-LAD and high-grade stenosis of the second diagonal branch (red arrows)**

LAD: left anterior descending

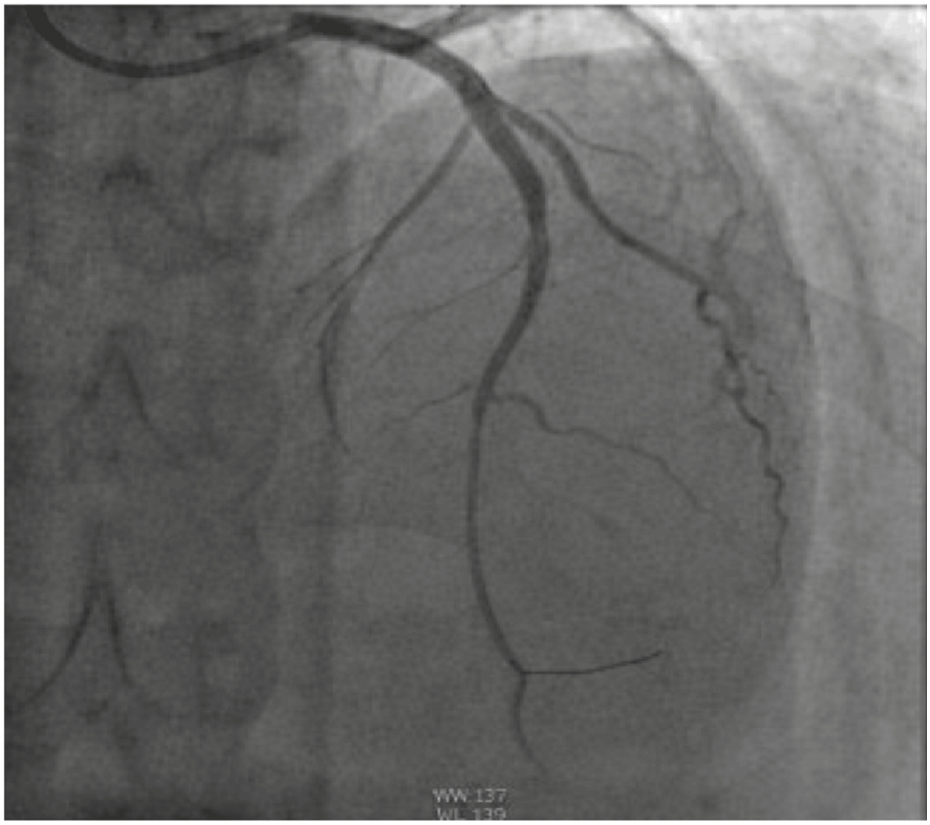



**FIGURE 3: Post-PCI angiography with stent placement across both lesions, demonstrating restoration of coronary flow**

PCI: percutaneous coronary intervention

## Discussion

This case illustrates several important clinical lessons regarding the de Winter ECG pattern and exercise-related acute coronary events and, to our knowledge, represents the first reported case of this pattern occurring during an endurance athletic competition. The de Winter pattern is a rare but well-established STEMI equivalent, occurring in approximately 2%-3% of patients with proximal LAD occlusion [4,5]. First described in 2008 in a series of 30 patients presenting with acute LAD occlusion, the pattern is defined by upsloping ST-segment depression of 1-3 mm at the J point transitioning into tall, peaked, symmetrical T waves in the precordial leads, often with concomitant ST-segment elevation in lead aVR [4]. Unlike classic anterior STEMI, the de Winter pattern does not demonstrate ST-segment elevation in the precordial leads, which poses a significant diagnostic challenge. Automated ECG interpretation algorithms are not designed to detect this pattern, and it is frequently misclassified as nonspecific ST-T-wave changes or non-ST-elevation acute coronary syndrome [7,8]. This misclassification can lead to critical delays in reperfusion therapy.

The transient nature of the de Winter pattern further complicates diagnosis. Evidence suggests that this ECG morphology typically evolves to classic ST-segment elevation within a median of approximately 114 minutes, representing an early phase of transmural ischemia rather than a static finding [5]. Serial ECGs, as recommended by the Fourth Universal Definition of Myocardial Infarction, are essential in patients with ongoing ischemic symptoms and an initially non-diagnostic ECG [2]. In the present case, the de Winter pattern was recognized on the initial ECG, which prompted expedited catheterization laboratory activation.

An important diagnostic consideration in patients presenting with tall, symmetric T waves in the precordial leads is hyperkalemia, which can produce peaked T waves that may superficially resemble the de Winter pattern [9,12]. Key distinguishing features include the clinical context (acute ischemic symptoms versus renal failure or metabolic derangement), the presence of upsloping ST-segment depression at the J point (characteristic of de Winter but not hyperkalemia), and the morphology of the T waves themselves (hyperkalemic T waves tend to be narrow-based and tented, whereas de Winter T waves are broader and arise from a depressed ST-segment) [9,12]. In our patient, the absence of renal dysfunction, the characteristic ST-depression morphology, and the clinical presentation of acute chest pain during exertion made hyperkalemia unlikely, and the diagnosis was confirmed by angiographic findings.

Currently, the pathophysiology of the de Winter pattern remains unclear, although several mechanisms have been proposed. These include subendocardial ischemia with preserved epicardial perfusion, the presence of collateral circulation, and anatomical variants in Purkinje fibers [13]. Xu et al. suggested that the pattern may represent a transitional phase when ischemia is expanding from the subendocardium to the epicardium, with the mid-myocardium's response to oxygen deprivation playing a key role [14]. These hypotheses remain speculative and warrant further investigation.

Exercise-related cardiac events during endurance competitions are uncommon but well-documented. A large case series of US triathlon participants from 1985 to 2016 identified 135 sudden deaths and cardiac arrests among over 4.7 million participants, yielding an incidence of 1.74 per 100000 [10]. The risk was substantially higher in men, particularly those aged 60 years and older (18.6 per 100000), and atherosclerotic coronary artery disease was among the most common findings at autopsy [10]. The American Heart Association has noted that strenuous physical activity transiently increases the risk of acute myocardial infarction and sudden cardiac death [15]. Vigorous exercise can trigger plaque rupture and acute coronary thrombosis in individuals with underlying, often subclinical, coronary artery disease. The present patient had only prediabetes and dyslipidemia, consistent with the reported demographic profile of de Winter pattern patients, who tend to be younger males with fewer conventional cardiovascular risk factors [7,15]. The physiological stress of an Ironman triathlon, involving sustained high-intensity exertion over many hours with associated dehydration, catecholamine surges, and hemodynamic stress, likely served as the precipitant for acute plaque rupture and LAD occlusion in this case.

Regarding outcomes, emerging data suggest that de Winter patients may have a more favorable prognosis compared with classic anterior STEMI. Alireza et al. (2025) compared 30 de Winter patients to matched anterior STEMI controls and found that de Winter patients had significantly lower in-hospital mortality (3% vs. 18%, p=0.04) and fewer malignant arrhythmias (7% vs. 27%, p=0.01) despite a higher prevalence of multivessel disease (60% vs. 38%, p=0.03) [16]. The authors hypothesized that ischemic preconditioning may underlie these findings. However, these results should be interpreted cautiously, given the small sample size. A separate observational study by Fujii and Ikari (2024) identified only two de Winter patients among 641 LAD-culprit acute coronary syndrome (ACS) cases, both of whom died, underscoring the heterogeneity of outcomes in this rare population [17]. Long-term follow-up data specific to de Winter patients remain limited, and post-PCI management follows the same GDMT used for any acute MI patient, including dual antiplatelet therapy, high-intensity statins, beta-blockers, and cardiac rehabilitation [6]. Although our patient was found to have a moderately reduced ejection fraction, the otherwise uncomplicated clinical course likely reflects the benefit of early recognition and prompt reperfusion, consistent with the favorable short-term outcomes reported in the Alireza et al. cohort.

Primary PCI remains the definitive therapy after recognition of the de Winter pattern [18]. The 2022 ACC Expert Consensus Decision Pathway recommends that de Winter's sign warrants immediate angiography, equivalent to the approach for classic STEMI [1,6]. In settings where PCI is not immediately available, thrombolysis has been proposed as a potential bridging strategy when PCI is delayed beyond 120 minutes. However, the evidence for thrombolytic efficacy in de Winter patients is mixed and limited. Xu et al. (2018) reported that two of three de Winter patients who received thrombolysis failed, and one had re-occlusion after initial success, suggesting poor thrombolytic response [14]. A case report by Xiao et al. (2023) similarly documented poor thrombolytic efficacy in a de Winter patient [19]. While isolated case reports of successful thrombolysis exist, primary PCI remains the clearly preferred approach when available, and thrombolysis should be considered only when transfer to a PCI-capable facility would result in unacceptable delays.

This report has several limitations inherent to single case reports, including the inability to establish a causal relationship between exercise and the de Winter pattern, as well as the lack of long-term follow-up data. The pathophysiologic mechanisms underlying the de Winter pattern also remain speculative, and the prognostic data currently available are based on small cohort studies. However, this case underscores the importance of education across the spectrum of acute care providers. Because 4%-7% of patients requiring urgent catheterization present with atypical ECG findings such as de Winter's sign, improved recognition among emergency physicians, cardiologists, and prehospital providers is essential to minimize door-to-balloon times and optimize outcomes [3]. Integration of STEMI-equivalent patterns into ECG education and automated interpretation algorithms represents an important opportunity to reduce diagnostic delays.

## Conclusions

This case highlights the de Winter ECG pattern as a rare but critical STEMI equivalent that mandates the same urgency of reperfusion as classic ST-segment elevation. Occurring in the high-stakes setting of an Ironman triathlon, it demonstrates that acute coronary occlusion can present with atypical ECG findings even in physically active individuals with minimal traditional risk factors. To our knowledge, this is the first reported case of the de Winter pattern occurring during an endurance athletic competition, expanding the clinical contexts in which this pattern has been documented. Prompt recognition of the de Winter pattern by the treating team enabled timely catheterization and successful revascularization. Continued education of emergency, cardiology, and prehospital providers regarding STEMI-equivalent ECG patterns is essential to ensure that these high-risk presentations are not missed, thereby reducing treatment delays and improving patient outcomes.

# Additional Information

## Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

**Concept and design:** Andrew Griffus, Gracelyn Bose, Aditya Thakkar

**Drafting of the manuscript:** Andrew Griffus

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**Supervision:** Gracelyn Bose, Sam Thomas, Poonam Puri

**Acquisition, analysis, or interpretation of data:** Sam Thomas, Aditya Thakkar, Poonam Puri

## Disclosures

**Human subjects:** Informed consent for treatment and open access publication was obtained or waived by all participants in this study. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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