EMBARGOED FOR RELEASE
Tuesday, April 8, 2014 at 12:01 a.m. EDT-USA

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Four Paraplegic Men Voluntarily Move Their Legs, an "Unprecedented Breakthrough" for Paralysis Community

New Research Documents the Effectiveness of Epidural Stimulation as a Therapy Option for Paralysis; Results Published Today in Brain

LOUISVILLE, Ky. (April 8, 2014) – Four young men who have been paralyzed for years achieved groundbreaking progress – moving their legs – as a result of epidural electrical stimulation of the spinal cord, an international team of life scientists at the University of Louisville, UCLA and the Pavlov Institute of Physiology reported today in the medical journal *Brain.* The study was funded in part by the Christopher & Dana Reeve Foundation and the National Institutes of Health.

All four participants were classified with a chronic motor complete spinal cord injury and were unable to move their lower extremities prior to the implantation of an epidural stimulator. This research builds on an initial study, published in the May 2011 edition of *The Lancet*, which evaluated the effects of epidural stimulation in the first participant, Rob Summers, who recovered a number of motor functions as a result of the intervention.

Now three years later, the key findings documented in *Brain* detail the impact of epidural stimulation in four participants, including new tests conducted on Summers. What is truly revolutionary is that the second, third and fourth participants were able to execute voluntary movements immediately following the implantation and activation of the stimulator. The results and recovery time were unexpected, leading researchers to speculate that some pathways may be intact post-injury and therefore able to facilitate voluntary movements.

"Two of the four subjects were diagnosed as motor and sensory complete injured with no chance of recovery at all," Claudia Angeli, Ph.D., senior researcher, Human Locomotor Research Center at Frazier Rehab Institute, and assistant professor, University of Louisville's Kentucky Spinal

Cord Injury Research Center (KSCIRC) and lead author. “Because of epidural stimulation, they can now voluntarily move their hips, ankles and toes. This is groundbreaking for the entire field and offers a new outlook that the spinal cord, even after a severe injury, has great potential for functional recovery.”

These results were achieved through continual direct epidural electrical stimulation of the participants’ lower spinal cords, mimicking signals the brain normally transmits to initiate movement. Once the signal was triggered, the spinal cord reengaged its neural network to control and direct muscle movements. When coupling the intervention with rehabilitative therapy, the impact of epidural stimulation intensified. Over the course of the study, the researchers noted that the participants were able to activate movements with less stimulation, demonstrating the ability of the spinal network to learn and improve nerve functions.

“We have uncovered a fundamentally new intervention strategy that can dramatically affect recovery of voluntary movement in individuals with complete paralysis even years after injury,” said Susan Harkema, Ph.D., University of Louisville professor and rehabilitation research director at KSCIRC, Frazier Rehab Institute, director of the Reeve Foundation’s NeuroRecovery Network and primary author of *The Lancet* article. “The belief that no recovery is possible and complete paralysis is permanent has been challenged.”

Beyond regaining voluntary movement, the research participants have displayed a myriad of improvements in their overall health, including the increase of muscle mass and regulation of their blood pressure, as well as reduced fatigue and transformational changes to their sense of well-being. Additionally, all four men were able to bear weight independently, as reported by the team, which also includes Yury Gerasimenko, Ph.D., of the Pavlov Institute of Physiology in St. Petersburg, Russia.

“This research brings up an amazing number of possibilities for how we can develop interventions that will help people recover movement they have lost,” said V. Reggie Edgerton, Ph.D., UCLA distinguished professor of integrative biology, physiology, neurobiology and neurosurgery. “The circuitry in the spinal cord is remarkably resilient. Once you get them up and active, many physiological systems that are intricately connected and were dormant come back into play.”

Providing Hope for People Living with Paralysis

With nearly six million Americans living with paralysis, including 1.275 million spinal cord injuries, this study confirms a significant breakthrough in terms of developing clinical therapies to advance the treatment of paralysis. The participants ranged in neurological level from C7-T5 and were at least two years post–injury at the time of the intervention. The initial research hypothesis stated that the two participants with the American Spinal Injury Association Impairment Scale (AIS) classification of AIS A would not elicit any voluntary movement, despite the therapy intervention, and the two participants who were AIS B would develop voluntary movement following a combination of training and epidural stimulation. However, in the presence of epidural stimulation, all four recovered voluntary control of their lower extremities, surprising researchers who believed at least some of the sensory pathway must be intact for epidural stimulation to be successful.

As the first epidural stimulation participant, Rob Summers moved the needle for the entire field with his unprecedented recovery. With a C6 injury, he was paralyzed below the chest after being struck by a vehicle in 2006. Summers currently resides in Portland, Oregon. The other three research participants include:

- Kent Stephenson was the second person to undergo epidural stimulation after sustaining an injury at T5-T6 during a motocross accident in 2009. He resides in Mount Pleasant, Texas.
- Andrew Meas was in a motorcycle accident in 2006, resulting in an injury at C6-C7. Meas was the third person implanted and lives in Louisville, Kentucky.
- Dustin Shillcox injured his spine at T5 in a devastating auto accident. He was the fourth participant and resides in Green River, Wyoming.

"With this study the investigators show that their findings about a motor complete patient regaining movement, as published three years ago in *The Lancet*, were not an anomaly," said Susan Howley, executive vice president for research at the Christopher & Dana Reeve Foundation. "At the present time, other than standard medical care, there are no effective evidence-based treatments for chronic spinal cord injury. However, the implications of this study for the entire field are quite profound and we can now envision a day where epidural stimulation might be part of a cocktail of therapies used to treat paralysis."

Investing in Epidural Stimulation

The research was funded by the Christopher & Dana Reeve Foundation and the National Institutes of Health (RO1EB007615, P30 GM103507), the Leona M. and Harry B. Helmsley Charitable Trust, the Kessler Foundation, University of Louisville and Jewish Hospital and St. Mary's Foundation, Frazier Rehab Institute and University Hospital.

"When we first learned that a patient had regained voluntary control as a result of the therapy, we were cautiously optimistic," said Roderic Pettigrew, M.D., Ph.D., director of the National Institute of Biomedical Imaging and Bioengineering, which provided support for the study. "Now that spinal stimulation has been successful in four out of four patients, there is evidence to suggest a large cohort of individuals, previously with little realistic hope of any meaningful recovery from spinal cord injury, may benefit from this intervention."

Epidural stimulation, in the context of paralysis of the lower extremities, is the application of continuous electrical current, at varying frequencies and intensities to specific locations on the lumbosacral spinal cord, corresponding to the dense neural bundles that largely control movement of the hips, knees, ankles and toes.

"This is a wake-up call for how we see motor complete spinal cord injury," said Edgerton, who has been conducting fundamental research in this area for 38 years and is a member of the Reeve Foundation's International Research Consortium on Spinal Cord Injury. "We don't have to necessarily rely on regrowth of nerves in order to regain function. The fact that we've observed this in four out of four people suggests that this is actually a common phenomenon in those diagnosed with complete paralysis."

Dr. Angeli and her colleagues are optimistic that the therapy intervention will continue to result in improved motor functions. In fact, based on observations from the research, there is strong evidence that with continued advancements of the epidural stimulator, individuals with a complete spinal cord injury will be able to bear weight independently, maintain balance and work towards stepping.

For more information about epidural stimulation studies and other spinal cord injury research, please visit http://chartingourcourse.org/research/victory.html.

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For research information, patient bios and multimedia, please visit
https://app.box.com/s/22vptu3trdhddy57j69i

Bibliographic details:
'Altering spinal cord excitability enables voluntary movements after chronic complete paralysis in humans' by Claudia Angeli, Victor R. Edgerton, Yury Gerasimenko, and Susan Harkema. Brain: A Journal of Neuroscience, doi: 10.1093/brain/awu038

About the Reeve Foundation
The Christopher & Dana Reeve Foundation is dedicated to curing spinal cord injury by funding innovative research and improving the quality of life for people living with paralysis through grants, information and advocacy. We meet all 20 of the Better Business Bureau's standards for charity accountability and hold the BBB's Charity Seal. For more information, please visit our website at www.ChristopherReeve.org or call 800-225-0292.

About the University of Louisville
The University of Louisville is Kentucky's metropolitan research university, with 22,000 students attending classes at 11 colleges and schools on three campuses. Bordered by its many medical partners, UofL's downtown Health Sciences Center is home to more than 3,000 students pursuing degrees in health-related fields with the Schools of Dentistry, Medicine, Nursing and Public Health and Information Sciences, as well as 14 interdisciplinary centers and institutes.

About UCLA
UCLA is California's largest university, with an enrollment of more than 40,000 undergraduate and graduate students. The UCLA College of Letters and Science and the university's 11 professional schools feature renowned faculty and offer 337 degree programs and majors. UCLA is a national and international leader in the breadth and quality of its academic, research, health care, cultural, continuing education and athletic programs. Seven alumni and six faculty have been awarded the Nobel Prize. For more news, visit the UCLA Newsroom and follow us on Twitter.

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