STARS Presentation Abstract
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"Oxygen Supply and Demand: The Human Vasculature's Impressive Matching Abilities"

Most people understand that oxygen is a vital element for the survival of cells, tissues, and the human body as a whole. In order to distribute oxygen efficiently and effectively, the cardiovascular system integrates multiple signal inputs and outputs to appropriately match oxygen supply, in the form of blood flow, to oxygen demand. This "metabolic autoregulation" has been known for some time; however, many people might be surprised to find out the specific mechanisms by which autoregulation occurs are still being discovered.

For many vascular responses, redundant mechanisms provide an experimental challenge to determining what role various pathways play. Yet this challenge has not stopped our efforts of understanding, in part because in many disease conditions and with the normal course of human aging, the precise matching of oxygen delivery to oxygen demand is impaired. Compromised vascular functioning contributes to the overall burden of cardiovascular diseases, a leading cause of morbidity and mortality, as well as a significant economic burden to our country.

Throughout my graduate training and now at the University of Dayton, I have studied the various ways in which the human body is able to respond to a variety of stressors in order to appropriately match oxygen delivery to oxygen demand. Muscle contractions, low oxygen (hypoxic) exposure, nervous system engagement and the combination of these stressors provide challenges to cardiovascular function that can be studied in young, healthy individuals as well as aged or diseased populations. Utilizing both invasive and non-invasive methods, specific signaling pathways have been elucidated that contribute to our understanding of these basic responses. We have primarily used the forearm as a functional model as a way to provide a high level of experimental control and prevent whole-body reflex responses from confounding our findings. However, strong evidence exists that links the functioning of blood vessels in the forearm and those in the heart and throughout the rest of the body.

Specifically, my work has involved various factors that the endothelium, the inner-most lining of the blood vessel, regulates and contributes in order to achieve metabolic autoregulation. We have examined the pathways that are disrupted with age and what interventions may reverse these impairments. Most recently, here at UD, we are determining how acute exposure to certain stresses such as low-oxygen exposure and sugar-sweetened beverage consumption can acutely impair vascular function.

The bulk of my experiences are in clinical-based human research; however, given the integrative nature of these responses, the experiments involved draw upon knowledge of animal physiology, fluid dynamics, physics, and electrophysiology to be performed. In addition, the implications of this research could have significant financial ramifications in terms of cost of care for related disease states such as obstructive sleep apnea and hypertension. Our studies provide important foundational knowledge from which we are able to expand our knowledge of human physiology in both health and disease.