Neuropathy and The Rebuilder

"The ReBuilder® System Effective Treatment for Neuropathy and Chronic Pain" - A Monograph by Inventor David B. Phillips, Ph. D.

The ReBuilder® Treatment System is designed to be simple to use in the home or in the physician's office, is non-invasive, safe, effective, affordable, is registered with the FDA, and is covered by many insurance plans. The ReBuilder® unit has simple to use controls, uses electrode pads that are placed directly on the bottoms of both feet or on the affected body part. It has no interaction with, nor does it interfere with, any medications the patient may be taking. Having a much more powerful electrical impulse than that of the human body, the ReBuilder® re-polarizes and re-educates the nerves to follow the correct paths. It also enables nerve impulses to jump the synaptic junction, reconnect the injured nerve cells, and deliver minerals and nutrients which revitalize those nerves. When this is accomplished, it promotes new nerve growth, restores blood circulation, returns feeling to the patient's extremities, and reduces pain. In many cases the ReBuilder® actually reverses neuropathy and chronic pain symptoms and restores nerves to their normal state allowing them to fully function on their own reducing the need for medications.

Neuropathy and chronic pain: The Condition

Neuropathy and chronic pain is characterized by pain, numbness, loss of tactile feedback, and poor tissue perfusion. These symptoms may indicate that oxygen is not getting to all the cells causing dysfunction.

Because the patient's quality of life is decreased, these results are often devastating. Pain medications do not cure the condition; it only helps mask it and, eventually, leads to complications with adverse side effects such as mental confusion and intestinal problems.

As a result of conducting our own research and reviewing published studies from around the world, we have been led to new models concerning the causes of neuropathy and chronic pain. We have concluded that it is not reasonable to merely label neuropathy and chronic pain symptoms as diabetic, peripheral, vascular, or "idiopathic". What is needed is a more full understanding of the etiology of the condition so new technology can be brought to bear with both ameliorative and therapeutic benefits.

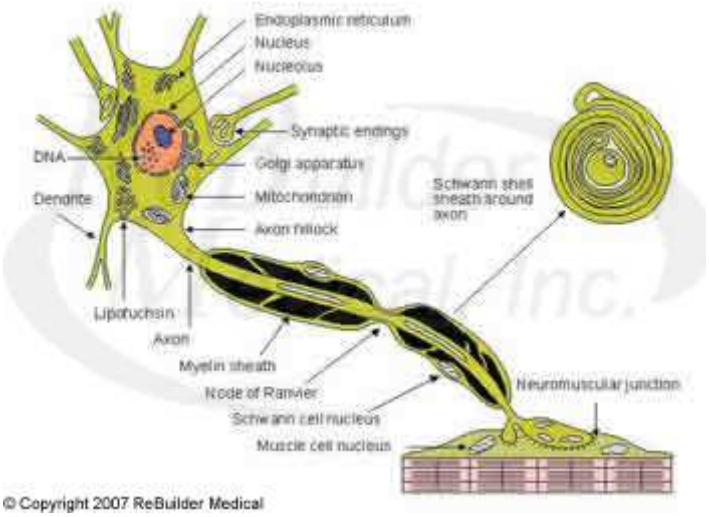


Figure 1: Anatomy of a nerve cell

Neuropathy and chronic pain results when nerve signal propagation is reduced between adjacent nerve cells due to insufficient oxygen being available to support nerve cell metabolism. This is responsible for 90% of all neuropathy and chronic pain cases. The remaining 10% is caused by physical trauma. Thus it appears that ***the main precipitating factor for neuropathy and chronic pain is hypoxia and demineralization of the synaptic fluid*** which creates shrinkage of the nerve cells which widens the gap between these cells making it more difficult for normal sensations to propagate, and loss of electrical conductivity in the synaptic fluid itself.

A temporary hypoxia of nerve tissue can be traced to most causes of neuropathy and chronic pain. The primary negative effects of this hypoxia are as follows:

- A defensive contraction of the nerve cell resulting in oversize synaptic junctions
- A loss of electrical conductivity of the synaptic fluid between nerve cells
- A defensive change in the electrical potentials of the cell membrane resulting in a higher resting state of the trigger level which effectively limits the sensitivity to incoming signals

For example, when the lumbar area experiences a muscle spasm, blood flow is restricted through that muscle resulting in reduced oxygen availability to the surrounding tissue, including nerve cells. Because muscles can use either oxygen or glucose metabolic pathways, they can recover quickly from a temporary reduction in the level of available oxygen. Nerve cells, on the other hand, are limited to the Krebs oxidative reductive metabolic system and must take immediate defensive steps to assure survival during this hypo oxygen state. One of the ways they accomplish this is to contract along their longitudinal axis like a rubber band, reducing their surface area and thus lowering their need for oxygen. (This also occurs when these cells are attacked by a harsh agent in the blood such as chemotherapeutic drugs, Agent Orange, environmental toxins, insecticides, etc.) The synaptic junctions between the axons of one nerve cell and the dendrites of the next nerve cell widen. Normal nerve transmission is now compromised because a nerve signal of normal intensity cannot jump this newly widened gap. The synaptic fluid between the nerve cells must be electrically conductive. Pure water does not conduct electricity, so this conductivity relies on minerals and specific neurotransmitters such as serotonin in the synaptic fluid to enable the propagation of the nerve signal. These minerals are delivered via the perfusion of adjacent tissues with fresh blood and kept in suspension by the periodic ionization of successfully transmitted nerve signals across the junction. When nerve signals are reduced because of these larger dimensions of the synaptic junction, necessary minerals are no longer held in place by electrical tension and are slowly leeched out. (See Figure 2 below) This adds to the impairment of effective nerve transmission.

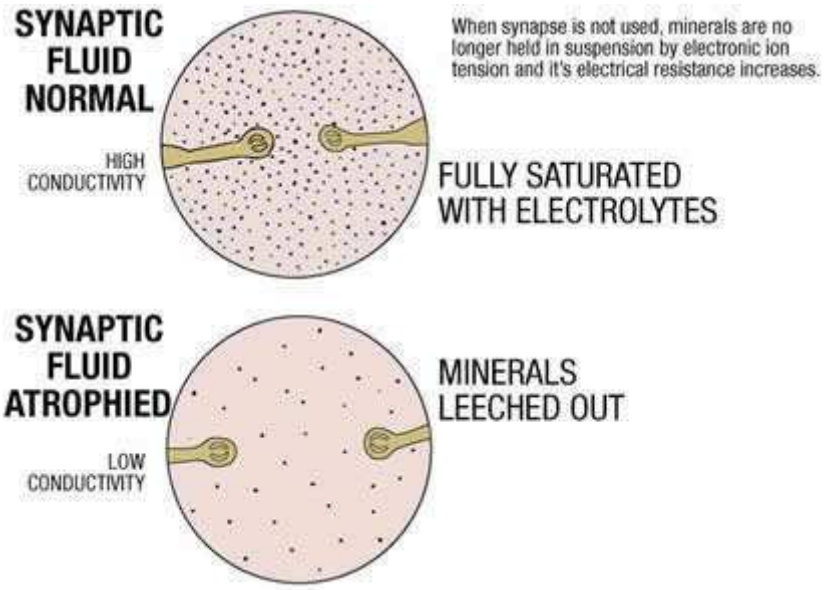
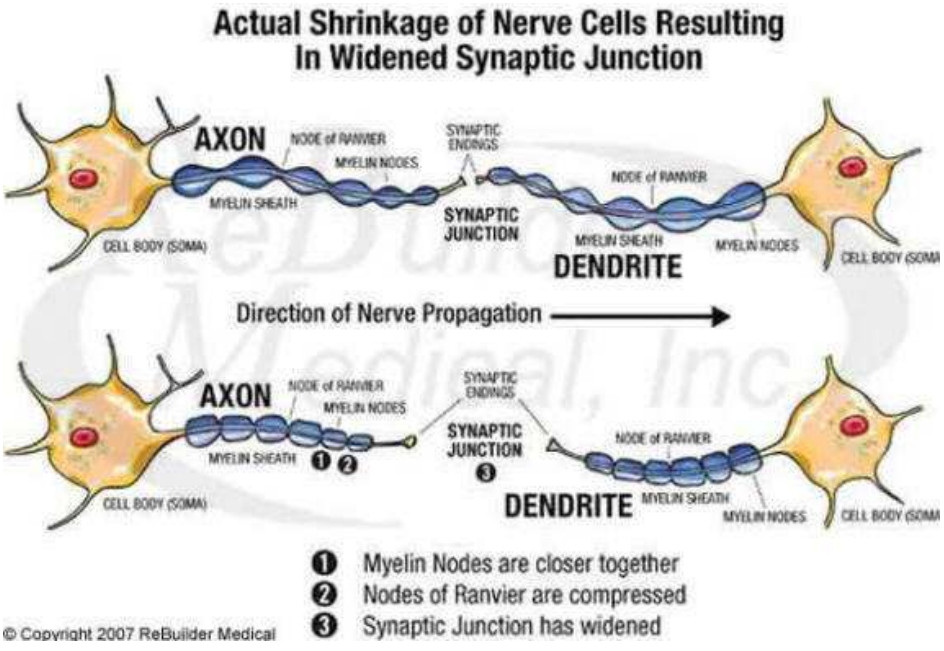


Figure 2: Minerals necessary for proper conduction across the synaptic junction can leech out when not actively used.

Common short term remedies with prescription drugs only ameliorate the pain temporarily and do little or nothing to mitigate or cure the underlying condition. They may provide some level of temporary relief, but as the disease progresses, the effective dosage of the drug needed to continue suppressing the pain increases concurrently. The side effects of these types of drugs are difficult to deal with and add to the patient's discomfort. When the increased drug dosage reaches a threshold level, the patient can become confused, ataxic, constipated, confined to a wheelchair or may become bedridden. Symptoms similar to Alzheimer's may soon follow.



When nerve signals can no longer jump the enlarged synaptic gap, the electrical tension that normally holds these minerals in place is absent, causing the synaptic fluid to leach out its mineral content. Electrical conductivity is reduced, thereby inhibiting the transmission of the normal nerves' electrical signals across this gap.

Figure 3: How a nerve cell shrinks resulting in a widened synaptic junction.

Neuropathy and chronic pain: the Causes

Trauma: Actual trauma is one of the major causes of neuropathy and chronic pain, and results when the myelin sheath is cut or etched away by chemotherapeutic agents, environmental toxins, poorly performed injections, or from amputations and accidents. Traumatic causes must obviously be mitigated by removing the cause as in drug therapy, chemotherapy, physical entrapment, and environmental poisons. Permanent tissue damage may be beyond the scope of any therapy. When these conditions are removed, the ReBuilder® may be a helpful adjunctive therapy in the healing process.

Diabetes: Diabetes can also trigger neuropathy and chronic pain by affecting the levels of glucose and/or insulin in the blood stream. When this occurs, minerals are driven out of the fluid in the synaptic junction thereby reducing conductivity and impairing nerve impulse transmission. Nerve signals propagates from the cell body unidirectionally over the synapse, first along the axon and then across the synapse to the next nerve or muscle cell. The synaptic cleft, the gap between presynaptic terminal and postsynaptic terminal, has a thickness of 10 - 50 nm. The fact that the impulse transfers across the synapse only in one direction, from the presynaptic terminal to the postsynaptic terminal, is due to the difference in electrical polarity between the sending axon and the receiving dendrite. *This is one of the reasons that the ReBuilder® sends its signal from one foot to the other* – it sets the relative potential in each gap properly so that it forces the signal to jump properly, always toward the central nervous system and not miss-fire and jump the wrong way, perhaps to a sending axon that can lead to the periphery.

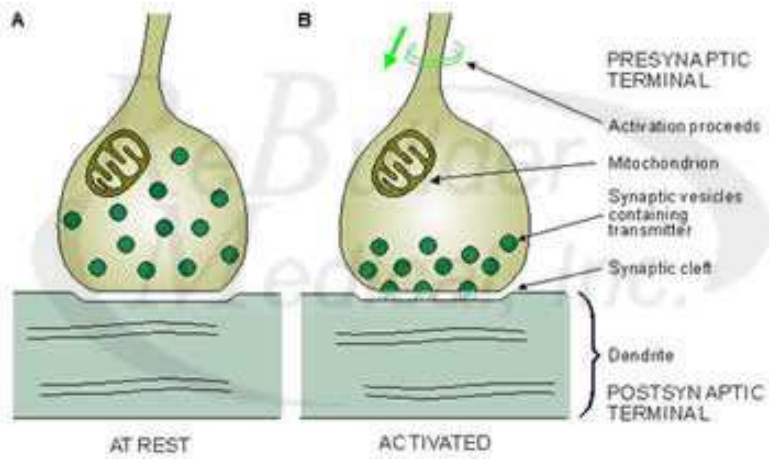


Figure 4

(A) At rest synaptic vesicles.
(B) Activated synaptic vesicles (when activation reaches the presynaptic terminal, electrical signals jump across the synaptic cleft to activate the postsynaptic terminal).

As a result of hypoxic cellular atrophy, nerve signals must now try to jump a larger gap through a less conductive medium. This loss of nerve transmission is first perceived as tingling, then burning, and finally as pain when the demineralization and gap widening process progresses. The initial perception associated with atrophied nerves and enlarged synaptic gaps is tingling as some of the normal signals are misdirected to nearby nerves. As the condition progresses, it happens more and more until more signals are misdirected than properly propagated, and the resulting sensation is one of pain. Finally, after the nerve signals can no longer be transmitted at all, numbness is the primary complaint. This secondary effect of neuropathy and chronic pain reduces the strength of the calf muscles which, in turn, reduces the blood flow to the lower extremities. This condition often results in poor tissue perfusion, insecure gait, balance problems, and other mobility issues.

Chemotherapeutic Agents: Prescribed for cancer precisely because they inhibit fast growing or fast acting cells, chemotherapeutic agents cause neuropathy and chronic pain in approximately one third of the patients to whom they are administered. Though nerve cells do not reproduce themselves like cancer cells do, they do change electrical states quickly and are thus particularly susceptible to the effects of chemotherapeutic drugs. The fast acting nerves are mistaken for fast growing neo-plasms. Chemotherapy has the effect of de-mineralizing the synaptic fluid, damaging the integrity of the nerve cells, and making it difficult for the ionization of the cell membranes to propagate the signal along the surface of the nerve. When ionization takes place, the outer membrane of the nerve cells change from positive to negative in a wave like motion taking a positive charge from one end of the nerve all the way to the other end. Chemotherapy is designed to interrupt the ability of the cell to control the permeability of the outer membrane and this process is electrically modulated. This electrical interruption is misapplied when the agent is in contact with the myelin sheath of a healthy, active nerve cell and causes the nerve cell to “short out” and inhibit the necessary different potentials in the nodes of the myelin sheath.

Cardiovascular Disease: By reducing the amount of blood that can perfuse the tissue of the lower legs and feet, cardiovascular disease can also cause neuropathy and chronic pain. When the arteries and veins become blocked, blood flow is reduced. One of the first symptoms is intermittent claudication which results in a reduction in the distance a patient can walk before the onset of localized leg pain due to reduced oxygen availability. Therefore, the muscle cells switch from aerobic metabolism to using anaerobic metabolism thereby creating greater than normal amounts of lactic acid, the by-product of muscle metabolism. The increased lactic acid collects in the cells causing inflammation and pain.

Lumbar Trauma: Trauma to the lumbar area of the back can be another cause of neuropathy and chronic pain. This trauma can be as slight as lifting a bag of groceries out of the trunk, picking up a grandchild, or bending down to tie a shoe. Our studies show a 60% correlation between repeated injuries to the lower back and subsequent development of neuropathy and chronic pain symptoms. During the acute phase of localized trauma, inflammation develops reducing arterial and venous blood to the lumbar synaptic junctions. Nerves in the region temporarily shrink due to the reduction in activity. Since the body tends to conserve resources, the affected nerves begin to atrophy, the synaptic junction gap begins to widen, and synaptic minerals leech away making signal transmission more difficult.

Signals of normal strength can no longer cross synapses that are damaged by the reduction in blood flow. The loss of signals across the synapses compounds the process of deterioration. Muscle atrophy and a host of other problems follow. We have found that a signal delivered at 7.83 cycles per second (the body's natural electromagnetic resonant frequency) and at an amplitude approximately 10 times that originally required will cross these enlarged synapses, repolarize them.

High Blood Pressure Medication: High blood pressure medication not only lowers blood pressure, it also reduces the ability of the arterial blood to refill the veins. This vacancy results as the venous muscle pumps the blood back to the heart. When this occurs the blood has a tendency to pool in the lower extremities; the nerves and synaptic junctions do not have enough necessary nutrition and oxygen to maintain their health resulting in nerve cell atrophy, loss of mineralization, and conductivity of the synaptic junctions as explained above.

Psychoactive Drug Therapy: These drugs, used to reduce anxiety or seizures, have the effect of reducing the intensity/frequency of all nerve signals. This, too, can result in loss of motor and sensory nerve function. These conditions can result in impaired mobility and balance issues due to the loss of muscle strength. Whenever overactive nerves that might be causing psychological problems are depressed, they depress borderline poorly functioning nerves as well.

The ReBuilder® Works on Three Separate, but Simultaneous Levels

Electro Stimulation of Nerves: The ReBuilder's® electrical signal is a compilation of two signals transmitted simultaneously. One signal is specifically designed to stimulate the nerves themselves and has a very narrow waveform with a small amount of current under the curve and a relatively high transient voltage (characteristically 40 to 90 volts ac.). The resulting current is miniscule and much below what is commonly found with traditional TENS devices. A larger than normal signal must be used because of the widening gap between the nerve cells (See Figure 3) and the loss of much of the conductivity in the synaptic junction fluid due to demineralization (See Figure 2) the ReBuilder's® nerve stimulation signal is many times stronger than the normal afferent and efferent signals; therefore, it can effectively complete the circuit. This stimulates the nerves causing them to re-establish their normal metabolic function. This signal, crossing the synaptic junctions, also re-polarizes the junctions causing them to be receptive to reabsorb minerals thus improving the conductivity.

Electro Stimulation of Muscles: The ReBuilder's® second signal, which overlays the nerve stimulation signal, is designed to stimulate the muscles. This signal has a different, wider waveform with a larger sub-threshold amount of current under the curve and a much smaller voltage (5 to 20 vac.). Muscles are most responsive to this waveform. This signal causes the muscles of the feet, calves, thighs, and buttocks to contract and relax in harmony with the ReBuilder's® signal. Overcoming any residual inflammatory resistance to blood flow, the ReBuilder's® proprietary signal also has specific characteristics that cause a complete relaxation of the muscles' fast and slow twitch cells between each contraction stimulus. In order for the venous pressure to move the blood through the muscles bringing oxygen and nutrients and taking away accumulated lactic acid, the muscle fibers cannot remain in spasm. Adequate blood flow can only occur in a flaccid muscle. This is an important consideration. It is not the contraction but primarily the time interval between the contractions that contribute to the increased perfusion of blood through the oxygen starved tissue.

If the frequency of the muscle stimulation signal is too fast, it does not give the muscle the appropriate time necessary to fully relax. If the signal's frequency is too slow, the muscle cannot entrain and recruit enough fibers for a sustained contraction. By stimulating the muscles to contract in this manner in response to the ReBuilder's® signal, the venous muscle pump is used to propel blood, against gravity, back up towards the heart. Blood flow is increased with mineral enriched blood which results in a flushing of metabolic byproducts. This not only offers relief of pain from the build up of excessive lactic acid, but it also triggers the creation of new muscle mass. The synaptic junctions, bathed with this mineral rich blood, are now able to permanently conduct the nerves signals more effectively and efficiently.

Combined Electro Stimulation at 7.83 Hz: This twin electrical signal (one to stimulate the nerve cells and the other to trigger muscle cells) is pulsed on and off at the frequency of 7.83 cycles per second. We have found that the human body is particularly sensitive to this frequency. One postulation for this sensitivity is that the electrical potential between the earth's atmosphere and the earth's surface is also approximately 7.83 Hz. Using this signal frequency, we have found that the body not only responds favorably but the brain is induced to release large amounts of endorphins. Endorphins, internal analgesics

as powerful as and chemically related to morphine but without any negative side effects, are created and modulated by the body's own chemistry. The effect of this endorphin release is a generalized sense of well-being, a reduction in pain and anxiety levels elsewhere in the body, and even a reduction in emotional pain. This ensures a very high level of patient compliance not only because the patient feels good physically during the massage-like treatment period but because he/she feels better emotionally afterward experiencing a reduction in global non-neuropathic (nociceptive) pain for a period of 4 to 6 hours.

An additional feature of the ReBuilder® is its simultaneous weighted DC signal. This intentional imbalance to the asymmetric waveform that results in a tiny DC current is designed to stabilize the trigger threshold that regulates the sensitivity of the nerve cell. Like a heart in fibrillation, this normally stable trigger level begins an unregulated oscillation that can result in erratic transmission of incoming nerve signals. Sometimes small signals are accepted for an attempt at propagation, and sometimes only large signals are accepted. This upsets the homeostasis of the part of the brain assigned to managing these signals and selecting the appropriate response. By sending this constant DC signal, the effect is to hold this resting potential at a fixed voltage long enough for the cell to stabilize itself and regain control.

When the conductive rubber electrodes are applied to feet, the current path is directed from one foot, to the ankle, up to the knee, the thigh, the lumbar area, down the other leg all the way to the foot. This means that all the nerves of both legs are stimulated simultaneously as well as all the muscles. This is a unique aspect of the ReBuilder®.

The ReBuilder® contributes to the healing process by accomplishing the following:

- Stimulates leg muscles to contract and relax thereby increasing blood velocity and volume with fresh blood to the nerves and muscles.
- Stimulates all the afferent and efferent nerves in the lower extremities with a signal larger than normal to re-establish the pathways for subsequent normal signals to follow.
- Draws axon and dendrite nerve endings closer together to facilitate proper nerve transmission.
- Builds residual pain relief each time the system is used.
- Causes the brain to release endorphins that reduce global pain and anxiety.
- Promotes the healing of non plantar surface diabetic skin ulcers and sprains.
- Increases muscle strength for safe, pain free walking.
- Promotes better mobility and balance as proprioception returns to the legs and feet.
- Reduces edema as muscle contractions encourage lymphatic drainage and movement to the proper nodes.
- Increases collateral circulation, stimulating vasogenesis.

The ReBuilder® accomplishes these functions in a simple to use home care system that is not only effective in helping relieve many of the symptoms of neuropathy and chronic pain and in limiting its progression, but can cause the regression of pain, burning, and numbness.

When the ReBuilder's® electrical signals stimulate the leg muscles to contract, this "venous muscle pump" moves the mineral rich blood to the muscles and the nerves. Osmotic pressure and the ionic tension from the ReBuilder's® signals successfully jumping across the gaps then carries these necessary minerals into the synaptic junctions between the nerve cells helping to restore the conductivity that is characteristically lost.

The Electrophysiology of Electro Stimulation with the ReBuilder®

The activation process encompasses certain specifics such as currents, potentials, conductivities, concentrations, ion flows, etc. The term *action impulse* describes the whole process. When activation occurs in a nerve cell, it is called a *nerve impulse*; correspondingly, in a muscle cell, it is called a *muscle impulse*. The *bioelectric* measurements focus on the *electric potential* difference across the membrane; thus the electric measurement of the action impulse is called the *action potential* that describes the behavior of the membrane potential during the activation. Consequently, we speak, for instance, of *excitatory postsynaptic potentials* (EPSP) and *inhibitory postsynaptic potentials* (IPSP). In *biomagnetic* measurements, it is the electric *current* that is the source of the magnetic field. Therefore, it is logical to use the term *action current* to refer to the source of the biomagnetic signal during the action impulse. These terms are further illustrated in Figure 5, below. Since it is these action potentials that are in a fibrillation mode similar to a myocardial infarction, the ReBuilder® can be thought of as a defibrillator for nerve cells.

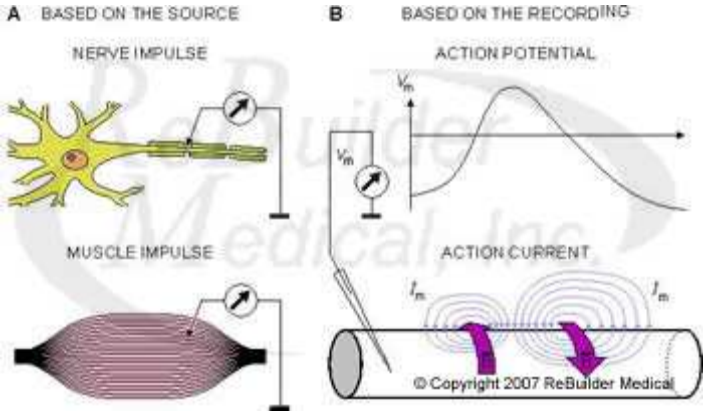


Figure 5: Clarification of the terminology used in connection with the action impulse:

A) The source of the action impulse may be nerve or muscle cell (correspondingly the nerve impulse or a muscle impulse). B) The electric quantity measured from the action impulse may be potential or current (correspondingly the action potential or action current).

The concentration of sodium ions (Na+) is about 10 times higher outside the membrane than inside, whereas the concentration of the potassium (K+) ions is about 30 times higher inside as compared to outside. When the membrane is stimulated so that the transmembrane potential rises about 20 mV and reaches the threshold, i.e., the membrane voltage changes from -70 mV to about -50 mV (these are illustrative and common numerical values), the sodium and potassium ionic permeabilities of the membrane change. The sodium ion permeability increases very rapidly at first, allowing sodium ions to flow from outside to inside, making the inside more positive. The inside reaches a potential of about +20 mV. After that, the more slowly increasing potassium ion permeability allows potassium ions to flow from inside to outside, thus returning the intracellular potential to its resting value. The maximum excursion of the membrane voltage during activation is about 100 mV; the duration of the nerve impulse is around 1 ms, as illustrated in Figure 6. While at rest, following activation, the Na-K pump restores the ion concentrations inside and outside the membrane to their original values.

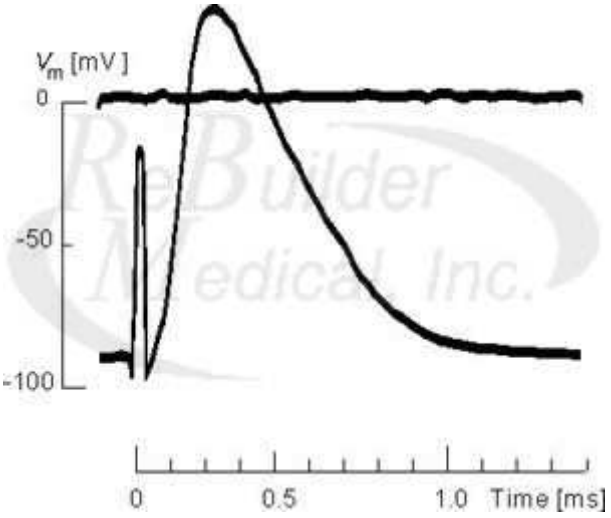
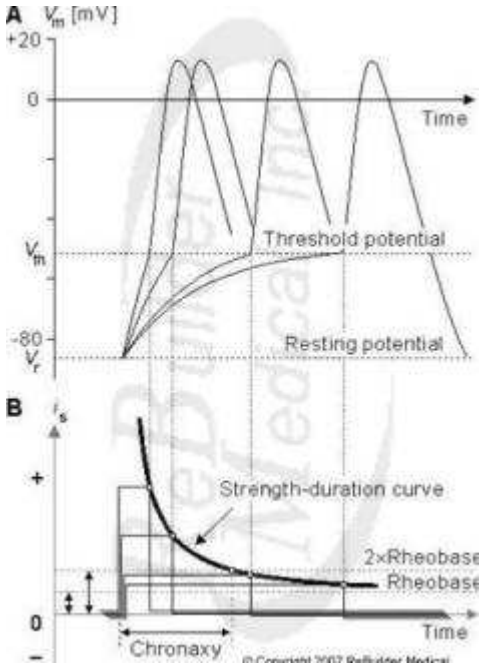


Figure 6: Nerve impulse recorded from a cat motoneuron following a transthreshold stimulus. The originating triggering stimulus may be seen at t = 0.

Whether an excitatory cell is activated depends largely on the strength and duration of the stimulus. The membrane potential may reach the threshold by a short, strong stimulus or a longer, weaker stimulus. The ReBuilder's® therapeutic benefit depends on its use of a short voltage pulse rather than current. Although the rheobase is very small, to get that true net figure, a transdermal signal must be larger and take into consideration both the resistance of the skin and the impedance of the body. The impedance acts as a threshold "brake" that must first be overcome and then immediately sensed and subsequent signals must be reduced to avoid overwhelming the nerve potentials. The ReBuilder® has special circuits that monitor and control these electrical parameters in real time. The curve illustrating this dependence is called the *strength-duration curve*; a typical relationship between these variables is illustrated in Figure 7on the following page. The smallest current adequate to initiate activation is called the *rheobasic current* or *rheobase*. Theoretically, the rheobasic current needs an infinite duration to trigger activation. The time needed to excite the cell with twice rheobase current is called *chronaxy*.



The Strength-Duration Curve

Figure 7: (A) The response of the membrane to various stimuli of changing strength (B), the strength-duration curve. The level of current strength which will just elicit activation after a very long stimulus is called rheobase. The minimum time required for a stimulus pulse twice the rheobase in strength to trigger activation is called chronaxy. (For simplicity, here, threshold is shown to be independent on stimulus duration.)

Accommodation and *habituation* denote the adaptation of the cell to a continuing or repetitive stimulus. This is characterized by a rise in the excitation threshold. *Facilitation* denotes an increase in the excitability of the cell; correspondingly, there is a decrease in the threshold. *Latency* denotes the delay between two events. In the present context, it refers to the time between application of a stimulus pulse and the beginning of the activation. Once activation has been initiated, the membrane is in the *absolute refractory period*, and is insensitive to new stimuli no matter how great the magnitude. During the *relative refractory period*, near the end of the activation impulse, the cell may be activated but only with a stimulus stronger than normal. A damaged nerve is in this relative refractory period and that is why the ReBuilder® sends a 10X signal.

The membrane voltage (transmembrane voltage) (Vm) of an excitable cell is defined as the potential at the inner surface (Φi) relative to that at the outer (Φo) surface of the membrane, i.e. Vm = (Φi) - (Φo). This definition is independent of the cause of the potential whether the membrane voltage is constant, periodic, or nonperiodic in behavior. Fluctuations in the membrane potential may be classified according to their character in many different ways. Figure 8 on the following page shows the classification for nerve cells developed by Theodore Holmes Bullock (1959). According to Bullock, these transmembrane potentials may be resolved into a resting potential and potential changes due to activity. The latter may be classified into three different types:

1. Pacemaker potentials: the intrinsic activity of the cell which occurs without external excitation.
2. Transducer potentials across the membrane, due to external events. These include generator potentials caused by receptors or synaptic potential changes arising at synapses. Both subtypes can be inhibitory or excitatory.
3. As a consequence of transducer potentials, further response will arise. If the magnitude does not exceed the threshold, the response will be nonpropagating (electrotonic). If the response is great enough, a nerve impulse (action potential impulse) will be produced which obeys the all-or- nothing law (see below) and proceeds unattenuated along the axon or fiber.

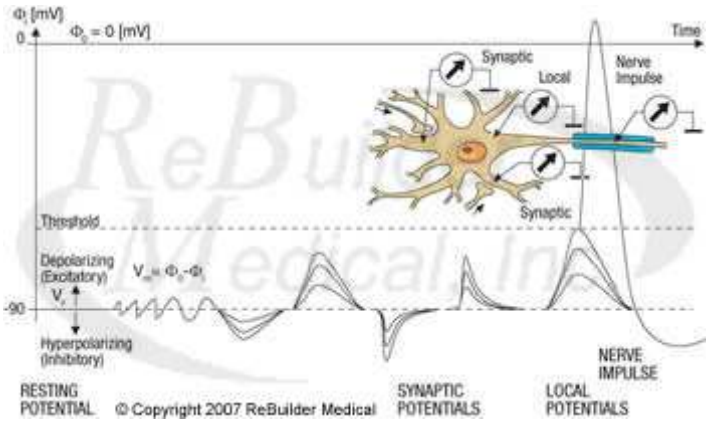


Figure 8: Trans membrane potentials according to Theodore H. Bullock.

Distinct and characteristic morphologic changes have been demonstrated in diabetic neuropathy and chronic pain including focal and generalized nerve fiber loss, nodal changes, blunted fiber regeneration, and segmental demyelination. (This segmental demyelination is a result of the shrinking of the nerve cell which draws the nodes together. When these nodes touch, they in effect, short each other out and lose their integrity.) (See Figure 3 on page 3).

Pathophysiologically, by utilizing the technique of threshold electrotonus, diabetic neurons (myelinated and unmyelinated) display selective reduction of inward rectification of the potassium channel. Thus, channel closure produces an excess of positively charged potassium (K+) on the inner side of the nerve membrane leading to depolarization. This also induces the opening of both the voltage and time-dependent calcium (Ca++) channels and sodium (Na+) channels. Evidence suggests that this axonal accumulation of sodium and calcium (as opposed to the opposite leeching of these minerals from the synaptic fluid) during dysesthetic neuropathy and chronic pain is key to the symptoms of paresthesiae and burning. Paresthesiae are believed to be produced by multiple cutaneous or motor axons firing ectopically and cyclically with alteration of Na-K-Cyclic adenosine monophosphate (C-AMP) and ATPase. The DC portion of the signal produced by the ReBuilder® stabilizes the uptake of these minerals by forcing a baseline voltage differential and inhibiting this de-polarization phenomenon. In addition, the application of additional biologically available Ca balances the Ca++ and the Na+.

Some researchers believe that a final common pathway might be a decrease in the intra-axonal concentration of C-AMP. Based upon the disappearance and/or significant improvement in the paresthesiae, it is tempting to speculate that this aberrant behavior of the fibers is affected at the cellular level with stabilization. Since these specific changes are seen to a greater extent in sensory nerves and with advanced age, it is hypothesized that ReBuilder® bio-stimulation selectively induces hyperpolarization or repolarization with a return to baseline axonal potential in the sensory afferents. The effects of this ReBuilder ®stimulation on peripheral nerve excitability may depend on a combination of factors including design,

strength, intensity, and duration as well as the functional state of the peripheral nerve. To date it has been difficult to identify electrophysiological changes by the conventional gold standards of serial nerve conductions and SSEP. These wave form factors that the ReBuilder® uses are designed to mimic a normal signal and are part of the patent pending technology. It is the purpose of the ReBuilder® to be an external source of stimulus to induce an action potential impulse which will then proceed fully along the axon.

Several general principles have emerged from our studies. First, electrical stimulation induces ionic gradient changes in the Na-K-ATPase system. Since there are distinct physiologic and neuro-biologic changes noted at the cell membrane level, it is postulated that repetitive sub-threshold stimulation of afferents also induces similar ionic changes. The most plausible explanation is that the ReBuilder® targets the small C-fibers and induces a change in the firing pattern of the C-fibers by recruitment, synchronization, and possible temporal summation, thereby producing either hyper-polarization or re-polarization. It is well known that the functional C-polymodal receptor afferents are functionally adaptive and can be modulated by drugs and temperature which act or influence their surface membrane receptors. Similarly, stimulation by either threshold or sub-threshold influences could produce the same effect. It is recognized that unmyelinated C-fiber axons comprise 75% of the axons in cutaneous peripheral nerves in the sole of the foot (epidermis and dermis) and have increased utilization of potassium channels. By virtue of this defect in the internal rectifying channel, there is an interference with neuronal transmission thereby producing a constant depolarization. In Figure 9 below, the active portion (B) is reduced and nerve propagation is inhibited in a salutatory manner. Those nerves that are unmyelinated (A) do not possess this feature and this is why, in neuropathy and chronic pain, the motor neurons may not be damaged in the same time sequence as the sensory neurons. This observation also accounts for the intermittent quality of the sensations or lack thereof in the same anatomical area. The ReBuilder® is designed to repolarize this defect in the internal rectifying channel and because 75% of the axons are in the plantar surface of the foot, this is one of the ReBuilder® administers its signals via the foot.

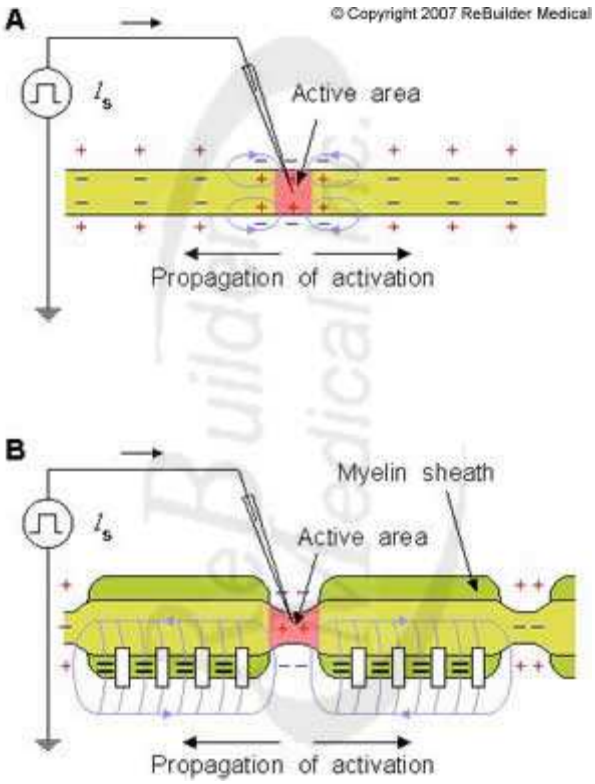


Figure 9: Conduction of a nerve impulse in a nerve axon.

(A) Continuous conduction in an unmyelinated axon.
(B) Saltatory conduction in a myelinated axon.

Since dramatic benefits are seen in diabetic patients, it is presumed that the ReBuilder® stimulation induced alteration of the nociceptive threshold (which depends on voltage-flux, flux density, time, and usage) leads pain modulation. This is the well known strength-duration relationship. These factors are all a part of the patent pending technology of the ReBuilder®. Examples of nociceptive pain include sprains, bone fractures, burn, bumps, bruises, inflammation (from an infection or arthritic disorder), obstructions, and myofascial pain (which may indicate abnormal muscle stresses).

Nociceptors are the nerves which sense and respond to parts of the body which suffer from damage. They signal tissue irritation, impending injury, or actual injury. When activated, they transmit pain signals (via the peripheral nerves as well as the spinal cord) to the brain. The pain is typically well localized, constant, and often with an aching or throbbing quality. Visceral pain is the subtype of nociceptive pain that involves the internal organs. It tends to be episodic and poorly localized.

Our research is finding that regardless of the absence of electrodiagnostic sensitivity, the morphologic and pathophysiologic changes raise several interesting questions. Axonal damage indicative of physical shrinkage along a longitudinal axis was seen in all the subjects with 100% loss of sensory action (SNAP) and 60% loss of compound motor potentials (CMAP). Despite this extensive damage, there was dramatic subjective, statistically significant benefit in 90% of the patients using the ReBuilder® in a clinical setting.

Since it is assumed that there is both A and C-fiber damage, the current results suggest this observed high frequency of regenerating axons, likely related to transient hypoxia, may be relevant to the benefits seen. This lack of available oxygen to the nerve cells has a cascading effect resulting in specific metabolic abnormalities that have been identified in diabetic neuropathy and chronic pain. Some of these include a reduction in nerve-free myoinositol, a reduction in the rate of

synthesis and transport of intra-axonal proteins, a reduced incorporation of glycolipids, electrolytes and amino acids into myelin, a reduction in nerve Na-K-AT-Pase, and excessive glycogen accumulation. It has also been documented that elevated glucose levels evoke a rise in the intracellular ATP levels thereby closing the potassium channel. Increased glucose levels also cause sore muscles from the conversion to lactic acid in the muscles which farther reduces blood flow and exacerbates hypoxia.

The idea that a single ReBuilder® treatment can induce a change in the firing pattern of the C-fibers is novel and appealing. However, one cannot ignore the therapeutic benefit over a longer period. Patients using the ReBuilder® clearly showed an accumulating improvement, particularly those with underlying diabetic neuropathy and chronic pain.

The intriguing issue of neuroprotection needs to be addressed. Does the ReBuilder® treatment delay the progression of peripheral nerve damage? So far follow up data suggests that it does.

As mentioned above, electrical stimulation alteration of the nociceptive threshold depends on voltage-flux, flux, density, time, and usage. According to Faraday's Law, a magnetic field (created by the ReBuilder's® current path) will exert a force on a moving ionic current. Furthermore, an extension of this physics principle known as the Hall Effect holds that when an electromagnetic field is perpendicular to the direction of flow, it will generate a secondary intracellular voltage and secondary heat. Since peripheral nerves in diabetic neuropathy and chronic pain have impaired blood flow with endoneurial hypoxia secondary to nerve micro vessel damage, it is tempting to speculate that improvement in the micro vascular circulation is also reflected in the feeling of warmth which may be due to an improvement in local and regional blood flow.

Safety Considerations

As intermittent electrical signals are received into the nervous system, the resistance, capacity, and impedance changes dramatically on a dynamic basis. This change must be monitored and the voltage, current, and other electrical parameters must be adjusted in real time. Unless an electrical device incorporates the safety features unique to the ReBuilder®, either the patient can be injured or the instrument will be damaged. **Therefore the clinician should not be tempted to try to stimulate the nerves and muscles simultaneously with a normal TENS or EMS device**. The ReBuilder® has patented technology built in which samples the patient's electrical parameters over 25,000 times per minute and automatically adjusts the output to ensure the patient's safety. This, coupled with the both the power supplied by a 9 volt battery and the electronic circuits inside the unit being electrically isolated from the direct contact with the patient, insures complete safety.