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Washington University surgeons successfully use artificial lung in toddler

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Two-year-old Owen Stark came to St. Louis Children's Hospital in the summer of 2010 near death from heart failure and dangerously high blood pressure in his lungs.

Washington University physicians and surgeons at St. Louis Children's Hospital knew they had to act fast to save his life. They collaborated to make several strategic and innovative decisions that led to the first successful use of an artificial lung in a toddler.

Their efforts are reported in the June 2011 issue of *The Journal of Thoracic and Cardiovascular Surgery.*

The artificial lung, made by Novalung of Germany, "breathes" outside the patient's body to add oxygen and remove carbon dioxide from the blood. It is approved only for adults and has been used to treat severe pulmonary infections or as a bridge to lung transplantation. The lung works without a pump, using the body's natural heartbeat to circulate blood.

Owen was transported to St. Louis Children's Hospital in full heart failure from abnormally high blood pressure in the lung's arteries. In this rare condition, called pulmonary hypertension, blood is prevented from entering the lungs because the arteries are too narrow. This causes the right side of the heart, which pumps blood through the lungs, to work harder than normal and become enlarged, which leads to heart failure.

Avihu Z. Gazit, MD, a Washington University pediatric critical care physician, was the first to treat Owen at St. Louis Children's Hospital. Initial tests showed that the right ventricle of Owen's heart was extremely large, compressing the left side of his heart and creating severe high blood pressure in the lungs, an often fatal condition with no known cause.

Typically, pulmonary hypertension is first treated with medication, Gazit says. However, Owen's condition was so severe that in addition to medication, he was placed on a ventilator in an attempt to force oxygen into his lungs. Physicians thought Owen may eventually need a lung transplant.

"We hoped the ventilator would allow us to get him well enough that he wouldn't need to be put on a heart-lung machine," Gazit says. "But 24 hours later, we knew that wouldn't be the case, and we had to make the decision to go forward with the heart-lung machine called ECMO (extracorporeal membrane oxygenation). We knew that his chances of survival were getting smaller and smaller."

ECMO gives the heart and lungs time to recover and respond to medical treatment prior to a lung transplant. However, it comes with a high rate of complications, including bleeding, blood clots, infection and stroke, and carries a high mortality rate in patients who go on to have a lung transplant. Complications become more severe the longer a patient is on the machine, especially after 10-14 days, Gazit says.

After 16 days on ECMO, Owen's heart had recovered but his lungs had not. Since there were no lungs available for transplant, Owen's physicians knew they didn't have a lot of time. So the team, led by Charles B. Huddleston, MD, professor of surgery and a cardiovascular surgeon at St. Louis Children's Hospital; Stuart C. Sweet, MD, associate professor of pediatrics and a lung transplant surgeon; Gazit; and R. Mark

Grady, MD, associate professor of pediatrics and director of the pediatric pulmonary hypertension program, decided to put Owen on the artificial lung, even though it had never been used on a child so young.

After getting emergency approval from the U.S. Food and Drug Administration and from Washington University's Institutional Review Board, Huddleston moved Owen from ECMO to the artificial lung in an innovative procedure without the need for a cardiopulmonary bypass.

The Novalung artificial lung is a small box about the size of a lunchbox that is attached through a shunt created between the main pulmonary artery and the left atrium of the heart.

"This case was very interesting and challenging from a physiological standpoint," Gazit says. "We had to determine what to do with Owen's lungs – do we support him and wait for a lung transplant or do we work to improve the lungs to get him off of the artificial lung? We had to think about this every step of the way to form an approach."

Occasionally Owen had to be taken off of the artificial lung to have parts of the circuit changed. Initially his blood pressure and oxygen levels dropped significantly, but over time, his ability to sustain adequate oxygen levels improved. Another indicator for improvement was the increased blood flow through Owen's lungs rather than through the device.

Owen was on the artificial lung for 23 days when he accidentally kicked off one of the device's connectors. This resulted in Owen having a stroke and required swift action. However, when Owen was taken to the operating room to reconnect the device, Huddleston found that Owen's lungs had healed enough to allow adequate blood flow on their own.

"Owen was able to come off of the artificial lung," Gazit says. "We had

no idea that we'd be able to get him off of the device before a transplant. It showed us that everything we did was the right thing."

"It is important to mention that our success is the result of a major collaborative effort," Gazit says. "Owen survived because of the dedication and hard work of our nursing staff, respiratory therapists and perfusionists."

A year later, Owen continues to take medication for pulmonary hypertension and so far has been able to avoid a lung transplant, says Stuart C. Sweet, MD, medical director of the Pediatric Lung Transplant Program at St. Louis Children's Hospital.

This experience with the artificial lung gives the medical community an option to manage young children with similar illnesses and support them prior to a transplant, Gazit says.

"We would like to be a part of or lead a trial," he says. "It requires a multi-institutional effort and we really hope that all of the large lung transplant centers will join us in this effort."

Provided by Washington University School of Medicine