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Heart rate and blood pressure monitoring in heart failure

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It has been long known that incessant tachycardia and severe hypertension can cause heart failure (HF). In recent years, it has also been recognized that more modest elevations in either heart rate (HR) or blood pressure (BP), if sustained, can be a risk factor both for the development of HF and for mortality in patients with established HF. Heart rate and BP are thus both modifiable risk factors in the setting of HF. What is less clear is the question whether routine systematic monitoring of these simple physiological parameters to a target value can offer clinical benefits. Measuring these parameters clinically during patient review is recommended in HF management in most HF guidelines, both in the acute and chronic phases of the disease. More sophisticated systems now allow long-term automatic or remote monitoring of HR and BP and whether this more detailed patient information can improve clinical outcomes will require prospective RCTs to evaluate. In addition, analysis of patterns of both HR and BP variability can give insights into autonomic function, which is also frequently abnormal in HF. This window into autonomic dysfunction in our HF patients can also provide further independent prognostic information and may in itself be target for future interventional therapies. This article, developed during a consensus meeting of the Heart Failure Association of the ESC concerning the role of physiological monitoring in the complex multi-morbid HF patient, highlights the importance of repeated assessment of HR and BP in HF, and reviews gaps in our knowledge and potential future directions.

Introduction

Monitoring heart rate (HR) and blood pressure (BP) is an established part of routine clinical practice in heart failure (HF) patients. The role of an elevated HR and BP in determining cardiovascular risk is well-known since the Framingham study.[1] Hypertension is the most prevalent risk factor for HF in the developed world, and long known to be a major and remediable risk factor for HF. The optimal target for BP control in primary prevention has been evaluated in many large-scale antihypertensive trials, but the optimal target BP or HR within an established HF population is less clear. The impact of elevated HRs on adverse outcomes and mortality in HF has been extensively studied,[2,3] especially in sinus rhythm. For HR, we have compelling evidence that it is beneficial to target a HR close to 60 b.p.m., but for BP the optimal target remains unclear.

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Increased HR has a complex interaction with BP, in the short-term BP increases cause reflex bradycardia via the arterial baroflex system and yet the same factors that drive an increased BP also frequently drive an increased HR, such as increased sympathetic tone. The development of systems to continuously measure both BP and HR can offer novel ways for us to measure HR and BP behaviour and to do so in intense detail.[4] It may well be that the complex interplay of these control systems of BP and HR and of respiration may offer even more powerful ways to measure prognostic risk within the HF population[5] and devise novel interventions.[6] Much of this HR/BP interaction behaviour is linked to the complex autonomic nervous system and its reflex control systems, which themselves are now being evaluated as a therapeutic target in HF.[7] It may well be that measurement of BP and HR by continuous or semi-continuous monitoring may offer a window for us to use this new research to improve our care of HF patients[8,9] and also to offer novel targets for intervention in HF. Thus, both BP and HR, and also their interactions, carry potentially important clinical value in the management of HF, and may in future offer us new therapeutic targets and approaches to managing our HF patients.

Benefits of heart rate and blood pressure monitoring in heart failure

Monitoring of HR and BP can contribute to improved outcomes in HF management if it leads to more effective use of guideline-directed medical therapy. In the case of resting HR in sinus rhythm, there is an inverse relation between this parameter and life expectancy.[10] Increased resting sinus HR is a risk factor for the development of HF and sudden cardiac death[11,12] and HR reduction a beneficial predictive factor in HF.[13] It has been demonstrated that HR reduction by 10 beats saves almost 5 kg ATP per day.[14] In fact, chronic HF is characterized by higher energy expenditure and blood supply to the myocardium, with impaired vascular resistance and ventricular loading and mechanical dyssynchrony.

The BEAUTIFUL trial showed the prognostic relevance of HR in HF with reduced ejection fraction patients, showing that those with higher HR had greater occurrence of cardiovascular death and HF hospitalization.[15] Similarly, the SHIFT trial found that the risk of cardiovascular death and HF hospitalization increased by 3% with every beat increase from baseline HR and by 16% for every 5 b.p.m. increase.[16] The CHARM programme[17] revealed the prognostic importance of temporal changes in resting HR in HF. In fact, change in HR over time predicted the outcome in HF patients. This further highlights the need for frequent outpatient monitoring of HR. Indeed, HR is a prognostic factor in HF especially in the early post-discharge period where it is related to symptomatic improvement and prognosis.[18] The EVEREST trial clarified that elevated 1 and 4-week post-discharge HR predicted mortality in patients with HF and left ventricular systolic dysfunction in sinus rhythm.[19] Monitoring HR in these post-discharge intervals is, therefore, recommended.

Finally, a meta-analysis[20] demonstrated that the magnitude of HR reduction is associated with the survival benefit of beta-blockers in HF, whereas the dose of beta-blocker is not. This implies that HR reduction in beta-blocker treatment for chronic HF mainly contributes to the clinical benefit in this treatment.[21,22] In contrast to the case for sinus rhythm in atrial fibrillation there is no clear association between HR and prognosis at least over the range of HR from 60 to 100 b.p.m.[23]

As for HR, BP is a key prognostic variable to be monitored over time, being directly related to HF development and progression.[1] Chronic hypertension has the potential to determine structural cardiac changes and ventricular dysfunction. For this reason, the lifetime risk for HF doubles in those with BP >160/100 vs. <140/90 mmHg in both sexes.[24] Further, there is increased recognition of the harmful consequences of pre-hypertensive chronic states (<140 mmHg).[25] There is no clear cut-off point delimitating the need for antihypertensive therapy, as the association between systolic BP and HF risk is continuous.[25,26] More complex BP behaviour may also be important to monitor in HF syndromes such as the interaction of BP and HR variability (HRV) discussed elsewhere in this article and BP response to simple tests.[27]

Guidelines-based indications for in-hospital heart rate and blood pressure monitoring

According to the ESC guidelines,[28] standard non-invasive monitoring of HR and BP is recommended (Class I) and should be performed from the initial presentation of HF.

For in-hospital monitoring, the 2018 guidance from the HFA/ESC[29] indicated that assessments of HR and BP should be repeated at intervals. The first monitoring should occur during hospitalization for acute HF, in order to provide optimal management and vaso-active drug usage.[30,31] Baseline/initial monitoring usually is performed in the emergency department at the point of initial admission. From then on clinical status monitoring should be performed based on the changing clinical variables of the patient. This usually happens in intensive or critical care unit settings. Repeated monitoring of HR and BP is made in the general ward or prior to discharge.[29] Finally, serial assessments of HR and BP should be part of a multidisciplinary after-discharge patient monitoring programme (remote monitoring).

Remote patient monitoring: implantable devices

Using implantable devices, HR and BP can be easily monitored over time, in order to prevent decompensation and consequent rehospitalizations.[4,32–34] Often, before an episode of decompensation, a rapid increase in mean HR occurs, and it can be simply detected by an implantable device. Measurement of short-term HRV can similarly prevent sudden cardiac death in chronic HF.[29] Among currently available sensors, HR derivatives are able to assess mean HR, nocturnal HR, HRV, HRV footprint, and HR during exercise.

For BP monitoring, haemodynamic sensors allow the detection of right ventricular pressure (Chronicle IHM),[35] RV dP/dt_{max}, left atrial pressure (HeartPOD),[36] and pulmonary artery pressure (Champion).[37] There is encouraging evidence showing the effectiveness and safety of implantable device measurements and their correlation with serial invasive measurements. Positive results come from meta-analyses,[38–41] whereas few clinical trials to date have demonstrated that implementation of an implantable device improves patient outcome, a notable exception being the CardioMEMS device. This represents an important knowledge gap to be fulfilled.

Conclusions

Repeated assessment of HR and BP over time is recommended for the care of patients with HF and provides prognostic information. Serial comprehensive inpatient and outpatient monitoring is crucial to the optimal management of acute and chronic HF patients to improve outcomes and to prevent adverse events.[42–46]

However, most of the guideline recommendations related to monitoring are based on consensus of opinion of the experts and/or small studies, retrospective studies and/or registries (level of evidence C).[47] For this reason, additional research is warranted.

Conflict of interest: none declared.

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