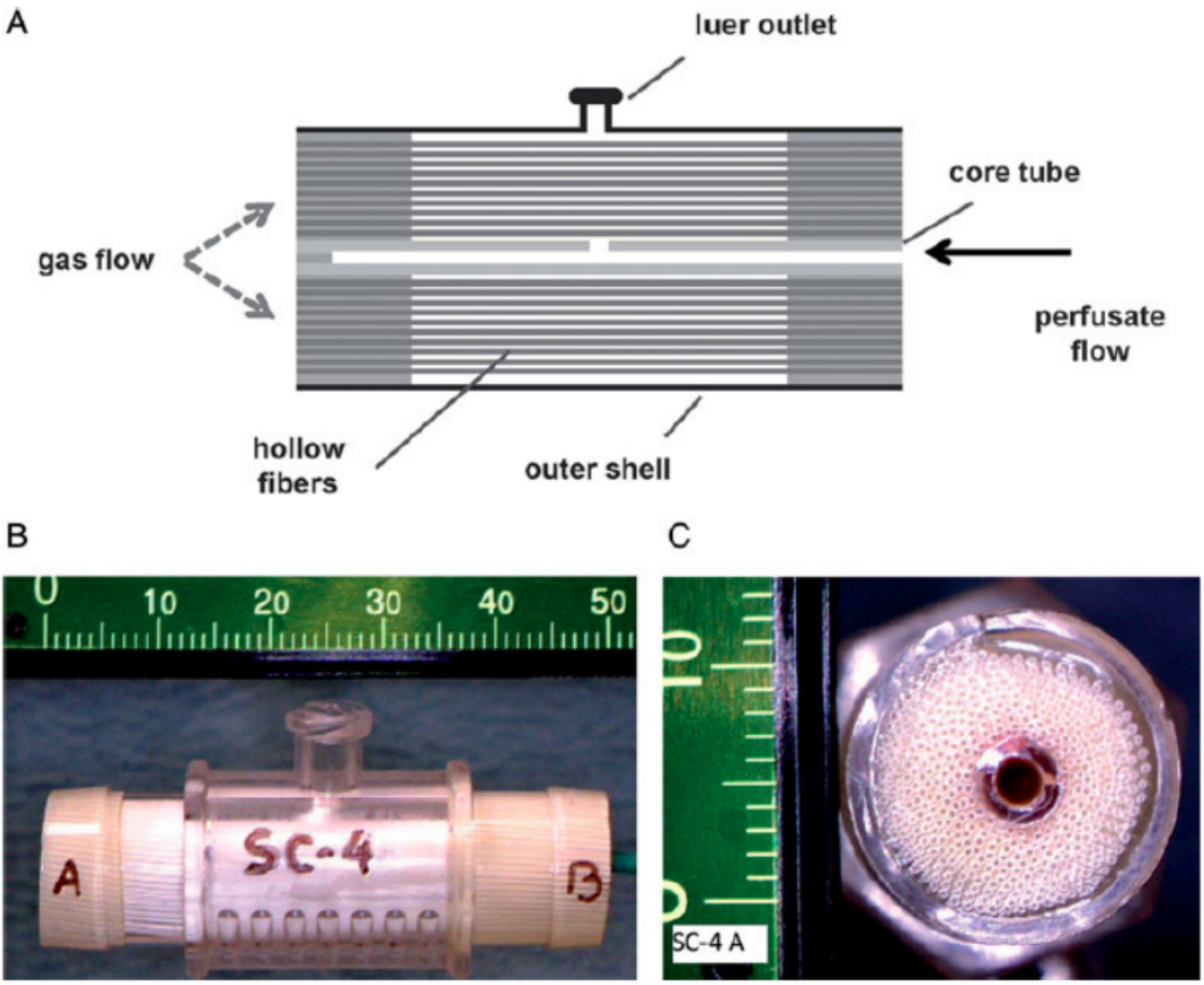
Oxygen-transfer performance of a new, very low-volume membrane oxygenator

During heart surgery, an external system (extracorporeal circulation) is often needed to replace the normal function of the heart and lungs to ensure blood circulation to the brain and all other organs. One key element of this external system is the membrane oxygenator. This component facilitates the uptake of oxygen by the blood in order to maintain an adequate supply for the entire body. Oxygenation of blood or other solutions is also required for many other applications in surgery and in research. Most researchers must use small experimental models, rather than large animals or humans, because they are easier to use and less expensive. For these situations, small oxygenators are required to match the small volumes of the system. Very few small oxygenators with suitable volumes (less than 2 milliliters (mL)) are available. Importantly, the oxygen transfer performance is rarely reported for these miniaturized oxygenators (mini-oxygenators).



As a result, their oxygen-transfer performance cannot easily be evaluated or used for comparison. In our recent publication, we report on a newly designed mini-oxygenator and investigate its oxygen-transfer performance. Our mini-oxygenator was designed with a central tube surrounded by porous hollow fibres oriented in a parallel manner (see Figure). This tube/fibre assembly was placed inside a hollow shell with a centrally located outlet, and all parts (central tube, fibres and outer shell) were sealed together at each end. With this design, the solution to be oxygenated enters the mini-oxygenator via the central tube, passes around the hollow fibres, and then exits via the outlet. Oxygen is passed through the inside of the hollow fibres, allowing its uptake by the blood (Panel A in Figure). The organization of the central tube and fibres can be seen in longitudinal and cross-sectional views (Panels B and C in Figure; scale in millimetres for both). A test circuit was used to analyze oxygen-transfer performance using blood and physiologic buffer. Twelve mini-oxygenators with an average priming volume of 1.5 mL were tested. With both blood and

physiologic buffer, oxygen transfer reached a maximum at a flow of 5 mL/min and decreased at higher flows up to 60 mL/min. Importantly, oxygen transfer capacity remained stable with blood perfusion over a period of at least 2 hours. In this work, we describe a method to reproducibly produce mini-oxygenators that possess a new design and very low volumes. We show that this new mini-oxygenator is able to effectively oxygenate blood and physiological buffer. Importantly, the level of oxygenation remains stable over time. We believe that our mini-oxygenator is ideal for research applications requiring oxygenation in low volume systems. Nonetheless, we are continuing our development of various aspects to further optimize oxygen-transfer performance.

Publication

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