

# Stanford Hospital Health Notes

A community health education series from Stanford Hospital & Clinics

## From the Inside Out: Deep Brain Stimulation Designed To Control Parkinson's Disease

Someone, maybe even Resa King herself, would have noticed sooner or later. When she walked, she wasn't swinging her right arm as she did the other. It was one small change in how her body behaved, something a relative noticed. Curious, she sought out a neurologist who wanted to see what happened when she tried to bring her thumb and forefinger together as quickly as she could. She thought she'd done pretty well, but there was a small tremor in her right arm.

Even though King was just 39, Parkinson's disease was already altering her body movements, slowly affecting her ability to control its motions, even simple ones like walking. Her leg dragged, she said, and people would ask her, "Did you hurt your knee?"

It would become much, much worse over the years. Early onset Parkinson's disease, what had attacked King, is not as common as the variety that shows up in people past age 65. Be-



Norbert von der Groeben

Parkinson's disease affected Resa King's ability to do even the simplest of tasks. The movement disorder, which typically develops in people over age 65, can slow speech, gait and thinking. The surgery King had gave her back a control of her body she had not known for years.

cause it affects younger people working full time and raising children, the tremor that is often its most dominant feature, early onset Parkinson's can be very noticeable and disabling. The disease hits the brain deep in its center, where much of motor control resides. With Parkinson's disease, a neurochemical called dopamine is not generated in enough quantity to facilitate the cascade of neural communication that normally allows us to walk and talk, and even think.

*"Eventually, if all these medications fail, we start thinking about other types of therapy, like deep brain stimulation."*

—Jaimie Henderson, MD, Director, Stereotactic and Functional Neurosurgery, Stanford Hospital & Clinics

"For whatever reason those brain cells die, and we still don't know most of the reasons," said Jaimie Henderson, MD, Director, Stereotactic and Functional

Neurosurgery at Stanford Hospital & Clinics. "The risk factors are being studied. It's clear there are some genetic components as well as some environmental—pesticides, jet fuel, other types of toxins like metals—but it's unclear as to what precise environmental factors may cause it or contribute to its development."

One percent of people over the age of 65 will develop Parkinson's disease; 1.5 million people have it now; about 50,000 people are diagnosed with the disease each year.

### New options

King received the best treatment available, a group of medications that replace or mimic

dopamine, with varying degrees of effect and duration. At first, they worked well for King, keeping her Parkinson's disease symptoms in check; the side effects, however, can be almost as disruptive of normal life as the illness. Little by little, King could do less and less. She would break glasses while unloading them from the dishwasher. She couldn't walk a straight line. She couldn't drive, or go to the store, or eat out at a restaurant.

Even with the maximum dosage of medication, she wasn't living anything close to a normal life.

Finally, she decided she wanted to see a doctor at Stanford Hospital & Clinics. She'd heard of a surgery that might help, something that seemed radical, and, to some, scary. The treatment is called deep brain stimulation—produced by a pacemaker-like device implanted in the brain and powered by a battery-driven control placed under the skin in the chest. Just as a cardiac pacemaker electrically regulates the speed of the heart's beating, the deep brain stimulator may regulate abnormal electrical rhythms in the brain that have emerged with Parkinson's disease.

"Medication is really the cornerstone of treatment for Parkinson's disease," Henderson said. "However, eventually all those medications will fail and then we start thinking about other types of therapy, like deep brain stimulation."

Henderson and Helen Bronte-Stewart, MD MSE, became King's physicians. Henderson's research has included the development of a lightweight replacement of the bulky halo frame that once held patients still for the many hours the surgery took. Now, a patient's head is secured with something that looks



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Resa King, whose life was drastically altered by early onset Parkinson's disease, decided to try deep brain stimulation when her medications no longer worked.

like a brimless plastic cap that covers just a couple of square inches around the entry point into the brain. Bronte-Stewart is the director of the Stanford Comprehensive Movement Disorders Center.

### Inside the brain

King was awake throughout the five-hour surgery. Henderson and Bronte-Stewart need to be able to see the impact of the surgery, mapped



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Before Resa King had surgery to implant a pacemaker-like device in her brain, she would not have been able to hold a glass for fear of breaking it. The side effects of medications for Parkinson's can cause abnormal, unpredictable and involuntary movements.

out with sub-millimeter accuracy the precise region deep in the brain that is involved with movement, the sensorimotor region. "It's relatively painless," King said, "but it does go on a long time."

*"We're exploring, listening to the brain, to the chatter of what the neurons are doing just to do a very simple movement."*

—Helen Bronte-Stewart, MD, MSE, Director, Comprehensive Movement Disorders Center, Stanford Hospital & Clinics

The target zone in the brain Henderson aims with a probe for is about the size of a lima bean and the precision of movement required about half the thickness of a thumbnail.

More is involved, of course, than just physical movement of the probe. As the microelectrode is moved around in the subthalamic nucleus in the brain, Bronte-Stewart listens to the sound of the neurons' electrical activity. "From the outside, it sounds like static," she said. "The electrode picks up firing from a small volume of neurons and nerve fibers. For me, however, it's like listening to the different instruments and melodies of an orchestra. We're trying to find the one that's talking to us, that's responding to the sensory inputs from specific joints of her body that I am moving."

The challenge of this surgery is that every person's brain is slightly different, which means that the exact place of the sensorimotor region may be different in different people and you can-

## About Deep Brain Stimulation:

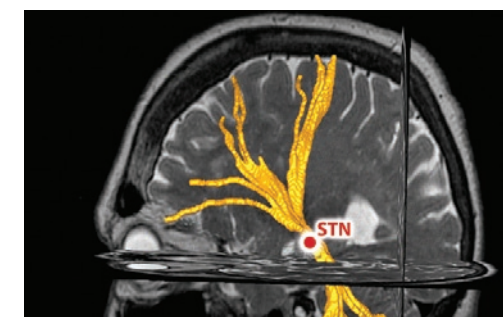
**How does it work?** DBS devices are typically placed in the subthalamic region of the brain, and the stimulator sends out the pulses of electricity that alter Parkinson's effect on movement. What Stanford researchers—Henderson was a member of the research team—recently discovered is that those changes happen because the electrical pulses are picked up by neural wires, called axons, which run from that region to outer regions of the brain.

**Who can it help?** Stanford evaluates patients for two days, one day on their medication and one day off. DBS is most effective with people who have had a good response to medication, but whose ability to live their life normally has been severely hampered by the side effects of the medication. Those side effects include uncontrollable movements. On average, DBS gives patients a 60 to 80 percent improvement in symptoms and a 50 to 60 percent reduction in medication use.

**Who can't it help?** DBS will not alter the effect of Parkinson's disease on speech or cognition. Nor is it effective on other movement disorders that may have some of the same symptoms as Parkinson's disease. It cannot help those who do not respond to medications.

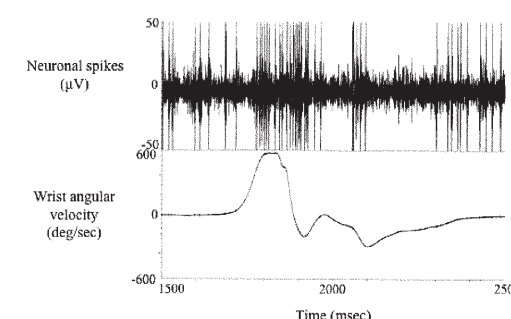
For more information about Parkinson's disease: [stanfordhospital.org/dbis](http://stanfordhospital.org/dbis)

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Working within the brain requires finding precise targets. The target for the deep brain stimulator is the subthalamic nucleus of the brain (where the letters STN are marked). It is roughly the size of a lima bean. Once that is located, the scale is further reduced—to a tenth of a millimeter. This image shows the sensorimotor networks as they extend to the outer portions of the brain.

### Neuronal activation with passive extension of the wrist



The brain is our body's central control organ and every physical movement, no matter how small, can be tracked by electrical activity as shown above. When physicians implant a brain stimulator, they can plot its impact with information like this.

not see it on an MRI scan. "Everybody has their own anatomy," said Bronte-Stewart, "their own wiring. We're exploring, listening to the brain, to the chatter of what the neurons are doing just to do a very simple movement."

*"People who saw me before and after—their reaction was astonishing. Their jaws dropped and they said, 'Wow, Resa, you look so great!'"*

—Resa King, patient, Stanford Hospital & Clinics

Once the stimulator is implanted, its activity needs to be adjusted—again, according to each patient's make-up. But even while she was still in the hospital, King said, she was able to get out of bed and walk to the bathroom. "I was like, 'This is really cool!' The nurses were trying to help me, but I said, 'I don't need that much help!'"

### Increasing knowledge

Deep brain stimulation for Parkinson's disease has been FDA approved for both sides of the brain

since 2002. King believes that as time passes, the device will be refined and improved. Bronte-Stewart agrees. She and Henderson continue to seek greater and more refined knowledge about the brain's behavior and what affects it. For Parkinson's, that knowledge particularly involves what Bronte-Stewart calls nodes of hypersynchrony—a place in the brain where networks coincide and coordinate, "a sweet spot," she said, "where, if we zap it, we might be able to normalize the whole network."

Right now, DBS has a specific set of Parkinson's symptoms that it can improve: speed of movement, fluidity of movement, gait and tremors. It will not improve problems with speech or cognition.



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Deep brain stimulation cannot remove all the symptoms of Parkinson's disease, but, for King, it has made it possible for her to return to most of the activities she had had to give up.

Stanford Hospital & Clinics is known worldwide for advanced treatment of complex disorders in areas such as cardiovascular care, cancer treatment, neurosciences, surgery, and organ transplants. Consistently ranked among the top institutions in the U.S. News & World Report annual list of "America's Best Hospitals," Stanford Hospital & Clinics is internationally recognized for translating medical breakthroughs into the care of patients. It is part of the Stanford University Medical Center, along with the Stanford University School of Medicine and Lucile Packard Children's Hospital at Stanford. For more information, visit [stanfordmedicine.org](http://stanfordmedicine.org).