

# Spinal Cord Stimulation

## *Its Role in Managing Chronic Disease Symptoms*

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Around the world some 34,000 patients undergo spinal cord stimulator implants each year. First used to treat pain in 1967, spinal cord stimulation (SCS) delivers mild electrical stimulation to nerves along the spinal column, modifying nerve activity to minimize the sensation of pain reaching the brain.

Since the therapy first entered routine use in the 1980s, advances have continued that enable more closely tailoring the therapy to a patient's individual needs. Newer lead designs provide more precise control of the electrical field and increasingly sophisticated devices offer a variety of stimulation parameters. A further advance has been the awareness that pain reduction can be achieved without evoking perceptible sensations.

The U.S. Food and Drug Administration (FDA) first approved SCS in 1989 to relieve chronic pain from nerve damage in the trunk, arms or legs. The therapy now accounts for about 70% of all neuromodulation treatments. That number is expected to grow in order to manage a variety of chronic long-term conditions.

SCS is used to treat pain that is mostly neuropathic in origin, that is, pain that arises from nerve damage and does not serve a protective purpose. The nerve damage may have occurred due to accident, injury, or disease. SCS therapy is most commonly indicated in neuropathic back and leg pain, typically seen in 25% of patients following back surgery.

Increasingly SCS is used to avoid futile back surgery. The second commonest indication is to treat the pain associated with complex regional pain syndrome. The third is the pain associated with peripheral neuropathic pain caused by nerve damage beyond the spine or brain, for instance, from viral infection, trauma, surgery or diabetes.

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Treatment should be undertaken as part of a healthcare team approach

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Other key uses are in the pain caused by ischaemia – a circulatory system problem involving an insufficient supply of oxygenated blood to tissues – such as in chronic critical limb ischaemia, refractory angina and some treatment-resistant vasculitis disorders that result from an inflammation of blood vessels.

Apart from neuropathic and ischaemic pain, SCS has been demonstrated in a number of cases of chronic visceral pain, such as in selected patients with chronic abdominal or pelvic pain, for instance, after major abdominal or pelvic surgery.

### **Spinal Cord Stimulation's Beneficial Function**

In these conditions the normal pain sensory and processing circuits of the spinal cord and brain are altered. Stimulation with SCS not only reduces abnormal pain signals reaching the brain but also restores the normal pain-inhibition pathways that may have been lost. It does this by eliciting the body's natural pain-relief substances, chemical neurotransmitters that are used by nerves to communicate with each other.

This not only results in reduced pain but also, in the presence of ischaemia, improved microcirculation.

It is important to appropriately select patients who are likely to benefit from SCS therapy. SCS does not work for all patients with all types of pain. Depending upon the scientific studies, 50 to 70% of patients suitable for SCS may experience 50% reduction in their reported pain at follow-up. An even higher proportion will experience a 30% pain reduction. Long-term neuropathic pain has a major impact upon measures of health-related quality of life. SCS in these circumstances has an impressive effect on improving quality of life.

SCS has a better track record in treating neuropathic back and leg pain than repeat back surgery or comprehensive pain management alone.

Not all healthcare systems may fund SCS for all the conditions mentioned, but the level of clinical and cost-effectiveness evidence supports its use for neuropathic pain indications, and in some health economies, for both ischaemic and visceral pain as well.

### Opting for Spinal Cord Stimulation

Patients who are considered for SCS have generally had chronic pain for more than a year. Chronic pain has a physical and emotional impact, so generally the sufferer has complex needs that need to be evaluated. First the correct medical diagnosis and pain mechanism is understood, and then the psychological impact is evaluated.

The idea is to not only determine if they are good candidates but also to support them through the process of health improvement. This might include learning better pain coping styles, reducing dependency on habit forming medication and learning to gradually restore physical function.

Your doctor may well be assisted by other healthcare professionals working within the multidisciplinary team. The actual spinal cord stimulation procedure itself may be done by pain specialists, anesthesiologists, neurosurgeons, rehabilitation doctors, or other trained specialists.

Implanting an SCS device is a complex but minimally invasive procedure and is best carried out by trained and experienced specialists.

### Neuromodulation with SCS Starts with a Trial Phase

Implanting the stimulator is a two-stage process. While watching on a monitor, the doctor will guide a hollow needle into the epidural space above the spinal canal. Through this passageway, one or more thin leads are threaded, each carrying a number of small electrical contacts along the end.

The leads are attached to a power supply that delivers a mild current. With feedback from the patient, the physician will adjust the position of the electrodes until the area of pain feels covered by a tingling sensation called

paraesthesia (this technique is called topographical mapping). Once the position is chosen, the lead is secured in place. Other techniques may rely upon an anatomical target being covered with electrical contacts confirmed by X-ray.

Rather than insert a cylindrical lead, some neurosurgeons prefer to do a small surgical procedure and directly place a paddle-type electrode where stimulation will be delivered.

Usually a trial period is offered and in most health economies, reimbursement for a permanent system will only be provided if an adequate response to this trial period is achieved. For instance, a response is generally considered adequate if pain is reduced by at least 50% although improvement in function and activity level may also be a consideration.

The patient spends a trial period of about seven days (sometimes less sometimes more) with an external pulse generator that is carried on a belt or in a pocket. Some health care specialists are questioning the benefit of a prolonged trial period if the indication and multidisciplinary assessment is supportive with satisfactory on-table trial responses from the patient.

The team will have explained how to use the stimulator device and how relevant outcomes will be assessed. Usually the trial period is carried out at home. Patients receive a hand-held external control unit. This allows them to switch between programs throughout the day in order to obtain desired coverage in different postures, such as sitting or lying down.

There are a few precautions regarding where and when to use active stimulation, however. It is not advised to turn on stimulation while operating heavy equipment or driving.

### Permanent Implantation is the Second Phase

After trying the therapy for about a week, a patient who has experienced a reduction in pain by at least half may choose to continue treatment with a permanent system. Some practitioners will use the existing lead from the trial and others will have previously removed that and will insert new leads.

For patients choosing a permanent SCS option, an implantable power source, around the size of a man's watch face is generally implanted under the skin – either in the upper buttock/back, upper chest wall, or abdominal area.

Managing the SCS system takes some oversight and commitment on the part of the patient. While the incision made on the patient's back usually heals after several days, surgical pain from the implanted pulse generator or receiver may last up to six weeks. Patients are advised to avoid stretching or twisting motions that may displace the system.

### Ways to Power the Electrical Stimulation

The implantable pulse generator (IPG) contains the battery, microprocessor and feed-through connections all sealed within a titanium cover. There are two different types of implantable power sources, the primary cell (non-rechargeable) and rechargeable battery. A third type of device has no battery but can be powered either by induction or megahertz frequency from closely applied external power sources.

Primary cell devices are usually larger and less costly but will have a limited duration of life expectancy. They are unable to support the energy demands of many of the newer sub-perception stimulation parameters. However they are simpler to use and if used at standard rates may last up to five years before needing to be surgically replaced.

Rechargeable batteries are charged by induction with a charging unit positioned over the IPG for an hour or two every few days depending upon use and preferred programming. A rechargeable device can last, depending upon manufacturer, between 10 and 25 years.

### Future Considerations Concerning SCS Treatment

Lead designs continue to evolve for enhanced function. Over the decades lead contacts have increased from one to four to eight and 16 electrical contacts. The aim is not only to treat multi-site pain but also to be able to control the electrical field better so that pain relief can continue for many years to come without need for a revision procedure.

MRI examinations in medicine have become increasingly commonplace. Some manufacturers have created SCS devices that can now be safely present during an MRI as long as manufacturer's guidance is followed.

Newer sub-perception stimulation parameters can result in pain reduction without the patient's awareness of stimulation. In conventional SCS, the stimulation creates tingling sensations in the area of pain covered called paraesthesiae. As practitioners gain experience they note that some patients prefer the paraesthesiae and others paraesthesiae free. Some patients, if their device allows, like to toggle between the two depending upon their pain circumstances.

Maximal benefit from SCS may depend upon the constancy and consistency of the stimulation. Feedback systems using a built-in accelerometer allow automatic toggling between preset programmes corresponding to each body position.

In more recent years, a specialized manufacturer developed technology to measure the spinal cord effects of SCS and automatically adjust the strength of its stimulation to keep the therapeutic stimulation constant.

### The Therapy's Potential Risks, Benefits and New Directions

Occasionally patients experience device complications, such as a displaced lead, internally fractured electrode, or device malfunction. Major complications, however, are rare, although at worst complications of the implant can include paralysis, nerve injury and death.

Complication rates should generally be lower in the hands of an experienced practitioner. The medical problems most often seen are bleeding at the site of the implant, or infection. In such instances, removal of the device and antibiotic treatment are generally

required. Infection rates can be as low as 1%, but may rise to 4% in some centres.

Mechanical complications such as lead migration are reducing due to improved technology and skilled technique. Persistent pain at the lead anchor site and implantable pulse generator pocket are important in 20% of patients and up to 5% of patients require a pocket revision in order to achieve better comfort.

Long-term outcomes with SCS are variable. Most patients continue with good pain reduction. A few find that their long-term pain condition resolves, but some develop tolerance to the effects of stimulation. More recent sub-threshold programming may restore pain relief in some of these cases of stimulation tolerance. Other patients will require additional diagnosis and pain treatment and some will need a revision of the SCS procedure.

In health economics studies, the cost of an SCS system has been estimated to pay for itself within three to four years when compared to usual care. Patients who benefit have fewer medical visits, reduced painkiller use, improved health-related quality of life, better sleep quality, greater activity levels, and may be more likely to return to work.

Rapid advances have expanded SCS options. Techniques to better control the electrical field with multiple contacts and feedback systems and sub-perception stimulation programmes have been welcome additions.

A newer, FDA-approved target for neurostimulation within the vertebral canal, meanwhile, is the dorsal root ganglion (DRG) – an easily accessible structure at the edge of the spine that plays a key role in the development and management of chronic pain. Recent advances have allowed targeted DRG stimulation for precise, constant subliminal stimulation for areas of pain that in some cases have been elusive.

The net result of all these technologies is to improve long-term outcomes at an affordable cost in an ever-wider range of patients.

**Please note:** *This information should not be used as a substitute for medical treatment and advice. Always consult a medical professional about any health-related questions or concerns.*