Thematic Issue Proposal for: The Open Biomedical Engineering Journal

(The thematic issues are peer-reviewed and may contain review articles, research articles, letters)

Title : "The advantages and drawbacks of pulsatile flow versus non-pulsatile flow for extra-corporeal circulation during cardiac surgery"

Lead Guest Editor: Prof. Christophe Baufreton
Guest Editors: Dr Olivier Fouquet, Dr Agnès Drochon

Position of the problem

CardioPulmonary Bypass is a technique that temporarily takes over the function of the heart and lungs during surgery, maintaining the circulation of blood and the oxygen content of the patient's body. The machine pumps the blood and using an oxygenator, allows red blood cells to take oxygen, and release carbon dioxide.
This technique has been used since 1953, but a controversy still exists about the flow conditions of blood: is pulsatile flow necessary or not? This controversy is due in part to the difficulty to quantify pulsatile flow in the circulation, to observe it in the microcirculation, to compare the studies (experiments, simulations, animals, humans,).

A majority of studies claim that pulsatile flow is more physiologic, provides better tissue perfusion, causes less complement activation when compared with non-pulsatile perfusion, significantly reduces systemic inflammation during and after CPB, and enhances gas exchange within the oxygenator membrane. The implementation of pulsatile flow may lead to improved patient outcomes in high-risk cardiac surgical procedures requiring prolonged CPB time. On the contrary, non-pulsatile cardiopulmonary bypass induces a progressive increase in systemic vascular resistance, potentially compromising microcirculatory and organ perfusion. It is associated with increased leukocyte activation, and other problems (clotting, renal function, lymphatic,…).
Other groups have some arguments against the use of pulsatile pumps: practical difficulties, cost, higher maximal velocities, flow rates and shear stresses at the wall (with potential ruptures of atherosclerotic plaques or hemolysis). Some people say that increasing the continuous flow rate will provide the same effect as working with pulsatile flow.
And some publications conclude that they cannot demonstrate any difference between pulsatile and non-pulsatile CPB.

It thus seems that the debate remains open: can the artificial pulse keep capillary beds open and cell metabolism stabilized during acute or chronic cardiac support? does artificial pulsatility propagate to the microcirculation ? how are the pulsatile signals delivered by the pumps dampened in the membrane oxygenators and arterial cannula? … how to describe a pulse waveform (frequency?, amplitude?, rise time?, decay time?, mean pressure or flow? …)? which methodologies would enable direct observation of the microcirculation during acute and chronic cardiac support? What is the exact physical meaning of criteria that are commonly used to quantify pulsatility (such as energy equivalent pressure (EEP) and surplus hemodynamic energy (SHE))? It is hoped that such a thematic issue will contribute to provide some answers to all these questions.
One of the papers of this Issue could even be devoted to a close question: on-pump cardiac surgery versus off-pump cardiac surgery? Which technique may be preferred? When? Why?

Schedule

Manuscript submission deadline: 15 August 2020
Peer Review due: 15 September 2020
Revision due: 15 October 2020

Notification of acceptance by the Guest Editors: 15 November 2020

Final manuscripts due: 15 December 2020

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