

## **Investigating the Mechanism of Intravascular Bubble Formation in Designed Arrays of Vascularized Systems on a Chip**

Dan Nicolau<sup>1</sup>

Karine Baasirri

<sup>1</sup> McGill University

Vascular gas embolism is a rare medical condition, resulting from the existence of air or gas into the venous or arterial system. Gas embolism is associated with a wide range of circulatory, cardiovascular, and neurological complications that can lead to sudden and unexplained death. Despite the recent increase in related studies, gas embolism remains under-reported with a poor understanding of its genesis and pathophysiology. In this work, intravascular bubble formation is investigated in an array of biomimetic microscale systems, where the endogenous generation of gas bubbles is induced by variations in the surrounding pressure. Microfluidic devices, based on polydimethylsiloxane, are designed and fabricated as vascularized systems on a chip with one main channel at two different diameters (30  $\mu\text{m}$ , and 40  $\mu\text{m}$ ), surrounded by a pressure chamber (200  $\mu\text{m}$ ) on each side, at a separation of 50  $\mu\text{m}$ . Two blood-equivalent solutions, at 20% and 46% hematocrit level, are prepared from a Glycerin and Xanthan Gum mixture to mimic the circulatory system. As the volume of air injection increased, the events related to gas embolism were occurring at shorter timespans with more significant characteristics, i.e., length and number of bubbles. Additionally, correlations have been established between the input parameters, i.e., the vascular diameter and equivalent hematocrit concentration, and the output parameters, i.e., the bubble size, velocity, frequency, and nucleation sites. Clinical Relevance  $\square$  This constitutes a solid, reproducible observation and quantification of intravascular bubble formation induced by global pressure variations, where the emergence of bubbles exhibits different patterns depending on biological characteristics related to gender and medical history.