All About TENS / EMS

Learn about your TENS Unit, Its History, Features, and Uses
INTRODUCTION

Whether by intuition or by accidental discovery, the use of electrical stimulation to treat pain and medical disorders goes far back in human history. It is fascinating how consistently and for how long people have been trying to apply electricity for therapeutic purposes.

We will touch on that history and many aspects of TENS / EMS, but the main purpose of this book is to give you a set of guidelines for optimal use of TENS and EMS devices for pain relief.

The listing of many common conditions for which TENS is applied, with diagrams for electrode placements for them, begins on page 23.

WHAT IS TENS / EMS?

MICRO-CURRENT ELECTRICAL STIMULATION

TENS is the acronym for “Transcutaneous Electrical Nerve Stimulation” and EMS is the acronym for “Electrical Muscle Stimulation.”

All Electronic Muscle Stimulators are technically TENS (Transcutaneous Electrical Nerve Stimulators), the difference being which nerves are stimulated. EMS devices stimulate the muscle motor nerves, causing them to contract, while TENS devices are designed to stimulate sensory nerve endings. They all work by generating an electrical pulse which stimulates nerves through the skin.

WHAT ARE THE DIFFERENCES?

1. TENS—(Transcutaneous Electronic Nerve Stimulation)—Numbs pain by affecting the nerve endings.
2. EMS—(Electronic Muscle Stimulant)—Works deeper and is a little stronger. Works with the muscles to relieve pain.

EMS has proven to be an effective means of preventing muscle atrophy. Doctors also see EMS as a means of increasing blood flow to muscles, increasing range of motion, increasing muscle strength, as well as enhancing muscle endurance. EMS will have pain management attributes in regards to muscle related pain, such as a spastic muscle, sore muscles, or tight muscles. A TENS device is more suited for nerve related pain conditions (acute and chronic conditions).
INTRODUCTION

A BRIEF HISTORY OF TENS / EMS

2750-2500 BC
Amazingly, stone carvings from the Egyptian Fifth Dynasty show a Torpedo (an electric fish rather like electric eels) being used to treat pain. The fish is capable of producing powerful electrical shocks. Egyptians used these shocks to relieve pain by placing the fish on painful regions of the body.

Ancient Rome
Similar use of torpedoes.

1600
Queen Elizabeth I’s physician explores the use of electrical charges in medicine

18th Century - Man-made electricity
Real progress in electrotherapy begins as humans begin to discover how to make and control electricity.

1752 USA
Benjamin Franklin uses electrostatic machines to treat patients in pain.

1745 Germany
Kratzenstein outlines the use of static electricity to treat affected body parts.

1780 Italy
Galvani, Professor of Anatomy experiments with the effects of electricity on muscular movement.

1800 Italy
Carlo Matteucci shows that injured tissue generates electric current.

1820+ Worldwide
Alternating current begins being used in Sinusoidal Stimulation.

1840 England
Galvani’s discovery leads to the use of Galvanic currents. England’s first electrical therapy department is established at Guy’s Hospital, under Dr. Golding Bird.

1860+ England
The start of Faradic Stimulation. Bristow develops the Bristow Coil, using Faraday’s principle of electromagnetically controlling the voltage of electricity.

1885 France
D’Arsonval again uses torpedoes, as a model for pain-relief electrical devices.

1891 France
D’Arsonval shows that a high frequency current (greater than 10,000Hz) can go through the body without producing any sensation other than heat. Below 10,000Hz, muscle contraction is elicited. He notes the ability of high frequency currents to modify physiological processes, including: respiratory exchange, dilation of peripheral blood vessels, arterial blood pressure.

1891 USA
Nicola Tesla outlines medical uses of high frequency currents, developing the forerunner of Longwave, Shortwave and Microwave diathermy devices, used for heating of deep body tissues.

1900+ Worldwide
The discoveries of Galvano, Faraday and Tesla are therapeutically adopted, stimulating the human body with Galvanic, Sinusoidal and Faradic currents, which became standard for Electrical Body Stimulation.

1906 USA
Lee de Forest builds the first thermonic triode vacuum valve.

1908 Germany

1914+ England
World War I casualties are treated for exercise, pain management and healing with Faradic, Sinusoidal, Galvanic and Longwave diathermy currents.

1920+ Worldwide
Combined Faradic, Sinusoidal, Galvanic and Switched Galvanic clinical "switch tables" are produced. Shortwave diathermy devices are produced.

1923 Australia
Australian therapists responsible for treating World War I casualties with electro-medicine obtain certification.

1930's Germany
Interferential currents are developed. Two alternating, medium frequency sinewave current paths are crossed to give pulsed low frequency modes of electrical stimulation. Interferential currents are much more comfortable than anything else available at the time.

1946 & 1953 Australia
In 1946 William Schockley of Bell Laboratories produces the first transistor, which eventually replaces the vacuum valve. In 1953 Texas Instruments produces the Silicone transistor.

1950's - 1990's Russia
“Russian Stimulation” is developed for athletes for building muscle and increasing power.

Mid-60s onwards - Modern Electrotherapy
Present day TENS begins with the landmark paper by Melzack and Wall, entitled “Pain Mechanism: A New Theory.” An enormous amount of scientific research followed, resulting in the therapy used today.
The "Pain Control Gate" theory suggested that strong afferent nerve stimulation by chemical, mechanical or electrical means overrides painful sensations at hypothetical pain control "gates" in the spinal cord.

Melzack and Wall’s "gate" is thought to be the substantia gelatinosa. When the gate is open pain impulses can pass easily; when the gate is partially open only some pain impulses can pass and when the gate is closed no pain impulses are able to pass. They suggested that the position of the gate depends upon the degree of large or small fiber firing. When large fibers firing predominates, the gate closes so that no impulses can pass through, whereas when small fiber predominates, the pain message can be transmitted.

Their work led to the development of the first Transcutaneous Electrical Nerve Stimulation (TENS) device. Today, TENS is used worldwide to combat a vast range of pain conditions without the side effects of drugs.

1970’s USA
Transcutaneous Electrical Nerve Stimulation (TENS) is acknowledged as a viable method of pain management by America’s Food and Drug Administration (FDA). Many American companies begin production of TENS devices. The heart pacemaker is developed.

1977 Australia
Lamers develops the "Biphasic Capacitance Discharge Micro-pulse" device, with equally active stimulation from both electrodes instead of just one.

1970’s & 80’s Sweden
Ericsson and Sjolund publish research comparing constant, high frequency TENS to bursts of high frequency TENS (termed acupuncture-like TENS), finding that the latter offers better pain relief and does in fact instigate a release of endorphins into the bloodstream.

1980’s USA
High voltage Galvanic stimulation of up to 500 volts is used in table-top clinical use devices.

1981 USA
Becker electrically induces limb regeneration in frogs and rats.

1990’s Worldwide
Advances in electrically conductive polymers and self-adhesive, electrically conductive gels allow for production of electrodes which are much more user-friendly.

1991 Australia
Lamers manufactures the worlds first multi-function stimulator, combining a TENS (for pain relief, etc.) with EMS (for muscle strengthening).

2000 USA
John McDonald of Washington University uses Electrical Muscle Stimulation (EMS) to exercise the muscles of a quadriplegic of 8 years. The patient defies medical science by regaining limited sensation and movement in his body.

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TYPES OF ELECTRICAL STIMULATION

TENS and EMS are not the only two approaches to using electrical stimulation. Some others are also included in the following outline:

Transcutaneous Electrical Nerve Stimulation (TENS)
The TENS type of stimulator is characterized by biphasic current. Most stimulators feature adjustable settings to control amplitude (intensity) of stimulation by controlling voltage, current, and pulse width (duration) of each pulse. Electrodes are placed at specific sites on the body for treatment of pain. TENS stimulates sensory nerves to block pain signals, and stimulate endorphin production to help normalize sympathetic function.

Common uses: Acute and chronic pain, back and cervical muscular and disc syndromes, RSD, arthritis, shoulder syndromes, neuropathies, and many other painful conditions.

Electronic Muscle Stimulator (EMS)
EMS stimulation is characterized by a low volt stimulation targeted to stimulate motor nerves to cause a muscle contraction. Contraction/relaxation of muscles has been found to effectively treat a variety of musculoskeletal and vascular conditions. EMS differs from TENS in that it is designed to stimulate muscle motor nerves, while TENS is designed to stimulate sensory nerve endings to help decrease pain.

Some of the uses of EMS are as follows:
Maintaining and Increasing Range of Motion: In conditions where the reduction of physiological range of motion is due to or the result of fractures with consequent immobilization, operative intervention, or arthroscopy, in shoulders, knees, and backs.

The Prevention or Retardation of muscle Disuse Atrophy: Muscle disuse atrophy is a reduction in muscle contraction and size due to prolonged impairment or joint immobility from surgery, injury or disease. The use of electrical stimulation to contract the muscles builds and strengthens the muscles, assisting in prevention of disuse atrophy.

Relaxation of muscle Spasms: Muscle spasms and cramping often occur in areas of localized pain and tenderness. Stimulation is used to fatigue the “spastic” muscle.

Muscle Reeducation: Evidence has shown that a combination of both exercise and electrical stimulation is far superior in strengthening atrophied muscles.

Increased Local Blood Circulation: Rhythmic muscle contraction helps improve blood circulation, thereby aiding in the reduction of localized swelling and tenderness.

Immediate Post-surgical Stimulation of Calf Muscles to Prevent Venous Thrombosis: The use of EMS to increase blood circulation assists in the prevention of venous thrombosis.
Interferential Stimulator (IF)

Interferential electrical stimulation is a unique way of effectively delivering therapeutic frequencies to tissue. Conventional TENS and Neuromuscular stimulators use discrete electrical pulses delivered at low frequencies of 2-160 Hz per second. However, Interferential stimulators use a fixed carrier frequency of 4,000 Hz per second and also a second adjustable frequency of 4,001-4,400 Hz per second. When the fixed and adjustable frequencies combine (heterodyne), they produce the desired signal frequency (Interference frequency). Interferential stimulation is concentrated at the point of intersection between the electrodes. This concentration can occur deep in the tissues as well as at the surface of the skin. Conventional TENS and Neuromuscular stimulators deliver most of the stimulation directly under the electrodes. Thus, with Interferential Stimulators, current perfuses to greater depths and over a larger volume of tissue than other forms of electrical therapy. When current is applied to the skin, capacitive skin resistance decreases as pulse frequency increases. For example, at a frequency of 4,000 Hz (Interferential unit) capacitive skin resistance is eighty (80) times lower than with a frequency of 50 Hz (in the TENS range). Thus, Interferential current crosses the skin with greater ease and with less stimulation of cutaneous nociceptors allowing greater patient comfort during electrical stimulation. In addition, because medium-frequency (Interferential) current is tolerated better by the skin, the dosage can be increased, thus improving the ability of the Interferential current to permeate tissues and allowing easier access to deep structures. This explains why Interferential current may be most suitable for treating patients with deep pain, for promoting osteogenesis in delayed and nonunion fractures and in pseudarthrosis, for stimulating deep skeletal muscle to augment the muscle pump mechanism in venous insufficiency, and for depressing the activity of certain cervical and lumbosacral sympathetic ganglia in patients with increased arterial constrictor tone.

Common uses: Pre and post-orthopedic surgery, joint injury syndrome, cumulative trauma disorders, increasing circulation and pain control of various origins.

High Voltage Pulsed Galvanic Stimulator (HVPGS)

High-voltage pulsed galvanic stimulation (HVPGS) is gaining widespread use for wound healing, edema reduction and pain relief. Carpal Tunnel Syndrome and Diabetic Foot are two major areas of use. Devices in this class are characterized by a unique twin-peak monophasic waveform with very short pulse duration (microseconds) and a therapeutic voltage greater than 100 volts. The combination of very short pulse duration and high peak current, yet low total current per second (Microcurrent) allows relatively comfortable stimulation. Furthermore, this combination provides an efficient means of exciting sensory, motor and pain-conducting nerve fibers. Perceptual discrimination of those responses is relatively easy to achieve and thus its clinical versatility.

Microcurrent Electrical Neuromuscular Stimulator (MENS)

The newest units use a very low voltage current, usually between 1uA and 1000uA. A microamp (uA) is 1/1000 of a milliamp (mA), so 1000 uA equals 1 mA. Most TENS devices have a milliamplitude of 1-80 mA. Microcurrent is measured in MicroAmps, millionths of an ampere. Current levels that seem to be most effective in helping tissue heal range from 20 to 500 MicroAmps.

Where TENS is used to hide pain, Microcurrent, because of its close proximity to our own body’s current, is thought to work on a more cellular level. It has been theorized that healthy tissue is the result of the direct flow of electrical current throughout the body. Electrical balance is disrupted when the body is injured at a particular site, causing the electrical current to change course. The use of Microcurrent over the injured site is thought to realign this flow, thus aid in tissue repair.

It has been found that ATP (Adenosine Triphosphate) in the cell helps promote protein synthesis and healing. The lack of ATP due to trauma of the tissue results in the decreased production of sodium and an increase in metabolic wastes, which is perceived as pain. The use of Microcurrent at an injured area helps realign the body’s electrical current, increase the production of ATP, resulting in increased healing and recovery, as well as blocking the pain that is perceived.
INTRODUCTION

A CLOSER LOOK AT TENS AND EMS: WHY DO THEY WORK?

TENS is a safe, easy to use and drug free method of pain relief used by hospital pain clinics and in physiotherapy since the 1960’s.

The TENS Unit is a small battery operated box which produces pain relieving electrical pulses. Either 2 or 4 self adhesive electrodes are applied to the skin and attached to the TENS unit with lead wires.

The tiny pulses are then passed from the TENS unit, via the lead wires and electrodes, so that they are applied to the nerves which lie underneath the skin surface. The electrodes are normally positioned over, or around, the area of pain but other more advanced applications may often prove better.

TENS works through 3 different mechanisms.

First, electrical stimulation of the nerves can block pain signals as they travel from the site of injury to the spine and upwards to the brain. If these signals arrive at the brain we perceive pain. If they are blocked en-route to the brain we do not perceive pain. This is known as “closing the pain gate”. When using TENS to “close the gate” we use Conventional TENS Mode. Conventional (or Continuous) TENS mode produces a gentle and pleasant “tingling” under and between the two electrodes. The “tingle” sensation helps to block the pain by closing the “pain gate” and slowing down the painful nerve signals - this produces analgesia (numbness) in the painful area.

Secondly, the body has its own built in mechanism for suppressing pain. It does this by releasing natural chemicals called endorphins in the brain and spinal cord and these chemicals act as very powerful analgesics. When using TENS to help activate endorphins we use Burst TENS Mode. Burst mode produces a rhythmic pulse which should be strong enough to produce a “twitch” in the muscles underneath the electrodes. This muscle “twitch” helps to release the endorphins and enkephalins and also helps the pain “switches” in the brain to be activated through muscular and reflex activity.

Finally, muscles which are in spasm, or have become short and hard as a result of long term hypertension, can produce much of the pain associated with back related problems and arthritis. We can help these muscles to relax and soften by using the gentle massage effect of Modulated TENS Mode. Modulation (massage) mode produces a gentle and comforting massage effect which exercises problematic muscles and helps to reduce musculoskeletal pain.

Pain Control Mechanisms

Pain
Pressure exerted on nerve tissue is the major cause of pain. Pain is an exceptionally strong signal that warns us that something is wrong. It may be a signal recorded from our skin touch receptors and from internal receptors located in our muscles, joints and organs. Pain warnings are necessary for our survival, as they activate our body to protect us from danger. However, when pain persists and we know its cause, we are able to apply therapy to the pressure causing the problem, and stimulation to alleviate the pain we are caused to feel from the pressure upon nerves. As many people develop cycles of “pain-spasm-more pain,” the breaking of a pain cycle enables the body to recover more rapidly.

Electronic Aspirin
The analgesia obtained using TENS is like an Electronic Aspirin. The combined mechanisms of endorphin release, an encephalin release and a gating effect, help suppress or shut off pain signals from reaching the brain. This has a hormonal effect of suppressing pain-conducting signals at nerve junctions and to Unlearn the Feeling of Pain.

Endorphin Release
The Medication Effect An endorphin release has a slow acting effect. TENS is applied at a low repetition (pulse) rate of less than ten pulses per second. The introduced electrical stimulation activates neural potentials within C type sensory nerve fibers, which transmit at the slow rate of the Autonomic Nervous System, to activate the body’s main pain defense mechanism. C type stimulation requires a longer application time of twenty five minutes to two hours to reach a maximum level of endorphin release, but because endorphins remain at effective levels in the blood stream for extended periods, a pain relief period of up to thirty six hours may be achieved. Sustained stimulation at low levels of pulse intensity has the strongest effect on managing chronic nagging pain. Experience has shown that for the management of chronic pain, an endorphin release is by far the most effective application of TENS Endorphins flow through the circulatory system acting like pain medication, inhibiting pain message transmission at nerve junctions throughout the body.

Endorphins, because of their analgesic medication type action, induce an analgesic effect that relieves other aches and pains, as well as the primary pain for which TENS is applied. It is worth noting that Morphine is a clone of endorphin and acts on the same reception center in the CNS. The strong pain management effect of morphine is also available from endorphins, which have a more powerful pain management effect than non-opiate advanced medication. An endorphin release occurs at a slow, deferred function similar in effect to medication in the blood stream, so repeated three times daily doses of TENS pain management may be required. The effect of an endorphin release may last much longer in the elderly.
TENS PAIN GATE: BLOCKING PAIN

**Figure A**
Under normal physiological circumstances, the brain generates pain sensations by processing incoming noxious information arising from stimuli such as tissue damage. In order for noxious information to reach the brain it must pass through a metaphorical “pain gate” located in lower levels of the central nervous system. In physiological terms, the gate is formed by excitatory and inhibitory synapses regulating the flow of neural information through the central nervous system. This “pain gate” is opened by noxious events in the periphery.

**Figure B**
The pain gate can be closed by activating mechanoreceptors through rubbing the skin. This generates activity in large diameter A afferents, which inhibits the onward transmission of noxious information. This closing of the “pain gate” results in less noxious information reaching the brain, reducing the sensation of pain. The neuronal circuitry involved is segmental in its organization. The aim of conventional TENS is to activate A fibres using electrical currents. The pain gate can also be closed by the activation of pain-inhibitory pathways become active during psychological activities such as motivation and when small diameter fibres (A) are excited physiologically. The aim of AL-TENS (Acupuncture-like TENS) is to excite small diameter peripheral fibres to activate the descending pain-inhibitory pathways.

**Gating Effect and Encephalin Release**
A gating effect obtained using TENS is a quick acting effect. It occurs because the introduced stimulation acts as a counter to the stimulus causing the pain, by blocking it from registering. It switches off painful sensations at hypothetical pain control gates in the Central Nervous System, thereby achieving a pseudo mechanical effect known as gating or blanket- ing. The theory of gating is that a pain control gate is closed by the hyper-activation of neural sensory potentials within A type nerve fibers, which overrides the slow velocity pain conducting neural potentials transmitted in the C type fibers. The function of A type sensory nerve fibers is to transmit reflex action potentials, other urgent messages of pain, other strong warning signals and skeletal muscle action messages at high velocities. This high velocity enables the use of high pulse rates of 100 to 400 pps to maximize a strong gating effect. A gating effect is achieved using short periods of strong stimulation. This is the most common form of electrical induced analgesia, but it is not necessarily the best, because it only controls pain for a short period.

An encephalin release also occurs in response to hyper activation of A type sensory nerve fibers. Encephalins act similarly to endorphins. A gating and encephalin release is required for strong acute pain management and in exceptional circumstances the condition may need ongoing pain management.

**Endorphin Release, Gating Effect and Encephalin Release**
A combined endorphin release, an encephalin release and a gating effect are all achieved at the same time by changing the rate of the stimuli to A, B and C type sensory nerve fibers, with a combined low and a high modulated (changing) rate stimuli. This induces a very effective short and long term pain management, which is a frequently used method of controlling pain.

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EMS = ELECTRONIC MUSCLE STIMULATOR

Muscle building - Rehabilitation - Massage - Endurance
Cross Training Power - Pain Management

Electronic Muscle Stimulators simulate or reproduce the physiological effects on the motor nerve produced by the brain, causing muscle contraction. During an exercise, your brain sends a message down the spinal cord through the nerves with all the muscles you’re using that causes them to relax and contract. This is called voluntary muscle action. Your brain is controlling the muscle by signalling it to expand and contract.

EMS electrodes are placed over the motor points of the muscle group to be exercised. When the stimulation is applied through the pads, the signal finds its way to these motor points and causes the muscle to expand and contract. This makes it possible to duplicate a conventional exercise, similar to an isometric exercise.

EMS is predominately used by doctors and physical therapists to prevent, or reduce, muscle atrophy. Atrophy is the weakening and loss of muscle tone, which is usually experienced after surgeries or injuries. EMS has proven to be an effective means of preventing muscle atrophy. Doctors also see EMS as a means of increasing blood flow to muscles, increasing range of motion, increasing muscle strength, as well as enhancing muscle endurance. EMS will have pain management attributes in regards to muscle related pain, such as a spastic muscle, sore muscles, or tight muscles. A TENS device is more suited for nerve related pain conditions (acute and chronic conditions).

Studies have shown that EMS stimulates large nerve axons (long outgrowths of a nerve cell body), some of which you cannot stimulate voluntarily. This allows you to train muscles that may normally have little activity. It is possible that EMS might allow for additional muscle hypertrophy (increased development of tissue by enlargement, without multiplication of cells).

EMS may be used by itself or with regular weight training to aid recovery and help muscles grow and get stronger. EMS can increase body temperature, heart rate and metabolism (promoting energy and fat absorption from the body).

Will EMS Improve My Physical Appearance?
EMS is widely used by bodybuilders and other athletes as a supplement to strength training. Olympic athletes have been utilizing EMS to enhance their training for over twenty years. EMS is used to increase muscle tone and endurance.

For best results, many bodybuilders use EMS in conjunction with working out. A rhythmic pumping of the muscles, produced by the EMS unit, helps deliver nutrients and oxygen to the muscles. Concurrently, waste products such as lactic acid are pumped out of the muscles. This increased blood flow to the muscles cuts down on recovery time and promotes healthy muscle activity. Bodybuilders also frequently use EMS for the relaxation of muscle spasms. EMS provides an increase in range of motion, which reduces the chance of injury. Men and Women are increasingly using EMS to enhance their appearance by toning their abdominal and chest muscles.

MICROCURRENTS IN COSMETOLOGY
AND BEAUTY

Electric currents have been incorporated into facial treatments for many years. The research and development conducted to assist baby boomers in maintaining a youthful appearance has promoted their evolution to the highly efficient apparatuses we have at our disposal today. Understandably, there is a great deal of interest around the muscle enhancement abilities of microcurrents. Many esthetic professionals are successfully marketing these treatments as “non-surgical lifts.”

The combination of different variations of currents allows these devices to show great results. The currents vary in the time they take to peak, whether gradually or quickly. The time the current remains peaked will also vary, as will the time the current takes to subside. The variation in the current and frequency can be concentrated on specific tissues and adapted to the individual needs of each client. The micro-currents utilized produce different effects on the muscle and the tissue of the skin.

If we look at the muscle enhancement abilities of these devices we need to understand what happens to muscle tissue as we get older. The facial muscles either relax causing poor tonus in the facial tissue, or stay contracted due to stress and habitual contraction. For example, in a young client, the zygomaticus muscles of the cheeks are nice and firm and there is definition to the cheek and jaw line. In a more mature client, the same muscles have relaxed and the definition of the cheek and jaw line is much softer. Continual frowning systematically contributes to permanent vertical lines above the nose. These changes in the muscle tonus develop over time and are due to the Golgi Apparatus of the muscles not responding as efficiently to nerve stimulation.

Micro current devices can be used to improve the muscle reception and re-educate the muscle to respond more effectively to regular nerve stimulation. The desired relaxed state of a muscle is semi-contracted, allowing it to function effectively. Microcurrents can help bring this “memory” back to the muscle, giving better tonus to the face and relaxing over contracted muscles. This means a firmer-appearing facial tonus and diminished appearance of lines.
The other major benefit of micro-current stimulation is the enhancement of tissue repair. The circulation is improved, providing better cellular exchange and regeneration.

For the best long-term results it is highly advisable to complete a series of treatments, two or three treatments a week for about four weeks, followed by a maintenance treatment every six weeks. The success of micro-current application is greatly influenced by the knowledge of the esthetician or beauty therapist, as the proper placement of the electrodes is crucial. The other result oriented component is to ensure that each client practice the proper home care regime to support the treatments.

HAZARDS AND CONTRAINDICATIONS

Contraindications to TENS are few and mostly hypothetical with few reported cases of adverse events associated with TENS in the literature. Nevertheless, therapists should be cautious when giving TENS to certain groups of patients.

Those suffering from epilepsy: If the patient were to experience a problem while using TENS, from a legal perspective it might be difficult to exclude TENS as a potential cause of the problem.

Women in the first trimester of pregnancy: TENS effects on fetal development are as yet unknown (although there are no reports of it being detrimental). To reduce the risk of inducing labour, TENS should not be administered over a pregnant uterus although TENS is routinely administered on the back to relieve pain during labour.

Patients with cardiac pacemakers: this is because the electrical field generated by TENS could interfere with implanted electrical devices.

TENS should not be applied internally (mouth), or over areas of broken or damaged skin. Therapists should ensure that a patient has normal skin sensation prior to using TENS, as if TENS is applied to skin with diminished sensation the patient may be unaware that they are administering high-intensity currents and this may result in a minor electrical skin burn. TENS should not be delivered over the anterior part of the neck as currents may stimulate the carotid sinus leading to an acute hypotensive response via a vasovagal reflex. TENS currents may also stimulate laryngeal nerves, leading to a laryngeal spasm.

TENS CONTROLS AND MODES

A microcurrent stimulation device typically offers the ability to control various modes and intensities of stimulation.

Amplitude:
This is the “INTENSITY” level of stimulating pulses. TENS/EMS pulses are usually at relatively low intensity, up to a maximum of 100 mA (milli-Amperes).

Zero intensity or amplitude means in effect the pulses are non-existent, or the device is not operating.

Caution: If the stimulation levels are uncomfortable or become uncomfortable, reduce the stimulation intensity to a comfortable level and contact your physician if problems persist.

Pulse Width
Duration, or interval, of pulses, measured in micro-seconds (μs). Pulses are separated by pulse intervals (time between pulses) also in μs, but not controlled separately.

Pulse Frequency
Setting for the number of pulses per unit of time (second). Standard measure is pulses per second in Hertz (Hz). TENS and EMS settings are usually up to 200 Hz.

Waveform or Pulse Shape
Shape of the visual representation of a pulse on an amplitude-time plot. For example, “Square,” “Sinusoidal,” etc.

Rectangular wave pulses. These are pulses of any duration between 1 and 600 ms separated by pulse intervals of anything from 1 ms to several seconds. Such pulses can stimulate motor and sensory nerves and can be used to stimulate denervated muscle.

“Accommodation” pulses. Triangular, trapezoidal, sawtooth, serrate, slow-rising, shaped, selective and accommodation pulses are all synonymous terms. Relatively long-duration pulses, usually 300-1000 ms, separated by pulse intervals of 1/2 to several seconds. These pulses are used to stimulate muscle, as opposed to nerve, tissue selectively and they are able to do this because of differences in muscle and nerve accommodation. (“Accommodation” refers to the ability of tissue to avoid stimulation by microcurrents.)

Phase
Current in one direction for a particular time. So biphasic pulses are delivered in continually switching directions (like “alternating current”).

Modulation
Simply meaning “change”, Modulation refers to electronic modulation of factors such as intensity, frequency and pulse width. Various Stimulation Modes employ electronic modulations:

NORMAL or Continuous Mode
The Normal or “Continuous” mode produces a continuous train of impulses. The stimulation parameters are not automatically interrupted nor varied in any way. In this mode, the pulses (usually from 2 to 150 Hz), and pulse width (usually from 50 to 300μs) are usually fully adjustable. The normal mode is quite versatile because it may be applied with a variety of rate and width settings.
BURST Mode
The burst mode provides a “burst” of a number of pulses, for example, seven pulses.

MRW (Modulated Rate and Width) Mode:
The pulse rate and width are automatically varied in a cycle to produce a pleasant, massage-like sensation. It’s believed that nerves can become accustomed to, or “accommodated” to the same electrical stimulus after a period of time and thus would require increasing the intensity to further “block” the pain. The Modulation mode was produced to offer a variety of different electrical stimulation, thus preventing nerve accommodation so that less intensity is required for long and effective treatment. As an example, during the beginning of 0.5 sec. period, the WIDTH decreases to 50% of its original setting and then during the next 0.5 sec. period, the RATE is decreased to 50% of its original setting. Therefore, the total cycle time is 1 second.

SD (Strength Duration) Mode:
Strength-Duration modulation consists of alternating modulated intensity and pulse width, so that the intensity in always increasing while the pulse width is decreasing and vice-versa. As an example, the stimulation intensity modulates to 62.5% maximum of setting (width equal to setting). The pulse width modulates to 67% of setting (intensity equal to setting). Total cycle time is 6 seconds. Rate (from 2~150Hz), and width (from 50~300μs) are fully adjustable.

Bi-Pulse Mode:
Delivers different modulations to each channel. As an example, delivers 4 pulses per second to Channel 1 (i.e. the pulse rate of Channel 1 is fixed at 4 Hz) while delivering 100 pulses per second to Channel 2 (i.e. the pulse rate of Channel 2 is fixed at 100Hz). Stimulation is burst on for 1.0 second, then off for 1.0 second. In the illustration each pulse appears as a vertical line. Pulse width (from 50~300μs) is fully adjustable.

TYPICAL CONTROLS
A panel often covers the controls for MODE, SET, INCREASE and DECREASE adjustment. Your medical professional may ask to set these controls for you and request that you leave the cover in place.

“INCREASE” control
Typically this control will show an “increase” character to increase the pulse width from 50–300μs, and to increase the pulse rate from 2 to 150Hz, and to increase the timer from 5 to 90 mins to continuous mode.

“DECREASE” control
Typically this control will show a “decrease” character to decrease the pulse width from 300–50μs, to decrease the pulse rate from 150 to 2Hz, and to decrease the timer from continuous mode to 90 to 5 min.

“MODE” control
This control will select for a Stimulation-Mode. Typically it offers mode status from five types of stimulation modes, such as Burst, Normal, MRW (Modulate Rate and Width), SD (Strength Duration) and Bi-Pulse.

“SET” control
This sets the selections made for the rate, width and timer.

“LCD Screen”
Typically an LCD will be utilized to display stimulating mode/pulse width/pulse rate and to display timer. The channel output will be indicated on the left side (Channel 1) and right side (Channel 2) of the LCD screen.

Be sure that when adjusting these stimulation modes, the intensity (Amplitude) controls are set to the minimum output positions.
CONSULT with your professional about using alternate electrode pad positions on your body, so that one particular area of skin does not get constant use. Sometimes changing electrode styles may also help. Different electrode manufacturers use different adhesives. Despite the fact that TENS electrodes use hypo-allergenic materials, a patient may still have difficulty with a certain brand of electrode. Moisturizing skin cream, applied after treatment, has been found to be helpful for many patients. If skin irritation still occurs, despite the above recommendations, discontinue use.

**Care of Devices**

The TENS unit is an electrical device. It should not be immersed in water for cleaning. A soft, damp rag should be sufficient to remove any dirt from the instrument case.

Store your electrodes in a cool dry place. Return the electrodes to their storage bag between uses.

Do not attempt to sterilize the instrument or immerse in any liquid.

Do NOT yank or twist the lead wire portion of the electrode. The electrode wire is deliberately made from thin strands of wire to increase flexibility and reduce the weight of the cord assembly. Otherwise the weight of the cord would pull the electrode right off your body.

When removing the pins from the electrode pad, hold onto the hard plastic part of the pin connector and remove slowly from the electrode pad. Electrode lead wires normally last at least 5 - 6 months with normal care and will last considerably longer if reasonable care is taken.

**Replacement Electrodes**

A full range of electrodes for your instrument are available from http://www.ib3health.com/ and electrodes may be available through your local medical supply dealer or a pharmacy that has a home health center. Ask for electrodes that use the industry standard pin style.
ELECTRODE PLACEMENT: GENERAL ILLUSTRATIONS

INTRODUCTION

TENS Pain Control Unit Placement Diagram

**General Illustrations**

- Trigeminal neuralgia
- Thalamic pain: where pain is most pronounced
- Postherpetic neuralgia: above affected dermatome, across affected dermatome
- Postoperative pain: large electrodes if appropriate
- Phantom limb pain: over main nerve bundle arising from phantom
- Dymenorrhoea (women)
- Knee pain (osteoarthritis): dual channel if appropriate
- Ankle pain

**TENS Pain Control Unit Placement Diagram - Rear View**

- Neck pain
  - bilateral
  - unilateral
- Postherpetic neuralgia: above affected dermatome, across affected dermatome
- Low back pain or dymenorrhoea
- Stump pain
- Hip pain
- Solatica
- Stump and phantom limb
- Peripheral vascular disease
- Tendinitis

**The Position of Electrodes and Electrical Characteristics of TENS when used to Manage Labour Pain**

- Electodes positioned to target afferents active during distension of cervix and lower uterine segment (1st stage labour)
- Electodes positioned to target afferents active during distension of pelvis and perineum (2nd stage labour)

- All four electrodes are active
- Between contractions: low intensity/low frequency (burst)
- During contractions: high intensity/high frequency (continuous)
In learning how to use your TENS/EMS device to your best advantage, a critical factor is electrode placement. What follows are suggestions for best uses of TENS for pain control, electrode placements, and appropriate settings.

Note: These settings are suggestions only, and are in general simpler, not intended for advanced users. Alternative approaches to use of TENS exist, as well as different environments, e.g., hospitals, where for example treatment times may be considerably longer; and we recommend getting your instructions on TENS use for your particular condition, from a qualified medical practitioner.

Placement is the key. The diagrams illustrate Electrode Placements for a variety of conditions. For the greatest effectiveness in pain relief, it is important to locate TENS electrodes in such a way that the current passes through the area giving distress, or along the nerves leading from the pain.

In the diagrams which follow, we have tried to make clear the optimal placement of electrodes for a wide variety of painful conditions.

Using the Diagrams
Refer to the Table of Contents list for the diagram illustrating the TENS solutions to various pain problems, including the common electrode positioning for the given conditions.

LOWER BACK PAIN
Recommended Settings:
MODE SETTING: C (Continuous)
PULSE WIDTH SETTING: 260
PULSE FREQUENCY SETTING: 50-80Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, 1-2 times daily

NEURALGIA (Nerve Pain) OF THE HIP
Recommended Settings:
MODE SETTING: M (Modulation)
PULSE WIDTH SETTING: 150-260
PULSE FREQUENCY SETTING: 80-120Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, up to 4 hours per day.

PHANTOM LIMB, LOWER EXTREMITIES
Recommended Settings:
MODE SETTING: C (Continuous) or M (Modulation)
PULSE WIDTH SETTING: 160 - 200
PULSE FREQUENCY SETTING: 50 - 100Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, 1-2 times daily
**SCIATICA**
Recommended Settings:
- MODE SETTING: M (Modulation)
- PULSE WIDTH SETTING: 260
- PULSE FREQUENCY SETTING: 150Hz
- AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, 1-2 times daily

**BICIPITAL TENDONITIS (Tendonitis of the Biceps)**
Recommended Settings:
- MODE SETTING: M (Modulation)
- PULSE WIDTH SETTING: 150 - 160
- PULSE FREQUENCY SETTING: 50Hz
- AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, 1-2 times daily

**TEMPORAL MANDIBULAR JOINT PAIN (TMJ, Jaw Pain)**
Recommended Settings:
- MODE SETTING: M (Modulation)
- PULSE WIDTH SETTING: 220
- PULSE FREQUENCY SETTING: 10Hz
- AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, up to 6 hours per day.

**SHOULDER PAIN**
Recommended Settings:
- MODE SETTING: M (Modulation)
- PULSE WIDTH SETTING: 260
- PULSE FREQUENCY SETTING: 80 - 100Hz
- AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, 1-3 times daily
COMMON CONDITIONS

REFLEX SYMPATHETIC DYSTROPHY
(Causalgia, Complex Regional Pain Syndrome [CRPS])
Recommended Settings:
MODE SETTING: M (Modulation)
PULSE WIDTH SETTING: 80 - 100 Hz
PULSE FREQUENCY SETTING: 30 Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, up to 4-6 hours per day.

TRIGEMINAL NEURALGIA (Tic Doloreux, Facial)
Recommended Settings:
MODE SETTING: M (Modulation)
PULSE WIDTH SETTING: 70
PULSE FREQUENCY SETTING: 00 Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, up to 3 times per day.

CERVICAL (Neck) PAIN
Recommended Settings:
MODE SETTING: C (Continuous)
PULSE WIDTH SETTING: 100 - 150
PULSE FREQUENCY SETTING: 60 - 100 Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, 1-2 times daily

CHRONIC CERVICAL (Neck) STRAIN
Recommended Settings:
MODE SETTING: M (Modulation)
PULSE WIDTH SETTING: 160
PULSE FREQUENCY SETTING: 30 Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes up to 4-5 hours per day.

TRIGEMINAL NEURALGIA (Tic Doloreux, Facial)

CERVICAL (Neck) PAIN

CHRONIC CERVICAL (Neck) STRAIN
COMMON CONDITIONS

CHRONIC CERVICAL SPINE PAIN (Postlaminectomy)
Recommended Settings:
MODE SETTING: M (Modulation)
PULSE WIDTH SETTING: 200
PULSE FREQUENCY SETTING: 10Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, up to 4-5 hours per day.

CERVICAL (Neck) OSTEOARTHRITIS
Recommended Settings:
MODE SETTING: C (Continuous)
PULSE WIDTH SETTING: 100 - 150
PULSE FREQUENCY SETTING: 100Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, up to 3 times per day.

UNILATERAL CERVICAL SPINE PAIN
Recommended Settings:
MODE SETTING: M (Modulation)
PULSE WIDTH SETTING: 100
PULSE FREQUENCY SETTING: 100Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, 1-2 times daily

MASTECTOMY – Right Side (Breast Removal)
Recommended Settings:
MODE SETTING: M (Modulation)
PULSE WIDTH SETTING: 260
PULSE FREQUENCY SETTING: 120Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
15 minutes, 3 times per day.
COMMON CONDITIONS

DEGENERATIVE ARTHRITIS: CERVICAL AND LUMBAR
Recommended Settings:
MODE SETTING: C (Continuous)
PULSE WIDTH SETTING: 100
PULSE FREQUENCY SETTING: 100Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, 1-2 times daily

LATERAL RIB CAGE PAIN
Recommended Settings:
MODE SETTING: C (Continuous)
PULSE WIDTH SETTING: 150
PULSE FREQUENCY SETTING: 100Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, 1-2 times daily

CHRONIC HIP PAIN
Recommended Settings:
MODE SETTING: M (Modulation)
PULSE WIDTH SETTING: 200
PULSE FREQUENCY SETTING: 100Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, 1-2 times daily

HERPES ZOSTER (SHINGLES) AND POST-HERPETIC NEURALGIA (PHN)
Recommended Settings:
MODE SETTING: C (Continuous)
PULSE WIDTH SETTING: 150
PULSE FREQUENCY SETTING: 100Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, 1-2 times daily
COMMON CONDITIONS

ACUTE MUSCLE AND LIGAMENT TEAR - ANKLE
Recommended Settings:
MODE SETTING: C (Continuous)
PULSE WIDTH SETTING: 100
PULSE FREQUENCY SETTING: 100Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient's comfort level.
Recommended Treatment Schedule:
Around 30 minutes, 1-2 times daily

POST-PODIATRIC SURGERY (involving lateral toes)
Recommended Settings:
MODE SETTING: C (Continuous)
PULSE WIDTH SETTING: 100 - 150
PULSE FREQUENCY SETTING: 100Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient's comfort level.
Recommended Treatment Schedule:
Around 30 minutes, up to 4 hours per day.

KNEE PAIN – POST-OP
Recommended Settings:
MODE SETTING: M (Modulation)
PULSE WIDTH SETTING: 100 - 150
PULSE FREQUENCY SETTING: 120Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient's comfort level.
Recommended Treatment Schedule:
Around 30 minutes, 1-2 times daily

DEGENERATIVE ARTHRITIS - KNEE PAIN
Recommended Settings:
MODE SETTING: C (Continuous)
PULSE WIDTH SETTING: 220
PULSE FREQUENCY SETTING: 80Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient's comfort level.
Recommended Treatment Schedule:
Around 30 minutes, 1-2 times daily
COMMON CONDITIONS

**RECURRENT PATELLAR SUBLUXATION (Dislocated Knee)**
Recommended Settings:
- MODE SETTING: C (Continuous)
- PULSE WIDTH SETTING: 220
- PULSE FREQUENCY SETTING: 80Hz
- AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, up to 4 hours per day.

**LOWER EXTREMITIES PAIN (REFLEX SYMPATHETIC DYSTROPHY, Causalgia, Complex Regional Pain Syndrome” [CRPS])**
Recommended Settings:
- MODE SETTING: C (Continuous) or M (Modulation)
- PULSE WIDTH SETTING: 160 - 80Hz
- PULSE FREQUENCY SETTING: 100Hz
- AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, 1-2 times daily

**LOWER LEG PAIN (DIABETIC NEUROPATHY or nerve damage)**
Recommended Settings:
- MODE SETTING: M (Modulation)
- PULSE WIDTH SETTING: 100 - 160
- PULSE FREQUENCY SETTING: 60 - 100Hz
- AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, 1-2 times daily

**CARPAL TUNNEL SYNDROME**
Recommended Settings:
- MODE SETTING: C (Continuous)
- PULSE WIDTH SETTING: 260
- PULSE FREQUENCY SETTING: 100Hz
- AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
20 minutes, 3 times per day.
COMMON CONDITIONS

WRIST PAIN
Recommended Settings:
MODE SETTING: C (Continuous)
PULSE WIDTH SETTING: 260
PULSE FREQUENCY SETTING: 30 - 50Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, 1-2 times daily

ELBOW & FOREARM PAIN
Recommended Settings:
MODE SETTING: C (Continuous)
PULSE WIDTH SETTING: 100
PULSE FREQUENCY SETTING: 100Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, 1-2 times daily

UPPER EXTREMITIES PAIN (REFLEX SYMPATHETIC DYSTROPHY)
Recommended Settings:
MODE SETTING: C (Continuous) or M (Modulation)
PULSE WIDTH SETTING: 220
PULSE FREQUENCY SETTING: 30 - 50Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
SUGGESTION: Initial treatment begins with a low PULSE WIDTH SETTING. Look for reduction in swelling and temperature.
Recommended Treatment Schedule:
Around 30 minutes, 1-2 times daily

ULNAR NERVE LESION (Ulnar Nerve Damage or Ulnar Nerve Palsy)
Recommended Settings:
MODE SETTING: C (Continuous)
PULSE WIDTH SETTING: 100
PULSE FREQUENCY SETTING: 100Hz
AMPLITUDE (OR OUTPUT INTENSITY): Always set for the patient’s comfort level.
Recommended Treatment Schedule:
Around 30 minutes, 1-2 times daily
COMMON CONDITIONS

ATYPICAL FACIAL PAIN
Recommended Settings:
- **MODE SETTING:** M (Modulation)
- **PULSE WIDTH SETTING:** 260
- **PULSE FREQUENCY SETTING:** 100Hz
- **AMPLITUDE (OR OUTPUT INTENSITY):** Always set for the patient’s comfort level.

Recommended Treatment Schedule:
Around 30 minutes, 1-2 times daily

REFERENCE BOOKS

**Reference Books**

**Clinical Electrotherapy 3rd Ed.**
By Roger M Nelson
Hardcover book 578 pages
Published: 1987
Including: Index – Photographs – Illustrations
ISBN: 0-8385-1491-X
Designed for students and practitioners of physical therapy, this book is a comprehensive overview of the use of electrotherapeutic devices and procedures in the clinical setting. Beginning with a review of the pertinent physiology, instrumentation, and the general principles of electrical stimulation, the text examines specific areas of electrotherapy.

**Electrotherapy, 11th Edition - Evidence-Based Practice**
By Sheila Kitchen
360 pp 190 ills Copyright 2002
Softcover
ISBN:0443072167
A well established and popular textbook which comprehensively covers the use of electrotherapy in clinical practice. It includes the background science as well as describing the different electrical agents and their therapeutic applications.

**Electrotherapy Explained, 3rd Edition - Principles and Practice**
By Ann Reed, BA, M CSP, DipTP, SRP and John Low, BA(Hons), FCSP, DipTP, SRP
448 pp 112 ill Copyright 2000
Softcover
ISBN:0750641495
This book explains in a clear and straightforward manner the principles and practice of modern electrotherapy. Totally updated, revised and redesigned, this bestselling text will continue to provide all the latest information on the subject for physiotherapy students and practitioners and all those seeking a comprehensive and well-referenced introduction to electrotherapy.

**Principles and Practice of Electrotherapy, 4th Edition**
By Joseph Kahn
184 pp 200 ills
Copyright 2000
Softcover
ISBN:0443065535
This text provides a practical manual that describes the indications, contraindications, and application techniques of electrotherapy. The author shares his point of view throughout, emphasizing treatment techniques, clinical skills, and innovative treatment planning.

**Electrotherapy in Rehabilitation**
By Meryl Gersh
Hardcover book, 413 pages
Published: 1992
ISBN: 0-8036-4025-0
Practitioners who want to become more familiar with the application of electrical currents in therapy and rehabilitation will appreciate this book. Written for the physiotherapist, the book covers neuromuscular excitation, pain control, electrodiagnostic and electrotherapeutic instrumentation, clinical evaluation of nerve and muscle excitability, use of TENS, and a variety of therapeutic uses for electrical stimulation.