BHF Centre/ElectroCardioMaths Multidisciplinary Programme Symposium (7th July 2011):
THE ELECTROMECHANICS OF HEART MUSCLE: CONDUCTION AND ARRHYTHMOGENESIS
Lecture Theatre G34, Sir Alexander Fleming Building, South Kensington Campus

0900-0915 Opening remarks
Prof Nicholas Peters, Professor of Cardiology & Associate Director of BHF Programme, NHLI

Session 1: Mathematical modeling of cardiac electrophysiology

0915-0935 Novel insights from a 1D model of cardiac impulse propagation
Dr Jennifer Siggers, Lecturer, Dept of Bioengineering

0935-0955 High-performance modelling of atrial electrophysiology using high-order methods
Prof Spencer Sherwin, Professor of Computational Fluid Mechanics & Associate Director of BHF Programme, Dept of Aeronautics

0955-1015 2D Lattice Models for the Activation Wavefront in Myocardial Tissue and Restitution, hysteresis and excitation-contraction coupling in rat myocardium
Caroline Roney, BHF Programme MRes Student, Dept of Bioengineering and NHLI

1015-1045 Coffee break

Session 2: Experimental models of arrhythmias

1045-1105 Modification of post-infarction arrhythmic substrate by gap junction modulation
Dr Fu Siong Ng, MRC Clinical Research Fellow, Cardiac Electrophysiology, NHLI

1105-1125 Electrical and structural remodelling in a goat model of AF - investigating the second factor
Rasheda Chowdhury, Research Assistant, Cardiac Electrophysiology, NHLI

1125-1145 Ultrastructural reverse remodelling of chronically failing hearts using SERCA2a gene therapy
Dr Alexander Lyon, NIHR Clinical Lecturer, NHLI

Keynote speaker 1:

1145-1230 MRI-Based Modeling of Cardiac Electrophysiology and Electromechanics
Prof Natalia Trayanova, Professor of Bioengineering, Johns Hopkins University

1230-1330 Lunch break

Session 3: Imaging of arrhythmia substrates

1330-1350 Cardiac motion tracking and segmentation using multiple modalities
Dr Wenzhe Shi, Dept of Computing

1350-1410 Automated analysis of post-ablation atrial enhancement using delayed-enhanced cMRI
Dr Louisa Malcolm-Lawes, BHF Clinical Research Fellow, Cardiac Electrophysiology, NHLI

1410-1430 Correlation of the Late Gadolinium-Enhanced MR image and the Voltage Map after Radio-Frequency Ablation
Dr Wenjia Bai, BHF Programme Post-doctoral Research Associate, Dept of Computing and NHLI

1430-1450 Maximizing information from electrogram content
Dr Shahnaz Jamil-Copley, BHF Clinical Research Fellow, Cardiac Electrophysiology, NHLI

1450-1515 Coffee break

Keynote speaker 2:

1515-1600 Molecular and functional remodeling of the failing human heart
Prof Igor Efimov, Professor of Bioengineering, Washington University in St. Louis

1600-1615 Closing remarks
Prof Nicholas Peters, Professor of Cardiology & Associate Director of BHF Programme, NHLI
Keynote speaker 1:

Natalia Trayanova, Ph.D.
Professor, Department of Biomedical Engineering and Institute for Computational Medicine, Johns Hopkins University, Baltimore, MD, USA

MRI-Based Modeling of Cardiac Electrophysiology and Electromechanics

Abstract:

Simulating cardiac electromechanical function is one of the most striking examples of a successful integrative multi-scale modeling approach applied to a living system directly relevant to human disease. Today, after nearly fifty years of research in the field and the rapid progress of high-performance computing, we stand at the threshold of a new era: anatomically-detailed tomographically-reconstructed models that integrate from the ion channel or sarcomere to the electromechanical interactions in the intact heart are being developed. Such models hold high promise for interpretation of clinical and physiological measurements in terms of cellular mechanisms; for improving the basic understanding of the mechanisms of dysfunction in disease conditions, such as reentrant arrhythmias, myocardial ischemia, and heart failure; and for the development and performance optimization of medical devices. Attempt is made to extend these models beyond electromechanics and include regulatory processes such as energy metabolism. Here we provide specific examples of the state-of-the-art in cardiac integrative modeling, including 1) improving ventricular ablation procedure by using MRI reconstructed heart geometry and structure to investigate the reentrant circuits formed in the presence of an infarct scar; 2) employing an electromechanical model of the heart to determine the mechanisms for electromechanical delay in heart failure; and 3) understanding the origin of alternans in heart failure.

Keynote speaker 2:

Igor R. Efimov, Ph.D.
The Lucy and Stanley Lopata Distinguished Professor of Biomedical Engineering, Professor of Cell Biology & Physiology, Professor of Radiology, Washington University in St. Louis, MO, USA

Molecular and functional remodeling of the failing human heart

Abstract:

The existing paradigm of electromechanical remodeling during heart failure is based upon numerous animal models, which have been studied over the years to ascertain the pattern and molecular basis of electrical activation under normal and pathological conditions. However, clinical relevance of these findings is yet to be determined due to significant interspecies difference. In collaboration with cardiac transplantation and cardiology programs at Washington University School of Medicine, we have developed an experimental program, which has acquired and studied in vitro 131 live human hearts as of today, 41% of which are donor hearts rejected from transplantation and 59% are explanted failing hearts. Using optical imaging we have investigated excitation in the normal and failing human hearts in specific anatomical structures: sinus node, atria-ventricular node, atria and ventricles. Using low- and high-density arrays we have investigated mRNA expression and remodeling in these structures during ischemic and non-ischemic cardiomyopathy. We further evaluated differences in gene expression between atria and ventricles, left ventricular endocardium and epicardium, males and females, and two age categories: 30 vs 60 year olds. Conclusions: Our data provide for the first time the quantitative basis for molecular and functional modeling of the human heart at the tissue and organ levels. Our data indicate that caution must be exercised during the translation of findings in the animal models to clinic.