Australia-China Centre for Tissue Engineering and Regenerative Medicine

Analysis of Emboli Transport Behaviour to Evaluate Aortic Cannula Design in a Multi-Patient Numerical Study during Cardiopulmonary Bypass

Mr Raymond Ho

PhD Candidate

Queensland University of Technology

WHEN: Wednesday April 13, 2022

TIME: 10 am – 12:00 noon (AEST UTC+10)

LOCATION:

In Person - KG-Q430

Online via ZOOM

Click Here for Link

ZOOM: Meeting ID: 870 4460 1481

Password: 477459

SPEAKER'S BIO:

Raymond is a self-employed chartered engineer working full time in industrial fluid power, mechanical design, verification, and validation of machinery. He has worked on projects in Europe, Asia, and the USA. He completed a Bachelor of Engineering in 1999 at the University of Technology Sydney and a Master of Engineering Science in 2015 at the University of Southern Queensland with final year projects in designing a robotic arm and 3D printed robotic fingertips. His interests are in philosophy, travel and classical motorcars and motorbikes.

Australia-China Centre for Tissue Engineering and Regenerative Medicine

ABSTRACT:

Cardiovascular disease (CVD) is the leading cause of mortality in Australia. Surgical intervention is often required to reduce death and uses cardiopulmonary bypass (CPB) to replace the heart and lungs temporarily during surgery. However, a surprising and frequent complication is brain injury while undergoing CPB. Clinical CPB studies have demonstrated that a common pathology is cerebral ischemia due to mobilised arterial particles called emboli, yet very little is known of its behaviour. This thesis analysed gaseous and solid emboli transport and investigated the CPB aortic cannula, commonly implicated with emboli generation. This study used numerical simulations and physical fluid experiments to assess several essential CPB variables. The results found that emboli morphology, CPB flow rate, blood viscosity, aortic cannula position and patient orientation affected emboli movement. Based on these variables, a novel aortic cannula was designed and compared to a standard cannula in a 20-patient computational study to determine cannula effectiveness. The novel cannula delivered a lower cerebral emboli load in 10 common and 10 bovine (1 in 5 human variant) aortas. The numerical model was verified using a grid convergence index approach, and the mathematical model was validated using a laser-based particle image velocimetry system. This thesis's contribution provides a better understanding of emboli behaviour during CPB supported cardiac surgery and offers a novel method to assess aortic cannula effectiveness; and highlights the importance of critical CPB variables and different aorta geometry. The study's findings can assist clinicians in better managing emboli fate to reduce the embolic load that may assist in minimising emboli related cerebral injury remained unexplored.