

Cardiac Chrono-Desynchronization Syndrome: Circadian Rhythm Disruption as an Independent Cardiovascular Risk Factor

Mirel Vashkoren*

Department of Cardiology, Heidelberg University, Heidelberg, Germany

DESCRIPTION

The human cardiovascular system operates under a finely tuned temporal framework governed by circadian rhythms that synchronize physiological processes with environmental light-dark cycles. These intrinsic biological rhythms regulate fluctuations in heart rate, blood pressure, vascular tone, and hormonal secretion across a 24-hour period. In recent decades, rapid societal and technological changes have led to widespread disruption of these natural cycles, raising concerns about their long-term impact on cardiovascular health. Within this evolving landscape, the concept of Cardiac Chrono-Desynchronization Syndrome (CCDS) is proposed as a novel clinical entity characterized by a persistent misalignment between endogenous cardiac timing mechanisms and external environmental cues, resulting in measurable cardiovascular dysfunction even in the absence of structural heart disease.

Circadian regulation of cardiovascular function is orchestrated by the central clock located in the suprachiasmatic nucleus of the hypothalamus, as well as peripheral clocks within cardiac tissue and vascular endothelium. These systems coordinate daily variations such as the morning surge in blood pressure, nocturnal dipping patterns, and oscillations in autonomic nervous system balance. Under normal conditions, sympathetic activity predominates during daytime hours to support physical and cognitive activity, while parasympathetic tone increases at night to facilitate rest and recovery. However, when circadian alignment is disrupted due to irregular sleep schedules, shift work, excessive exposure to artificial light, or chronic behavioral stress, this delicate balance is disturbed, leading to a cascade of physiological consequences that may predispose individuals to cardiovascular disease.

The pathophysiological basis of CCDS involves multiple interrelated mechanisms. One of the most prominent is autonomic imbalance, characterized by sustained sympathetic overactivity and reduced parasympathetic modulation. This shift can result in persistent elevation of heart rate and blood pressure, increased myocardial oxygen demand, and reduced heart rate variability, all of which are recognized predictors of

adverse cardiovascular outcomes. In addition, circadian disruption has been associated with endothelial dysfunction, mediated by impaired nitric oxide synthesis and increased oxidative stress. These changes contribute to vascular stiffness, reduced vasodilatory capacity, and a pro-inflammatory state that promotes atherogenesis.

Hormonal dysregulation also plays a central role in CCDS. Cortisol, a glucocorticoid hormone with a well-defined circadian pattern, typically peaks in the early morning and declines throughout the day. Disruption of this rhythm can lead to either blunted or exaggerated cortisol responses, both of which have been linked to metabolic and cardiovascular abnormalities. Similarly, melatonin, a hormone produced during darkness, exerts cardioprotective effects through antioxidant and anti-inflammatory mechanisms. Reduced or irregular melatonin secretion, often observed in individuals with disrupted sleep patterns, may further exacerbate cardiovascular risk by impairing nocturnal blood pressure regulation and increasing oxidative stress.

Clinically, CCDS may manifest in subtle but significant ways that are often overlooked in routine practice. Patients may report palpitations, fatigue, or sleep disturbances without clear evidence of structural heart disease. Ambulatory blood pressure monitoring may reveal non-dipping or reverse-dipping patterns, which are strongly associated with increased cardiovascular morbidity. Electrocardiographic findings may include altered heart rate variability and occasional arrhythmias, particularly during periods of circadian misalignment. Importantly, these manifestations may occur in otherwise healthy individuals, underscoring the need for heightened clinical awareness and more comprehensive diagnostic approaches.

The proposed diagnostic framework for CCDS emphasizes the integration of behavioral, physiological, and biochemical assessments. Documentation of circadian misalignment can be achieved through sleep diaries, actigraphy, or wearable devices that track activity and light exposure. Cardiovascular evaluation may include 24-hour Holter monitoring to assess heart rate variability and detect arrhythmias, as well as ambulatory blood pressure measurements to evaluate diurnal patterns. Biomarkers

Correspondence to: Mirel Vashkoren, Department of Cardiology, Heidelberg University, Heidelberg, Germany, E-mail: m.vashkoren@med.uni-heidelberg.de

Received: 02-Jan-2026, Manuscript No. JCEC-26-41102; **Editor assigned:** 05-Jan-2026, PreQC No. JCEC-26-41102 (PQ); **Reviewed:** 19-Jan-2026, QC No. JCEC-26-41102; **Revised:** 26-Jan-2026, Manuscript No. JCEC-26-41102 (R); **Published:** 02-Feb-2026, DOI: 10.35248/2155-9880.26.17.992

Citation: Vashkoren M (2026). Cardiac Chrono-Desynchronization Syndrome: Circadian Rhythm Disruption as an Independent Cardiovascular Risk Factor. *J Clin Exp Cardiol*. 17:992.

Copyright: © 2026 Vashkoren M. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

such as cortisol and melatonin levels, measured at multiple time points, may provide additional insights into the degree of circadian disruption. Exclusion of structural heart disease through imaging modalities remains an essential component of diagnosis. Management of CCDS requires a multifaceted approach aimed at restoring circadian alignment and mitigating its cardiovascular effects. Behavioral interventions are central to this strategy and include the establishment of regular sleep-wake schedules, reduction of nighttime light exposure, and optimization of daytime activity patterns. Chronotherapy, which involves the timing of medication administration to align with circadian rhythms, may enhance therapeutic efficacy and reduce side effects. For example, administering antihypertensive medications in the evening rather than the morning may improve nocturnal blood pressure control in individuals with non-dipping patterns. In selected cases, pharmacological agents such as melatonin supplements may be considered to support circadian regulation, although their long-term cardiovascular benefits require further investigation.

From a research perspective, CCDS represents a fertile area for exploration at the intersection of chronobiology and cardiology.

Future studies should aim to establish standardized diagnostic criteria, identify genetic and environmental modifiers, and evaluate the long-term impact of circadian interventions on cardiovascular outcomes. Advances in wearable technology and digital health platforms offer exciting opportunities for continuous monitoring and personalized management, potentially transforming the way circadian-related disorders are detected and treated.

CONCLUSION

Cardiac chrono-desynchronization syndrome provides a conceptual framework for understanding the cardiovascular consequences of circadian rhythm disruption. By recognizing the heart as a temporally regulated organ, this model highlights the importance of aligning biological and environmental rhythms to maintain optimal function. As modern lifestyles continue to challenge traditional circadian patterns, integrating temporal biology into cardiovascular medicine may become an essential component of both prevention and treatment strategies.