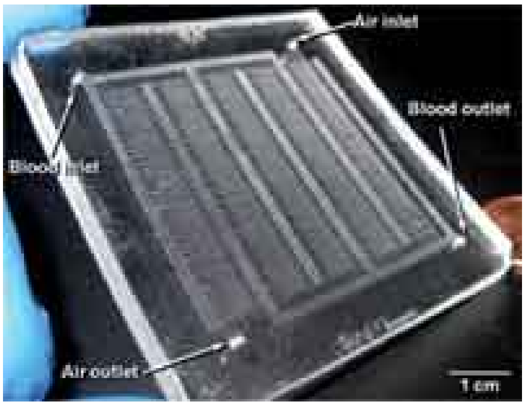
Artificial Lung Mimics Real Organ’s Design And Efficiency



Use in humans is still years away, but for the 200 million lung disease sufferers worldwide, the device is a major step toward creating an easily portable and implantable artificial lung, said Joe Potkay, a research assistant professor in electrical engineering and computer science at Case Western Reserve University. Potkay is the lead author of the paper describing the device and research, in the journal Lab on a Chip.

The scientists built the prototype device by following the natural lung’s design and tiny dimensions. The artificial lung is filled with breathable silicone rubber versions of blood vessels that branch down to a diameter less than one-fourth the diameter of human hair.

“Based on current device performance, we estimate that a unit that could be used in humans would be about 6 inches by 6 inches by 4 inches tall, or about the volume of the human lung. In addition, the device could be driven by the heart and would not require a mechanical pump,” Potkay said.

Current artificial lung systems require heavy tanks of oxygen, limiting their portability. Due to their inefficient oxygen exchange, they can be used only on patients at rest, and not while active. And, the lifetime of the system is measured in days.

The Cleveland researchers focused first on improving efficiency and portability. Potkay, who specializes in micro- and nano-technology, worked with Brian Cmolik, MD, an assistant clinical professor at Case Western Reserve School of Medicine and researcher at the Advanced Platform Technology Center and the Cardiothoracic Surgery department at the Louis Stokes Cleveland VA Medical Center.

Michael Magnetta and Abigail Vinson, biomedical engineers and third-year students at Case Western Reserve University School of Medicine, joined the team and helped develop the prototype during the past two years.

The researchers first built a mould with miniature features and then layered on a liquid silicone rubber that solidified into artificial capillaries and alveoli, and separated the air and blood channels with a gas diffusion membrane.

By making the parts on the same scale as the natural lung, the team was able to create a very large surface-area-to-volume ratio and shrink the distances for gas diffusion compared to the current state of the art. Tests using pig blood show oxygen exchange efficiency is three to five times better, which enables them to use plain air instead of pure oxygen as the ventilating gas.

Potkay's team is now collaborating with researchers from Case Western Reserve's departments of biomedical engineering and chemical engineering to develop a coating to prevent clogging in the narrow artificial capillaries and on construction techniques needed to build a durable artificial lung large enough to test in rodent models of lung disease.

Within a decade, the group expects to have human-scale artificial lungs in use in clinical trials.

They envision patients would tap into the devices while allowing their own diseased lungs to heal, or maybe implant one as a bridge while awaiting a lung transplant – a wait that lasts, on average, more than a year.

The research was funded by the U.S. Department of Veterans Affairs.