Title: Effects of Intradialytic Exercise on Resilience to Hemodialysis-Induced Cardiac Injury: A Case Study

Trainee Name: Lisa Hur

Supervisor(s): Dr. Christopher McIntyre

Structured Abstract:

Introduction: Hemodialysis (HD) is a dominant form of renal replacement therapy in patients diagnosed with end-stage kidney disease. However, despite being a life-saving therapy, HD is associated with high rates of cardiovascular mortality resulting from recurrent cardiac ischemia-reperfusion injury during each HD treatment session. Exercise during HD has been shown to improve intradialytic hemodynamic tolerability, although its mechanisms remain elusive. The objective of the present study was to use intradialytic CT perfusion imaging and echocardiography to noninvasively evaluate cardiac injury during HD with and without exercise. Participants are being actively recruited in this ongoing study and preliminary results from a single participant are presented.

Methods: The participant underwent a total of two intradialytic imaging sessions over two study visits. During the first study visit, a baseline dynamic contrast-enhanced CT scan (Revolution CT, GE) was conducted prior to dialysis treatment, followed by a peak stress scan at 225 minutes into HD treatment, and a final scan post-HD. Following each CT scan, apical 4 and 2-chamber views of the heart were acquired via bedside 2D echocardiography (Vivid Q, GE). During the second study visit, patients were asked to cycle on a stationary ergometer during the first 30 minutes of HD treatment. Following the same protocol as the first visit, three sets of CT and echocardiography images were acquired. The dynamic CT images were analyzed using the Johnson-Wilson-Lee tracer kinetic model, from which myocardial perfusion (MP) maps were generated. Segmental MP were quantified and compared across the three timepoints. Systolic function was evaluated by measuring segmental longitudinal strain (i.e., cardiac contractile function) using a commercially available software (EchoPAC, GE), with myocardial segments demonstrating >30% reduction in longitudinal strain (compared to pre-HD) defined as regional wall motion abnormalities (RWMA).

Results: Currently, one patient has completed both study visits. During the first visit, left ventricular MP dropped from pre-HD to peak stress (74.8 ml/min/100g to 63.4 ml/min/100g, respectively), followed by recovery post-HD (72.1 ml/min/100g). In comparison, during the second visit, while the pre-HD and peak stress MP values were similar to that of the first visit, a recovery in MP post-HD was not observed with intradialytic exercise (51.6 ml/min/100g). However, fewer RWMAs at peak stress were observed with intradialytic exercise compared to no exercise (2 vs. 3 myocardial segments, respectively).

Discussion: These preliminary results suggest that intradialytic exercise may increase cardiac resilience to HD-induced cardiac injury by ischemic preconditioning-like mechanisms. Future work will include investigating the association between arrhythmic events (detected using an implantable loop recorder) and both coronary artery disease and intradialytic perfusion heterogeneity.