The Body Electric; Electrodes work for a range of ailments, from heart trouble and epilepsy to chronic pain and depression.

Date: August 22, 2005 Publication: Newsweek International Author: Ehrenfeld, Temma; Romano, Andrew

Byline: Temma Ehrenfeld (Graphic by Andrew Romano)

Shelagh Leggett, a divorced mother of four, was only 38 when she took an overdose of painkillers. Doctors pumped her stomach in time, but afterward nothing, and no one, could restore her joy in life. Over the next 12-1/2 years she took every antidepressant drug available, survived 16 visits to psychiatric wards and endured 21 rounds of electroshock therapy, yet none of it worked. Then one day Leggett learned from watching television about a new approach to depression. In June 2003, she became the first patient in London to receive surgically implanted wires to treat depression--a little pacemakerlike device on the left side of her neck. She began to feel better after a month; not long after that she moved to Spain. "I was depression-free," she says.

Doctors and scientists are accustomed to thinking of the body as a biochemical system that can be changed through drugs, or as tissue and bone that can be altered by surgery. Now they're increasingly seeing the human form as an electrical field. In the last five years, the number of ailments for which electrical implants show promise has blossomed, from heart trouble to hearing loss, incontinence, chronic pain and obesity, among others. Because they involve surgery and all its attendant risks, these devices are still a last resort. But global use of implants has doubled since 2000 to a quarter of a million people, estimates James Cavuoto, publisher of the Neurotech Business Report--and that's not counting the heart patients. Many doctors are beginning to think that implants are a relatively side-effect-free and efficient alternative to drugs.

The device that gave Leggett so much relief--a vagus-nerve stimulator, which acts on the brain through the vagus nerve in the neck--looks promising for more than depression. Researchers are now checking its effectiveness on a host of psychiatric ailments, such as bulimia and anxiety (including posttraumatic stress disorder, panic and obsessive-compulsive disorder), as well as chronic headaches and migraines, and Alzheimer's. The implant, which consists of wires around the nerve and a generator placed under the collarbone or in the armpit, sends out mild intermittent pulses. This tickling--scientists call it neuromodulation--has been found to reduce the frequency of epileptic fits (the device was approved for epileptics in Europe in 1994). Patients reported that the treatment lifted their spirits, even when it didn't help their seizures. Animal studies then showed that VNS stimulation increases the firing rate of the nerve cells that produce norephrenine and serotonin, two neurotransmitters that affect mood. VNS stimulation has the effect of a "subtle wake-up call," says Richard Selway, a neurosurgeon at King's College Hospital in London who treated Leggett.

One of the big advantages of implants is that their effects are quick (sometimes within minutes) and reversible (you can turn them off). In a 2003 test of an implant for migraines at the Presbyterian Hospital of Dallas, all eight patients in the study reported that their headaches began to lighten as soon as the stimulation began, and disappeared within a half hour. When the stimulation was turned off, headaches returned instantly and peaked within 20 minutes. "Some people had devastating headaches daily and now have fantastic improvement," says Peter Goadsby of the Institute of Neurology in London, who helped run the migraine study. "For people who have failed with other treatments, it's a no-brainer."

Side effects of implants also tend to be milder than those of drugs. For instance, whereas migraine medicines can cause tremors and weight gain, implants for migraine tend to cause only a mild tingling when they're turned on and off. Leggett gets a catch in her throat when her VNS device clicks on, but she says she prefers that to the side effects of medication (low blood pressure, weakness) and of electroshock therapy (in her case, two years of memory loss). "You can be reasonably precise using electrical stimulation," says Stanford neuroscientist Robert Malenka, "whereas with any drug you're bathing the whole brain."

The biggest obstacle to wider use of VNS is cost, says Rik Buschman, a researcher at the Twente Institute for Neuromodulation in Enschede, the Netherlands. A VNS operation currently costs $20,000, and there's a risk that the device will fail. What's more, replacing the batteries every six years requires new surgery each time. It doesn't help that many scientists aren't yet convinced of the effectiveness of implants for depression. Houston-based implant manufacturer Cyberonics found marked improvement in 30 percent of severely depressed patients after a year with a VNS implant, compared with 13 percent of those without, but the study tested VNS only as a supplemental treatment.

Technology now in the pipeline may make implants a more attractive alternative. On the drawing board: longer-lasting batteries, implants that can be recharged like a cell phone and devices using tiny batteries that don't require the surgical insertion of a separate generator. Scientists are also looking for ways to place the electrodes more accurately. Some treatments call for stimulating targets no bigger than raisins deep inside the brain. Ultrasensitive microphones may soon allow a surgeon to identify target neurons by "listening" to the sounds they make.

Eventually, magnets that stimulate the brain from the outside may replace implants entirely, avoiding the need for any surgery. And there's some evidence that electrical stimulation can lead neurons to grow or change function in desirable ways. There's still a long way to go, but doctors now have a new tool in the medical kit.

CAPTION(S): (text/illustration) NEW FRONTIERS IN NEUROTECH: Armed with new devices and new discoveries, scientists are using neurostimulation to treat all manner of ailments. A look at what's available today -- and what to expect in the near future. (graphic omitted)