Stem cells and mathematical models: The future of medical research

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Human induced pluripotent stem cells (hiPSCs), which can be differentiated into cardiac myocytes, are used in a wide variety of applications such as developing patient-specific disease models, or the

evaluation of novel therapeutic compounds for treatment of certain cardiac diseases. The integration of these cell model systems into laboratories, like those at the Masonic Medical Research Institute (MMRI), have helped revolutionize the current and future state of medical research efforts. Dr. Jonathan Cordeiro, Research Assistant Professor at the MMRI, has been utilizing hiPSCs in his electrophysiology work since 2012. In a recently published manuscript, Dr. Cordeiro used hiPSC cardiomyocytes to investigate cardiac arrythmias, or irregular heartbeats, to create a scientific model to understand the mechanisms for how these anomalies occur. "iPSCs are a great model for studying disease because they can be created in large quantities and are specific to humans. Their introduction to biomedical research has truly been a game changer in the way we do science," said Dr. Cordeiro.

As part of a project to determine the effectiveness and safety of new pharmaceutical compounds on the heart, Dr. Cordeiro collaborated with researchers from Norfolk State University (NSU) to differentiate these cells to cardiomyocytes (heart cells) and develop mathematical tools to better evaluate cellular response to drug treatment. By understanding how drugs alter ion channels and action potentials, scientists like Dr. Cordeiro can determine which drugs have the greatest efficacy with the least adverse effects. "Essentially, we are using math to help improve treatments for disease," said Dr. Makarand Deo, Associate Professor in the Department of Engineering at NSU. Experiments are founded upon the precision and effectiveness of the scientific models in use, very few of which incorporate hiPSCs. Due to hiPSCs originating from human cells, this model offers a more direct and accurate way to predict exactly how a new therapy will affect the patient.

The manuscript was published online in *Frontiers in Physiology* on June 16, 2021. It is an extension of previous research conducted with collaborators at the U.S. Department of Health and Human Services.

Additional authors include Akwasi Akwaboah, Bright Tsevi, and Pascal Yamlome from the Department of Engineering at NSU, and Maila Brucal-Hallare from the Department of Mathematics at NSU. The paper, "An in silico hiPSC-Derived Cardiomyocyte Model Built with Genetic Algorithm," can be accessed by visiting frontiersin.org/articles/10.3389/fphys.2021.675867/full.

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