
Preface

There is something both mundane and exotic about the use of stimulation to treat human disease and distress. Common human behaviors that are inborn or learned from early childhood suggest potential benefits from stimulation after injury. After painful trauma to bones, joints, or soft tissues, the painful part often is grasped or rubbed. Abdominal cramps lead to rubbing or pressure on the abdominal wall. With lumbar strain, a closed fist against the sacrum or spine is often observed. These behaviors offer clues about the existence of neural systems by which stimulation can produce salutary effects.

The medical application of electrical stimulation for the treatment of pain and other disorders has a very long history. Ancient Egyptian practitioners used electrical shocks produced by specific species of fish to treat pain. With the advent of machines to produce electrostatic charges in the 1700s, the medical use of technology to deliver electric shocks to the skin began. With the development of the battery by Volta, which used chemical means to produce electricity, “electrotherapy” evolved as a treatment for both medical and psychiatric disorders. Direct current (galvanism) was used by the early 1800s, and the heat and tissue damage that it produced was harnessed to treat tumors, uterine fibroids, and other maladies. Within a short time, however, Faraday developed a safer alternating current and the medical use of electrical stimulation advanced greatly with the development of “faradic” devices.

Guillaume Duchenne (1806–1875), a prominent French neurologist, has been credited as the “father of electrotherapy,” popularizing the use of interrupted and alternating currents to treat a wide variety of medical and psychiatric ills during the mid-1800s. By the end of this century, the medical use of electrical stimulation via electrodes and needles was commonplace in many countries. The nonpsychiatric focus of this effort was in the treatment of musculoskeletal disorders, including paralysis and pain.

Not surprisingly, growing demand for the treatment created a marketplace for devices and practitioners. Many physicians acquired or constructed their own machines and offered electrotherapy routinely. Nonphysicians, some who were technically adept and some who sold nostrums, created lucrative businesses. Fraud and quackery increased and became recognized as a serious threat to the development of medicine, which by the early twentieth century was formally adopting a more scientific approach to patient care. The famous Flexner report in 1910 identified the teaching of treatments with no known biological basis as a major impediment to the standardization of high-quality medicine, and in the years that followed its publication, medical schools dropped electrotherapy from curriculums.

The pendulum swung away from the view of stimulation as a mainstream allopathic therapy for more than 50 years, even as neuroscience made stunning advances in discerning the anatomy of the nervous system and the role of electricity in its physiology. In pain management, the 1966 publication of the gate control theory by Melzack and Wall initiated a renewed interest in the potential therapeutic effects of peripherally applied stimulation. Although the specific predictions of this theory have required numerous alterations, the underlying concept—that activation of endogenous non-nociceptive neural systems can potentially suppress nociceptive afferent input—was broadly and profoundly heuristic. It generated hypotheses about the potential for multiple segmental and suprasegmental pain-modulating systems, and touched on a biomedical understanding of analgesic therapies as

diverse as ancient acupuncture techniques and a variety of approaches subsumed by the electrotherapy rage of the prior century.

The use of electrical stimulation to relieve pain regained scientific and clinical credibility, and is itself now subsumed under the broader strategy of neuromodulation. The latter term was coined to remind clinicians of the biological or practical linkages among a rapidly growing number of interventions undergoing investigation and development for pain and other disorders. From the clinical perspective, neuromodulation has had a flexible definition that has broadened in tandem with extraordinary advances in technology and the adoption by pain specialists of interventions that involve placement of both electrical leads and catheters to specific sites in the body. The International Neuromodulation Society now endorses the view that neuromodulation encompasses any therapy that targets specific sites in the nervous system and delivers either electricity or drugs in an effort to reduce symptoms or restore function.

From the clinical perspective, neuromodulation techniques are currently important in the treatment of an array of disorders. In addition to diverse types of chronic pain, neuromodulation techniques are used for refractory epilepsy and movement disorders; hearing loss; and dysmotility disorders involving gastrointestinal tract, bladder, or diaphragm. The future in restorative medicine may be the realization of the science fiction of decades ago.

Like so much of medicine, the clinical advances in the use of neuromodulation for pain have represented the combination of clinical practices developed from observations, clinical trials of new tools created to accomplish specific technical goals, and translational work drawn from an increasingly robust understanding of neurophysiology. Some techniques, such as “old-fashioned” transcutaneous electrical nerve stimulation and new-fashioned transcranial electrical or magnetic stimulation, are seemingly so safe that clinical use has (in the first instance) and will (in the second) advance before either the biological basis or trials-based efficacy is ascertained. Other interventional approaches that involve more risky and expensive implants likely will be used in a small segment of the population with pain unless evidence grows to justify broader uptake. For all these treatments, the future will depend in part on the emerging scientific evidence pertaining to the neural basis of chronic pain, most notably the nature and impact of neuroplasticity and genetics.

Two things are clear. First, stimulation of sites in the body for therapeutic purposes related to pain management has returned from the historical dust heap to a place of importance in the science and practice of pain medicine. A clinical interest in pain requires knowledge of neuromodulation.

Second, the world of neuromodulation is changing very rapidly and there is a compelling need for accessible compendia that can update scientists and clinicians alike about the current status. This volume, nicely edited by Drs. Knotkova and Rasche, provides a broad background, explaining the science and offering a snapshot of clinical neuromodulation circa 2014. It explores the role of neuroplastic changes in the effects produced by stimulation and describes the large variation that characterizes all human responses to these treatments. It is both a brief history of a period with extraordinary scientific motion and a jumping off point for the next set of advances and issues. It will not be the last word on neuromodulation, but is an excellent work to prepare for a future of change.

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