

Nonhemodynamic Parameters from Implantable Devices for Heart Failure Risk Stratification



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KEYWORDS

• Heart failure • Remote monitoring • Implantable defibrillator • Vital signs • Thoracic impedance

KEY POINTS

- Vital signs are ubiquitously monitored by the physician because they provide important information about the condition of a patient.
- In the setting of heart failure, heart rate and blood pressure carry important prognostic information, whereas respiration may provide important information about the short-term risk of acute heart failure events.
- Implantable cardioverter defibrillators (ICDs) can monitor several parameters that contain important prognostic information or provide a risk assessment of acute heart failure events.
- The occurrence of atrial and ventricular arrhythmias, heart rate variability (HRV), and activity level may be used to assess long-term prognosis. Thoracic impedance can provide a short-term risk assessment of acute heart failure events.
- Although no single parameter precisely defines long-term prognosis for survival or short-term risk of acute heart failure events, combining such parameters may provide a means to a more accurate risk assessment.

Chronic heart failure is common, and there are more than 1 million hospital admissions annually in the United States for acute decompensated heart failure.¹ Much of the medical expense and morbidity associated with heart failure is derived from these hospitalizations.² Further, heart failure hospitalizations are associated with an increased risk of subsequent mortality.³ Accordingly, there is a continuing search for methods for the early detection of worsening heart failure. There are several parameters that are monitored by implantable electronic devices currently in practice or that could easily be obtained clinically, which provide important prognostic information and may be useful in remote patient monitoring. However, several of these parameters have been limited by their

sensitivity and specificity in assessing the condition of a given patient. Despite these limitations, the data provided can be useful clinically and may be even more useful when incorporated into the entirety of the clinical information available regarding a patient.

INFORMATION GATHERED FROM REMOTE MONITORING VITAL SIGNS

Blood Pressure

Blood pressure is a ubiquitously monitored parameter, obtained in every clinic and hospital visit. However, the importance of blood pressure as a prognostic indicator is often overlooked. In patients with acute heart failure, there is a U-shaped

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curve describing risk of death for patients hospitalized with acute heart failure (Fig. 1).⁴ The mortality seems to nadir in the range of 140 to 150 mm Hg systolic, whereas the nadir is in the range of 70 to 80 mm Hg diastolic. The reasons for this are not entirely clear, but part of it seems to be related to the association of low blood pressure with poor systolic function; this is made clearer when grouping patients into those with heart failure with preserved ejection fraction and heart failure with reduced ejection fraction (Fig. 2).⁵ The greatest risk of death is in patients with reduced ejection fraction and low blood pressure. Further, higher blood pressures in the preserved ejection fraction group are not associated with an increase in the risk of mortality, whereas the typical U-shaped curve is present for patients with heart failure with reduced ejection fraction.

The utility of blood pressure monitoring in the management of patients with heart failure lies with the impact on prognosis. There may be further utility in using the data to titrate standard heart failure therapy, including beta-blockers, angiotensin converting enzyme inhibitors, and angiotensin receptor blockers, but there are no compelling data to demonstrate that this strategy is superior to the use of symptoms and clinic-measured blood pressures. The data may also be used to assist in the management of hypertension. Most patients with heart failure have a history of hypertension, and many patients, particularly those with heart failure with preserved ejection

fraction, have ongoing issues with high blood pressure. Remotely monitored blood pressure measurements may be useful in the management of these patients.⁶

Heart Rate

Heart rate is another vital sign that is monitored in all patients. Historically, heart rate was used as a prognostic indicator in patients with heart failure and provided solid predictive value.⁷ However, with the common use of β -blockers and some anti-arrhythmic drugs that lower heart rates, the ability to use heart rate as a prognostic metric has diminished. Despite this, there is still predictive value in heart rates, best seen with the use of implantable pacemakers and ICDs, which monitor heart rates continuously. In doing so, they are well positioned to measure heart rates under several conditions, including at rest as detected by the accelerometer inside the device, at night, or averages during the day. Even considering the ability of such devices to continuously monitor heart rate, the predictive value for either mortality or heart failure events is modest.

Measurements of HRV have been evaluated for several decades in patients with heart failure.⁸ Even in the presence of β -blockers and other medications that affect heart rate, HRV has shown solid prognostic value in patients with heart failure, although the predictive value may be diminished.⁹ The measurement has been made in several ways

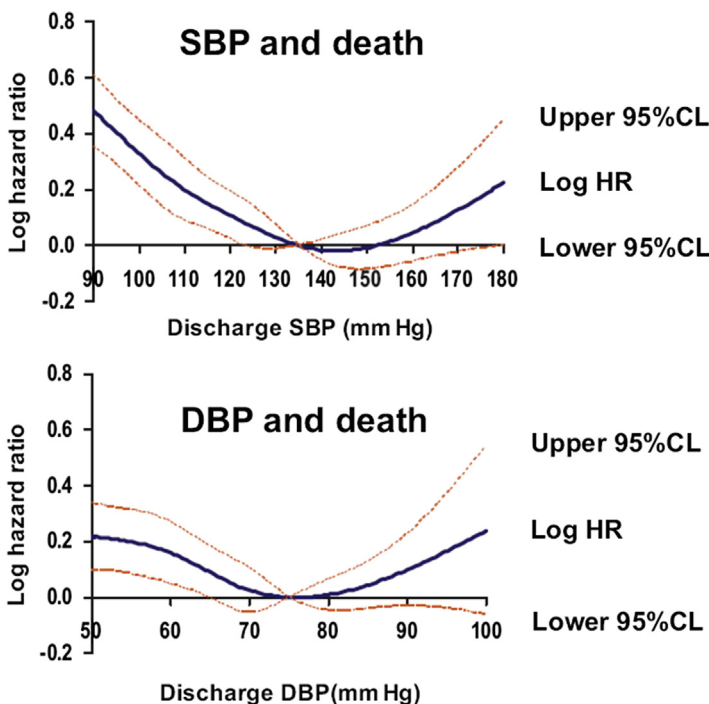


Fig. 1. Spline curves relating discharge systolic blood pressures (SBP) and diastolic blood pressures (DBP) with mortality in patients who were admitted with heart failure, adjusted for covariates and medications. CL, confidence limit; HR, hazard ratio. (From Lee DS, Ghosh N, Floras JS, et al. Association of blood pressure at hospital discharge with mortality in patients diagnosed with heart failure. *Circ Heart Fail* 2009;2(6):618; with permission.)

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