Abstract 134 Figure 2

Conflict of Interest Heart Failure

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AN IMPROVED EJECTION FRACTION PARAMETER CAPABLE OF REPRESENTING CARDIAC FUNCTION REGARDLESS OF HEART MORPHOLOGY TO DISTINGUISH HFPEF FROM NORMAL HEARTS

¹Choon Hwai Yap, ²Yu Zheng, ²Wei Xuan Chan, ²Christopher Charles, ²Mark Richards, ³Smita Sampath, ³Asad Abu Bakar Ali, ²Hwa Liang Leo. ¹Imperial College London, London, UK; ²National University of Singapore; ³Merck Sharp & Dohme

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Background Ejection Fraction (EF) has been an important parameter describing cardiac function, because of earlier work demonstrating its correlation with outcomes. However, during conditions such as Heart Failure preserved ejection fraction (HFpEF), EF fails to distinguish HFpEF from healthy patients. There are further reports that EF can be skewed by the geometry of the heart, and Heart Failure (HF) can present a

wide variety of cardiac morphologies due to remodelling. The reason for the poor performance of EF and its dependency on geometry is unclear, and it is further unclear if such geometric changes from HF remodelling affects cardiac function. We strive to address this here, and derive an improved and simple EF parameter to resolve this.

Methods We developed a simple discretized numerical model to relate incompressible myocardial strains to stroke volume. We used data from two porcine animal models of heart failure, one for HFpEF and one for HF reduced EF (HFrEF), and literature clinical measurements to inform our model. We used the model to test the effects of geometric changes relevant to HF on the ability of the heart to convert myocardial strains to flow function.

Results Our animal models showed that cardiac dilation and wall thickening are primary features relevant to HF. Further investigation via our numerical model showed that wall thickening with no change to strain artificially increased EF, while cardiac dilation with no change to strain artificially decreased EF, demonstrating that EF can be skewed by geometric

changes during HF remodelling, and is an inaccurate representation of cardiac function. We further showed that this is because EF is calculated using the endocardial boundary rather than the mid-wall layer, because a corrected EF parameter (CEF) that uses the mid-wall layer for quantification resolves this shortcoming. This CEF became independent of cardiac geometry, and could successfully distinguish HFpEF and healthy heart in our animal models, where EF could not. The CEF can be calculated easily with measurements of EF, wall thickness, and LV inner diameter. We further showed that the myocardial strains at the endocardial and epicardial boundary deviated significantly from each other and from the strains at the mid-wall layer, and this magnitude of deviation depended on the cardiac geometry, suggesting that any quantification of cardiac function using the epi- or endo- boundaries can be skewed by geometric changes to the heart, and will be ineffective. Finally, we tested specific types of HF morphologies, namely, eccentric hypertrophy, concentric hypertrophy, and concentric remodelling with our numerical model. We found that the concentric remodelling morphology is the most inefficient in converting myocardial strains to stroke volume, while eccentric hypertrophy is the most efficient. This may explain why HFpEF hearts, which are likely have wall thickening similar to concentric remodelling, have exercise intolerant, and our results suggest that cardiac dilation during HFrEF is providing advantages to help with flow function.

Conclusion We demonstrated that geometric changes during HF remodeling can significantly impact cardiac function, and can skew functional parameters like EF. We further showed that the reason for EF's shortcoming is due to a flawed reliance on quantification using the endocardial boundary of the heart rather than the mid-wall layer. We proposed a new CEF parameter to replace EF that can resolve the shortcoming, and that can distinguish HFpEF from healthy hearts.

Conflict of Interest None to declare

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WHAT ACTUALLY HAPPENS IN A SPECIALIST HEART FAILURE CLINIC?

¹Arvind Singhal, ¹Jiliu Pan, ¹Barbara Cassimon, ²Martin Cowie. ¹Royal Brompton Hospital, London, UK; ²Imperial College, London

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Introduction Provision of specialist outpatient services has struggled to keep up with the growing demands of the heart failure (HF) epidemic in the UK. The Covid-19 pandemic necessitated a dramatic change in how HF clinics are delivered, with a reduction in face-to-face contact. The need for in-person appointments remains unknown. We evaluated pre-pandemic face-to-face clinic appointments in detail, to see what appointments achieved, in order to plan future services.

Methods We conducted a retrospective cohort study of patients who had completed 3 years of follow up (1st January 2017 to 31st December 2019) in a specialist HF clinic. Inclusion criteria were a clinician diagnosis of HF or left ventricular systolic dysfunction (from clinic letters and echocardiography), or at least moderate valvular disease with symptoms. Patient electronic health records were reviewed, and for each clinic attendance, the following were noted:

• Presence of new or worsening symptoms or signs of HF, or symptoms relating to HF treatment, as assessed by the clinician
• Change in cardiovascular medications
• Investigations

requested
• Documented patient education, advice, or discussion of care plan

Results 100 patients were included in the cohort. The median age was 68, and patients were predominantly male (80%) with HFrEF (78%). There was a total of 666 appointments over the 3 years of follow up. Patients had a median of 2 appointments per year (Figure 1). Figure 2 shows the frequency of investigations, symptoms and clinician actions in appointments. 21% of appointments documented new or worsening HF or treatment-related symptoms, and cardiovascular therapy was changed in 36% of appointments, ranging from 55% of nurse-led appointments to 31% where the patient saw a junior doctor. Therapy change was more common in appointments when there was a change in symptoms (53% vs 31%, $p < 0.001$). 41% of patients had no documented worsening in HF symptoms throughout the entire 3 year follow up period. Patient education or clinical advice was documented in 32% of appointments. Follow-up duration was shorter following a change in symptoms (127 vs 163 days, $p = 0.03$) and therapy change (128 vs 170 days, $p = 0.03$). 45% of appointments had no documented worsening HF symptoms, change in cardiovascular therapy, specialist referral or specialist test (excluding echocardiography and phlebotomy); we consider these to be 'routine' follow-up appointments.

Conclusion Most HF patients were seen in a specialist HF clinic at least 6-monthly, but worsening symptoms and therapy change at the time of consultation were uncommon. Investigations other than phlebotomy and echocardiography, which may be performed outside of specialist centres, were rarely

Frequency distribution of appointments

Abstract 136 Figure 1

Activity in HF appointments

Abstract 136 Figure 2