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breathe easy

An intravenous electrode that offers new hope to patients on ventilators

Dr. Andy Hoffer will be the first to tell you that necessity is the mother of all invention, but that idiom never rang truer than when his own mother fell ill.

It was shortly before his planned trip over Christmas in 2006 to his family home in Uruguay (one of the top four countries in the 2010 Soccer World Cup, he says proudly) that he received word his mom had pneumonia and was rushed to intensive

care in a local hospital. The biomedical physiologist at SFU immediately went to her bedside, where she lay connected to a mechanical ventilator.

recovered from her illness after one week, but now couldn't breathe well enough on her own. All around them were other sick people, other stories: kids, middle-aged people, victims of trauma, sunstroke, the elderly; all struggling with varying degrees of success to get off their ventilators.

"My mother's condition was worsening with the prolonged bed stay. I was trying to figure out why it was so difficult to wean off the ventilator," he says, adding that physician friends advised that failure-to-wean is common, with 20 to 30% of patients becoming ventilator-dependent.

His mom worked with a respiratory therapist, training her to breathe on her own, but she would fatigue after a few hours and start to panic, so she was put back on the machine overnight. It was the same story for many patients, often kept sedated to prevent them from fighting the machine.

"I knew that the diaphragm could weaken from not being used during ventilation, but I had no idea of how incredibly quickly it atrophies," he says, adding that a year later, Levine published an eye-opening finding in patients who died after 18 to 69 hours of sedation and ventilation: their diaphragm muscle fibers had atrophied to less than half of normal size. "It's scary how fast the diaphragm muscle declines."

"While I was trying to find a better way to help wean my mom, in visualizing the tubes and leads that were keeping her alive, I had a key insight. I came up with an idea for pacing the diaphragm that should speed up the weaning process."

Hoffer had studied neurophysiology at Johns Hopkins, earning his PhD. He was specifically interested in the control of limb movement and developed implantable cuff sensing electrodes permanently connected to nerves. He led the development of Neurostep, a pacemaker-like device implanted in the thigh that enables people with paralysis from stroke to walk again.

Hoffer's diaphragm pacing technology doesn't require any surgical exposure of nerves; it is a minimally invasive, temporary procedure. Based on his experience is the use of electrical stimuli, he figured the diaphragm would benefit from electrical activation during ventilation in order to prevent or reverse disuse atrophy. He asked himself, "how does one put in an electrode quickly, simply, and reversibly, that can be removed after the patient recovers?"

He came up with the Lungpacer intravenous electrode, placed in the upper chest under local anesthesia. The nerves that control the diaphragm run next to large veins under the clavicle. The Lungpacer electrode "inside-out cuff" design provides mechanical stability and selectively activates the diaphragm using very low currents. Hoffer and his SFU team have since been busy developing and testing a medical grade, disposable electrode lead.

The Lungpacer lead, connected to a bedside control unit, will produce diaphragm contractions to keep it strong. Similar in concept to a car's block heater, the Lungpacer will keep the diaphragm warmed up and ready to work normally when the patient is ready to breathe again.

When he conceived this technology, he thought "of people like my mom, but I didn't have any idea of how large a number of people this problem affects. The elderly are more susceptible but a lot of young people die too. Ventilator-dependent patients in ICUs are the most expensive hospital in-patients, and too often they die."

Lungpacer Medical (lungpacer.com) has completed proof of concept, safety, and stability in animal trials and recently won several awards for its innovative technology and compelling business case.

Hoffer's mom inspired but couldn't benefit from the Lungpacer; she died that March.

"It isn't ready for use in people yet, but we are not far from it. By this time next year we hope to be testing it in patients." ●



Dr. Andy Hoffer receiving the LifeSciences BC 2010 award.

care in a local hospital. The biomedical physiologist at SFU immediately went to her bedside, where she lay connected to a mechanical ventilator.

"She was conscious but couldn't breathe on her own, nor speak, eat or drink" he says.

He spent the next five weeks with his mom, witnessing her inability to wean herself from the machine. She had