**University of Leicester**

British Heart Foundation Centre of Research Excellence

PhD studentship

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**Section 2 – *Project Information***

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| **Project Title** | Development and implementation of cardiac diffusion tensor imaging in patients with or at risk of developing heart failure |
| **Project Summary** | |
| Heart failure (HF) costs the NHS an estimated £2 billion annually, which constitutes about 2% of the total NHS budget. HF with preserved ejection fraction (HFpEF) is the dominant form(1), and is thought to be a systemic disorder with phenotypic variants linked to co-morbidities, including obesity and type 2 diabetes (T2D)(2). In HFpEF, the prognosis is poor, and treatment options are limited(3). The pathophysiology of HFpEF is incompletely understood. HF is the most common and deadliest complication of T2D(4). Aortic stenosis (AS) is the most common valve disease requiring intervention in the UK. The pressure overload caused by the narrowed valve results in adverse remodelling, characterised by LV hypertrophy, diastolic dysfunction and myocardial fibrosis(5). People with diabetes and AS are at increased risk of HF and have increased concentric remodelling which is similar to that seen in HFpEF.  In this project, the student will aim to establish a translational research programme centred on the development and clinical application of cardiac diffusion tensor imaging (DTI) to investigate myocardial microstructure in cardiometabolic and valvular heart disease. Diffusion MRI provides a unique window into myocardial fibre architecture, with the potential to detect subtle microstructural changes that precede conventional markers of disease(6). Cardiac DTI enables diffusion encoding with user-defined second-order motion-compensated gradient waveforms. Diffusion metrics such as fractional anisotropy (FA), mean diffusivity (MD), helix angle (HA) and the secondary eigenvector angle (E2A) can be calculated(7-9).  The student will receive training in DTI, as well as post-processing using AI techniques, and will be involved in establishing and optimising cardiac DTI in Leicester under the supervision of Dr Afzali. Once established, test-retest reproducibility will be assessed in healthy volunteers, before application to patient groups (T2D and AS). DTI measures will be correlated to other imaging, clinical and exercise parameters in ongoing studies with extensive phenotyping.  The PhD student will be supervised by a multi-disciplinary group of supervisors with expertise in DTI, cardiac MRI, clinical Cardiology and engineering/AI, and also supported by the wider cardiovascular imaging group, including research radiographers to assist with image acquisition and clinical research fellows working in diabetes/heart failure and aortic stenosis. | |
| **References** | |
| 1. Upadhya B, Kitzman DW. Heart failure with preserved ejection fraction: New approaches to diagnosis and management. Clin Cardiol. 2020;43(2):145-55.  2. Shah SJ, Kitzman DW, Borlaug BA, van Heerebeek L, Zile MR, Kass DA, et al. Phenotype-Specific Treatment of Heart Failure With Preserved Ejection Fraction: A Multiorgan Roadmap. Circulation. 2016;134(1):73-90.  3. Savarese G, Lund LH. Global Public Health Burden of Heart Failure. Card Fail Rev. 2017;3(1):7-11.  4. HQIP. National Diabetes Audit, 2017-18. Report 2a: Complications and Mortality. Heatlhcare Quality Improvement Partnership; 2018.  5. Dweck MR, Boon NA, Newby DE. Calcific aortic stenosis: a disease of the valve and the myocardium. Journal of the American College of Cardiology. 2012;60(19):1854-63.  6. Sosnovik DE, Wang R, Dai G, Reese TG, Wedeen VJ. Diffusion MR tractography of the heart. Journal of cardiovascular magnetic resonance : official journal of the Society for Cardiovascular Magnetic Resonance. 2009;11(1):47.  7. Basser PJ, Pierpaoli C. Microstructural and physiological features of tissues elucidated by quantitative-diffusion-tensor MRI. 1996. J Magn Reson. 2011;213(2):560-70.  8. Scollan DF, Holmes A, Winslow R, Forder J. Histological validation of myocardial microstructure obtained from diffusion tensor magnetic resonance imaging. Am J Physiol. 1998;275(6):H2308-18.  9. Nielles-Vallespin S, Khalique Z, Ferreira PF, de Silva R, Scott AD, Kilner P, et al. Assessment of Myocardial Microstructural Dynamics by In Vivo Diffusion Tensor Cardiac Magnetic Resonance. Journal of the American College of Cardiology. 2017;69(6):661-76. | |
| **Specific entry requirements**  Applicants should have, or expect to achieve, at least a 2:1 Honours degree (or overseas equivalent) in a relevant discipline (e.g. Biomedical Sciences, Physics, Engineering, Mathematics, Computer Sciences, Medical Imaging). A relevant Master’s degree and prior experience in AI/ML techniques, bioinformatics, computer vision and biomedical engineering would be advantageous.  Standard University of Leicester English language requirements | |