Device-Collected Heart Rate Variability Predicts Ventricular Arrhythmia

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(Int Heart J 2020; 61: 861-862)

The remote monitoring system (RMS) of cardiac implantable electronic devices (CIEDs) is a handy standard tool in arrhythmia therapy. It is well-known that home monitoring (HM) can reduce the composite endpoint of all-cause mortality or hospitalization for worsening heart failure (WHF).1 In heart failure (HF) patients with an implantable cardioverter defibrillator (ICD), shocks delivery of the device is associated with a poor prognosis.2 Early detection of arrhythmia using RM leads to rapid therapeutic intervention and prevention of ICD shock therapy, and thus the prognosis in patients with an ICD is improved.3 Although many studies have attempted to identify CIED parameters that would predict cardiac events, useful parameters for predicting the appropriate ICD therapies have not yet been identified. For example, the OptiVol™ fluid status trend algorithm (Medtronic, Minneapolis, MN, USA) and almost the same algorithm, CorVue™ (Abbott Medical, St. Paul, MN, USA), have been widely studied. In the algorithms, intrathoracic impedance (ITI) was tested to evaluate whether the ITI changes could predict HF. While clinical trials and some observational studies using these diagnostic tools have been conducted, the algorithms could not demonstrate acceptable and reproducible sensitivity.4,5 Still, useful parameters for predicting cardiac events have not yet been identified, even though abundant data are obtained from CIEDs.

Recent evidence suggests that interactions between the heart and the autonomic nervous system (ANS) contribute to the initiation and perpetuation of arrhythmias. The dynamic interplay between the sympathetic and parasympathetic nerve systems, modulated by physiological inputs and reflexes, dynamically regulates the hemodynamic and electrical functions of the heart and vascular system (Figure).6 Many studies have established that ANS dysfunction is associated with an increased risk of mortality and morbidity. Elevated fasting insulin levels increase sympathetic nerve activity. Thus patients with diabetes have a 3- to 5-fold increased risk of sudden death compared to patients without diabetes.7 Based on the importance of the ANS in the pathophysiology of arrhythmias, pharmacologic interventions such as beta-blockade or various neuromodulatory interventions targeting cardiac autonomic modulation have been developed. Examples include autonomic ganglionic plexi ablation, renal denervation, epicardial botulinum toxin injection, sympathectomy, and spinal cord stimulation.8

Heart rate variability (HRV) is one of the quantitative markers for autonomic activity. Low HRV is associated with an increased risk of ventricular arrhythmia in patients with an ICD.9 In this issue of the International Heart Journal, Shirakawa, et al. investigated whether HRV obtained by CIED can predict ventricular tachycardia (VT)/ventricular fibrillation (VF).9 The study was retrospective and enrolled patients with ICDs, in which HRV analytic function was installed. Using time intervals between successive normal heartbeats, NN intervals, the standard deviation of all NN intervals (SDNNi) in successive 5-minute epochs was calculated as the index of time-domain analysis of HRV. It was found that SDNNi was statistically significantly higher in patients with ICD therapy events than in patients without such events. Logistic regression analysis demonstrated that the mean SDNNi during the observation periods had a moderate prediction accuracy with an area under the curve (AUC) of 0.86 and high sensitivity of 100% in predicting VT/VF.9

It also revealed that the ΔSDNNi, a change of SDNNi at seven days before VT/VF from the baseline, could predict the arrhythmias with a better accuracy, such as max ΔSDNNi with AUC = 0.91 or min ΔSDNNi with AUC = 0.88.9

This study had several limitations, including retrospective analysis and a small sample size from a single institution. Also, a multicenter and long-term follow-up investigation is required to establish this parameter as a marker for predicting ventricular arrhythmia. However, the results indicated that SDNNi and its changes might be useful parameters in predicting VT/VF in patients with an
ICD. This study implies that RM could be a highly useful tool to predict VT and VF over the long term.9

Disclosure

Conflicts of interest: The authors have no financial conflicts of interest to disclose concerning the report.

References