The Development of a Cardiac Magnetic Resonance Database to Understand the Etiology of Cardiomyopathy Using Novel Biomechanical Biomarkers

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We seek to develop a large comprehensive database of cardiac magnetic resonance (CMR) studies that can be used to expand and validate our understanding of myocardial tissue properties and functional decline in patients with cardiovascular disease. Subjects included in the study have had CMR imaging performed with gadolinium-based contrast-enhanced images. The database contains a collection of medical history/patient outcomes and comprehensive image analyses on CMR sequences, and will serve a multitude of projects that are currently under development.

Cardiac magnetic resonance (CMR) imaging is considered the gold-standard for evaluating myocardial function and tissue characterization due to its superior special resolution and lack of radiation (1). With the recent development of novel AI-driven biomechanical models (2), the marriage of superior imaging to 3D models has the potential to expand and validate our understanding of myocardial tissue properties and functional decline in patients with cardiovascular disease. We seek to develop a large comprehensive database of CMR studies that can be used for this purpose.

The database under development consists of subjects who were prospectively recruited for research at St. Francis Hospital & Heart Center (Roslyn, New York) and consented to have CMR performed with gadolinium-based contrast-enhanced images included. This imaging technique supplements the diagnosis and identification of conditions including myocardial viability, cardiomyopathy, myocarditis, and other infiltrative myocardial processes by visualizing fibrotic scar tissue after the injection of contrast material (3). The database includes past medical history, echocardiogram results, clinical outcomes, and quantitative image measurements.

A team of scientists including physicians, fellows, epidemiologists, and volunteers (including the author of this report) are involved in two phases: first by conducting extensive reviews of patient charts over several databases to collect medical history/patient outcomes, and second through comprehensive image analyses on CMR sequences. Image analysis was performed using proprietary software (SuiteHEART v5.1, NeoSoft, LLC, Pewaukee, WI) and consisted of measuring volumetric and functional variables on steady-state free precession cine sequences, the quantity of fibrotic scar tissue on delayed enhancement images, and the quantity and velocity of blood flow through the major vessels using phase contrast images. This database will serve a multitude of projects that are currently under development.

Among 2771 subjects included, 2091 subjects with phase-contrast imaging available will be used to validate an AI-enabled model that estimates pulmonary artery pressure (used to diagnose pulmonary hypertension) in an attempt to provide an imaging-based approach to one that is normally measured invasively (4). An additional 680 subjects who underwent cardiac catheterization within 24 hours of their CMR and had invasive cardiac chamber pressures measured will be used in conjunction with novel 3D biomechanical models provided by the University of Auckland to better understand the mechanical effects of myocardial deformation in various disease groups.

Of particular interest, we hope to link biomarkers extracted from these 3D biomechanical models to patient outcomes to better understand the etiology specific disease groups including heart failure patients with preserved/reduced ejection fractions (5). We also hope to utilize 3D echocardiography (6) to take advantage of the superior temporal resolution provided by echocardiograms in a multi-modality framework.

In conclusion, our multi-faceted database development project will provide scientists with necessary data to advance understanding of the etiology of cardiomyopathy.

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Iliana Mouhlas (she/her) is a second-year student at Villanova University. She recently declared a biochemistry major and health humanities and the medical arts minor, and is a member of MEDLIFE club, Pre-medical club, Hellenic Student Association, Villanova Society for Biochemistry and Molecular Biology, and more. She is from Long Island, NY, and wants to pursue a medical degree in the future. Iliana is passionate about learning and experiencing many different fields of medicine. She is new to research and wants to continue her newfound interest during her time at Villanova.

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Jonathan Weber (he/him) is an epidemiologist and clinical research manager at St. Francis Hospital & Heart Center (Roslyn, NY). He works primarily in the Division of Cardiac Imaging alongside physician-scientists who examine imaging-based biomarkers in order to better understand the etiology and mechanisms behind progression of heart failure and other cardiac conditions. Jonathan is also interested in the impact of environmental exposures on chronic diseases and is currently pursuing a PhD in Environmental & Planetary Health at the CUNY School of Public Health & Health Policy.