HEALTHIER CMR PHENOTYPES ARE LINKED TO FAVOURABLE BRAIN MRI STRUCTURE AND FUNCTION METRICS IN THE UK BIOBANK

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Background Existing work, using indirect health measures, suggests independent links between brain and heart health within disease cohorts. We studied the links between MRI-derived heart and brain structure and function in the UK Biobank population-based cohort.

Methods Image acquisition and analysis was according to pre-defined protocols. We included the following cardiovascular metrics: left ventricular (LV) stroke volume (LVSV), LV global functional index (LVGFI), LV mass to LV end-diastolic volume ratio (LVM: LVEDV), global longitudinal strain (GLS), left atrial ejection fraction (LAEF), aortic distensibility (AoD). T1 and T2 structural images were used to determine overall brain volume, volume of white matter hyperintensities, and volumes of several subcortical structures. We considered microscopic features of white matter integrity assessed using diffusion tensor imaging (DTI) and neurite orientation dispersion and density imaging (NODDI), across a range of white matter fibre tracts. Associations between heart and brain measures were computed using standardised betas from multivariable linear regression models, adjusted for age, sex, deprivation, obesity, education level, alcohol consumption, diabetes, hypertension, high cholesterol, smoking, physical activity, systolic blood pressure, total cholesterol, and glycosylated haemoglobin.

Results We studied 30,373 participants; average age was 63 ± 7.5 years-old; 52% were women. Adverse cardiovascular phenotypes across all metrics were associated with larger volume of white matter hyperintensities (e.g., LV GFI: Beta = -0.049; 95% CI = [-0.060, -0.039]; p-value = 3.82×10^{-20}). Higher LVSV (Beta = 0.031; 95% CI = [0.022, 0.039]; p-value = 1.57×10^{-12}) and greater AoD (Beta = 0.027; 95% CI = [0.016, 0.039]; p-value = 5.76×10^{-6}) were associated with larger total grey matter volumes. Higher LV GFI, higher LAEF, and higher AoD were associated with healthier white matter microstructure as per higher neurite density and stronger myelin

membranes (e.g., fractional anisotropy with LV GFI: Beta= 0.052; 95% CI= [0.040, 0.064]; p-value= 1.79×10^{-17}). Healthy white matter microstructure was associated with less concentric LV hypertrophy (LVM: LVEDV: Beta= -0.051; 95% CI= [-0.064, -0.038]; p-value= 2.94×10^{-15}) and better GLS (Beta= -0.032; 95% CI= [-0.044, -0.019]; p-value= 4.89×10^{-7}).

Conclusion In this large population cohort, we demonstrate independent links between heart and brain health using detailed MRI. Participants with healthier hearts had significantly less brain atrophy, less brain microvascular injury, and healthier neuronal structure.

7 PREDICTORS OF MYOCARDIAL FIBROSIS AND RESPONSE TO ANTI-FIBROTIC THERAPY IN HEART FAILURE WITH PRESERVED EJECTION FRACTION

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Objectives To identify baseline characteristics that associate with baseline myocardial fibrotic burden, predict change in myocardial fibrosis over a year, and predict response to the novel anti-fibrotic agent, pirfenidone, in patients with heart failure with preserved ejection fraction (HFpEF).

Background Myocardial fibrosis, measured using cardiovascular magnetic resonance extracellular volume (ECV), is associated with adverse outcome in HFpEF. In the PIROUETTE (The Pirfenidone in Patients with Heart Failure and Preserved Left Ventricular Ejection Fraction) trial, pirfenidone reduced myocardial fibrosis.

Methods Amongst patients enrolled in the PIROUETTE trial (n=107), linear regression models were used to assess the relationship between baseline variables and baseline myocardial ECV, and with change in myocardial ECV (week 52 value

minus baseline value), adjusting for treatment allocation. Linear regression models were used to identify baseline variables that modified pirfenidone treatment effect.

Results Body mass index, left atrial reservoir strain, haemoglobin and aortic distensibility were associated with baseline ECV in stepwise modelling (table 1). QRS duration, left ventricular mass and presence of an infarct at baseline were associated with an increase in ECV from baseline to week 52 in stepwise modelling. Whilst QRS duration, presence of an infarct, global longitudinal strain and left atrial strain modified the treatment effect of pirfenidone when considered individually, no baseline variable modified treatment effect on multivariable modelling.

Conclusions Baseline characteristics were identified that associate with myocardial fibrosis and can predict change in myocardial fibrosis over 1 year. No variables that independently modify the treatment effect of pirfenidone were identified (PIROUETTE, NCT02932566).

8 INTELLIGENT LOCALISERS: AN INTEGRATED TIME-SAVING DEEP LEARNING SOLUTION FOR THE PLANNING OF CINE IMAGING AND IDENTIFICATION OF UNEXPECTED FINDINGS FROM A SINGLE TRANSAXIAL STACK

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Background CMR scans typically begin with a transaxial stack for anatomical evaluation, but current strategies require (1) additional localiser images for cine planning and (2) expert staff present to identify unexpected findings and adjust protocols for maximum yield.

We present an integrated deep learning solution to (1) automate scan plane prescription without need for localisers and (2) identify important protocol-changing findings at the earliest stages of the scan.

Methods Task 1: We trained a neural network on 1,300 CMR transaxial stacks to identify the spatial co-ordinates of the cardiac apex and the 6 locations on the mitral annulus corresponding to 2-, 3-, and 4-chamber views. By identifying these points, the network proposed long-axis scanning planes, which were compared with a gold-standard of experienced radiographers who had access to the full conventional range of localiser images. 130 scans were used as a testing set.

Task 2: We trained a neural network on 1,500 transaxial stack slices to perform automated segmentation of important cardiac structures, great vessels, and other pathologies. The system assembled a 3D model of the thorax from which it made clinical measurements which were compared to those

Abstract 7 Table 1 Associations between selected patient characteristics and myocardial extracellular volume (ECV) at baseline

Baseline Covariate	Univariable Model			Multivariable Model		
	β -coefficient	95% CI	P-value	β -coefficient	95% CI	P-value
BMI - kg/m ²	-0.18 (0.05)	-0.28 to -0.08	<0.001	-0.19 (0.05)	-0.29 to -0.10	<0.001
Haemoglobin - g/dL	-0.49 (0.20)	-0.89 to -0.09	0.02	-0.69 (0.18)	-1.05 to -0.34	<0.001
LA strain (reservoir) -%	-0.13 (0.04)	-0.20 to -0.06	<0.001	-0.11 (0.04)	-0.20 to -0.03	0.01
Aortic distensibility - 10 ⁻³ /mmHg	0.43 (0.35)	-0.27 to 1.13	0.22	0.69 (0.29)	0.11 to 1.27	0.02

BMI - body mass index; CI - confidence interval; LA - left atrial.