

A microscopic view of various cells, including large spherical cells with textured surfaces and smaller, more uniform cells, all set against a blue background. The cells are arranged in a scattered pattern, with some in the foreground and others in the background, creating a sense of depth.

# Improving Cell Health

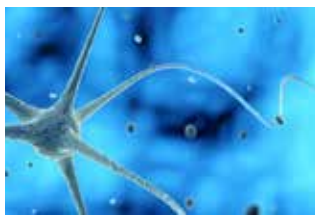
An analysis of PEMF and the  
benefits of *cm2 technology*  
on wellness and performance.

Written and compiled by Dale C Gledhill,  
Gregory Anderson D.P.M., Kade Huntsman M.D.



# Improving Cell Health:

## An Analysis of PEMF and the Benefits of cm2 Technology on Wellness and Performance



### Abstract:

Medical scientists have researched and employed Pulsing Electromagnetic Field (PEMF) energy therapy for over a hundred years as a modality for improving health and wellness. Until recently, competition from pharmaceutical approaches has suppressed this mode of treatment in western medicine. In Europe and Asia, the technology flourishes and is utilized as a key treatment for health and wellness. NASA and other leading space programs have also adopted PEMF energy therapy within their program. Exploring the larger impacts of cell health and understanding the body on a molecular level have become leading topics of research worldwide. Currently, there are over three thousand scientific studies demonstrating and documenting the profound benefits of PEMF therapies and other human efforts to effect positive cell health. This document will provide an overview of the human cell matrix, the history and technology behind PEMF and its effects on cell health, as well as the benefits of the newest hybrid energy PEMF-cm2 technology from Nimbus Performance.

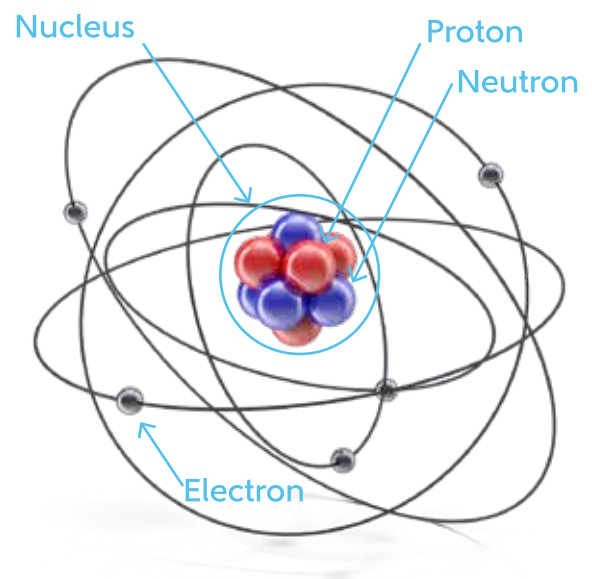


## The Human Body Consists Entirely of Atoms

Your body is one organism. However, many parts make up that whole. As you consider the various levels of the body you understand that many parts are within those parts and this continues until you reach the sub-atomic level. As an example, this is like a pine tree. At first, you notice the entire tree, a whole organism. But as you look closer, you notice the branches, then the twigs on the branches, and even each needle on the twigs. Thousands—if not millions—of needles exist on that one single pine tree and you can keep going noticing smaller parts until you reach the sub-atomic level. The same analogy holds for the human body or the body of any animal. First, you notice the entire body. Next, you see that the entire body is made up of parts and organs, and each of those organs is made up of a variety of tissues. When you examine a magnified sample of one of the human body's tissues under a microscope, millions of cells become visible. When you turn up the magnification for a closer look, you see cells contain molecules that are made up of even smaller components called atoms. The entire body is built from atoms.

### Everything is Built with Atoms

All matter is made of atoms. An atom itself is made up of three types of smaller particles called subatomic particles. These are protons, neutrons, and electrons. Protons and neutrons make up the center of the atom—called the nucleus, while electrons orbit the nucleus in a small cloud. Electrons carry a negative charge and protons carry a positive charge. In a normal—or neutral—atom, the number of protons and electrons is equal. Often, but not always, the number of neutrons is the same too.



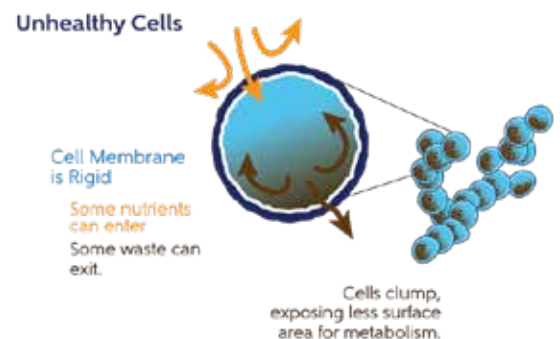
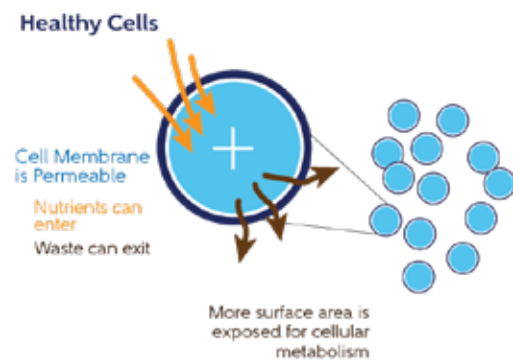
# The Human Body's Atoms are Continually Controlled by Electrical Signals

Our bodies are controlled and enabled by electrical signals running through them via atoms. When an atomic charge is out of balance, an atom becomes either positively or negatively charged. This switch in charge allows electrons to flow from one atom to another. This flow of electrons, or negative charge, is what we call electricity. Since our bodies are huge masses of atoms, its cells can be moved or manipulated electrically.

For scientific proof of this fact, we need look no further than the standard Magnetic Resonance Imaging (MRI) scan routinely performed in hospitals worldwide. During an MRI, protons absorb the energy from the magnetic field produced by the equipment. This causes the protons to flip their spin and align in the same direction. When the magnetic field is turned off, the protons gradually return to their normal spin, a process called precession. The process of moving and energizing cells is fundamental in molecular science.

All atoms and cells and their associated energy are electromagnetic in nature— nothing happens in the body without an electromagnetic movement among cells. When a cell's electromagnetic activity ceases, its life ceases. Electromagnetic energy within and between cells controls the body's chemistry, energy output, and all wellness and repair functions. Degradation of this energy in cells impairs cell metabolism, impacting many functions, like the transport of oxygen, nutrition, and fluids as well as the removal of  $\text{CO}_2$  (waste).

When cells are not healthy or metabolizing efficiently, the body is not healthy—in whole or in part. Because cells handle so many vital functions, healthy cells are responsible for quicker recoveries, improved energy, and long-term good health. We are just like the pine tree previously discussed. It may look beautiful, but if the roots—where it takes in oxygen, nutrients, and moisture—are unhealthy, the tree will eventually become sick. The same is true with humans. Poor cell energy, like degraded roots, will translate into overall health concerns.



Russian scientists explore PEMF for bone loss prevention in space.

1950s



1970s

NASA receives grants to study PEMF and secures a patents for its use in bone loss prevention.

PEMF floods into the western medical community and is studied for alleviating dozens of medical conditions.

1990s



Today

Hybrid PEMF technology is born—in the form of Nimbus cm2 Technology.

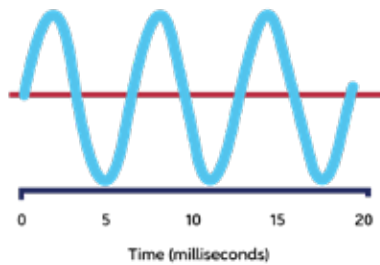
## The History of PEMF

The former Soviet Union has used PEMF therapy for over fifty years. As a result, PEMF is regarded in formerly Soviet countries as standard treatment—complementary to pharmacology. During the Soviet space program of the 1950s, PEMF was used by the cosmonauts to address the loss of bone density that occurs outside the Earth's gravitational and magnetic fields. This form of therapy was embraced by the Soviet medical community and eventually used in hospitals throughout all the Soviet Union and in Eastern Europe. After the collapse of the USSR, the research data and electronic devices became available to Europe. Countries like Germany, Switzerland and Austria incorporated the technology into their healthcare systems and it became readily available to more people. Since this early introduction, thousands of studies now have given the world a clearer understanding of how PEMF benefits cell health and various medical conditions.

In America, the National Aeronautical and Space Administration (NASA) also sought to prevent and treat bone and muscle since prolonged space

exploration requires a solution to this problem. NASA has spent millions of dollars on research and intellectual property to develop this technology further. Their testing also confirmed PEMF was effective in the treatment of various muscle and bone diseases, tissue growth and had measurable effects on cells at the molecular level.

Starting in 1950, the United States and Japanese private sector science communities began investigating PEMF and also confirmed its bone healing effects (Bassett et al., 1964; Yasuda, 1953). Years of research and thousands of studies later, science has confirmed the energy boosting mechanism of PEMF at the cellular level—including its use for many debilitating medical conditions. The worldwide scientific community acknowledges PEMF therapy for pain management, cell rejuvenation, and improved performance. In fact, the FDA approved PEMF for healing fractures in 1979 and has more recently approved it for palliative care and depression. It's safe to say, western medicine has now embraced PEMF energy therapy and the powerful positive effects it has on the human cell matrix.



### The Difference Between a Pulsed and a Static Magnetic Field

A pulsed electromagnetic field is different

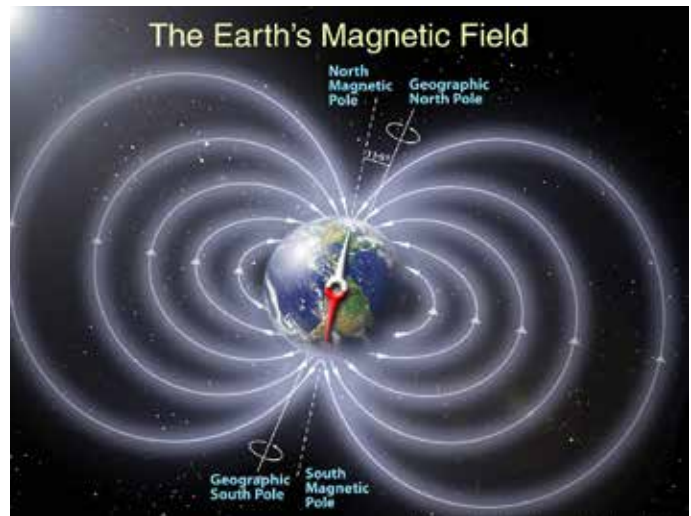
from a static field like the one our earth generates. PEMF pulsates between “on and off” or a positive to negative field. This dynamic or moving magnetic field—when applied in the vicinity of human cells—will move or energize the individual cells at the atomic level. This movement, either by electromagnetic attraction or detraction, will generate a voltage as per the scientific law known as Faraday’s Law.

### Effect of a Low Intensity PEMF on the Human Body

A low intensity pulsed electromagnetic field affects the behavior of any charged objects nearby. Because the body is comprised entirely of atoms, it is therefore electric. For example, every heartbeat generates electromagnetic waves throughout the blood vessels of the body. Every body movement and function is communicated electrically between cells. Every flex of our skeletal structure produces a current. A Pulsing magnetic field passing through our body will have an electromagnetic effect in some way on each of the estimated 70 trillion cells, via movement or manipulation.

### Basic Cell Functions

Bones, muscles, tendons, blood, and all body parts are all bundled cells, which are comprised entirely of atoms. Some of the basic functions of a cell are to generate energy, eliminate waste, repair and regenerate, to facilitate communication within the body, and perform whatever predetermined functions based on the cell’s type and location in the body.

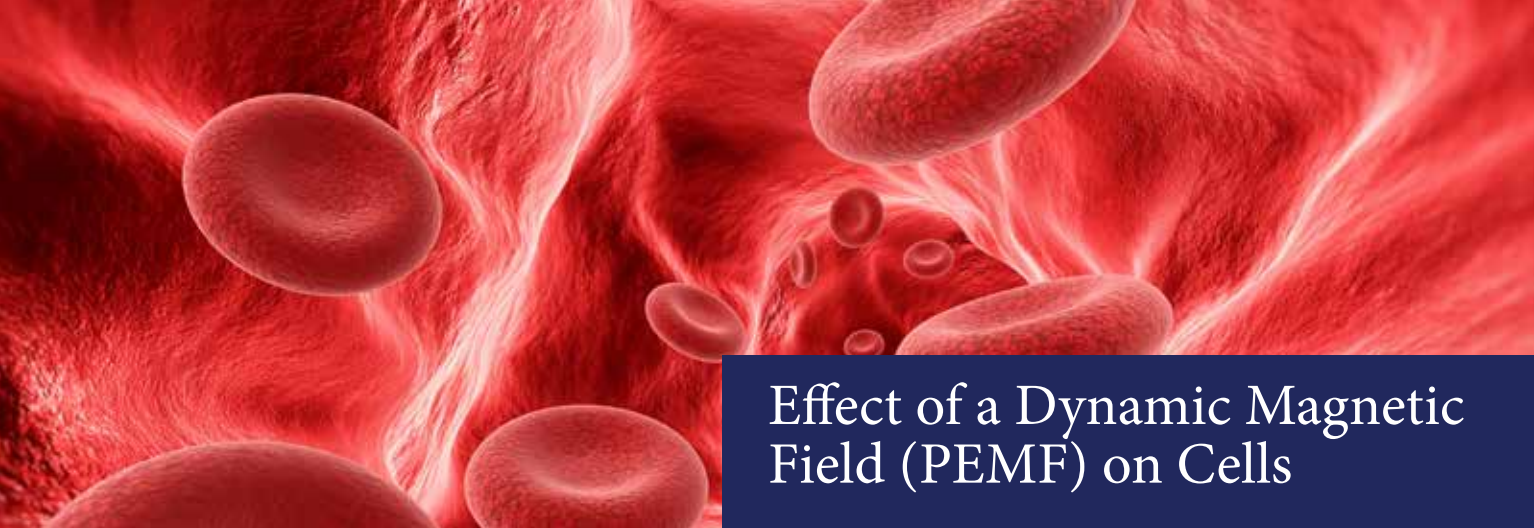


### What is an Electromagnetic Field?

Have you ever held two magnets in your hands, tried to force them together and felt the resistance between them? If so, you have experienced both a static magnetic field and the repelling effect of like charges.

The Earth has a static magnetic field which is measured between 35 and 50 microtesla, a standard of measurement of the flux or field strength. A dynamic magnetic field is different from a static field because it is always in flux or moving. This pulsing or dynamic field and can be created by introducing a pulsing electrical current upon a coil. This dynamic field is referred to as a Pulsed Electro-Magnetic Field (PEMF). Similar to the way that a changing magnetic field can generate an electric current, a changing electric field generates a magnetic field. An electromagnetic field is a physical field produced by moving electrical charges.

This field affects the behavior of any other charged objects near the field, including human cells and atoms.



## Effect of a Dynamic Magnetic Field (PEMF) on Cells

A dynamic pulsed electromagnetic field, when induced upon the body increases the movement of ions and electrolytes at the atomic level, affecting the cells in the skeleton, blood and all parts of the body. This movement stimulates atoms and cells into an array of chemical and electric actions:

- Increasing cellular membrane permeability by mechanically contracting (exercising) the cell. This is done by stimulating the opening of the ion channels through the cell membrane.
- Boosting individual red blood cell energy (mv) or polarity to help induce repelling (spreading out one from another). A free-suspended red blood cell performs better, with improved uptake of oxygen and nutrients as well as better removal of carbon dioxide waste product.
- Improved flow into micro-capillaries when red blood cells are free-suspended.
- Improved cell metabolism by stimulating the opening of the ion channels.
- Assisting to rebalance, re-energize, or heal cells where deficient.
- Assisting in cell apoptosis—the normal process of retiring sick or dying cells.
- Aiding in the increased production of Adenosine Triphosphate (ATP), the body's energy source.



### ATP and Its Importance to Performance and Wellness

All cells need energy to function and Adenosine Triphosphate (ATP) is the energy the body utilizes to perform primary tasks. ATP is fundamental to all cell and body functions and is necessary to sustain life itself. ATP also regulates cell metabolism by transporting chemical energy within our cells and converting it to energy to power muscles and movement. Low ATP levels cause our cells to be sick, which can impact their ability to heal, regenerate, or function properly. Through the introduction of a PEMF, cells will experience an increase in the movement of ions and electrolytes, helping to improve and rebalance cell energy.

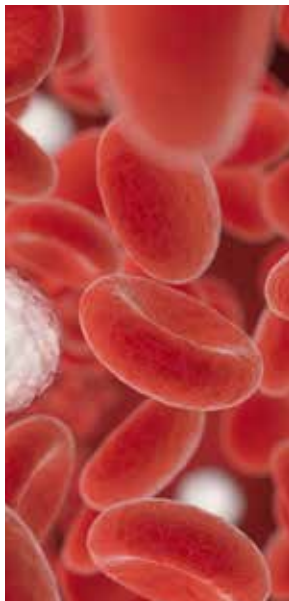
### The Overall Effect of Healthy Cells

When cells are healthy (energized and balanced), they metabolize efficiently and perform as intended. Cells of the same type come together to make tissues, and those tissues come together to make organs and bones. Healthy, charged red blood cells remove waste better and continually work to restore the body to a healthy state of living. Cellular movements in the tissue have a positive effect on pain, healing, well-being, and all normal functions. By optimizing cellular function within our entire body, we can have a positive effect on all intended body functions which in turn improves performance, healing, and overall happiness.

# Key Effects of PEMFs Demonstrated Through Medical Studies



Also see addendum following this document for more detailed study summaries.



**Increased and Improved Circulation** - When the body is injured, exposed to stress, diseased, has a nutrition deficiency, or suffers any one of hundreds of negative impacts, your red blood cells are often negatively affected. When a red blood cell is compromised, the electrical membrane charge is not optimal. This resulting electrical imbalance frequently causes cells to stack or bunch together. This is called “Rouleaux effect”. This condition can hamper vascularization and can negatively affect oxygen and nutrient uptake. When a dynamic magnetic field (PEMF) exercises a cell, the membrane of the cell frequently becomes properly charged, allowing the cell to repel itself or freely suspend from other cells which improves cell metabolism. Proper cell metabolism increases circulation; oxygen and nutrients move properly and efficiently throughout the body. In contrast, poor circulation makes tissues unhealthy and prone to disease, breakdown, and low energy output. Improved circulation helps tissues get the nutrition and oxygen they need, while expelling the waste by-product of dying cells. Good circulation helps with all body functions and enhances healing.



**Enhanced Muscle Function** - Muscle energy also improves through a process called Myosin Phosphorylation. Myosin is muscle, and phosphorylation is energy (ATP) production. This allows muscles to work harder for longer, and recover more swiftly from their tasks. Muscles that have adequate ATP production are key to maximum output and function

**Decreased Inflammation** - Inflammation is a cascade of physiologic processes triggered by the body in an effort to repair cellular damage in tissues by increasing the blood flow to the damaged area and increasing the number of good inflammatory cells. The process of inflammation is generated and supported by the interaction of a number of immune cell types, with other cell types (like T cells) playing a regulatory role in the cascade effect. Inflammation





is a necessary and beneficial process, but it often persists longer than necessary—sometimes developing into chronic inflammation. PEMFs have been found to limit and reduce this type of chronic, damaging inflammation.



**Bone Healing** - Magnetic fields pass completely through the body, tissues, organs and even the bones. PEMF devices work to repair bones, whether they are damaged by surgery, injury, or disease. PEMF devices have been found to improve bone regeneration after osteoporosis and osteopenia as well as other bone-destroying conditions.



**Blood Oxygenation** - Just as a fire cannot burn without oxygen, our cells cannot produce heat and energy without oxygen. Our lungs extract oxygen from the air we breathe. Then it passes into our blood and is carried away from the heart and delivered to the rest of the body, including all the organs. PEMF's separating effect on red blood cells help with the process of distributing oxygen via circulation through micro-capillaries. The absorbed oxygen within each red blood cell is transported through the body, where it is absorbed into the individual cells, organs and tissues. In the cells, enzymes and other basic cell energy production processes use the oxygen for cell metabolism, the energy necessary to function properly. The metabolism of an organism determines which substances it will find nutritious and which it will find harmful. Proper blood-oxygen levels at the cellular level allow this process to continue rapidly and efficiently. After the oxygen exchange, free-suspended red blood cells efficiently carry deoxygenated blood and metabolic waste products away from those same cells and back to the heart and lungs for recycling and expulsion.



**ATP Production** - The action of improved cell permeability, boosted movement of ions and electrolytes and improved oxygen uptake, all actions of PEMF, will assist the body's ability to improve ATP production (energy) , generating energy and all the associated benefits.



## Scientific Studies Performed on Multiple Conditions

There are over 2,000 peer-reviewed medical studies supporting the clinical effects of PEMF on a vast array of medical conditions. The studies are too numerous and long to include in this document, but we have included a selection at the conclusion of this summary. The fact that these studies are so broad and varied further supports the Nimbus Performance mantra that, “healthy cells are the body’s building blocks to repair itself, facilitate wellness and optimize performance.”

*The following is a partial list of key conditions for which medical studies have shown PEMF produced a positive effect.*

- Pain Reduction
- Improved Circulation
- Neuropathy Care
- Bone Non-Union Repair
- Bone Strengthening
- Disease Prevention
- Shortened Injury Recovery
- Decreased Use of Narcotics
- Treatment of Arthritis
- Treatment of Osteoporosis
- Treatment of Fibromyalgia
- Treatment of Carpel Tunnel Syndrome
- Anti-Inflammatory Treatment
- Treatment of Diabetic Ulcers
- Treatment of Skin Wound Healing
- Treatment of Plantar Fasciitis
- Treatment of Charcot Foot
- Reducing Blood Pressure



## Medical Support for PEMF

The human body is amazing and has been equipped to repair and or rebuild most any condition thrown upon it. The real power of PEMF is that it stimulates the body's natural ability to repair or maintain itself properly at the cellular level by energizing cells at the nuclear level. Stimulating the ions and electrolytes improves cell membrane permeability, energy output, and balance. Healthy cells require energy to perform at peak levels.

Healthy cells are the key to a healthy body and lifestyle.

PEMF addresses and boosts cellular energy, which is required for health, wellness, and repair. It is for this reason that safely powered PEMF is effective and has no known side effects. PEMF only boosts what a healthy body should be able to do on its own.

However, it is important to note that the method of PEMF delivery may significantly affect the outcome and benefits.

## The Next Frontier in PEMF and Energy Therapy

### The Evolution of Nimbus Performance cm2 Technology

Dr. Gregory Anderson, like most surgeons, uses an existing, FDA approved PEMF product called a Bone Stimulator when a patient has a bone non-union. A Bone Stimulation device generally costs between \$3,500 USD and \$7,000 USD, depending upon the supplier and the insurance reimbursement.

While using Bone Stim units on select patients, Dr. Anderson documented that other tissues near the treatment area



### Improved Performance and Faster Regeneration are Convincing Factors for Users

Hermann Maier, three time World Cup and two time Olympic gold medal skier, almost severed his leg in a near-fatal motorcycle accident in August of 2001. After dozens of medical procedures, he was introduced to PEMF Therapy. In January of 2003, he won the World Cup Super G at Kitzbuehel, Austria in only his second race following his recovery.

"No one expected him to walk again—let alone ski competitively. Winning world-class races was never even considered. From now on, I'm treating every member of the team with PEMF Therapy."

—Heini Bergmuller,  
Austrian Ski Team Manager



Dr. Huntsman



Dr. Anderson

were also affected: bone was much healthier (dense) and

soft tissues were healthy, vibrant and showed little or no atrophy.

One of Dr. Anderson's frustrations as a highly successful foot and ankle surgeon was the persistent Bone Cast Disease he saw in patient cases that required non-weight bearing or limited mobility as part of the treatment protocol. When an appendage is idle, bone and soft tissue cells begin to degrade, resulting in Bone Cast Disease. The treatment is generally weeks of physical therapy. Could PEMF help alleviate this problem?

Dr. Anderson consulted with Dr. Kade Huntsman, a renowned back and neck surgeon to discuss his findings. Dr. Huntsman also used Bone Stim technology in his practice, to insure against costly revision surgeries. The combination of their positive experiences with PEMF lead the



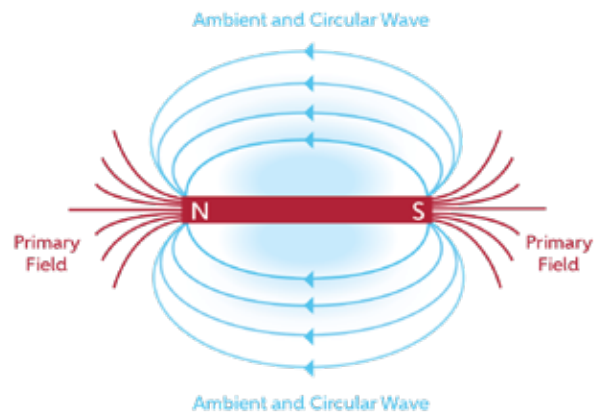
Dale C Gledhill

two surgeons to contact Dale C. Gledhill, an expert at new technology development and manufacturing. Doctors Anderson and Huntsman asked Gledhill to research and build a "never built before" device that would replicate only the overflow field generated by a standard PEMF device.

The PEMF Bone Stim devices currently on the market use a large circular or rectangular copper

coil. This focuses a powerful magnetic field into the bone to generate a current across the non-union and promote osteogenesis.

The innovative Nimbus Performance design works differently. Instead of a large coil producing a penetrative field, Gledhill's design was engineered to produce only the circular field that will immerse the area of treatment in a cloud of pulsing energy—termed cm2.



## The Birth of cm2 Technology

To replicate only the circular part of the magnetic field required an entirely new product design and delivery system. It was scientifically impossible with standard PEMF designs to capture and enhance only the circular part of the magnetic field.

Gledhill conceived a unique system of using a tiny micro-coil with a patented E-core to capture and recycle the overflow field, or circular wave.

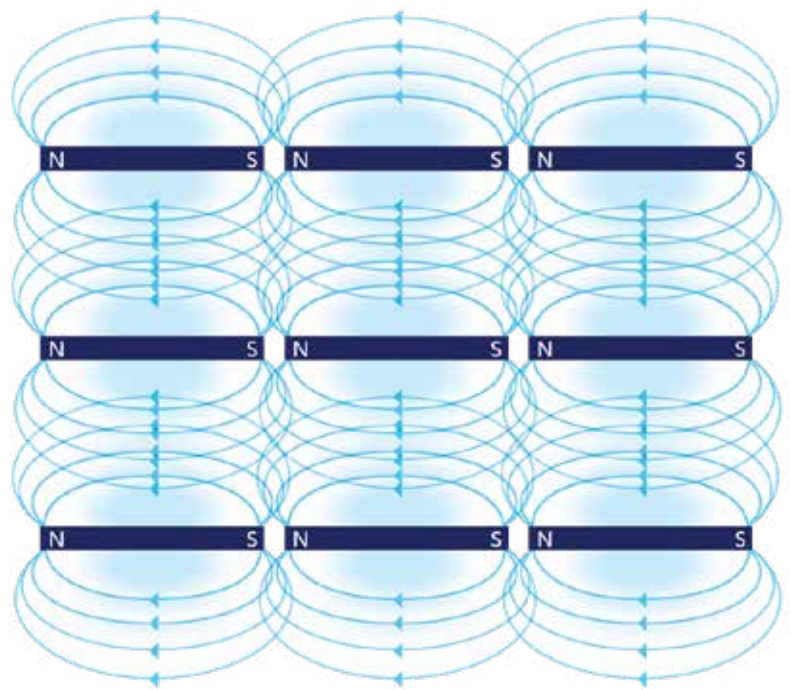
Next, it was hypothesized that building series of these micro coils would produce an overlapping and immersive field without weak or magnetic hotspots. This novel concept—using a sequenced field of multiple micro-coils—confirmed their hypothesis. A total immersion of the entire treatment area in a hybrid PEMF proved effective and exceeded all the surgeons’ requirements.

A new technology was born; a dynamic, low intensity, pulsed electromagnetic field that is safe, circular and immersive. The team named the new technology called cm2, referencing the cellular matrix squared or enhanced.

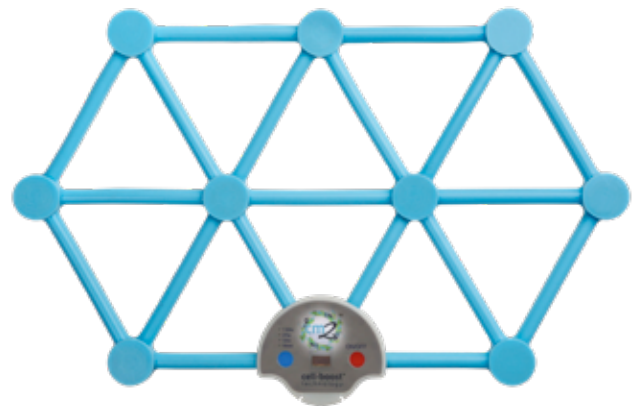
Using cm2 technology to deliver a low intensity hybrid wave of immersion has been extremely effective in replicating and boosting the stable field—as originally identified years earlier in the “magnetic field overflow” area of a standard Bone Stim device. This new technology immerses the entire target area with a low intensity, pulsating magnetic field to continually exercise and move the ions and electrolytes at the atomic level. Unlike a standard bone stimulation, cm2 does not broadcast a powerful, amplified voltage through the bone. Rather, it evenly spreads a safe, pulsing field over all cells, in both hard and soft tissue. An additional benefit of the cm2 technology is that the field can be generated with very low power and within an ultra-safe range.

## The Nimbus cm2 Program

Dr. Anderson, Dr. Huntsman, and Mr. Gledhill, have now commercially developed this technology in tandem with Nimbus Performance and are making cm2 available worldwide. Nimbus currently offers cm2 in two devices, a WEB and a BAND—each with its own unique purpose and application. Additional applications are in development.



Micro-coils and Immersive cm2 Technology



Nimbus Performance WEB

The Nimbus Performance WEB is designed for injury treatment and works by immersing the entire treatment area with cm2 cell boost technology. The WEB immerses the entire musculoskeletal target area with the cm2 pulse, affecting the entire cell structure as outlined in this document. Because it is so immersive, the WEB is very effective at boosting the target zone into the healing phase and starting the body’s natural healing cascade.

PEMF has been shown to reduce inflammation and pain, aid in bone repair and offers many other benefits through improved capillary vascularization

and improved oxygen and nutrition uptake. The benefits of PEMF to facilitate a swifter return to a normal lifestyle are well-documented<sup>1</sup>. Additionally, Nimbus Performance has seen tremendous positive results and improved life stories from individuals using the WEB

The Nimbus Performance BAND is designed to be worn on the wrist to continually flood the ulnar and radial arteries with cm2 cell boost technology. Using cm2 in this way assists the body's natural abilities by modifying the energy of red blood cell membranes to aid in cell separation. Red blood cells commonly bunch or stack together, a medical condition called rouleaux formation (see photo on right) which has multiple causes, but is nearly impossible to avoid. While there are many causes, Rouleaux is primarily the result of cell membranes having varied negative (-) energy (mv) levels.

When the red blood cell membrane has a proper and "like" negative (-) charge or "like" zeta potential, the cell will repel and free-suspend, similar to how two magnets will repel if the like charge (+ or -) are contiguous. Healthy red blood cells are medically described as "the cells are nicely spread, and they are sometimes touching or even slightly overlapping, but they are not piled up on top of each other sticking or stacking."

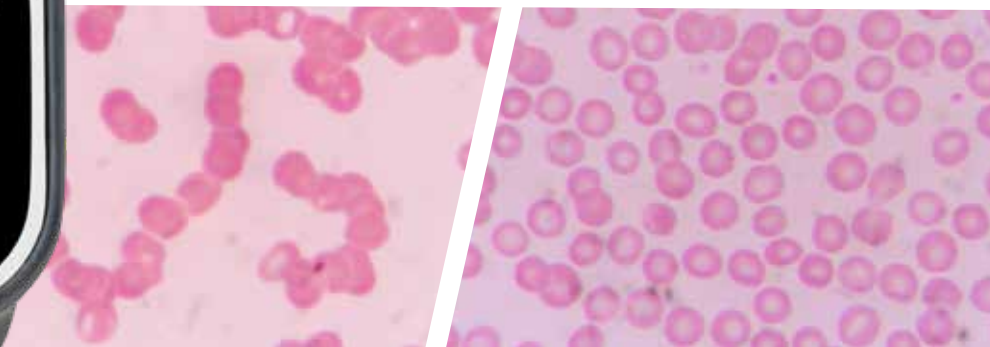


Red blood cells are the body's tools for delivering oxygen and nutrition, for waste (CO<sub>2</sub>) removal, and for fluid distribution to all tissues and organs. From the moment a red blood cell leaves the bone marrow, it is optimally adapted to perform this task on its short 120-day life cycle. The membrane is specifically built for maximum absorption and transport capability. Its unique concave shape is ideal for optimized surface area and flexibility. But, when these cells stack, their ability to perform vital transport functions is vastly degraded. In fact, when 7 or more red blood cells stack, their surface membrane is reduced by 50% or more.

The capillaries in a human body are approximately the diameter of one red blood cell. When cells are in a rouleaux state, their ability to enter the 100,000 miles of capillaries is impaired and circulation suffers.

The Nimbus Performance cm2 BAND pulses its hybrid PEMF on the passing red blood cells in the radial and ulnar artery in the wrist. This cm2 pulse excites the ions and electrolytes to aid the body's capability to change the zeta potential of a cell. This energy event is targeted to balance the cell membrane charge so that "like cells" will repel each other, exposing the entire cell surface area.

Nimbus Performance believes the positive health effects of separated and healthy blood cells will be significant with frequent use of the cm2 BAND. Preliminary users of this technology have confirmed that boosting and energizing cells assisted their body's natural abilities.



Rouleaux Formations

Healthy Red Blood Cells



## The Financial and Physical Impact of Health

It is important to note that in regard to the human body, prevention generally costs less than 10% of the cost of medical treatment for a health issue. Prevention is always preferable to treatment from any perspective— be it a financial, physical, or general happiness outlook.

Healthy cells are a powerful preventive force against disease, potentially eliminating the financial stress and physical rigors of treatment. The financial and physical impact of the Nimbus Performance cm2 technology can easily be quantified. Consider the following:

- What are the costs of being absent from employment and reduced earning power?
- What is the cost of each additional week of physical therapy?
- What are the costs and benefits of reduced narcotics use?
- What are the costs of sitting on the sideline of a sports team during extended recovery?
- What are the emotional costs of overall poor health and lifestyle depletion?
- What are the emotional and physical costs of inactivity or low energy?
- What are the benefits of operating at peak physical and cognitive performance?

These considerations continually drive customers to Nimbus Performance Technology.

### **Nimbus Performance Intellectual Product Protection**

Nimbus Performance has multiple and significant U.S. patents issued or pending and multiple foreign patents pending. We believe our breakthrough cm2 technology will significantly impact personal wellness. Nimbus Performance, LLC has taken significant steps to protect the commercialization of our cm2 technology.

### **Nimbus Performance cm2 Summary**

The human body is magnificent and amazing. The deeper we study and uncover its secrets, we understand that healthy cells are vital to the body's ability to repair and rebuild. When cells are healthy, the human body is empowered to full potential. The power of the cm2 technology is solely tied to cell health and providing appropriate energy so the human body can perform its trillions of functions efficiently. The complex human body is constantly being encumbered with stress and injury, which often leads to disease and a diminished quality of everyday living.

Nimbus Performance's science is all about YOU—and to help unleash the amazing power you already have within.

*Nimbus Performance cm2 technology  
—it's science, and you.*

The statements in this document have not been evaluated by the FDA. The product or information is not intended to diagnose, treat, cure or prevent any disease. This information is published for the benefit of Nimbus Performance. Always consult a health professional for medical treatment. Nimbus Performance supports sound science and independent research.



## Supporting Medical and Scientific Studies

The following summaries and linked medical studies have been chosen to support the science and concepts presented in this document. All information is public and only represents a fraction of publicly available medical studies regarding PEMF and its positive effects on cells and normal body health restoration. There is no claim to ownership of these studies; they are only provided as a reference. At Nimbus, we encourage independent research and embrace science as core to product development.

Although the studies included are primarily on standard PEMF, we believe our hybrid PEMF (termed cm2) is superior in control, cost, safety and effectiveness.

### **Red Blood Cell, Zeta Potential and Electrical Charge of a Red Blood Cell**

Electrical properties of the red blood cell membrane and immunohematological investigation

Heloise Pöckel Fernandes, Carlos Lenz Cesar, and Maria de Lourdes Barjas-Castro

**Quotes:** “Repulsive force is generated by the negative charges on cell surfaces that occur due to the presence of carboxyl group in sialic acids in the erythrocyte membrane.(1,2) Clumping occurs when the aggregation force is greater than the force of repulsion.(1)”

### **PEMF and Alzheimer’s Disease**

On review, after applying external electromagnetic fields ranging 5 to 8 Hz, large improvements were detected in Alzheimer’s patients. These included improved visual memory, drawing performance, spatial orientation, mood, short-term memory and social interactions.

R. Sandyk, “Alzheimer’s Disease: Improvement of Visual Memory and Visuoconstructive Performance Treatment with Picotesla Range Magnetic Fields,” *International Journal of Neurosci*, 76(3-4), June 1994, p. 185-225.

As generally supported, a person’s biological daily clock may causally be related to memory deterioration in Alzheimer’s patients and in the aging. Synchronizing of the circadian rhythms using magnetic fields, (this article suggests) could lead to improved memory for those affected.

R. Sandyk, et al., “Age-related Disruption of Circadian Rhythms: Possible Relationship to Memory Impairment and Implications for Therapy with Magnetic Fields,” *International Journal of Neurosis*, 59(4), August 1991, p. 259-262.



## **PEMF and Amyotrophic Lateral Sclerosis (Lou Gehrig's Disease)**

A study of three patients with Amyotrophic Lateral Sclerosis were treated with a pulsed magnetic field administered by a PEMF apparatus. Given three times a week for approximately 75 sessions to achieve maximum benefits, all three experienced beneficial effects.

A. Bellosi & R. Berget, "Pulsed Magnetic Fields: A Glimmer of Hope for Patients Suffering from Amyotrophic Lateral Sclerosis," Second World Congress for Electricity and Magnetism in Biology and Medicine, 8-13 June 1997, Bologna, Italy.

## **PEMF and Ankle Sprain**

Results of this double-blind, placebo-controlled study indicated that treatment with two 30-minute sessions of noninvasive pulsed radio frequency therapy is effective in significantly decreasing the time required for edema reduction in patients suffering from lateral ankle sprains.

A.A. Pilla & L. Kloth, "Effect of Pulsed Radio Frequency Therapy on Edema in Ankle Sprains: A Multisite Double-Blind Clinical Study," Second World Congress for Electricity and Magnetism in Biology and Medicine, 8-13 June 1997, Bologna, Italy, p. 300.

## **PEMF and Arthritis**

Three hours of exposure to a 50-Hz magnetic field in this study revealed that experimentally induced inflammation and suppressed arthritis in rats was significantly inhibited as a result.

Y. Mizushima, et al., "Effects of Magnetic Field on Inflammation," *Experientia*, 31(12), December 15, 1975, p.1411-1412.

A double-blind, placebo-controlled research study on the effects of pulsed electrical fields administered over a 4 week period revealed significant improvement in patients receiving the therapy relative to the controls.

J.C. Reynolds, "The Use of Implantable Direct Current Stimulation in Bone Grafted Foot and Ankle Arthrodeses: A Retrospective Review," Second World Congress for Electricity and Magnetism in Biology and Medicine, 8-13 June 1997, Bologna, Italy.

In this general review article on the treatment of patients with psoriatic arthritis with magnetic fields, the authors state that an alternating low-frequency magnetic field (30-40 mT) improves the clinical state of afflicted joints. Such treatments are normally carried out for 30 minutes per day over a period of 15 to 20 days.

V.D. Grigor'eva, et al., "Therapeutic Use of Physical Factors in Complex Therapy of Patients with Psoriatic Arthritis," *Vopr Kurortol Fizioter Lech Fiz Kult*, (6), 1995, p. 48-51

This research studied the effects of PEMF therapy alone or combined with conventional drugs in rheumatoid arthritis patients. This treatment consisted of 14 days with 6 minute exposures daily. An obvious improvement was seen after 3 days of treatment, with greater improvement by patients suffering from mild to moderate levels of the disease. End results computed into a 90 percent patient improvement rate.

9B.Y. Drozdovski, et al., "Use PEMF Therapy with an AMLT-01 Apparatus in Complex Therapy for Rheumatoid Arthritis," *Fiz Med*, 4(1-2), 1994, p. 101-102

This study on 7 to 14 year old juveniles suffering from rheumatoid arthritis examined effects of low-frequency magnetic fields from a Polius-1 device. Ten daily treatment exposures of 10 to 12 minutes each were conducted on three experimental groups. The three groups showed 58, 76, 37 percent beneficial effects from the treatment.

E.A. Shlyapok, et al., "Use of Alternating Low-Frequency Magnetic Fields in Combination with Radon Baths for Treatment of Juvenile Rheumatoid Arthritis," *Vopr Kurortol Fizioter Lech Fiz Kult*, 4,1992, p. 13-17.

Low frequency and constant magnetic fields in patients suffering from rheumatoid arthritis and osteoarthritis was the focus of this study. Patients with stages 1 & 2 rheumatoid arthritis as well as patients with osteoarthritis, showed the beneficial effects from treatments. These low frequency, constant magnetic fields were found especially beneficial to the knees, ankles and wrists.

V.D. Grigor'eva, et al., "Therapeutic Application of Low-Frequency and Constant Magnetic Fields in Patients with Osteoarthritis Deformans and Rheumatoid Arthritis," *Vopr Kurortol Fizioter Lech Fiz Kult*, 4, 1980, p. 29-35.

## **PEMF and Blepharitis (infection of the eyelid)**

Study results indicated that using a magnetic ointment containing reduced iron powder, with an alternating magnetic field had beneficial effects with patients suffering from chronic blepharitis.

V.A. Machekhin, et al., "A New Method for Treating Chronic Blepharitis Using Magnetic Compounds and an Alternating Magnetic Field," *Vestn Oftalmol*, 109(4), July-September 1993, p. 16-18.

## **PEMF and NASA**

NASA has spent millions of dollars and years research trying to solve the issue of musculoskeletal degradation of astronauts in space, outside of the earth's magnetic field.

Their study focused on:

- Types of magnetic fields that are on effective on human cells growth and repair.
- How to stimulate cell growth.
- How to replicate the benefit of nature (magnetic fields) on mammals.
- Defining a PEMF technology that could replicate nature.

The NASA studies concluded the PEMF therapy is effective at healing bones and developing and repairing traumatized cellular tissue as well as moderating multiple neurological diseases. In 2009 NASA was awarded a U.S. patent for PEMF use to enhance tissue repair and reverse bone loss experienced by astronauts.

## **PEMF on Pain**

**Institution:** Department of Plastic Surgery, Akademikliniken, Storängsvägen 10, 115 42, Stockholm, Sweden.  
per.heden@ak.se

**Summary:** This study was undertaken to determine if PEMF could provide pain control after breast augmentation

**Highlight Quotation:** VAS data showed that pain had decreased in the active cohort by nearly a factor of three times that for the sham group.

**Conclusion:** “Patient use of postoperative pain medication correspondingly also decreased nearly three times faster in the PEMF versus the placebo “

Department of Plastic Surgery, Akademikliniken, Storängsvägen 10, 115 42, Stockholm, Sweden.

**Background:** Postoperative pain may be experienced after breast augmentation surgery despite advances in surgical techniques which minimize trauma. The use of pharmacologic analgesics and narcotics may have undesirable side effects that can add to patient morbidity. This study reports the use of a portable and disposable noninvasive pulsed electromagnetic field (PEMF) device in a double-blind, randomized, placebo-controlled pilot study. PMID: 18506512 [PubMed - indexed for MEDLINE]

## **PEMF on Pain(2) and Wound Care**

**Institution:** Division of Plastic and Reconstructive Surgery, Columbia University Medical Center, New York-Presbyterian Hospital, New York, NY. 2Neurosurgery Laboratory, Montefiore Medical Center and the Albert Einstein College of Medicine, Bronx, NY. 3Department of Biomedical Engineering, Columbia University, New York, NY. 4Department of Orthopedics, Mount Sinai School of Medicine, New York, NY.

**Summary:** Surgeons seek new methods of pain control to reduce side effects and speed post-operative recovery. Pulsed electromagnetic fields (PEMF) are effective for bone and wound repair and pain and edema reduction. This study examined whether the effect of PEMF on post-operative pain was associated with differences in levels of cytokines and angiogenic factors in the wound bed

**Highlight Quotation:** PEMF therapy significantly reduced post-operative pain and narcotic use in the immediate post-operative period

**Conclusion:** PEMF therapy significantly reduced post-operative pain and narcotic use in the immediate post-operative period.

Effects of Pulsed Electromagnetic Fields on IL-1beta and Post Operative Pain: A Double-Blind, Placebo-Controlled Pilot Study in Breast Reduction Patients. Rohde C, Chiang A, Adipoju O, Casper D, Pilla AA.

**Background:** Surgeons seek new methods of pain control to reduce side effects and speed post-operative recovery. Pulsed electromagnetic fields (PEMF) are effective for bone and wound repair and pain and edema reduction. This study examined whether the effect of PEMF on post-operative pain was associated with differences in levels of cytokines and angiogenic factors in the wound bed. PMID: 19927043 [PubMed]

## **PEMF and Cell Growth**

**Institution:** Department of Orthopedics, University of Texas Health Science Center at San Antonio, 78229-3900, USA

**Summary:** The mechanisms involved in pulsed electromagnetic field stimulation of nonunions are not

known. Animal and cell culture models suggest endochondral ossification is stimulated by increasing cartilage mass and production of transforming growth factor-beta 1.

**Highlight Quotation:** This indicates that human nonunion cells respond to pulsed electromagnetic fields in culture and that transforming growth factor-beta 1 production is an early event

**Conclusion:** The delayed response of hypertrophic and atrophic nonunion cells (> 24 hours) suggests that a cascade of regulatory events is stimulated, culminating in growth factor synthesis and release. PEMF had a positive effect on cell Growth.

Pulsed electromagnetic fields increase growth factor release by nonunion cells. Guerkov HH, Lohmann CH, Liu Y, Dean DD, Simon BJ, Heckman JD, Schwartz Z, Boyan BD. Department of Orthopaedics, University of Texas Health Science Center at San Antonio, 78229-3900, USA. PMID: 11249175 [PubMed - indexed for MEDLINE]

## **PEMF and Angiogenesis (new blood vessels)**

**Institution:** New York University Medical Center, Institute of Reconstructive Plastic Surgery, New York, New York, USA

**Summary:** Pulsed electromagnetic fields (PEMF) have been shown to be clinically beneficial in repairing bones and other tissues, but the mechanism of action is unclear. The present study examined the effect of PEMF on angiogenesis in order to elucidate a potential mechanism for its therapeutic effect.

**Highlight Quotation:** PEMF may facilitate healing by augmenting the interaction between ontogenesis and blood vessel growth. This finding not only elucidates a novel mechanism for PEMF action, but suggests extended applications for PEMF

**Conclusion:** *although PEMF has been used for years by clinicians to supplement bone healing, its precise mechanism of action has not been determined. Our data provide evidence to support the concept that PEMF acts by promoting angiogenesis primarily through the coordinated release of FGF-2.*

**Specific Aims:** Pulsed electromagnetic fields (PEMF) have been shown to be clinically beneficial in repairing bones and other tissues, but the mechanism of action is unclear. The present study examined the effect of PEMF on angiogenesis in order to elucidate a potential mechanism for its therapeutic effect.

## **PEMF and Bone Repair (osteoblasts)**

**Institution:** Bone Tissue Engineering Research Lab, Center for Nano Bioengineering, Chung Yuan Christian University, Chung Li, Taiwan, Republic of China

**Summary:** We use an in-vitro osteoblast cell culture model to investigate the effects of low-frequency (7.5 Hz) pulsed electromagnetic field (PEMF) stimulation on osteoblast population, cytokines

**Highlight Quotation:** The results demonstrate that PEMF can stimulate osteoblast growth

**Conclusion:** *Although the lower intensities of the PEMF are yet to be determined, the results of this study can shed light on the mechanisms of PEMF stimulation on non union fracture therapy and osteoporosis prevention in the future.*

Cytokine release from osteoblasts in response to different intensities of pulsed electromagnetic field stimulation.

The results demonstrate that PEMF can stimulate osteoblast growth, release of TGFbeta1... Although the lower intensities of the PEMF are yet to be determined, the results of this study can shed light on the mechanisms of PEMF stimulation on non union fracture therapy and osteoporosis prevention in the future. PMID: 17886003 [PubMed - indexed for MEDLINE]

## **PEMF, Inflammation and Arthritis**

**Institution:** Department of Pharmacology and Toxicology, Madras Veterinary College, Vepery, Chennai, India

**Summary:** This study aims to explore the anti inflammatory effect of PEMF and its possible mechanism of action in amelioration of adjuvant induced arthritis

**Highlight Quotation:** Exposure of arthritic rats to PEMF at 5 Hzx4 microT x 90 min, produced significant anti exudative effect resulting in the restoration of the altered parameters.

**Conclusion:** *The results of this study indicated that PEMF could be developed as a potential therapy for Rheumatoid Arthritis in human beings.*

Low frequency and low intensity pulsed electromagnetic field exerts its anti-inflammatory effect through restoration of plasma membrane calcium ATPase activity. The results of this study indicated that PEMF could be developed as a potential therapy for RA in human beings. PMID: 17537462 [PubMed - indexed for MEDLINE]

## **PEMF and Wound Healing**

**Institution:** Laboratory of Experimental Physiology, Ioannina University School of Medicine, Greece. tanasisa@yahoo.gr

**Summary:** The aim of the present study was to investigate the effects of short duration PEMF on secondary healing of full thickness skin wounds

**Highlight Quotation:** there was a statistically significant acceleration of the healing rate

**Conclusion:** *a qualitative improvement of healing progress was identified by histological examination at all time points, with the PEMF group compared to the control group*

The effect of pulsed electromagnetic fields on secondary skin wound healing: an experimental study.

## **PEMF and Osteoarthritis lesions**

**Institution:** Laboratory of Experimental Surgery, Research Institute Codivilla-Putti, Rizzoli Orthopaedic Institute, Bologna, Italy. milena.fini@ior.it

**Summary:** The aim of the present study was to discover whether the therapeutic efficacy of PEMFs was maintained in older animals also in more severe OA lesions

**Highlight Quotation:** PEMF stimulation significantly changed the progression of OA lesions.

**Conclusion:** *PEMFs maintained a significant efficacy in reducing lesion progression.*

Effect of pulsed electromagnetic field stimulation on knee cartilage, subchondral and epiphyseal trabecular bone of aged Dunkin Hartley guinea pigs. PMID: 17459652 [PubMed - indexed for MEDLINE]

## **PEMF and Bone Healing**

**Institution:** Department of Biomedical Engineering, The Orthopaedic Research Center, Lerner Research Institute of The Cleveland Clinic Foundation, Cleveland, OH 44195, USA.

**Summary:** This study tested the hypothesis that pulsed electromagnetic field (PEMF) treatments augment and accelerate the healing of bone trauma

**Highlight Quotation:** This latter observation demonstrates the specificity in the relationship between waveform characteristics and biological outcomes.

**Conclusion:** *Although both PEMF- and placebo-treatment groups exhibited similar onset of hard callus at approximately 9 days after surgery, a 2-fold faster rate of hard callus formation was observed with the PEMF group.*

Pulsed electromagnetic field treatments enhance the healing of fibular osteotomies. PMID: 15936919 [PubMed - indexed for MEDLINE]

## **PEMF and Bone Fractures**

A group of 83 adults with ununited fractures were examined for the effects of bone grafting and pulsed electromagnetic fields for this study. Results showed a successful healing rate of 87 percent in the original 38 patients treated with bone grafts and PEMF for ununited fractures with wide gaps, malalignment, and synovial pseudarthrosis. Of the 45 patients that were not successfully treated with PEMF and had bone grafting, when re-treated with pulsing electromagnetic fields, achieved a 93 percent success rate.

C.A. Bassett, et al., "Treatment of Therapeutically Resistant Non-unions with Bone Grafts and Pulsing Electromagnetic Fields," *Journal of Bone Joint Surg*, 64(8),  
October 1982, p. 1214-1220.

Examining the effects of pulsing electromagnetic fields on 125 patients suffering from ununited fractures of the tibial diaphysis, showed a healing success rate of 87%.

C.A. Bassett, et al., "Treatment of Ununited Tibial Diaphyseal Fractures with Pulsing Electromagnetic Fields," *Journal of Bone Joint Surg*, 63(4),  
April 1981, p. 511-523.

Results of this study showed treatment with pulsed electromagnetic fields resulted in an overall success rate of at least 75 percent in patients suffering from tibia lesions.

M.W. Meskens, et al., "Treatment of Delayed Union and Nonunion of the Tibia Pulsed Electromagnetic Fields. A Retrospective Follow-up," *Bull Hosp Jt Dis Orthop Inst*, 48(2),  
Fall 1988, p. 170-175.

This review article makes the following observations with respect to the use of pulsed electromagnetic fields in treating non-union fractures, failed arthrodesis, and congenital arthrodesis. The treatment has been shown

to be more than 90 percent effective in adult patients. In cases where union does not occur with PEMFs alone after approximately four months, PEMF treatment coupled with fresh bone grafts ensures a maximum failure rate of only 1 to 1.5 percent. For those with delayed union three to four months following fracture, PEMFs appear to be more successful than in patients treated with other conservative methods. For more serious conditions, including infected non-unions, multiple surgical failures, long-standing atrophic lesions, failed knee arthrodesis after removal of infected prostheses, and congenital pseudo-arthrodesis, PEMF treatment has exhibited success in most patients.

17C.A. Bassett, "The Development and Application of Pulsed Electromagnetic Fields (PEMFs) for Ununited Fractures and Arthrodeses," *Clin Plast Surg*, 12(2), April 1985, p. 259-277.

Results of this study found that 35 of 44 non-united scaphoid fractures 6 months or older healed in a mean time of 4.3 months during pulsed electromagnetic field treatment using external coils and a thumb spica cast.

G.K. Frykman, et al., "Treatment of Nonunited Scaphoid Fractures Pulsed Electromagnetic Field and Cast," *Journal of Hand Surg*, 11(3), May 1986, p. 344-349.

This double-blind, placebo-controlled study examined the effects of pulsed electromagnetic fields in femoral neck fracture patients undergoing conventional therapy. PEMF treatment was started within two weeks of fracture, and patients were instructed to make use of the electromagnetic device for 8 hours per day over a 90-day period. Results showed beneficial effects relative to controls after 18 months of follow-up.

E. Betti, et al., "Effect of Electromagnetic Field Stimulation on Fractures of the Femoral Neck. A Prospective Randomized Double-Blind Study"; Second World Congress for Electricity and Magnetism in Biology and Medicine, 8-13 June 1997, Bologna, Italy.

Results of this double-blind study showed significant healing effects of low- frequency pulsing electromagnetic fields in patients treated with femoral intertrochanteric osteotomy for hip degenerative arthritis.

G. Borsalino, et al., "Electrical Stimulation of Human Femoral Intertrochanteric Osteotomies. Double-Blind Study," *Clin Orthop*, (237), December 1988, . 256- 263.

In this study, 147 patients with fractures of the tibia, femur, and humerus who had failed to benefit from surgery-received treatment with external skeletal fixation in situ and pulsed electromagnetic fields. Results indicated an overall success rate of 73 percent. Femur union was seen in 81 percent and tibia union in 75 percent.

M. Marcer, et al., "Results of Pulsed Electromagnetic Fields (PEMFs) in Ununited Fractures after External Skeletal Fixation," *Clin Orthop*, (190), November 1984, . 260-265

This study examined the effects of extremely low frequency electromagnetic fields (1-1000 Hz, 4 gauss) on new bone fractures of female patients. Results led the authors to suggest that EMF treatment accelerates the early stages of fracture healing.

O. Wahlstrom, "Stimulation of Fracture Healing with Electromagnetic Fields of Extremely Low Frequency (EMF of ELF)," *Clin Orthop*, (186), June 1984, . 293- 301.

This study examined the preventive effects of low-frequency pulsing electromagnetic fields against delayed union in rat fibular osteotomies and diaphyseal tibia fractures in humans. Results indicated such treatment

modulated and accelerated fracture union in both groups.

A.W. Dunn & G.A. Rush, 3d, "Electrical Stimulation in Treatment of Delayed Union and Nonunion of Fractures and Osteotomies," Southern Medical Journal, 77(12), December 1984, . 1530-1534.

This article discusses the cases of two children with bone non-union following lengthening of congenitally shortened lower legs. Pulsed sinusoidal magnetic field treatment was beneficial for both patients.

F. Rajewski & W. Marciniak, "Use of PEMF for Treatment of Bone Malunion in Limb Lengthening. Preliminary Report," Chir Narzadow Ruchu Ortop Pol, 57(1-3), 1992, . 247-249.

Results of this study showed that 13 of 15 cases of long bone nonunion treated with pulsed electromagnetic fields in combination with Denham external fixator united within several months.

R.B. Simonis, et al., "The Treatment of Non-union Pulsed Electromagnetic Fields Combined with a Denham External Fixator," Injury, 15(4), January 1984, . 255-260.

Results of this study found electromagnetic field stimulation to be an effective treatment for nonunion among a group of 37 French

L. Sedel, et al., "Acceleration of Repair of Non-unions electromagnetic Fields," Rev Chir Orthop Reparatrice Appar Mot, 67(1), 1981, . 11-23.

Results of this study found treatment induced pulsing to be beneficial in patients suffering from nonunions unresponsive to surgery.

J.C. Mulier & F. Spaas, "Out-patient Treatment of Surgically Resistant Non- unions Induced Pulsing Current - Clinical Results," Arch Orthop Trauma Surg, 97(4), 1980, .293-297.

In this interview with Dr. C. Andrew L. Bassett, a physician researching the use of pulsed electromagnetic fields for the past 30 years at Columbia University's Orthopedic Research Lab, Dr. Bassett notes that approximately 10,000 of the 12,000-plus orthopedic surgeons in the U.S. have used pulsed electromagnetic fields on at least one patient. Many such surgeons have incorporated the therapy on a more regular basis. He estimates that a total of at least 65,000 patients nationwide have received the treatment, with a probable success rate of between 80 and 90 percent. Use of the treatment has been primarily in patients suffering from non-united fractures, fusion failures, and pseudoarthrosis.

C.A. Bassett, "Conversations with C. Andrew L. Bassett, M.D. Pulsed Electromagnetic Fields. A Noninvasive Therapeutic Modality for Fracture Nonunion (Interview)," Orthop. Review, 15(12) 1986 781-795.

This review article notes that the use of pulsed electromagnetic fields began in 1974, and that 250,000 nonunion patients have received the treatment since. The author argues that success rates are comparable to those of bone grafting, and that PEMF treatment is more cost-effective and free of side effects. The FDA approved PEMF use in 1982, although it remains widely unused due to physician misunderstanding and lack of knowledge concerning the treatment.

A. Bassett, "Therapeutic Uses of Electric and Magnetic Fields in Orthopedics," in D.O. Carpenter & S.



Ayrapetyan, (eds.), *Biological Effects of Electric and Magnetic Fields. Volume II: beneficial and Harmful Effects*, San Diego: Academic Press, 1994, . 13-48.

This 7-year study examined data on more than 11,000 cases of nonunions treated with pulsed electromagnetic fields for up to 10 to 12 hours per day. Results indicated an overall success rate of 75 percent.

A.A. Goldberg, "Computer Analysis of Data on More than 11,000 Cases of Ununited Fracture Submitted for Treatment with Pulsing Electromagnetic Fields," *Bioelectrical Repair and Growth Society, Second Annual Meeting*, 20-22 September 1982, Oxford, UK, . 61.

This study examined the effects of low-frequency electromagnetic fields (1-1000 Hz) on middle-aged female patients suffering from fresh radius fractures. Results showed significant increases in scintimetric activity surrounding the fracture area after two weeks of EMF treatment relative to controls.

O. Wahlstrom, "Electromagnetic Fields Used in the Treatment of Fresh Fractures of the Radius," *Bioelectrical Repair and Growth Society, Second Annual Meeting*, 20-22 September 1982, Oxford, UK, . 26.

This study examined the effects of constant magnetic fields in patients suffering from fractures. Results showed that magnetic exposure reduced pain and the onset of edema shortly after trauma. Where edema was already present, the treatment exhibited marked anti-inflammatory effects. The strongest beneficial effects occurred in patients suffering from fractures of the ankle joints.

G.B. Gromak & G.A. Lacin, "Evaluations of the Efficacy of Using a Constant Magnetic Field in Treatment of Patients with Traumas," in I. Detlav, (ed.), *Electromagnetic Therapy of Injuries and Diseases of the Support-Motor Apparatus. International Collection of Papers*, Riga, Latvia: Riga Medical Institute, 1987, . 88-95.<

Results of this study found that 10 hours per day of electromagnetic stimulation (1.0-1.5 mV) produced complete union in 23 of 26 patients receiving the treatment for nonjoined fractures.

A.F. Lynch & P. MacAuley, "Treatment of Bone Non-Union Electromagnetic Therapy," *Ir Journal of Med Sci*, 154(4), 1985, . 153-155.

This review article looks at the history of pulsed electromagnetic fields as a means of bone repair. The author argues that success rates have been either superior or equivalent to those of surgery, with PEMF free of side effects and risk.

C.A.L. Bassett, "Historical Overview of PEM-Assisted Bone and Tissue Healing," *Bioelectromagnetics Society, 10th Annual Meeting*, 19-24 June 1988, Stamford, CT, . 19.

## **PEMF and Bone Repair**

**Institution:** Cátedra de Patología I, Escuela de Odontología Asociación Odontológica Argentina, Universidad del Salvador, Buenos Aires, Argentina. dgrana@salvador.edu.ar

**Summary:** The objective of this study was to determine whether short exposure to pulsed electromagnetic fields (PEMF) accelerates bone repair and peri-implant bone formation

**Highlight Quotation:** short daily electromagnetic stimulation appears to be a promising treatment for acceleration of both bone-healing and peri-implant bone formation.

**Conclusion:** *Bone healing was evaluated by image analysis in terms of ossification area, and perimeter and diameter of the lesion. Peri-implant ossification was assessed in terms of ossification percentage. At day 10 the area of ossification index was higher in the PEMF group.* PMID: 18841750 [PubMed - indexed for MEDLINE]

## **PEMF and Osteoporosis**

**Institution:** WHO Collaborating Centre for Metabolic Bone Disease, University of Sheffield Medical School, UK.

**Summary:** We examined the effect of pulsed electromagnetic fields (PEMFs) on bone formation and disuse osteoporosis sustained during limb lengthening in a double-blind study

**Highlight Quotation:** Stimulation with pulsed electromagnetic fields has no effect on the regenerate bone, but does prevent bone loss adjacent to the distraction gap

**Conclusion:** *does prevent bone loss adjacent to the distraction gap with the PEMF group.*

Effect of pulsed electromagnetic fields on bone formation and bone loss during limb lengthening. Bone. 1996 Jun;18(6):505-9.

## **PEMF and Fractures**

**Institution:** Department of Biomedical Engineering, Lerner Research Institute of The Cleveland Clinic Foundation, ND20, 9500 Euclid Avenue, Cleveland, OH 44195, USA.

**Summary:** The effectiveness of non-invasive pulsed electromagnetic fields (PEMF) on stimulating bone formation in vivo to augment fracture healing is still controversial, largely because of technical ambiguities in data interpretation within several previous studies. To address this uncertainty, we implemented a rigorously controlled, blinded protocol using a bilateral, mid-diaphyseal fibular osteotomy model in aged rats that achieved a non-union status

**Highlight Quotation:** our data demonstrate measurable biological consequences of PEMF exposure on in vivo bone tissue

**Conclusion:** *over the course of treatment. We found a significant reduction in the amount of time-dependent bone volume loss in PEMF-treated, distal fibular segments as compared to their contralateral sham-treated bones.*

Bone mass is preserved in a critical-sized osteotomy by low energy pulsed electromagnetic fields as quantitated by in vivo micro-computed tomography.

PMID: 15304283 [PubMed - indexed for MEDLINE]

## **PEMF and Diabetic Wound Healing**

**Institution:** Faculty of Medical Sciences, Department of Physiology, Tarbiat Modares University, Tehran, Iran

**Summary:** the main purpose of the present study is to investigate the effect of extremely low frequency pulsed electromagnetic fields (ELF PEMFs) on skin wound healing in diabetic rats

**Highlight Quotation:** the rate of healing in diabetic rats receiving PEMF was significantly greater than in the diabetic control group

**Conclusion:** *Based on the above-mentioned results we concluded that this study provides some evidence to*

*support the use of PEMFs to accelerate diabetic wound healing.*

## **PEMF and Pain**

**Institution:** Albert Einstein College of Medicine, Bronx, NY, USA. bstrauch@montefiore.org

**Summary:** Our objective was to review the major scientific breakthroughs and current understanding of the mechanism of action of PEMF therapy, providing clinicians with a sound basis for optimal use

**Highlight Quotation:** This review shows that plastic surgeons have at hand a powerful tool (PEMF) with no known side effects for the adjunctive, noninvasive, non pharmacologic management of postoperative pain and edema

**Conclusion:** *PEMF therapy has been used successfully in the management of postsurgical pain and edema, the treatment of chronic wounds.*

Evidence-based use of pulsed electromagnetic field therapy in clinical plastic surgery.

## **PEMF and NASA**

**Institution:** The study was funded by grants from NASA and the National Institutes of Health to NCIRE, the Northern California Institute for Research and Education

**Summary:** When a limb is immobilized in a cast, when an astronaut experiences zero gravity, or whenever a person lies down, the weight-bearing bones of the body such as those in the spine and leg, are relieved of their burden, a condition known as skeletal unloading. When skeletal unloading persists for several weeks, bones start to deteriorate: the number of bone cells decreases, movement into the bone of such minerals as calcium and phosphorous slows, and production of bone-cell precursors called osteoprogenitor cells diminishes.

**Highlight Quotation:** ‘The big problem that NASA is facing in their plans to send a manned flight to Mars is how to get people there and back without having their skeletons turn to matchsticks

**Conclusion:** *Yet discovering a way to stop bone loss from skeletal unloading will impact more than just a few astronauts. Anyone who is immobilized in any way for a long period of time can benefit.*

The study was funded by grants from NASA and the National Institutes of Health to NCIRE, the Northern California Institute.

## **PEMF and Drop Foot**

**Institution:** Lehrstuhl für Orthopädie der Friedrich-Schiller-Universität Jena am Rudolf-Elle-Krankenhaus, Eisenberg, Germany. r.fuhrmann@krankenhaus-eisenberg.de

**Summary:** Realignment of a fixed drop foot to restore gait pattern

**Highlight Quotation:** Immobilization of the ankle in neutral position within a plaster or a walker for 6 weeks

**Conclusion:** *Six patients (mean age 52 years) presented with a neurologic fixed drop foot deformity that had developed more than 8.3 years ago. After 12 months, five patients showed a neutral hindfoot position; one patient exhibited a plantar flexion of 5 degrees . Active dorsiflexion was limited in four patients (MRC [Medical*

Research Council] 2/5) and not visible in one patient. Total range of motion comprised 20 degrees (active) and 35 degrees (passive)

## **PEMF and Fibromyalgia**

**Institution:** Fourth Physical Medicine and Rehabilitation Clinic, Ankara Physical Medicine and Rehabilitation Education and Research Hospital, Ankara, Turkey.

**Summary:** evaluate the clinical effectiveness of low-frequency pulsed electromagnetic field (PEMF) therapy for women with fibromyalgia

**Highlight Quotation:** Low-frequency PEMF therapy might improve function, pain, fatigue, and global status in FM patients.

**Conclusion:** The PEMF group showed significant improvements in FIQ, VAS pain, BDI score, and SF-36 scale in all domains at the end of therapy.

## **PEMF and Spinal Injury**

**Institution:** Rancho Los Amigos Medical Center, Downey, California 90242, USA

**Summary:** The purpose of this study was to determine the effects of pulsed electromagnetic fields on osteoporotic bone at the knee in individuals with chronic spinal injury

**Highlight Quotation:** While the stimulation appeared useful in retarding osteoporosis, the unexpected exaggerated decline in the control knees and reversal at 6 months suggests underlying mechanisms are more complex than originally anticipated.

**Conclusion:** *There were larger effects closer to the site of stimulation. While the PEMF stimulation appeared useful in retarding osteoporosis*

## **PEMF and Osteoporosis**

**Institution:** University of Hawaii School of Medicine, Straub Clinic and Hospital, Honolulu

**Summary:** To determine the effect of a 72 Hz pulsating electromagnetic field (PEMF) on bone density of the radii of osteoporosis-prone women

**Highlight Quotation:** The data suggest that properly applied PEMFs, if scaled for whole-body use, may have clinical application in the prevention and treatment of osteoporosis.

**Conclusion:** *mineral densities of the treated radii measured by single-photon densitometry increased significantly in the immediate area of the field during the exposure period and decreased during the following 36 weeks*

Bone density changes in osteoporosis-prone women exposed to pulsed electromagnetic fields (PEMFs). J Bone Miner Res. 1990 May;5(5):437-42.

## **PEMF and Plantar Fasciitis**

**Purpose:** To assess whether patients using PEMF stimulators at night for treatment of plantar fasciitis have reduced usage of pain medications, while maintaining an adequate control of their pain.

**Design:** A double blind, randomized prospective study covering a 7 day treatment period. Patients were trained in use of stimulator and supplied with data forms to record their pain level (VAS) upon awakening and at night. They also kept a log of medication used.

Study was approved by North Texas Institutional Review Board at Medical City Dallas in August 2008.

**Analysis of Medication Usage:** All medications were translated into 'doses' using multiples of the base concentration (ibuprofen 200 mg, acetaminophen 250 mg).

**Results:** 70 patients have been enrolled to date, with 28 controls and 42 stimulator units. Repeated measures ANOVA is statistically significant for a difference in time response between the 'stim' and 'cont' groups ( $p=0.02$ ). The evening VAS shows no difference between groups.

Graph 3 show medication doses for the two groups over the 7 days. There is a large clinically significant difference in usage. In the 'stim' group, no medication was used on 82.3% (242/294) of the patient-days while no medication was used in 'cont' group on 68.4% (134/196) of the patient-days ( $p < 0.001$ ). On days 3 and 4, there was a strong trend to reduced usage by the 'stim' group ( $p=0.07$ ) while on day 7, the difference was larger ( $p=0.06$ ). When total medication over days 1-4 is compared, the 'stim' group uses less than 1/2 that of the controls, while over the full 7 days, total medication usage drops by 55%. Large variances in usage preclude significant p-values with current enrollment levels.

No study related adverse events were reported by any patient.

**Discussion:** The study shows that using the stimulator at night leads to a steadily increasing reduction of morning pain even though the patients use less than 1/2 the medication doses of the control group.

## **PEMF and Bronchitis**

Results of this double-blind, placebo-controlled study indicated that both low- frequency electromagnetic field treatment and treatment with pulsed electromagnetic fields proved effective in patients suffering from chronic bronchitis when coupled with standard drug therapies. Magnetic field treatment consisted of a total of 15 15-20-minute daily exposures.

V.M. Iurlov, et al., "The Efficacy of the Use of Low-Frequency Electromagnetic Fields in Chronic Bronchitis," *Voen Med Zh*, 3, 1989, . 35-36.

## **PEMF and Cancer**

Results of this study found that prolonged exposure to a 7-tesla uniform static magnetic field for a period of 64 hours inhibited growth of three human tumor cell lines in vitro.

R.R. Raylman, et al., "Exposure to Strong Static Magnetic Field Slows the Growth of Human Cancer Cells in Vitro," *Bioelectromagnetics*, 17(5), 1996, . 358-363.

This study examined the effects of a rotational magnetic field on a group of 51 breast cancer patients. Results showed a significant positive response in 27 of them.

N.G. Bakhmutskii, et al., "The Assessment of the Efficacy of the Effect of a Rotational Magnetic Field on the Course of the Tumor Process in Patients with Generalized Breast Cancer," *Sov Med*, (7), 1991, . 25-27.

Results of this study indicated that exposure to a rotational magnetic field inhibited Walker's carcinoma tumor growth as much as 90 percent in some cases.

N.G. Bakhmutskii, et al., "The Growth Dynamics of Walker Carcinosarcoma During Exposure to a Magnetic Eddy Field," *Vopr Onkol*, 37(6), 1991, . 705-708.

Results of this study indicated that pulsed magnetic field stimulation increased the incorporation of antitumor agents into cells, and thus increased antitumor activity shifting the cell cycle to a proliferative from a nonproliferative phase.

Y. Omote, "An Experimental Attempt to Potentiate Therapeutic Effects of Combined Use of Pulsing Magnetic Fields and Antitumor Agents," *Nippon Geka Gakkai Zasshi*, 89(8), August 1988, .. 1155-1166.

Results of this study found that 20-30 sessions of PEMF administered preoperatively exhibited antitumor effects in patients suffering from lung cancer.

L.S. Ogorodnikova, et al., "Morphological Criteria of Lung Cancer Regression Under the Effect of PEMF," *Vopr Onkol*, 26(1), 1980, . 28-34.

This study examined the effects of microwave resonance therapy (MRT) in patients suffering from various forms of cancer. Results showed that MRT treatment prior to surgery reduced the spread of cancer-associated conditions and reduced the risk associated with surgery in 87 percent of patients. MRT applied postoperatively had beneficial effects in 68 percent.

D.V. Miasoedov, et al., "Experience with the Use of Microwave Resonance Therapy as a Modifying Factor in Oncological Therapy," Abstracts of the First All- Union Symposium with International Participation, May 10-13, 1989, Kiev, Ukraine, .. 313-315.

Results of this study proved that the combination of weak pulsed electromagnetic fields with antioxidant supplementation is beneficial in the treatment of patients suffering from tongue cancer, improving speech, pain control, and tolerance to chemotherapy.

U. Randoll & R.M. Pangan, "The Role of Complex Biophysical-Chemical Therapies for Cancer," *Bioelectrochem Bioenerg*, 27(3), 1992, . 341-346.

Results of this controlled study indicated that treatment with a constant magnetic field significantly improved long-term (3-year) survival time in patients undergoing radiation therapy for cancer of the throat. Constant magnetic field therapy consisted of the application of 300 mT for 30 minutes to tumor and metastasizing regions immediately prior to each irradiation.

V.G. Andreev, et al., "Radiomodifying Effect of a Constant Magnetic Field in Radiation Therapy of Patients with Cancer of the Throat," *Fizicheskaiia Meditzina*, 4(1-2), 1994,. 92.

Results of this Russian study indicated that the use of whole body eddy magnetic fields, coupled with more conventional cancer therapies is effective in the treatment of patients suffering from a variety of different malignancies.

V. Smirnova, "Anti-Tumorigenic Action of an Eddy Magnetic Field," *Vrach*, 2, 1994, . 25-26

This article reports on the case of a 48-year-old-woman with breast cancer who was treated successfully with PEMF. Infiltration showed a marked decrease following 30 whole body exposures to an eddy magnetic field for 60 minutes. One metastatic node disappeared while the size of others was reduced following 60 such exposures. A total regression of tumor and metastases was seen following the completion of a course of 110 exposures.

N.G. Bakhmutskii, et al., "A Case of Successful Treatment of a Patient with Breast Cancer Using a Rotating Electromagnetic Field," *Soviet Medicine*, 8, 1991, . 86-87.

This study examined the effects of whole body magnetic fields (16.5-35 G, 50- 165 Hz) on patients suffering from different forms of cancer. Treatment consisted of 15 cycles, each 1-20 minutes in duration, and was coupled with more traditional cancer therapies. Results showed that the PEMF had overall beneficial effects, particularly with respect to improved immune status and postoperative recovery.

V.A. Lubennikov, et al., "First Experience in Using a Whole-Body Magnetic Field Exposure in Treating Cancer Patients," *Vopr Onkol*, 41(2), 1995, . 140-141.

### PEMF and Heart Disease

Results of this study found that the addition of PEMF to the treatment of patients suffering from ischemic heart disease and osteochondrosis led to clinical improvements.

I. Rodin, et al., "Use of Low-Intensity Eddy Magnetic Field in the Treatment of Patients with Skin Lymphomas," *Voen Med Zh*, 317(12), 1996, . 32-34.

Results of this study involving 23 parasystolic children found that low-frequency magnetic field exposure improved humoral and cellular processes involved in the regulation of cardiac rhythm.

M.A. Dudchenko, et al., "The Effect of Combined Treatment with the Use of PEMF on the Systemic Hemodynamics of Patients with Ischemic Heart Disease and Spinal Osteochondrosis," *Lik Sprava*, (5), May 1992, . 40-43.

The authors of this study report on their development of a polymagnetic system called *Avrora-MK-01* used to administer impulse magnetic fields to diseases of the leg vessels. Results indicated positive effects on peripheral capillaries in 75- 82 percent of patients receiving the treatment at a pre-gangrene stage.

E.M. Vasil'eva, et al., "The Effect of a Low-frequency Magnetic Field on Erythrocyte Membrane Function and on the Prostanoid Level in the Blood Plasma of Children with Parasystolic Arrhythmia," *Vopr Kurortol Fizioter Lech Fiz Kult*, (2), March-April 1994, . 18-20.

Results of this study showed exposure to low-frequency alternating magnetic fields had beneficial effects in children with primary arterial hypertension, as seen in the attenuation of sympathetic and vagotonic symptoms.

Y.B. Kirillov, et al., "PEMF in Obliterating Vascular Diseases of the Lower Extremities," *Vopr Kurortol Fizioter Lech Fiz Kult*, (3), May-June 1992, . 14-17.

This study demonstrated that traveling pulsed magnetic field and magnetic laser treatment produced beneficial effects in patients suffering from the initial stages of essential hypertension.

V.S. Zadionchenko, et al., "Prognostic Criteria of the Efficacy of Magnetic and Magnetic-laser Therapy in Patients with the Initial Stages of Hypertension," *Vopr Kurortol Fizioter Lech Fiz Kult*, (1), January-February 1997, . 8-11.

In this article, the authors propose a new approach to treating atherosclerosis through the alteration of biophysical properties both intracellular and extracellular. Citing their own preliminary data, they suggest atherosclerotic lesions might be selectively resolved without harming normal blood vessel allowing the lesions to take up the magnetically excitable submicron particles and then applying an external alternating electromagnetic field.

R.T. Gordon & D. Gordon, "Selective Resolution of Plaques and Treatment of Atherosclerosis Biophysical Alteration of "Cellular" and "Intracellular" Properties," *Medical Hypotheses*, 7(2), February 1981, . 217-229.

This study examined the effects of constant MKM2-1 magnets on essential hypertension patients. Results indicated the treatment decreased arterial pressure in stage II patients, with PEMF being shown to produce beneficial effects on the central hemodynamics and microcirculation.

S.G. Ivanov, et al., "The PEMF of Hypertension Patients," *Ter Arkh*, 62(9), 1990, . 71-74.

Results from several recent studies conducted the author are reviewed. Conclusions are that pulsed electromagnetic fields exhibit protective effects against necrosis from acute ischemia in rats, cerebral infarcts in rabbits, and myocardium infarcts in rats.

R. Cadossi, "Protective Effect of Electromagnetic Field Exposure on Acute Soft Tissue Ischaemic Injury," *Second World Congress for Electricity and Magnetism in Biology and Medicine*, 8-13 June 1997, Bologna, Italy.

This study examined the effects of extremely high frequency electromagnetic radiation (EHF EMR) in 93 patients suffering ischemic heart disease. EHF treatment consisted of 10 to 15 exposures of the lower end of the sternum from a PEMF device. Treatment was performed five times weekly for a total of 30 minutes per day, with drug therapy being maintained during this period. Positive results tended to occur after 5 to 6 treatment sessions, with a good or satisfactory response being reported in 82 of 93 patients, and lasting as long as 11 months after hospital release.

I.E. Ganelina, et al., "Electromagnetic Radiation of Extremely High Frequencies in Complex Therapy for Severe Stenocardia," *Millimetrovie Volni v Biologii I Meditsine*, (4), 1994, . 17-21.

Results of this placebo-controlled study demonstrated a 76-percent effectiveness rate for running impulse magnetic field therapy in a group of arterial hypertensive patients. Treatment consisted of two 25-minute exposures per day over a period of 10-20 total exposures, at frequencies of 10 or 100 Hz and magnetic field intensity of 3 or 10 mT.

L.L.Orlov, et al., "Indications for Using a New Magnetotherapeutic Method in Arterial Hypertension," *Soviet Medicine*, (8), 1991, . 23-24.



This study examined the efficacy of the reinfusion of autologous blood following magnetic field exposure in hypertensive patients. Positive effects were found in 92 percent of patients receiving the treatment.

I.G. Alizade, et al., "Magnetic Treatment of Autologous Blood in the Combined Therapy of Hypertensive Patients," *Vopr Kurortol Fizioter Lech Fiz Kult*, (1), 1994, . 32-33

This double-blind, placebo-controlled study examined the effects of PEMF in patients suffering from first-or second-stage hypertension. A magnetic field of 50 Hz, 15-25 mT was applied to acupuncture points He-Gu and Shen'-Men for 15-20 seconds per day for a total of 9-10 days. Results: The treatment improved headaches in 88 percent of patients, dizziness in 89 percent, and irritability in 88 percent. In general, 95 percent of hypertensive patients experienced beneficial effects from the treatment, and the morbidity rate decreased twofold following one course extended over a period of 5-6 months.

E.V. Rolovlev, "Treatment of Essential Hypertension Patients an Alternating Magnetic Field Puncture," All-Union Symposium: Laser and Magnetic Therapy in Experimental and Clinical Studies, June 16-18, 1993, Obninsk, Kaluga Region, Russia, . 221-223.

This placebo-controlled study examined the effects of constant and of running magnetic fields in patients suffering from stage II hypertension. Results found that constant magnetic fields exhibited benefits in 68 percent of patients treated, and running magnetic fields were helpful in 78 percent. Only 30 percent of controls showed improvement. Constant magnetic field treatment consisted of constant magnets applied to the inner side of the wrist on each hand for 35-40 minutes daily over a period of 7-10 days. Running magnetic field treatment.

S.G. Ivanov, et al., "Use of Magnetic Fields in the Treatment of Hypertensive Disease," *Vopr Kurortol Fizioter Lech Fiz Kult*, (3), 1993, . 67-69.

This double-blind, placebo-controlled study found that PEMF was effective in the treatment of symptoms associated with stage II hypertension, such as headache, dizziness, and cardiodynia. The therapy consisted of permanent circular magnets (16 mT) applied to the inner forearm for 30-45 minutes per day over a period of 10 sessions.

S.G. Ivanov, "The Comparative Efficacy of Nondrug and Drug Methods of Treating Hypertension," *Ter Arkh*, 65(1), 1993, . 44-49.

This controlled study examined the effects of PEMF in patients suffering from neurocirculatory hypotension (low blood pressure) or hypertension (high blood pressure). Treatment consisted of a running pulsed magnetic field generated an "ALIMP" device (0.5 mT, 300 Hz) administered for 20 minutes per day over a course of 10 days. Patients suffering from hypotension did not benefit significantly from the PEMF. Hypertension patients, however, showed a marked improvement with respect to symptoms including headache, chest pain, extremity numbness, abnormal systolic and diastolic blood pressure, and work capacity.

L.L. Orlov, et al., "Effect of a Running Pulse Magnetic Field on Some Humoral Indices and Physical Capacity in Patients with Neurocirculatory Hypo- and Hypertension," *Biofizika*, 41(4), 1996, . 944-948.

This double-blind, placebo-controlled study found that low-frequency, low-intensity electrostatic fields (40-62 Hz) administered for 12-14 minutes per day helped normalize blood pressure in patients suffering from hypertension.

T.A. Kniazeva, "The Efficacy of Low-Intensity Exposures in Hypertension," *Vopr Kurortol Fizioter Lech Fiz Kult*, 1,1994, . 8-9.

This study examined the effects of low-frequency alternating magnetic fields in patients suffering from arteriosclerosis or osteoarthritis deformans. Treatment involved 10-15 minute daily leg exposures over a total of 15 days. Results showed the treatment to be effective in 80 percent of arteriosclerosis patients and 70 percent of those with osteoarthritis formation.

A.G. Kakulia, "The Use of Sonic Band Magnetic Fields in Various Diseases," *Vopr Kurortol Fizioter Lech Fiz Kult*, 3,1982, . 18-21.

This study examined the effects of low-frequency magnetic fields (25 mT) in patients suffering from atherosclerotic encephalopathy. Treatment involved 10-15 minute daily exposures over a total of 10-15 applications. Results showed clinical improvements with respect to chest pain, vertigo, headache, and other symptoms.

S.S. Gabrielian, et al., "Use of Low-Frequency Magnetic Fields in the Treatment of Patients with Atherosclerotic Encephalopathy," *Vopr Kurortol Fizioter Lech Fiz Kult*, 3, 1987, . 36-39.

## **PEMF and Chronic Venous Insufficiency**

This study examined the effects of alternating magnetic fields (15-20 minutes per day over a period of 20 days) in patients suffering from chronic venous insufficiency, varicose veins, and trophic shin ulcers. Results showed good effects in 236 of the 271 patients receiving the treatment. Thirty-four patients reported satisfactory effects. Only one patient experienced no effects.

E.I. Pasyukov, et al., "Therapeutic Use of Alternating Magnetic Field in the Treatment of Patients with Chronic Diseases of the Veins of the Lower Limbs," *Vopr Kurortol Fizioter Lech Fiz Kult*, 5, 1976, . 16-19.

This review article notes that PEMF in a variety of forms has been successfully used in the treatment of chronic venous insufficiency and is a commonly used physical therapy for the condition.

A.P. Dovganiuk, "Balneologic and Physical Therapy of Chronic Venous Insufficiency of Extremities," *Vopr Kurortol Fizioter Lech Fiz Kult*, 2, 1995, . 48- 49.

This study examined the effects of running impulse magnetic fields in patients suffering from vessel obliteration diseases of the legs. Treatment consisted of 15- 20 whole body exposures (0.5-5 mT, 1-2 Hz) lasting 15-20 minutes each. Results showed treatment led to a significant reduction in the number of patients experiencing leg pain while at rest. Among patients previously unable to walk a 500-m distance, 52 percent were able to complete the distance following treatment. Circulation improved in 75-82 percent of patients.

Y.B. Kirillov, et al., "PEMF for Obliterative Disease of the Vessels of the Legs," *Vopr Kurortol Fizioter Lech Fiz Kult*, 3, 1992, .. 14-17.

## **PEMF and Carpal Tunnel Syndrome**

**Study Article:** Pulsed magnetic field therapy in refractory neuropathic pain secondary to peripheral neuropathy: electrodiagnostic parameters.

**Published:** *Journal of Back and Musculoskeletal Rehabilitation*, 18 (2005) 79–83 79

**Authors:** Michael I. Weintrauba and Steven P. Coleb

**Results:** Statistical reduction (ANOVA) of pain scores at end of treatment (23%) and also end of follow-up (37%) were noted in the 33 hands that completed the study. The PGIC questionnaire revealed 67% improvement. There were no adverse events or safety issues. **Conclusion:** Our pilot data suggests that directing PEMF to the carpal tunnel region can provide modest, short-term relief for a majority of individuals.

## **PEMF and Charcot Foot**

**Article:** A Closer Look at Bone Stimulators for Charcot

**Published:** *Podiatry Today*, Vol. 19, Issue 12. Dec 01 2006.

**Author:** Michael S. Downey, DPM, FACFAS

Charcot osteoarthropathy remains a chronic, progressive and destructive process that often affects the bony architecture and joints of the foot and ankle, primarily in patients with diabetic peripheral neuropathy. Despite advances in the diagnosis and management of this condition, the deformity continues to be associated with a high incidence of recurrence, treatment failure and resultant morbidity. If left untreated, Charcot foot predictably leads to deformity, ulceration, infection and amputation.

The authors performed reconstructions in 28 patients with Charcot deformities of mainly Lisfranc's joint or the ankle joint. In their series, the researchers performed an open or percutaneous tendo-Achilles lengthening, arthrodesis of the involved joints with the use of a hybrid or ring-to-ring external fixator, and application of PEMF external bone growth stimulation immediately postoperatively. While they reported consistently good results in their series, the study authors recognized that a larger series would be necessary to support their positive results further. Current evidence supports the use of electrical or mechanical bone growth stimulation in the acute stages of Charcot foot.

## **PEMF and Dental Problems**

This controlled study examined the effects of adjunctive PEMF therapy on oral surgery recovery. Patients received the therapy once per day beginning between 3 to 5 days prior to oral surgery. Therapy was maintained until the point of hospital release. Results found the therapy produced significant healing relative to controls, which received conventional treatment only.

L.C. Rhodes, "The Adjunctive Utilization of Diapulse Therapy Pulsed High Peak Power Electromagnetic Energy) in Accelerating Tissue Healing in Oral Surgery," *Q National Dental Association*, 40(1),1981, . 4-11

This study found that patients suffering from various oral diseases experienced more rapid healing when treated with both conventional therapies and 30 minutes per day of pulsed electromagnetic fields (5 mT, 30 Hz), as opposed to conventional therapies alone.

## **PEMF and Depression**

This review article examined the literature concerning the use of transcranial magnetic stimulation in the treatment of depression. Results showed the high- frequency, repetitive transcranial magnetic stimulation treatment to be an effective, side-effect free therapy for depression that may hold promise for treating related psychiatric disorders as well.

M.T. Kirkcaldie, et al., "Transcranial Magnetic Stimulation as Therapy for Depression and Other Disorders," *Aust N Z J Psychiatry*, 31(2), April 1997, . 264- 272.

Noting that there is good reason to believe the pineal gland is a EMF system and that application of magnetic fields in experimental animals has a similar effect to that of acute exposure to light with respect to melatonin secretion, the authors propose that magnetic treatment could be a beneficial new therapy for winter depression in humans.

R. Sandyk, et al., "Magnetic Fields and Seasonality of Affective Illness: Implications for Therapy," *International Journal of Neurosci*, 58(3-4), June 1991, . 261-267.

This review article notes that transcranial magnetic stimulation has been shown to elicit antidepressant effects, electrically stimulating deep regions of the brain.

C. Haag, et al., "Transcranial Magnetic Stimulation. A Diagnostic Means from Neurology as Therapy in Psychiatry?" *Nervenarzt*, 68(3), March 1997, . 274-278.

In this theoretical paper, the author argues that deep, low-rate transcranial magnetic stimulation can produce therapeutic effects equivalent to those of electroconvulsive therapy but without the dangerous side effects.

T. Zyss, "Will Electroconvulsive Therapy Induce Seizures: Magnetic Brain Stimulation as Hypothesis of a New Psychiatric Therapy," *Psychiatr Pol*, 26(6), November-December 1992, . 531-541.

This study examined the effects of PEMF therapy as a supplemental treatment in patients suffering from various types of depression. PEMF therapy involved the use of a (5.6 mm 53 GHz), and consisted of up to 60 minutes of exposure per day, 2 to 3 times per week, for a total of as many as 15 exposures. Results showed that combined MW/conventional treatment produced a complete recovery in over 50 percent of cases studied, a significant improvement in 41 percent, and some improvement in 8 percent. Recovery rates among controls (conventional treatment only) were 4, 48, and 41 percent, respectively.

G.V. Morozov, et al., "Treatment of Neurotic Depression with a Help of Extremely High Frequency Electromagnetic Radiation," *Zh Nevropatol Psikhiatr Im S S Korsakova*, 96(6),1996, . 28-31.

Results of this study led researchers to conclude that patients suffering from major depression experienced a significant reduction of depressive symptoms following treatment with transcranial magnetic stimulation coupled with standard medication relative to patients taking the medicine. This was true after just three TMS treatments.

Conca, et al., "Transcranial Magnetic Stimulation: A Novel Antidepressive Strategy?" *Neuropsychobiology*, 34(4),1996, . 204-207.

## **PEMF and Dermatitis**

This study examined the effects of conventional treatments combined with millimeter wave (MW) therapy (54- to 70-GHz frequency, 8-15 daily exposures of 15-30 minutes each) on patients suffering from atopic dermatitis. Results indicated that the MW therapy was well-tolerated all patients, with the rash generally regressing after 7-8 exposures. Marked recovery was seen among 78 percent of patients receiving the combination treatments. Two-year follow-up showed a 23-percent relapse rate among combination patients, compared to 54 percent among controls.

V.P. Adaskevich, "Effectiveness of the Use of Millimeter-Range Electromagnetic Radiation in Complex Treatment of Atopic Dermatitis Patients," *Millimetrovie Volni v Biologii I Medicne*, (3), 1994, . 78-81

## **PEMF and Diabetes**

In this study, 320 diabetics received impulsed magnetic field treatment while 100 diabetics (controls) received conservative therapy alone. Results showed beneficial effects with respect to vascular complications in 74 percent of the patients receiving PEMF combined with conservative methods, compared to a 28-percent effectiveness rate among controls.

I.B. Kirillovm, et al., "Magentotherapy in the Comprehensive Treatment of Vascular Complications of Diabetes Mellitus," *Klin Med*, 74(5), 1996, . 39-41.

This study involving 72 diabetics with purulent wounds found that magnetic fields aided healing significantly.

R.A. Kuliev & R.F. Babaev, "A Magnetic Field in the Combined Treatment of Suppurative Wounds in Diabetes Mellitus," *Vestn Khir Im I I Grek*, 148(1), January 1992, . 33-36.

## **PEMF and Diseases of the Larynx**

Results of this study found that alternative magnetic field of sound frequency proved to be an effective treatment in patients suffering from acute inflammatory diseases of the larynx.

D.I. Tarasov, et al., "Effectiveness of Local Magnetic Field of the Acoustic Frequency in the Treatment of Patients with Acute Inflammatory Diseases of the Larynx," *Vestn Otorinolaringol*, (6), November-December 1995, . 11-15.

## **PEMF and Duchenne-Erb Disease**

This study examined the effects of electromagnetic fields in the treatment of 5- year-old children suffering from Duchenne-Erb disease. Children were exposed to either UHF or DMW therapy for 8-12 minutes per day on alternating days over a period of approximately 10 days. Following the electromagnetic fields course, children received mud applications on the collar area and injured extremity. Results showed that treatment decreased contractures in shoulder and elbow joints, increased mobility and muscle strength, and improved general function of the arm.

A.D. Burigina, et al., "Electromagnetic Waves in Complex Therapy of Children with Birth Trauma: Effects of Ultra-High-Frequency Electric Fields on Central Hemodynamics and the Shoulder Plexus," *Vopr Kurortol Fizioter Lech Fiz Kult*, (4),1992, 35-38.

## **PEMF and Endometriosis**

Results of this study found that the administration of constant magnetic field in combination with other treatment modalities led to significant beneficial effects in patients suffering from acute endometritis following abortion.

V.M. Strugatskii, et al., "A Permanent Magnetic Field in the Combined Treatment of Acute Endometritis After an Artificial Abortion," *V.K Fizioter* (6), November-December 1996, . 21-24.

## **PEMF and Epilepsy**

This article reports on the cases of three patients with partial seizures who received treatment with external artificial magnetic fields of low intensity. Such treatment led to a significant attenuation of seizure frequency over a 10-14- month period.

P.A. Anninos, et al., "Magnetic Stimulation in the Treatment of Partial Seizures," *International Journal of Neurosci*, 60(3-4), October 1991, . 141-171.

Experimental results indicated that the administration of modulated electromagnetic fields of 2-30 Hz suppressed epilepsy in rats.

G.D. Antimonii & R.A. Salamov, "Action of a Modulated Electromagnetic Field on Experimentally Induced Epileptiform Brain Activity in Rats," *Biull Eksp Biol Med*, 89(2), February 1980.

This review article cites one study in particular in which results showed that pretreatment with 30 minutes of exposure to a 75-mT pole strength, DC-powered magnetic field significantly prevented experimentally induced seizures in mice.

M.J. McLean, et al., "Therapeutic Efficacy of a Static Magnetic Device in Three Animal Seizure Models: Summary of Experience," *Second World Congress for Electricity and Magnetism in Biology and Medicine*, 8-13 June 1997, Bologna, Italy.

This double-blind, placebo-controlled study examined the effects of 2-hour exposure to weak magnetic fields (0.2-0.7 G, irregularly oscillating 0.026-0.067 Hz) produced 3 pairs of orthogonal Helmholtz coils on pain perception in healthy subjects. Results showed that magnetic treatment significantly reduced the perception of pain.

F. Sartucci, et al., "Human Exposure to Oscillating Magnetic Fields Produces Changes in Pain Perception and Pain-Related Somatosensory Evoked Potentials," *Second World Congress for Electricity and Magnetism in Biology and Medicine*, 8-13 June 1997, Bologna, Italy.

This article reports on the case of a severe epileptic who experienced a significant lessening of behavior disturbances and seizure frequency following treatment with low-frequency, external artificial magnetic fields.

R. Sandyk & P.A. Anninos, "Magnetic Fields Alter the Circadian Periodicity of Seizures," *International Journal of Neurosci*, 63(3-4), April 1992, . 265-274.

Low-frequency, external artificial magnetic field treatment was shown to significantly reduce seizures in four adult epileptic cases.

R. Sandyk & P.A. Anninos, "Attenuation of Epilepsy with Application of External Magnetic Fields: A Case Report," *International Journal of Neurosci*, 66(1-2), September 1992, . 75-85.

## **PEMF and Gastroduodenitis**

Results of this study indicated that treatment with decimeter-band electromagnetic fields improved motor function of the stomach and reduced dyspepsia and pain in children suffering from chronic gastroduodenitis. Treatment made use of the "Romashka" apparatus (a cylinder applicator, 100 mm in diameter, power of 6-8 W) applied to the gastroduodenal region, and consisted of 6-12 minute exposures every other day for a total of 8-12 exposures.

L.M. Petrukhina, et al., "Effect of a Decimeter Wave Electromagnetic Fields on the Motor Function of the Stomach in Children with Strong Gastroduodenitis," *Vopr Kurortol Fizioter Lech Fiz Kult*, (1),1987, . 54-56.

This controlled study examined the effects of PEMF (100 Hz) coupled with conventional therapy in children suffering from chronic gastroduodenitis. Children received 8-10 exposures lasting between 6 and 10 minutes. Results showed that the treatment reduced inflammation in 72 percent of patients relative to just a 45-percent rate among controls. About 77 percent of treatment patients experienced elimination of gastro-esophageal and duodeno- gastral refluxes, compared to 29 percent of controls.

O.V. Bukanovich, et al., "Sinusoidally-Modulated Currents in the Therapy of Chronic Gastroduodenitis in Children," *Vopr Kurortol Fizioter Lech Fiz Kult*, 2, 1996, . 22-26.

## **PEMF and General**

Results of this study indicated that the optimal frequency of pulsed magnetic fields ranges between 10.0 and 25.0 Hz in the treatment of chronic inflammatory conditions of the locomotor apparatus, ischemia of the blood vessels of the lower extremities, dyspeptic syndrome, lactation mastitis, and other diseases. Treatment proved best when the therapeutic cycle was repeated after a 2-3 month period.

L. Navratil, et al., "Possible Therapeutic Applications of Pulsed Magnetic Fields," *Cas Lek Cesk*, 132(19),October 11, 1993, . 590-594.

This article reviews the use of PEMF in Czechoslovakia. Noting that this modality has been used for more than a decade, the author states that PEMF has been shown to be effective in treating rheumatic diseases, sinusitis, enuresis, and ischemic disorders of the lower extremities. Positive findings have also been shown with respect to multiple sclerosis and degenerative diseases of the retina.

J. Jerabek, "Pulsed PEMF in Czechoslovakia--A Review," *Rev Environ Health*, 10(2), April-June 1994, . 127-134.

This review article notes that pulse-type electromagnetic fields (PEMF) are the most frequently used type of electromagnetic therapy. Another form is pulsed radio frequency; PRF therapy generally includes daily sessions of 30-minute exposure and is primarily used in cases of pain and edema, with results being apparent quickly when the therapy is effective. PEMF treatment is most successful when used in bone healing, with results occurring over a longer period of time.

A.A. Pilla, "State of the Art in Electromagnetic Therapeutics: Soft Tissue Applications," Second World Congress for Electricity and Magnetism in Biology and Medicine, 8-13 June 1997, Bologna, Italy.

This study examined the effects of electromagnetic fields administered over a period of 10 days on 354 patients suffering from various orthopedic conditions. Results showed the effects to be positive, with the greatest benefit experienced among patients with acute lesions.

G. Annaratone, et al., "PEMF in Clinical and Ambulatory Practice," *Minerva Med*, 74(14-15), April 7, 1983, . 823-833.

Noting that beneficial effects of low-energy, time-varying magnetic fields have been shown since the early 1970s, this review article cites studies pointing to its success in the treatment of a wide range of conditions. The best results for this modality obtained in the area of bone healing.

C.A. Bassett, "Fundamental and Practical Aspects of Therapeutic Uses of Pulsed Electromagnetic Fields (PEMFs)," *Crit Rev Biomed Eng*, 17(5), 1989, . 451-529.

This review article claims that over a quarter of a million patients worldwide with chronically ununited fractures have experienced beneficial results from treatment with pulsed electromagnetic fields. In addition, the author cites studies pointing to the treatment's efficacy with respect to other conditions such as nerve regeneration; wound healing, graft behavior, diabetes, heart attack, and stroke.

C.A. Bassett, "Beneficial Effects of Electromagnetic Fields," *Journal of Cell Biochem*, 51(4), April 1993, p. 387-393.

This review article notes that low-intensity millimeter waves have been used for treating a wide variety of medical conditions in the former Soviet Union since 1977, with more than a million patients treated and more than a thousand treatment centers in existence. This therapy has been approved for widespread use the Russian Ministry of Health, and over 300 scientific publications have described its effects. A typical course of treatment involves 10-15 daily exposures ranging from 15 to 60 minutes each.

A.G. Pakhomov, "Millimeter Wave Medicine in Russia: A Review of Literature," *Infrared Lasers and Millimeter Waves Workshop: The Links Between Microwaves and Laser Optics*, January 21-22, 1997, Brooks Air Force Base, Texas.

This study concluded that the use of millimeter wave (MW) therapy was effective in the treatment of both children and adults suffering from a variety of orthopedic diseases, including osteochondrosis, arthrosis, infantile cerebral paralysis, Perthes' disease, and inborn femur dislocation. PEMF therapy with exposure for 15-30 minutes in children or 30-60 minutes in adults over a period of 10-12 total exposures.

S.D. Schvchenko, et al., "Experience with Treating Some Orthopedic Diseases with Millimeter Range Radiation of Nonthermal Intensity," *Millimeter Waves in Medicine and Biology*.

Digest of Papers of the 11th Russian Symposium with International Participation, April 21-24, 1997, Zvenigorod, Moscow Region, Russia, p. 33-35. 139. A.M.

This research examined the effects of low-frequency pulsed electromagnetic fields on patients suffering from a wide range of disorders, including musculoskeletal disorders, neurological disorders, circulatory diseases, traumatic disorders, gastroenterological problems, and stress-related morbidity. Treatment made use of the



Rhumart apparatus, which produced waveforms with peak amplitudes up to 30 G. Results, based on the patients' own subjective ratings, indicated the treatment to be beneficial across most conditions, with the strongest effects seen in those suffering from musculoskeletal and traumatic disorders.

Begue-Simon & R.A. Drolet, "Clinical Assessment of the Rhumart System based on the Use of Pulsed Electromagnetic Fields with Low Frequency," *International Journal of Rehabil Research*, 16(4),1993, p. 323-327.

This review article summarizes findings presented at the Third Workshop on the use of low-intensity millimeter waves in medicine, held in Zvenigorod, Moscow Region, Russia. Such findings pointed to the efficacy of MW therapy with respect to alcoholism and its associated symptoms, gastric and duodenal ulcers, psoriasis, chronic furunculosis, and cardiovascular diseases.

Y.L. Arzumanov, "An Overview of the Third Workshop 'Use of Millimeter Waves in Medicine,'" *Millimetrovie Volni v Biologii i Meditsine*, (3), 1994, p. 104-107.

This study examined the effects of PEMF on patients suffering from a variety of eye and brain vascular disorders. Treatment made use of the "Polius-1" apparatus (50 Hz), with most patients receiving a course of 15-20 daily exposures. Results showed overall general improvements in 95 percent of patients with eye diseases.

N. Gilinskaya & L.V. Zobina, "Magnetic Field Application for the Treatment of Vascular Diseases of the Brain and Eyes," in Y.A. Kholodov & N.N. Lebedeva (eds.), *Problems of Electromagnetic Neurobiology*, Moscow, Nauka,1988, p. 94-98.

This review article notes that low-frequency electromagnetic therapy has been used for a variety of purposes. Those specifically identified the author include cell growth promotion, pain reduction, improved blood circulation, bone repair, increased wound healing, sedative effects, enhanced sleep, and arthritic relief.

R.A. Drolet, "Rhumart Therapy: A Non-invasive Cell Regeneration Ion and Anti- Inflammatory Therapy Using LF-EM Fields," *Bioelectromagnetics Society, 4th Annual Meeting*, 28 June-2 July 1982, Los Angeles, CA, p. 45.

This review article notes that treatment with an "Infita" apparatus, used to deliver low-frequency magnetic fields, has been shown to improve general hemodynamics and microcirculation in addition to exhibiting anti- inflammatory, sedative, and analgesic effects in Olympic-level Russian athletes.

A. Zaslavskii, et al., "A Low-frequency Impulse Apparatus for Physical Therapy 'Infita,'" *Med Tehk*, 5,1994, p. 39-41.

This review article cites studies pointing to the efficacy of low-frequency magnetic fields in the treatment of a wide variety of conditions, including burns, arthritis, fractures, arterial aneurysms, PMS, phantom pain, tuberculosis, ischemic heart disease, hypertension, bronchial asthma, and ulcerated varicose veins, among others.

V.M. Bogoliubov & L.A. Skurikhina, "Therapeutic Application of Constant and Low-Frequency Magnetic Fields," *Vopr Kurortol Fizioter Lech Fiz Kult*, (2), 1979, p. 65-72.

This study examined the effects of extremely-low-frequency magnetic fields (TAMMAT device) in the treatment of a group of 650 patients suffering from a host of various diseases. Treatment consisted 15-25 minute daily exposures 5 days per week over a total of 20-25 days. Most patients experienced improvements

after 2-3 exposures. Marked improvements were seen with respect to analgesic, anti-inflammatory, anti-tumor, and immune-enhancing effects.

V.I. Kovalchuk, et al., "Use of Extremely-Low-Frequency Magnetic Fields in Clinical Practice," *Fizicheskaia Meditzina*, 4(1-2), 1994, p. 87

This article reports on the efficacy of a Russian electromagnetic stimulation apparatus termed "Cascade." The authors state that data from 508 patients suffering from various ailments who were treated with the device indicate it to be anywhere from 75 to 100 percent effective. Examples of conditions in which the device was used include stubborn fractures, post-traumatic contractures, crush syndrome, and Perthes' disease.

S.A. Schastnyi, et al., "A Contact-Free, Biologically Adequate Electromagnetic Stimulation of Repair Regeneration of Osseous, Cartilaginous, and Muscular Tissues in Children," *Vestn Ross Akad Med Nauk*, (3), 1994, p. 38-42.

This review article on the use of pulsed PEMF in Czechoslovakia points to its efficacy across a variety of conditions, including joint problems, enuresis, multiple sclerosis, diabetes, and carpal tunnel syndrome.

J. Jerabek, "Pulsed PEMF in Czechoslovakia: A Review," *First World Congress for Electricity and Magnetism in Biology and Medicine*, 14-19 June 1992, Lake Buena Vista, FL, p. 81.

## **PEMF and Glaucoma**

In this study, patients with primary open-angle glaucoma with compensated intraocular pressure were administered PEMF using an ATOS device with 33-mT magnetic field induction. The procedure was administered to a patient in a sitting posture with a magnetic inductor held before the eye. Sessions lasted 10 minutes and each course included 10 sessions. Following 4-5 months of therapy, results showed improved vision acuity 0.16 diopters, on an average of 29 out of 30 eyes with vision acuity below 1.0.

Bisvas, et al., "Possibilities of PEMF in Stabilization of Visual Function in Patients with Glaucoma," *Vestn Oftalmol*, 112(1), January-March 1996, p. 6-8.

## **PEMF and Hair Loss**

This double-blind, placebo-controlled study examined the effects of pulsed electromagnetic fields on hair loss in men suffering from male pattern baldness. PEMF exposures were administered to the head for 12 minutes and were given weekly or twice weekly over a period of 36 weeks. Results found the PEMF treatment both prevented hair loss and promoted re-growth without side effects.

W.S. Maddin, et al., "The Biological Effects of a Pulsed Electrostatic with Specific Reference to Hair: Electrotrichogenesis," *International Journal of Dermatology*, 29(6), 1990, p. 446-450.

## **PEMF and Headache**

Results of this double-blind, placebo-controlled study demonstrated that the administration of a pulsed magnetic field for less than one hour to headache patients produced significant beneficial effects, as shown subjective patient reports, as well as EEG activity.

O. Grunner, et al., "Cerebral Use of a Pulsating Magnetic Field in Neuropsychiatry Patients with Long-term Headache," *EEG EMG Z Elektroenzephalogr Verwandte Geb*, 16(4), December 1985, p. 227-230

This article reports on the case of an acute migraine patient who was successfully treated with external magnetic fields.

R. Sandyk, "The Influence of the Pineal Gland on Migraine and Cluster Headaches and Effects of Treatment with picoTesla Magnetic Fields," *International Journal of Neurosci*, 67(1-4), November-December 1992, p. 145-171.

This article examined the effects of millimeter wave therapy in the treatment of 107 patients suffering from headaches of varying causes. Treatment consisted of the Nao-Hu, Bai-Huei, and Hua-Chai acupuncture points being exposed to 5.6- and 4.9-mm wavelengths via the use of "Yav'-1-5.6" or "Electronka-KVCh" devices, respectively. Exposure lasted up to 60 minutes per day over a course of 10 days. All patients experienced positive results following 3-5 exposures. After one year, 48 percent of patients remained free of headaches, with a significant decrease in another 41 percent.

B.M. Popov & T.A. Al'shanskaya, "Use of Traditional and Non-traditional Methods in the Treatment of Headache," *Millimeter Waves in Medicine and Biology. Digest of Papers of the 11th Russian Symposium with International Participation*, April 21-24, 1997, Zvenigorod, Moscow Region, Russia, p. 68-71.

This study examined the effects of pulsed electromagnetic fields (20 minutes per day for 15 days) in the treatment of patients suffering from chronic headaches.

Results indicated the treatment to be most effective in patients suffering from tension headaches, with 88 percent of such patients reporting positive results. Beneficial results were also experienced patients suffering from migraines (60 percent), cervical migraines (68 percent), and psychogenic headaches (60 percent).

A. Prusinski, et al., "Pulsating Electromagnetic Field in the Therapy of Headache," *Hungarian Symposium on PEMF, 2nd Symposium*, May 16-17, 1987, Szekesfehervar, Hungary, p. 163-166.

In this study, 90 headache patients were treated with pulsating electromagnetic fields via large coils to the body for 20 minutes per day for a total of 15 days.

Results found the treatment to be either excellent or good for those patients suffering from migraine, tension, and/or cervical headaches. Patients experiencing post-traumatic or cluster headaches did not experience such benefits.

A. Prusinski, et al., "Pulsating Electromagnetic Field in the Therapy of Headache," *Journal of Bioelectr.*, 7(1),1988, p. 127-128.

Results of this study indicated that pulsating electromagnetic fields (12 Hz and 5 mT) were an effective prophylactic treatment for patients suffering from cervical and migraine headaches.

J. Giczi & A. Guseo, "Treatment of Headache Pulsating Electromagnetic Field a Preliminary Report," *Hungarian Symposium on PEMF, 2nd Symposium*, May 16-17, 1987, Szekesfehervar, Hungary, p. 74-76.

This placebo-controlled, double-blind study examined the effects of pulsed electromagnetic fields (2-5 Hz and flux densities of 3-4 mT) on patients suffering from migraine headaches. PEMFs were administered to the head for 10-15 minutes per day over a period of 30 days. Results showed a mean improvement level of 66 percent in patients receiving the treatment, compared to just 23 percent among controls.

L. Lazar & A. Farago, "Experiences of Patients Suffering from Migraine-Type Headache Treated with PEMF," *Hungarian Symposium on PEMF, 2nd Symposium*, May 16-17, 1987, Szekesfehervar, Hungary, p. 137-140.

## **PEMF and Hemophilia**

In this study, hemophiliacs suffering from joint hemorrhage received millimeter wave (MW) therapy at biologically active points beginning on the first day of hospital release. Adults were treated with an “Electronica-KVCh” device (61 GHz, 5 mW maximum power) and children were treated with a “Porog” device, which generates low-intensity wide-band MMW noise. Exposures in both groups lasted for 20-25 minutes per day and were extended over a period of 10 days. Results indicated the treatment to be more effective than conventional therapy with respect to alleviation of pain, need for medication, and other parameters.

V.V. Aleschenko & I.O. Pisanko, “EHF-Therapy for Hemophylic Arthropathy and Hemarthroses of the Knee Joint,” Millimeter Waves in Medicine and Biology. Digest of Papers of the 10th Russian Symposium with International Participation, April 24-26, Moscow, Russia, 1995, p. 61-63.

## **PEMF and Hepatitis**

This double-blind, placebo-controlled study examined the effects of millimeter wave therapy combined with conventional methods in the treatment of viral hepatitis in children. Making use of a “Yav’-1-5,6” or “Yav’-1-7,7” device, MW therapy involved 14-15 exposures of, on average, 30 minutes per day at wavelengths of either 5.6 or 7.1 mm. Results indicated the combined treatment to be more effective than conventional treatment only, leading to a more rapid restoration of liver function.

A.A. Shul’diakov, et al., “Electromagnetic Radiation of Millimeter Range in Treatment of Children with Acute Viral Hepatitis,” Millimeter Waves in Medicine and Biology, 10th Russian Symposium with International Participation, April 24-26, 1995, Moscow, Russia, p. 21-23.

Results of this study showed that the use of magnetic fields was effective in treating patients suffering from viral hepatitis who had previously not benefited from conventional drug therapies.

I.A. Il’inskii, et al., “Experience with the Use of Glucocorticosteroids and Magnetic Fields in the Intensive Therapy of Severe Forms of Viral Hepatitis,” Soviet Medicine, 9,1978, p. 72-74.

This study examined the effects of PEMF in children suffering from various forms of viral hepatitis. PEMF consisted of alternating magnetic fields applied to the liver area daily over a total of 10-15 days. Results indicated PEMF led to more rapid and trouble-free recovery.

V.V. Krasnov & A.I. Shilenok, “PEMF of Hepatitis A and B in Children,” *Pediatrics*, 10, 1991, p. 54-57.

## **PEMF and Herniated Disk**

This double-blind, placebo-controlled study examined the effects of PEMF in patients following herniated disk surgery. Results showed that 52 percent of patients receiving the treatment compared to 30 percent of controls reported being free of symptoms at the time of hospital release.

K. Perjes, et al., “Effect of PEMF on Recovery After Herniated Disk Surgery,” Hungarian Symposium on PEMF, 2nd Symposium, May 16-17, 1987, Szekesfehervar, Hungary, p. 159-162.

## **PEMF and Hip Problems**

This double-blind study examined the effects of pulsed electromagnetic fields on loosened hip prostheses. Results showed an increase of bone density in all patients receiving PEMF treatment compared to only 60 percent of controls. The authors argue such findings suggest PEMF elicits early bone reconstruction, which enhances early weight bearing.

G. Gualtieri, et al., "The Effect Pulsed Electromagnetic Field Stimulation on Patients Treated of Hip Revesions with Trans-Femoral Approach," Second World Congress for Electricity and Magnetism in Biology and Medicine, 8-13 June 1997, Bologna, Italy.

This study examined the effects of pulsed electromagnetic fields (50 Hz, 50 G) in treating aseptic loosening of total hip prostheses. PEMF therapy consisted of 20 minutes per day for 6 days per week over a total of 20 such sessions and was begun, on average, a year and a half following the start of loosening. Results showed PEMF to have some beneficial effects with respect to loosened hip arthroplasties, although it was not effective in patients suffering severe pain due to extreme loosening.

K. Konrad, "Therapy with Pulsed Electromagnetic Fields in Aseptic Loosening of Total Hip Prostheses: A Prospective Study," *Clinical Rheumatology*, 15(4), 1996, p. 325-328.

## **PEMF and Joint Disease**

Results of this 11-year study involving 3014 patients found pulsed magnetic field treatment at low frequencies and intensities to be a highly effective, side-effect- free therapy for joint disease.

E. Riva Sanseverino, et al., "Therapeutic Effects of Pulsed Magnetic Fields on Joint Diseases," *Panminerva Med*, 34(4), October-December 1992, p.187-196.

## **PEMF and Kidney Problems**

This review article notes that placebo-controlled studies have shown positive results concerning the use of pulsed magnetic field therapy in the treatment of secondary chronic pyelonephritis.

V.A. Kiyatkin, "Pulsed Magnetic Field in Therapy of Patients with Secondary Chronic Pyelonephritis," Second World Congress for Electricity and Magnetism in Biology and Medicine, 8-13 June 1997, Bologna, Italy.

## **PEMF and Lung Disease**

This study examined the effects of low-frequency magnetic fields coupled with conventional therapies in rats suffering from inflammatory lung disease. Results showed that rats receiving the magnetic fields experienced significant reductions in lung abscesses and associated symptoms, and similar beneficial effects were seen among a group of 165 human patients receiving comparable treatment.

L.V. Iashchenko, "Low-Frequency Magnetic Fields in the Combined Therapy of Inflammatory Lung Diseases," *Probl Tuberk*, 3, 1988, p. 53-56.

## **PEMF and Lupus Erythematosus**

This review article examined the data concerning impulsed magnetic fields in the treatment of lupus erythematosus. Studies indicate that the treatment can be beneficial due to its anti-inflammatory and

analgesic effects, its positive action on microcirculation, and immunological reactivity.

I.V. Khamaganova, et al., "The Use of a Pulsed Magnetic Field in the Treatment of Lupus Erythematosus," *Ter Arkh*, 67(10),1995, p. 84-87.

Results of this study indicated that the bitemporal application of ultrahigh- frequency electromagnetic fields to the hypothalamo-hypophyseal area daily over

a period of 18-20 days had beneficial effects in patients suffering from systemic lupus erythematosus.

V.D. Sidorov, et al., "The Immunomodulating Effect of Microwaves and of an Ultrahigh-Frequency Electrical Field in Patients with Systemic Lupus Erythematosus," *Vopr Kurortol Fizioter Lech Fiz Kult*, (4), 1991, p. 36-40.

## **PEMF and Multiple Sclerosis**

This article reports on the case of a 55-year-old female chronic progressive multiple sclerosis patient who received a single external application of low magnetic fields (7.5-picoTesla; 5-Hz frequency) which lasted 20 minutes. The treatment quickly led to improvements in a variety of areas, including fatigue, sleep, vision, bladder function, movement and speech problems, and mood.

R. Sandyk, "Rapid Normalization of Visual Evoked Potentials picoTesla Range Magnetic Fields in Chronic Progressive Multiple Sclerosis," *International Journal of Neurosci*, 77(3-4), August 1994, p. 243-259.

This study reports on four cases of multiple sclerosis who experienced improvements in visuospatial and visuomotor functions following treatment with external application of low magnetic fields.

R. Sandyk, "Further Observations on the Effects of External picoTesla Range Magnetic Fields on Visual Memory and Visuospatial Functions in Multiple Sclerosis," *International Journal of Neurosci*, 77(3-4), August 1994, 203-27

This article reports on the case of a 50-year-old female chronic progressive multiple sclerosis patient who received a single external application of low magnetic fields who experienced significant improvements following the treatment.

R. Sandyk, "Successful Treatment of Multiple Sclerosis with Magnetic Fields," *International Journal Neurosci*, 66(3-4),October 1992, p. 237-250.

This article reports on the cases of three patients suffering from long-time symptoms of multiple sclerosis who received treatment with extra cerebral pulsed electromagnetic fields over a period of between 6 and 18 months. Results showed all three patients experienced significant improvements in cognitive functions.

R. Sandyk, "Progressive Cognitive Improvement in Multiple Sclerosis from Treatment with Electromagnetic Fields," *International Journal of Neurosci*, 89(1- 2),January 1997, p. 39-51.

This is a report on the cases of two chronic multiple sclerosis patients exhibiting severe speech problems. Symptoms were completely resolved following 3-4 weeks of treatment with pulsed electromagnetic fields.

R. Sandyk, "Resolution of Dysarthria in Multiple Sclerosis Treatment with Weak Electromagnetic Fields," *International Journal of Neurosci*, 83(1-2),November 1995, p. 81-92.

This article reports on the cases of three multiple sclerosis patients suffering from alexia (lack of understanding of written words) who experienced a reversal of the alexia following the start of pico tesla-range electromagnetic field treatment.

R. Sandyk, "Reversal of Alexia in Multiple Sclerosis Weak Electromagnetic Fields," *International Journal of Neurosci*, 83(1-2), November 1995, p. 69-79.

This article reports on the case of a middle-aged disabled female patient with a 19-year history of chronic relapsing-remitting multiple sclerosis. Within one day of receiving experimental treatment with picotesla electromagnetic fields, the patient exhibited improvements in her condition. The patient continued with 1-2 treatments per week over a period of 32 months. During this time, significant improvements were seen with respect to a range of physical symptoms, as well as cognitive functions.

R. Sandyk, "Long Term Beneficial Effects of Weak Electromagnetic Fields in Multiple Sclerosis," *International Journal of Neurosci*, 83(1-2), November 1995, p. 45-57.

This article reports on the case of a 36-year-old man severely disabled with partial paralysis and lack of coordination. Three treatment sessions per week with pulsed electromagnetic fields over a period of one year led to a range of improvements, including improvements in gait, balance, bowel and bladder functions, vision, mood, and sleep. No progression of symptoms associated with multiple sclerosis was seen throughout the course of EMF treatment.

R. Sandyk, "Treatment with Electromagnetic Field Alters the Clinical Course of Chronic Progressive Multiple Sclerosis--A Case Report," *International Journal of Neurosci*, 88(1-2), November 1996, p. 75-82.

This article reports on the cases of two multiple sclerosis patients suffering from chronic ataxia who performed poorly on human figure drawing tests administered to measure body image perception. Treatment with extracerebral applications of picotesla flux electromagnetic fields led to improvements in gait and balance as well as a normalization in body image perception as seen on a repeat of the same test each patient.

R. Sandyk, "Effect of Weak Electromagnetic Fields on Body Image Perception in Patients with Multiple Sclerosis," *International Journal of Neurosci*, 86(1-2), July 1996, p. 79-85.

This article reports on the case of a 51-year-old female patient with remitting- progressive multiple sclerosis who experienced a successful reduction in carbohydrate craving believed to be associated with the exacerbation of her condition following treatment with a series of extra cranial AC pulsed applications of PEMF.

R. Sandyk, "Treatment with Weak Electromagnetic Fields Attenuates Carbohydrate Craving in a Patients with Multiple Sclerosis," *International Journal of Neurosci*, 86(1-2), July 1996, p. 67-77.

This article reports on the cases of three multiple sclerosis patients suffering from a chronic progressive course of the disease who experienced a reduction in tremors following treatment with brief external applications of pulsed EMFs of 7.5-pT intensity.

R. Sandyk & L.C. Dann, "Weak Electromagnetic Fields Attenuate Tremor in Multiple Sclerosis," *International Journal of Neurosci*, 79(3-4), December 1994, p. 199-212.

This article reports on the cases of three female chronic multiple sclerosis patients who experienced a reversal of cognitive deficits following treatment with brief external applications of alternating pulsed electromagnetic fields in the picotesla range of intensity.

R. Sandyk, Reversal of Visuospatial Hemi-inattention in Patients with Chronic Progressive Multiple Sclerosis Treatment with Weak Electromagnetic Fields," *International Journal of Neurosci*, 79(3-4), December 1994, p. 169-184.

This article reports on the cases of three female multiple sclerosis patients with poor word fluency who experienced a 100-percent increase in word output following 4-5 sessions of treatment with external applications of extremely weak electromagnetic fields in the pico tesla range of intensity.

R. Sandyk, Improvement in Word-fluency Performance in Patients with Multiple Sclerosis Electromagnetic Fields," *International Journal Neurosci*, 79(1-2), November 1994, p.75-90.

This article reports on the case of a 58-year-old male multiple sclerosis patient with a 37-year history of the disease. Treatment with external application of magnetic fields in the pico tesla range led to a speedy improvement of neurological symptoms in the areas of walking, balance, sensory symptoms, and bladder function. Improvements in numerous cognitive functions were seen within 24 hours of treatment as well.

R. Sandyk & R.P. Iacono, "Improvement PicoTesla Range Magnetic Fields of Perceptual-motor Performance and Visual Memory in a Patient with Chronic Progressive Multiple Sclerosis," *International Journal of Neurosci*, 78(1-2), September 1994, p. 53-66.

This article reports on the case of a 36-year-old multiple sclerosis patient who experienced immediate improvements in visuo-perceptive functions following treatment with external application of pico tesla-range magnetic fields.

R. Sandyk & R.P. Iacono, "Multiple Sclerosis: Improvement of Visuo-perceptive Functions PicoTesla Range Magnetic Fields," *International Journal of Neurosci*, 74(1-4), January-February 1994, p. 177-189.

This article reports on the cases of three multiple sclerosis patients suffering from falls due to rapid deterioration in balance and triggered distracting external auditory stimuli. Treatment with a series of extra cranially applied, low-frequency picotesla-range intensity electromagnetic fields quickly resolved such symptoms associated with a loss of balance.

R. Sandyk, "Application of Weak Electromagnetic Fields Facilitates Sensory- motor Integration in Patients with Multiple Sclerosis," *International Journal of Neurosci*, 85(1-2), March 1996, p. 101-110.

This article reports on the cases of three multiple sclerosis patients experiencing continuous and debilitating daily fatigue over the course of several years. Treatment with extracranially applied picotesla flux electromagnetic fields dramatically improved symptoms of fatigue in all three patients.

R. Sandyk, Treatment with Weak Electromagnetic Fields Improves Fatigue Associated with Multiple Sclerosis, *International Journal of Neurosci*, 84(1-4), February 1996, p. 177-186.



This article reports on the cases of two female patients with chronic progressive- stage multiple sclerosis who suffered from regular worsening of their symptoms starting approximately a week prior to menstruation and abating at menstruation onset. Such symptoms were resolved in both patients two months following the start of treatment with the extracranial application of weak electromagnetic fields.

R. Sandyk, Premenstrual Exacerbation of Symptoms in Multiple Sclerosis is Attenuated Treatment with Weak Electromagnetic Fields, *International Journal of Neurosci*, 83(3-4), December 1995, p. 187-198.

This article reports on the case of a 64-year-old female patient with a 22-year history of chronic progressive multiple sclerosis. Two 30-minute treatments with low-level electromagnetic fields produced a marked improvement in a variety of symptoms.

R. Sandyk R.P. Iacono, Resolution of Longstanding Symptoms of Multiple Sclerosis Application of PicoTesla Range Magnetic Fields, *International Journal of Neurosci*, 70(3-4), June 1993, p. 255-269.

Results of this double-blind, placebo-controlled study found that pulsed electromagnetic fields administered daily over a period of 15 days proved to be an effective treatment in reducing spasticity and incontinence associated with multiple sclerosis.

A. Guseo, Double-Blind Treatments with Pulsating Electromagnetic Field in Multiple Sclerosis, *Hungarian Symposium on PEMF, 2nd Symposium*, May 16-17, 1987, Szekesfehervar, Hungary, p. 85-89.

Results of this double-blind, placebo-controlled study indicated that pulsed electromagnetic fields administered daily over a period of 15 days is a generally effective treatment in reducing symptoms associated with multiple sclerosis, with the most positive improvements involving the alleviation of spasticity and pain.

A. Guseo, Pulsing Electromagnetic Field Therapy of Multiple Sclerosis the Gyuling-Bordacs Device: Double-Blind, Cross-Over and Open Studies, *Journal of Bioelectr.*, 6(1), 1987, p. 23-35.

Results of this double-blind, placebo-controlled study indicated that exposure to magnetic fields produced beneficial clinical effects in patients suffering from cerebral paralysis and in patients with multiple sclerosis.

A. Sieron, The Variable Magnetic Fields in the Complex Treatment of Neurological Diseases, *European Bioelectromagnetics Association, 3rd International Congress*, 29 February - 3 March 1996, Nancy, France.

## **PEMF and Muscle Injury**

This study examined the effects of pulsed electromagnetic fields on recovery following muscle injury in rats. Results showed that both pulsed and constant magnetic fields were equally effective, with the constant field being more intense.

I.E. Detlav, The Influence of Constant and Pulsed Electromagnetic Fields on Oxidation Processes in Muscle, in I.E. Detlav, (ed.), *Electromagnetic Therapy of Injuries and Diseases of the Support-Motor Apparatus*. International Collection of Papers, Riga, Latvia: Riga Medical Institute, 1987, p. 12-16.

This study examined the effects of pulsed electromagnetic fields (Gyuling- Bordacs device) in patients suffering from peripheral muscle paralysis. Treatment consisted of 20-minute exposures (2-50 Hz, 70 G).

Results showed 50-Hz pulsed electromagnetic fields to be the most effective level of treatment and that such therapy enhanced muscle irritability in peripheral paralysis patients as well as in healthy controls.

L. Mecseki, The Study of the Efficacy of PEMF in Peripheral Paralysis, Hungarian Symposium on PEMF, 2nd Symposium, 16-17, May 1987, Szekesfehervar, Hungary, p. 149-158.

## **PEMF and Neck Pain**

This double-blind, placebo-controlled study examined the effects of low-energy pulsed electromagnetic fields administered via soft collars on patients suffering from persistent neck pain. Results indicated significantly beneficial effects following three weeks of treatment.

D. Foley-Nolan, Low Energy High Frequency (27.12 MHZ) Therapy for Persistent Neck Pain. Double Blind Placebo Controlled Trial, Bioelectromagnetics Society, 12th Annual, June 10-14, 1990, San Antonio, TX, p. 73.

## **PEMF and Nerve Damage**

This controlled study found that exposure to pulsed electromagnetic fields enhanced the speed and degree of peripheral nerve regeneration twofold in rats with experimentally severed sciatic nerves.

H. Ito C.A. Bassett, Effect of Weak, Pulsing Electromagnetic Fields on Neural Regeneration in the Rat, Clin Orthop, (181), December 1983, p. 283-290.

Results of this controlled study demonstrated that treatment with 15 minutes per day of pulsed electromagnetic fields enhanced recovery time of experimentally-injured nerves in rats.

A.R. Raji R.E. Bowden, Effects of High-peak Pulsed Electromagnetic Field on the Degeneration and Regeneration of the Common Peroneal Nerve in Rats, Journal of Bone Joint Surg, 65(4), August 1983, p. 478-492.

Results of this study indicated that the use of pulsed electromagnetic fields on experimentally divided and sutured nerves in rats sped up regeneration of damaged nerves and the time it took for limb use to be recovered.

A.M. Raji, An Experimental Study of the Effects of Pulsed Electromagnetic Field (Diapulse) on Nerve Repair, Journal of Hand Surg, 9(2), June 1984, p. 105-112.

This study examined the effects of a Soviet Polyus-1 low-frequency magnet therapy device used to administer approximately 10 mT for approximately 10 minutes in patients with optic nerve atrophy. Patients underwent 10-15 sessions per course. Results showed that vision acuity in patients with low acuity values (below 0.04 diopters) improved in 50 percent of cases. It was also found that the

treatment improved ocular blood flow in cases of optic nerve atrophy. Optimal benefits were experienced after 10 therapy sessions.

L.V. Zobina, Effectiveness of PEMF in Optic Nerve Atrophy. A Preliminary Study, Vestn Oftalmol, 106(5), September-October 1990, p. 54-57.

## **PEMF and Neurological Disorders**

This article summarizes clinical results obtained by the authors in using pulsed electromagnetic fields (Gyuling-Bordacs device) in the treatment of neurological and locomotor disorders among a group of 148 patients in a hospital setting over a period of 3 years. The authors claim that 58-80 percent of such patients experienced benefits of some kind over the course of PEMF treatment.

G. Terlaki, Clinical Experiences PEMF, Hungarian Symposium on PEMF, 2nd Symposium, 16-17 May 1987, Szekesfehervar, Hungary, p. 175-179.

This study examined the effects of PEMF on patients suffering from nervous system diseases. Treatment consisted of 10-12 6-minute exposures (10- 20 kG, 0.1-0.6 Hz). Results indicated beneficial effects in 25 of the 27 patients receiving the treatment.

A.A. Skorometz, Magnetic Impulse Therapy of Patients with Spondylogenic Diseases of the Nervous System, Fizicheskaia Meditzina, 3(1-2), 1993, p. 41-43.

Results of this study found that the use of magnetic fields (30-35 mT, 10 and 100 Hz) produced beneficial effects in 93 percent of patients suffering from nerve problems.

A.G. Shiman, Use of Combined Methods of magnetoelectrotherapy in the Treatment for Polineuropathies, Vopr Kurortol Fizioter Lech Fiz Kult, (5), 1993, p. 38-41.

## **PEMF and Osteoarthritis**

Results of this double-blind, placebo-controlled study indicated that exposure to pulsed electromagnetic fields had beneficial effects in the treatment of patients suffering from painful osteoarthritis of the knee or cervical spine. PEMF therapy consisted of 18 exposures lasting 30 minutes and administered 3-5 times per week.

D.H. Trock, The Effect of Pulsed Electromagnetic Fields in the Treatment of Osteoarthritis of the Knee and Cervical Spine. Report of Randomized, Double Blind, Placebo Controlled Trials," Journal of Rheumatology, 21(10), 1994, p. 1903-1911.

This double-blind, placebo-controlled study indicated that treatment with pulsed electromagnetic fields produced significant favorable effects in patients suffering from osteoarthritis.

D.H. Trock, Treatment of Osteoarthritis with Pulsed Electromagnetic Fields," Bioelectric Repair and Growth Society, Vol. XIII, 13th Annual Meeting, 10-13 October 1993, Dana Point, CA, p. 14.

This double-blind, placebo-controlled study showed that treatment with pulsed electromagnetic fields yielded significant benefits in patients suffering from osteoarthritis of the knee or cervical spine. PEMF therapy (25 G, 5-24 Hz) consisted of 18 30-minute exposures over a period of 3-4 weeks.

A.J. Bollet, Treatment of Osteoarthritis with Pulsed Electromagnetic Fields, European Bioelectromagnetics Association, 2nd Congress, 9-11 December 1993, Bled Slovenia, p. 46.

This controlled study examined the effects of changeable magnetic fields (Polus- 101 device) coupled with more conventional therapies in the treatment of patients suffering from osteoarthritis. Magnetic therapy

consisted of daily 20 minute exposures for a total of 12 sessions. Results showed more rapid improvements of immunological indices and alleviation of symptoms associated with the disease among patients receiving the combination therapy compared to those treated only conventionally.

The Use of Changeable Magnetic Field in Treatment of Osteoarthritis, European Bioelectromagnetics Association, 3rd International Congress, February-3 March 1996, France.

## **PEMF and Osteochondrosis**

This study examined the effects of alternating magnetic fields (50 Hz, 10-50 mT) combined with conservative therapy in patients suffering from spinal osteochondrosis. Treatment consisted of 20-minute exposures over a total of 20- 25 such exposures per course. Results showed clinical benefits in 95 percent of patients receiving the combination treatment compared to just 30 percent among controls.

L.L. Butenko, The Use of Alternating Magnetic Fields in Spinal Osteochondrosis, Mechanisms of Biological Action of Electromagnetic Fields, 27-31 October 1987, Pushchino, USSR, USSR Academy of Sciences, Research Center for Biological Studies, Inst. of Biological Physics, Coordination Council of Comecon Countries and Yugoslavia for Research in the Fields of Biological Physics, p. 183.

## **PEMF and Osteonecrosis**

This pilot study found that the use of pulsed electromagnetic fields produced beneficial effects in patients suffering from osteonecrosis of the femoral head.

N.S. Eftekhari, Osteonecrosis of the Femoral Head Treated Pulsed Electromagnetic Fields (PEMFs): A Preliminary Report, 1983, p. 306-330.

This study examined the use of pulsed electromagnetic fields in the treatment of osteonecrosis. Compared to published findings concerning surgical treatment, results showed PEMF therapy to be superior in producing improvement.

L. Hinsenkamp, Preliminary Results in Electromagnetic Field Treatment of Osteonecrosis, Bioelectrochem Bioenerg.30, 1993, p. 229-236.

## **PEMF and Osteoporosis**

This study examined the effects of pulsed electromagnetic fields on postmenopausal osteoporosis in 10-month-old female rats. Results showed that EMF treatment for one hour per day for 4 months with a 30-gauss maximum pulse reduced bone mass loss to within 10 percent, while a 70-gauss maximum pulse reduced bone mass loss entirely.

M. Hinsenkamp, Preliminary Results in Electromagnetic Field Treatment of Osteonecrosis, Bioelectrochem Bioenerg.30, 1993, p. 229-236.

This study examined the effects of long-term pulsing electromagnetic fields in the form of repetitive pulse burst waves over a period of 6 months in osteoporotic rats. Results showed increased bone volume and formation activity.

S. Mishima, The Effect of Long-term Pulsing Electromagnetic Field Stimulation on Experimental Osteoporosis of Rats, Sangyo Ika Daigaku Zasshi, 10(1), March 1, 1988, p. 31-45.

This study examined the effects of a 72-Hz pulsating electromagnetic field administered for 10 hours per day over a period of 12 weeks on bone density in women prone to osteoporosis. Results found significant increases in bone mineral density in the area of EMF exposure.

F. Tabrah, Bone Density Changes in Osteoporosis-prone Women Exposed to Pulsed Electromagnetic Fields (PEMFs), Journal of Bone Miner Res, 5(5), May 1990, p. 437-442.

In this study, osteoporosis patients received treatment with pulsed electromagnetic fields (50 G, 50-100 Hz) for 30 minutes per session over a period of two years involving 20 sessions. These subjects were compared to similar patients treated with calcitonin. Results indicated PEMF to be effective in reducing pain, and to be even more so when combined with the conventional drug treatment.

T.W. Bilotta, The Use of Low-Frequency Low Magnitude PEMFs in Treatment of Osteoporosis, Journal of Bioelectr, 8(2),1989, p. 316.

This controlled study examined the effects of pulsed electromagnetic fields in women suffering from postmenopausal osteoporosis. Treatment consisted of daily 30-minute exposures for 20 days every six months. Results showed that PEMF treatment combined with 100 IU per day of nasal spray synthetic salmon calcitonin arrested bone decrease and significantly increased bone mass relative to patients receiving drug therapy alone.

T.W. Bilotta, Influence of Pulsed Electromagnetic Fields on Post-Menopausal Osteoporosis, First World Congress for Electricity and Magnetism in Biology and Medicine, 14-19 June 1992, Lake Buena Vista, FL, p. 78.

Results of this study found the use of total-body low-frequency magnetic fields (60 G, 50-100 Hz) to be effective in the treatment of patients suffering from osteoporosis-related symptoms. Treatment consisted of a total of 15 exposures of 30 minutes each.

G. Saveriano S. Ricci, Treatment of Senile Osteoporosis Caused Rachialgia with Low-Frequency PEMFs, Journal of Bioelectr, 8(2), 1989, p. 321.

## **PEMF Otitis Externa**

This study examined the effects synchronizing pulse waves in the impaired area when treating patients suffering from acute diffuse otitis externa with low-level magnetic fields in combination with conventional therapies. Patients were divided into three groups. The first received ultrahigh-frequency or very-high-frequency electromagnetic waves. The second received 15-minute daily exposures to 50- Hz alternating or pulsating 20-mT magnetic fields. The third group of patients were treated switching on the same magnetic fields only during propagation of the pulse wave through the ear vessels. Results showed a 100 percent recovery rate in patients across all three groups, with recovery taking the least amount of time among those in group 3.

## **PEMF and Pancreatitis**

This study found that sinusoidal and continuous low-frequency alternating magnetic field generated a Polius-1 apparatus exhibited beneficial effects in patients suffering from chronic pancreatitis.

A.A. Fedorov, The Use of a Low-frequency Magnetic Field in the Combined Therapy of Chronic Pancreatitis, Vopr Kurortol Fizioter Lech Fiz Kult, (5), September-October 1990, p. 28-30.

This controlled study examined the effects of combining pulsed electric stimulation and laser light with conventional treatment in patients suffering from acute pancreatitis. Results showed the combined therapy to have the most significant effects in patients with severe forms of the disease.

O.G. Savina, A Low-Frequency Pulsed Current and a Low-Intensity Laser Radiation in the Treatment of Acute Pancreatitis, Vopr Kurortol Fizioter Lech Fiz Kult, (2), 1995, p. 39-40.

## **PEMF and Parkinson's Disease**

This article reports on the case of a 73-year-old male Parkinson's patients suffering from disabling resting and postural tremors in the right hand, as well as other symptoms. Two successive 20-minute treatments with AC pulsed electromagnetic fields of 7.5-picotesla intensity and 5-Hz frequency sinusoidal wave led to improvements in visuospatial performance and a legible signature. Significant improvements in Parkinsonian motor symptoms were also seen following additional treatments.

R. Sandyk, Brief Communication: Electromagnetic Fields Improve Visuospatial Performance and Reverse Agraphia in a Parkinsonian Patient, International Journal of Neurosci, 87(3-4), November 1996, p. 209-217

This article reports on the case of a medicated 61-year-old Parkinson's patient who experienced rapid reversal of symptoms following a single external application of picotesla-range magnetic fields.

R. Sandyk R.P. Iacono, Reversal of Visual Neglect in Parkinson's Disease Treatment with picoTesla Range Magnetic Fields, International Journal of Neurosci, 73(1-2), November 1993, p. 93-107.

This article reports on four Parkinson's patients who experienced significant improvement in symptoms following treatment with picotesla-range magnetic fields. Two additional patients suffering from Parkinson's-related dementia experienced significant improvements in visuospatial impairment.

R. Sandyk, Magnetic Fields in the Therapy of Parkinsonism, International Journal of Neurosci, 66(3-4), October 1992, p. 209-235.

Noting that transcranial magnetic stimulation (TMS) is a new and noninvasive method of direct cortical neuron stimulation, this review article discusses recent studies showing that TMS has led to improvements in symptoms associated with Parkinson's disease and depression.

M.S. George, et al., "Transcranial Magnetic Stimulation: A Neuropsychiatric Tool for the 21st Century," Journal of Neuropsychiatry Clin Neurosci, 8(4), Fall 1996, p. 373-382.

Results of this study showed that the application of ELF magnetic fields via a plastic helmet device housing a set of coils (generating fields of 8 Hz and 7.5 pT) produced beneficial clinical effects after 30 minutes in patients suffering Parkinson's disease and multiple sclerosis.

J. Bardasano, Extracranial Device for Noninvasive Neurological Treatments with Pulsating ELF Magnetic Fields, Second World Congress for Electricity and Magnetism in Biology and Medicine, 8-13 June 1997, Bologna, Italy.

This article reports on two Parkinson's patients who experienced improvements in motor symptoms following treatment with external application of weak electromagnetic fields in the picotesla range.

R. Sandyk, Parkinsonian Micrographia Reversed Treatment with Weak Electromagnetic Fields, International Journal of Neurosci, 81(1-2), March 1995, p. 83-93.

This article reports on the cases of three Parkinson's patients on full medication who exhibited an improvement in right hemispheric functions following a series of treatments with external application of electromagnetic fields in the picotesla range.

R. Sandyk, "Improvement in Short-term Visual Memory Weak Electromagnetic Fields in Parkinson's Disease, International Journal of Neurosci, 81(1-2), March 1995, p. 67-82.

This article reports on the case of a nonmedicated 49-year-old male Parkinson's patient who experienced a dramatic improvement in motor, depressive, and cognitive symptoms following treatment with brief extracranial applications of picotesla-range electromagnetic fields.

R. Sandyk, "A Drug Naive Parkinsonian Patient Successfully Treated with Weak Electromagnetic Fields, International Journal of Neurosci, 79(1-2), November 1994, p. 99-110.

This article reports on the case of a 61-year-old Parkinson's patient who experienced improvements in the severity of motor problems 30 minutes after treatment with external application of weak electromagnetic fields in the picotesla range. Sham treatment had no such effects in the same patient.

R. Sandyk R.P. Iacono, Reversal of Micrographia in Parkinson's Disease Application of picoTesla Range Magnetic Fields, International Journal of Neurosci 77(1-2), July 1994, p. 77-84.

This article reports on the cases of five Parkinsonian patients on full medication who experienced a marked improvement in performance on Thurstone's Word- Fluency Test following treatment with a series of extremely-low-intensity electromagnetic fields in the picotesla range and of 5-8 Hz frequency.

R. Sandyk, Improvement in Word-fluency Performance in Parkinson's Disease Administration of Electromagnetic Fields, International Journal of Neurosci, 77(1- 2), July 1994, p. 23-46.

This article reports on the case of a 69-year-old Parkinsonian patient who was able to discontinue most medication for two weeks following two treatment sessions with extracranial picotesla-range magnetic fields. Symptoms recurred after three weeks and the patient received four more magnetic field sessions on consecutive days after four weeks. The patient was then able to discontinue medications completely.

R. Sandyk, Treatment of Parkinson's Disease with Magnetic Fields Reduces the Requirement for Antiparkinsonian Medications, International Journal of Neurosci, 74(1-4), January-February 1994, p. 191-201.

This article reports on the cases of five medicated Parkinsonian patients who experienced improvements in motor, behavioral, and autonomic functions, and in visuoconstructional tasks following treatment with extracranial application of magnetic fields in the picotesla range.

R. Sandyk, Reversal of a Visuoconstructional Deficit in Parkinson's Disease Application of External Magnetic Fields: A Report of Five Cases, *International Journal of Neurosci*, 75(3-4), April 1994, p. 213-228.

This article reports on the cases of three medicated Parkinsonian patients who experienced relief from disabling periods of freezing gait following treatment with extracerebral applications of pulsed electromagnetic fields in the picotesla range.

R. Sandyk, Freezing of Gait in Parkinson's Disease is Improved Treatment with Weak Electromagnetic Fields, *International Journal of Neurosci*, 85(1-2), March 1996, p. 111-124.

The cases of four nondemented Parkinsonian patients under full medication are discussed in this article. These patients performed poorly on human figure drawing tests administered to measure body image perception. Treatment with extracerebral applications of picotesla-range intensity electromagnetic fields led to marked improvements in body image perception as seen on a repeat of the same test each patient.

R. Sandyk, Improvement of Body Image Perception in Parkinson's Disease Treatment with Weak Electromagnetic Fields, *International Journal of Neurosci*, 82(3-4), June 1995, p. 269-283.

This article reports on the cases of four medicated Parkinsonian patients who experienced reversal of visuospatial impairments as measured the Clock Drawing Test following treatment with externally applied weak electromagnetic fields of picotesla-range intensity.

R. Sandyk, Reversal of Visuospatial Deficit on the Clock Drawing Test in Parkinson's Disease Treatment with Weak Electromagnetic Fields, *International Journal of Neurosci*, 82(3-4), June 1995, p. 255-268.

This article reports on the case of a 68-year-old male patient suffering from Parkinson's disease over a period of 7 years. The patient had experienced little relief from traditional medical therapy. Treatment with external application of picotesla-range magnetic fields led to quick improvements with respect to tremor and foot dystonia, gait, postural reflexes, mood, anxiety, and cognitive and autonomic functions.

R. Sandyk K. Derpapas, The Effects of External picoTesla Range Magnetic Fields on the EEG in Parkinson's Disease, *International Journal of Neurosci*, 70(1-2), May 1993, p. 85-96.

This article reports on the cases of four Parkinsonian patients who exhibited significant improvements in motor symptoms following treatment with externally applied magnetic fields of picotesla-range intensity.

R. Sandyk K. Derpapas, Further Observations on the Unique Efficacy of PicoTesla Range Magnetic Fields in Parkinson's Disease, *International Journal of Neurosci*, 69(1-4), March-April 1993, p. 67-83

This article reports on two cases of fully medicated Parkinson's patients who experienced enhanced visuoperceptive functions as measured numerous drawing tests following extracranial treatment with picotesla-range magnetic fields.

R. Sandyk R.P. Iacono, Rapid Improvement of Visuoperceptive Functions picoTesla Range Magnetic Fields in Patients with Parkinson's Disease, *International Journal of Neurosci*, 70(3-4), June 1993, p. 233-254.



This article reports on the case of a 69-year-old Parkinsonian patient on full medication who experienced a marked improvement on several different drawing tests following 30 minutes of treatment with picotesla-range magnetic fields.

R. Sandyk, The Effects of PicoTesla Range Magnetic Fields on Perceptual Organization and Visual Memory in Parkinsonism, *International Journal of Neurosci*, 73(3-4), December 1993, p. 207-219

This article reports on the case of a Parkinson's patient suffering from severe movement problems who received treatment with external artificial weak magnetic fields with a frequency of 2 Hz and intensity of 7.5 picotesla over a period of 6 minutes. Results showed a significant attenuation in disability and near total reversal of the symptoms lasting approximately 72 hours. The patient then applied equivalent magnetic fields on a daily basis at home. Sustained improvement was seen throughout an observation of one month.

R. Sandyk, Magnetic Fields in the Treatment of Parkinson's Disease, *International Journal of Neurosci*, 63(1-2), March 1992, p. 141-150.

This article reports on the case of a 67-year-old male patient suffering from Parkinson's disease and levodopa-related motor fluctuations. Treatment with the application of external weak magnetic fields led to improvements in general Parkinsonian symptoms along with the amelioration of symptoms.

R. Sandyk, Weak Magnetic Fields in the Treatment of Parkinson's Disease with the Phenomenon, *International Journal of Neurosci*, 66(1-2), September 1992, p. 97-106.

## **PEMF and Peripheral Neuritis**

In this study, patients suffering from peripheral neuritis were exposed to high- frequency electromagnetic radiation on acupuncture points. EMR was generated Electronica-EnF, Aria, and Porog devices with tunable frequencies ranging between 53 and 78 GHz. Treatments were daily and lasted 25 minutes. Results showed full restoration of nerve function in 87 percent of patients.

O. Vassilenko and N.F. Vassilenko, Use of Extremely High Frequency Electromagnetic Radiation for Treating Peripheral Neuritis, *Second World Congress for Electricity and Magnetism in Biology and Medicine*, 8-13 June 1997, Bologna, Italy.

## **PEMF and Pneumonia**

Results of this study showed that magnetic laser therapy decreased the severity of acute respiratory insufficiency and treatment course, and prevented destructive complications in children with infiltrative acute destructive pneumonia between the ages of 1 and 12 years.

E.A. Gaidashev, An Evaluation of the Effect of Magnetic-laser Therapy on External Respiratory Function in Complicated Forms of Acute Pneumonia in Children, *Vopr Kurortol Fizioter Lech Fiz Kult*, (3), May-June 1995, p. 2-14.

## **PEMF and Post-Herpetic Neuralgia**

This study found both pulsed magnetic field treatment (20-30 minutes per day) and whole body alternating current magnetic field treatment (30 minutes per day) to be effective therapies for post-herpetic neuralgia in older patients. Pulsed magnetic field treatment consisted of 0.6-T (6-kG) samarium/cobalt magnets surrounded spiral coils generating a maximum 0.1-T pulse. Pads were pasted on the sensory areas innervated the dorsal root of the spinal cord where there was scar-association pain or paresthesia. Stimuli were delivered

at 280 V and 8 Hz. Alternating current magnetic field treatment involved a treatment bed consisting of 19 electrodes containing paired coils and with a maximum magnetic flux density around the electrodes of 0.08 T.

C. Kusaka, Pulse Magnetic Treatment and Whole-Body, Alternating Current Magnetic Treatment for Post-Herpetic Neuralgia, *Journal of Japanese Biomagnetism Bioelectromagnetics Society*, 8(2), 1995, p. 29-38.

## **PEMF and Pseudoarthrosis**

In this study, 92 congenital pseudoarthrosis patients received treatment with pulsing electromagnetic fields. Results indicated a 76-percent rate of lesion recovery.

J.S. Kort, et al., Congenital Pseudoarthrosis of the Tibia: Treatment with Pulsing Electromagnetic Fields, *Clin Orthop*, (165), May 1982, p. 124-137.

In this study, 34 patients with congenital pseudoarthrosis-associated infantile nonunions received treatment with pulsing electromagnetic fields. Results indicated that 50 percent experienced full healing, 21 percent experienced healing with need for protections, and 29 percent experienced failure. The majority of failures were among men with a history of early fracture. Following the demonstration of coil effects, the PEMF treatment was combined with surgical realignment, immobilization, and grafting.

C.A. Bassett, Congenital Pseudarthroses of the Tibia: Treatment with Pulsing Electromagnetic Fields, *Clin Orthop*, (154), January-February 1981, p. 136-148.

In this study, 29 congenital pseudoarthrosis patients received extremely-low- frequency pulsing electromagnetic fields. Results: Over 70 percent experienced full healing, 21 percent experienced healing with need for protections, and 29 percent experienced failure. The majority of failures were among men with a history of early fracture.

C.A. Bassett, A Non-operative Salvage of Surgically-resistant Pseudarthroses and Non-unions Pulsing Electromagnetic Fields. A Preliminary Report, *Clin Orthop*, May 1977, p. 128-143.

In this article, the authors report on their own clinical use of electrodynamic field therapy in the treatment of 271 pseudoarthrosis patients over a period of 8 years. They report bony healing in 92 percent of such cases.

F. Lechner, Treatment of Infected Pseudarthroses with Electrodynamic Field Therapy, *Fortschr Med*, 97(20), May 24, 1979, p. 943-949.

This study examined the effects of pulsed electromagnetic fields on 91 patients with congenital pseudoarthrosis of the tibia. Results showed an overall success rate of 72 percent.

C.A. Bassett M. Schink-Ascani, Long-term Pulsed Electromagnetic Field (PEMF) Results in Congenital Pseudarthrosis, *Calcif Tissue Int*, 49(3), September 1991, p. 216-220.

Results of this study indicated that treatment with pulsed electromagnetic fields had beneficial effects in children suffering from congenital pseudoarthrosis.

M.L. Sutcliffe A.A. Goldberg, The Treatment of Congenital Pseudoarthrosis of the Tibia with Pulsing Electromagnetic Fields: A Survey of 52 Cases, *Clinical Orthop*, (166), 1982, p. 45-57.

Results of this study indicated that pulsed electromagnetic fields (72 Hz) can be an effective therapy for patients suffering from lesions associated with congenital pseudoarthroses when treatment is combined with appropriate orthopedic management.

J.S. Kort C.A.L. Bassett, Role of Electricity in the Treatment of Congenital Pseudoarthrosis of the Tibia, *Reconstr Surg Traumatol*, 19, 1985, p. 140-146.

## **PEMF and Psychiatric Disorders**

Noting the well-established dangers associated with electroconvulsive therapy, the author, in this theoretical article, argues that transcranial magnetic stimulation should be looked at as an alternative psychiatric treatment. The author asserts that TMS has several advantages over ECT in that it is painless, noninvasive, and more effective on deep structures of the brain.

T. Zyss, Deep Magnetic Brain Stimulation - The End of Psychiatric Electroshock Therapy? *Medical Hypotheses*, 43(2), 1994, p. 69-74.

## **PEMF and Respiratory Problems**

Results of this study showed that the use of low-frequency magnetic fields helped to prevent and treat critically ill patients suffering from pyoinflammatory bronchopulmonary complications, and to prevent such complications as well.

G.A. Mozhaev Iiu Tikhonovskii, The Prevention and Treatment of Suppurative- inflammatory Complications in the Bronchopulmonary System During Prolonged Artificial Ventilation, *Anesteziol Reanimatol*, (4), July-August 1002, p. 47-51.

This article reports on the case of a schizophrenic patient suffering from respiratory difficulties associated with neuroleptic withdrawal. Treatment using external application of picotesla-range magnetic fields quickly attenuated the severity of such problems.

R. Sandyk K. Derpapas, Successful Treatment of Respiratory Dyskinesia with picoTesla Range Magnetic Fields, *International Journal of Neurosci*, 75(1-2), March 1994, p. 91-102.

## **PEMF and Sexual Disorders**

Results of this placebo-controlled study showed that PEMF exhibited beneficial effects with respect to cavernous blood flow in male patients suffering from sexual problems.

I.I. Gorpinchenko, The Use of Magnetic Devices in Treating Sexual Disorders in Men, *Lik Sprava*, (3-4), March-April 1995, p. 95-97.

This study examined the effects of a combination pulsing magnetic field (PMF)/vacuum therapy in the treatment of impotence. Vacuum therapy consisted of the penis being placed into a hermetic cylinder with a negative pressure of 180-260 mmHg for 10-12 minutes per exposure for a total of 12-15 exposures. PMF therapy consisted of the same length and number of exposures, with 6 Hz, 30 mT being applied to the penile area at the same time as vacuum therapy. Results showed that, following the combination therapy, sexual function was restored in about 71 percent of patients, was improved in 17 percent, and did not change in

17 percent. For those patients receiving vacuum therapy only, the numbers were 51, 24, and 24 percent, respectively.

I.V. Karpukhin V.A. Bogomol'nii, Local Vacuum-PEMF of Impotency Patients, *Vopr Kurortol Lech Fiz Kult*, (2), 1996, p. 38-40.

This double-blind, placebo-controlled study examined the effects of weak magnetic fields in men suffering from various sexual disorders, including decreased erection and premature ejaculation. The three different magnetic stimulators used included the BiopotenzorEros, Bioskan-1 devices. All patients wore one of the three devices for a 3-week period. Results showed full restoration of sexual function in 38 percent of patients in the Biopotenzor group, 31 percent in the Eros group, 36 percent in the Bioskan-1 group, and in just 15 percent of the controls. Improvements in sexual function were seen among 42 percent, 39 percent, 47 percent, and 18 percent, respectively.

I.I. Gorpinchenko, "The Use of Magnetic Devices in Treating Sexual Disorders in Men," *Lik Sprava*, (3-4), 1995, p. 95-97.

## **PEMF and Sleep Disorders**

Results of this double-blind, placebo-controlled study indicated that low-energy- emission therapy significantly improved sleeping patterns among patients suffering from chronic psychophysiological insomnia. Therapy was administered 3 times per week, always in late afternoon and for 20 minutes, over a period of 4 weeks.

R. Hajdukovic, Effects of Low Energy Emission Therapy (LEET) on Sleep Structure, First World Congress for Electricity and Magnetism in Biology and Medicine, 14-19 June 1992, Lake Buena Vista, FL, p. 92.

This double-blind, placebo-controlled study examined the effects of low-energy emission therapy (27 MHz amplitude-modulated electromagnetic fields) in patients suffering from insomnia. Treatment consisted of 3 exposures per week over a 4-week period. Results showed significant increases in total sleep time among patients in the treatment group relative to controls.

M. Erman, "Low-Energy Emission Therapy (LEET) Treatment for somnia," Bioelectromagnetics Society, 13th Annual Meeting, 23-27 June 1991, Salt Lake City, UT, p. 69.

This review article notes that studies have found low-energy emission therapy to be effective in the treatment of chronic insomnia, and suggests that it may also be of value for patients suffering from generalized anxiety disorders.

C. Guilleminault B. Pasche, Clinical Effects of Low Energy Emission Therapy, Bioelectromagnetics Society, 15th Annual Meeting, 13-17 June 1993, Los Angeles, CA, p. 84.

## **PEMF and Spinal Cord Injury**

Results of this study found that exposure to constant magnetic fields improved healing in rats with experimentally induced spinal cord injury, and in human patients suffering from spinal cord trauma as well.

E.V. Tkach, Characteristics of the Effect of a Constant Electromagnetic Field on Reparative Processes in Spinal Cord Injuries, *Zh Nevropatol Psikhiatr*, 89(5), 1989, p. 41-44.

This study examined the effects of functional magnetic stimulation used to treat spinal cord injury in seven male patients. Results showed the treatment to be an effective noninvasive approach.

M.K. Sheriff, Neuromodulation of Detrusor Hyper-reflexia Functional Magnetic Stimulation of the Sacral Roots, British Journal of Urology, 78(1), July 1996, p. 39-46.

## **PEMF and Stroke**

Results of this study demonstrated that treatment with sinusoidal modulated currents coupled with Transcranial magnetic fields proved more effective than either therapy on its own in the treatment of stroke patients during the period of early rehabilitation.

F.E. Gorbunov, The Effect of Combined Transcranial Magnetic and Electric Impulse Therapy on the Cerebral and Central Hemodynamic Status of Stroke Patients in the Early Rehabilitation Period, Vopr Kurortol Fizioter Lech Fiz Kult, (3), May-June 1996, p. 21-24.

This study found that exposure to pulsed electromagnetic fields following focal cerebral ischemia provided significant protection against neuronal damage, in rabbits.

G. Grant, Protection Against Focal Cerebral Ischemia Following Exposure to a Pulsed Electromagnetic Field, Bioelectromagnetics, 15(3), 1994, p. 205-216.

Results of this study pointed to the efficacy of magnetic field therapy in the treatment of patients suffering from a variety of conditions associated with different brain vascular diseases.

N.Y. Gilinskaia, Magnetic Fields in Treatment of Vascular Diseases of the Brain, Magnitologiya, 1, 1991, p. 13-17.

## **PEMF and Tendonitis**

**Article:** Localized pulsed magnetic fields for tendonitis therapy.

**Published:** Biomedical Sciences Instrumentation, 2006;42:428-33

**Author:** Owegi R, Johnson MT.

Energy medicine has existed for centuries in some parts of the world, but in recent years, western health care practitioners have taken a heightened interest in these therapies. Treatment by use of pulsed magnetic fields (PMF) is currently being explored in both chronic and inflammatory diseases such as cancer, epilepsy, psoriasis, rheumatoid arthritis, and tendinitis. In the U.S., PMFs have already been approved for use in treatment of bone fractures in humans and clinical trials have been conducted for lower back pain. This study presents a summary of the therapeutic potential of a localized PMF treatment for tendinitis... The system has been used to accelerate wound healing and soft tissue swelling. It generates a specific PMF that induces an electrical field within the tendon. This induced electrical field is thought to influence the healing process by affecting the inflammatory cells that line the tendon sheath. In this study, we have used an established model of tendinitis along with a validated method for appraising edema and gait (Achilles' Functional Index), to test the hypothesis that the proposed PMF signal is effective in reducing the indicators of acute tendinitis injury. Our findings suggest a role for the treatment of soft tissue injury. The symbolic stand point of PMF treatments is to push the need for a revolutionary leap, from the more dominant pharmaceutical and surgical interventions, to the advanced applications of non-invasive therapies that would minimize the medicinal risk

of side effects, and eliminate the risk of complicated drug interactions. This device uses a 27.12 MHz incorporation was used to evaluate cell proliferation. The two osteosarcoma cell lines increase their thymidine incorporation when exposed to a PEMF for at least 30 min, both in a medium containing 10% fetal calf serum and in a serum-free medium. NHOC are known to increase their cell proliferation when exposed to PEMF but only if cultured in the presence of 10% fetal calf serum. In this experimental condition, three of the four cell lineages studied required at least 9 h of PEMF exposure to increase their DNA synthesis, whereas one cell lineage increased its cell proliferation after 6 h of PEMF exposure. Our observations confirm the hypothesis that the proliferative responses of NHOC and human osteosarcoma cell lines to PEMF exposure are quite different. Moreover, NHOC required minimal exposure times to PEMF to increase their cell proliferation, similar to that needed to stimulate bone formation in vivo.

Results of this double-blind, placebo-controlled study indicated that pulsed electromagnetic field therapy exhibited significant beneficial effects in the treatment of patients suffering from persistent rotator cuff tendonitis.

A. Binder, Pulsed Electromagnetic Field Therapy of Persistent Rotator Cuff Tendinitis. A Double-blind Controlled Assessment, *Lancet*, 1(8379), March 31, 1984, p. 695-698.

## **PEMF and Tourette's Syndrome**

This article reports on the case of a 6-year-old boy suffering from Tourette's syndrome who experienced improvements in visuoconstructional and visuomotor skills, along with more general symptomatic improvements, following the extracranial application of electromagnetic fields in the picotesla range of intensity.

R. Sandyk, Improvement of Right Hemispheric Functions in a Child with Gilles de la Tourette's Syndrome Weak Electromagnetic Fields," *International Journal of Neurosci*, 81(3-4), April 1995, p. 199-213.

## **PEMF and Tuberculosis**

This study examined the efficacy of millimeter waves combined with conventional drug treatment in patients suffering from tuberculosis. MW therapy consisted of 10 exposures of the thymus area for 60 minutes per day using a "Yavor" apparatus (6.4 or 7.1 mm wavelength). Controls received drug treatment only. Results indicated that while MW/drug therapy had no effect on the clearance of the tuberculosis bacteria, it did facilitate clinical recovery faster than drug therapy alone.

A. Khomenko, Use of Millimeter-Range Electromagnetic Radiation in Complex Therapy for Pulmonary Tuberculosis, *Millimetrovie Volni v Biologii i Meditsine*, (3), 1994, p. 53-61.

This study examined the effects of extremely-high-frequency therapy as administered via a 1 apparatus (7.1 mm wavelength) on tuberculosis patients. Results showed a 25-percent improvement in patients receiving the therapy as a pathogenic treatment. A 72-percent improvement rate was seen among patients who received the therapy as treatment for concurrent diseases.

T.V. Kalinina V.D. Churaev, Expense with the Use of the EHF-Therapy at Ryasan' Regional Clinical TB Dispensary, *Millimetrovie Volni v Biologii i Meditsine*, (4), 1994, p. 52-53.

This controlled study examined the effects of constant elastic electromagnetic fields (40 mT) in patients suffering from pulmonary tuberculosis. Therapy consisted of 30-45 minute daily application of either a single magnet or a pair of magnets placed on the chest at an area high in skin temperature over a 1-3 month period. When coupled with conventional treatments, one third of patients receiving the constant electromagnetic fields experienced healing of tubercular cavities. contrast, only one fifth of patients receiving conventional treatment alone experienced such effects. One month into combination treatment, there was no evidence of mycobacterium tuberculosis in the sputum in half the patients relative to only one third of controls.

A.S. Solov'ena, Use of Constant Magnetic Field for Increasing the Effectiveness of Chemotherapy in Patients with Pulmonary Tuberculosis, *Probl Tuberk*, 8, 1987, p. 53-56.

## **PEMF and Ulcers (Gastric and Duodenal)**

Results of this study showed that the administration of mill metric electromagnetic waves helped to normalize blood properties, subsequently improving the effectiveness of more conventional gastric and duodenal ulcer treatment.

M.V. Poslavskii, Treatment of Peptic Ulcer Electromagnetic Irradiation of the Millimetric Range, *Sov Med*, (1),1989, p. 29-31.

This study examined the effects of millimeter wave (MW) therapy in 317 patients suffering from duodenal and gastric ulcers. MW therapy consisted of 30 minutes per day exposure of the epigastric area apparatus,(10 mW/cm<sup>2</sup>, 5.6-mm wavelength) until complete ulcer cicatrisation was achieved. Results showed a 95-percent rate of ulcer cicatrisation in patients receiving the treatment compared to a 78-percent rate in controls. One year follow up showed a 54-percent ulcer recurrence rate in MW-treated patients, which was markedly less than the rate for controls.

M.V. Poslavsky, Experience with Application of Millimeter-Range Radiation for Treatment and Prophylaxis of Stomach and Duodenal Ulcer, *Vopr Kurortol Fizioter Lech Fiz Kult*, (4), 1989, p. 31-36.

This controlled study found extremely-high-frequency therapy to be an effective treatment in patients suffering from duodenal ulcers. Treatment consisted of 5-10 exposures, lasting 20-30 minutes, and making use of the G4-142 apparatus (53.5-70.0 GHz frequency range).

M.V. Teppone, Extremely-High Frequency Therapy of Duodenal Ulcer, *Klin Med*, 9(10), 1991, p. 74-77.

This study compared the effects of traditional drug treatment (TDT) to those of microwave resonance therapy (MRT) in patients suffering from duodenal ulcers. Results indicated the mean hospital stay for patients in the TDT group was approximately 22 days. Throughout this period, ulcers healed in 38 percent of patients, were reduced in 17 percent, showed no change in 43 percent, and increased in 2 percent. No pain relief was seen in 32 percent. contrast, mean discharge time for patients in the MRT group was approximately 12 days. Pain was generally stopped in 3-6 days. Complete healing occurred in 81 percent, a decrease was seen in 16 percent, and ulcer size did not change in just 3 percent. Remission occurred in 98 percent of such patients.

S.S. Dudka, A Comparative Assessment of the Efficacy of Drug Therapy and Microwave Resonance Therapy for Ulcerative Disease of the Duodenum," *Fundamental and Applied Aspects of the Use of Millimeter Electromagnetic Radiation in Medicine. Abstracts of the 1st All-Union Symposium with International Participation*, May 10-13, 1989, Kiev, Ukraine, p. 195-197.

In this study, microwave resonance therapy (MRT) was administered to 2642 patients suffering from duodenal ulcers and to 78 with gastric ulcers. Treatment involved the use of a G4-142 device (53.6-78.3 GHz, less than 2 mW/cm<sup>2</sup> incident power) as well as Elektronika-KVCh and Porog-1 devices. Patients received 6-12 daily exposures of between 20 and 25 minutes. Results showed a total ulcer cicatrization in 80 percent of patients, and arrested pain syndrome in almost 100 percent.

V.A. Kutzenok, Microwave Resonance Therapy of Stomach and Duodenal ulcers, Fundamental and Applied Aspects of the Use of Millimeter Electromagnetic Radiation in Medicine. Abstracts of the 1st All-Union Symposium with International Participation, May 10-13, 1989, Kiev, Ukraine, p. 192-193.

## **PEMF and Ulcers (Trophic)**

This study examined the use of PEMF coupled with galvanization and intratissue electrophoresis in 86 patients suffering from trophic ulcers. A "Potok- 1" apparatus with a density of current equal to 0.05-0.1 mA/cm<sup>2</sup> was used to create an electrical field. The "MAG-30 apparatus for low-frequency PEMF with induction of 30 mT and area of exposure of 20 cm<sup>2</sup> was applied to a trophic ulcer site at the same time. Results led the authors to conclude that magnetogalvanotherapy is the recommended treatment for trophic ulcers of the lower extremities.

A.V. Alekseenko, Use of Magnetic Therapy Combined with Galvanization and Tissue Electrophoresis in the Treatment of Trophic Ulcers, *Klin Khir*, (7-8), 1993, p. 31-34.

This review article discusses the theoretical and clinical applications of magnetic field therapy in the treatment of trophic ulcers of the lower limbs.

A. Sieron, Use of Magnetic Field in Treatment of Trophic Leg Ulcers, *Pol Tyg Lek*, 46(37-39), September 1991, p. 717-719.

This study looked at the effects of conventional trophic ulcer treatment alone and in combination with alternating magnetic field (AMF) or constant magnetic field (CMF) exposures in a group of patients suffering from various types of trophic ulcers of the lower limbs. Results showed an average hospital stay of 31 days in the CMF group and 27 days in the AMF group, compared to 40 days among controls. Based on these and related findings, the authors suggest combination AMF therapy to be most effective.

I.G. Sukhotnik, Comparative Effectiveness of Using Constant and Alternating Magnetic Fields in the Treatment of Trophic Ulcers, *Vest Khir*, 144(6), 1990, p. 123-124.

This placebo-controlled study examined the effects of pulsed electromagnetic fields in the treatment of decubitus ulcers in hospitalized elderly patients with stage II and III pressure ulcers. Patients received daily PEMF stimulation in conjunction with conventional treatment for a period of up to 5 weeks. The findings were that combined PEMF/conventional treatment was superior to conventional treatment and to the placebo received controls.

S. Comorosan, The Effect of Diapulse Therapy on the Healing of Decubitus Ulcer, *Romanian Journal of Physiol*, 30(1-2), 1993, p. 41-45.

Results of this study found that the daily use of electromagnetolaser therapy decreased mean healing time in patients suffering from lower extremity trophic ulcers to approximately 18 days, compared with



approximately 26 days in patients receiving laser therapy alone.

F.V. Galimzianov, Laser and Electromagnetolaser Therapy for Trophic Ulcers of the Lower Extremities in Chronic Venous Insufficiency, *Vestn Khir Im I I Grek*, 152(5-6),1994, p. 70-72.

This double-blind, placebo-controlled study found that treatment with non thermal pulsed electromagnetic energy (PEMET) accelerated wound healing in spinal cord injury patients suffering from stage II and III pressure ulcers. PEMET treatment consisted of pulsed 27.12-MHz energy produced via a Diapulse device. Energy was delivered the use of a treatment head placed in wound dressings, in 30-minute periods twice a day for 12 weeks or until sores healed.

C.A. Salzberg, The Effects of Non-Thermal Pulsed Electromagnetic Energy on Wound Healing of Pressure Ulcers in Spinal Cord-Injured Patients: A Randomized, Double-Blind Study, *Wounds: A Compendium of Clinical Research and Practice*, 7(1), 1995, p. 11-16.

This double-blind, placebo-controlled study examined the effects of pulsed electromagnetic fields (75 Hz, 2.7 mT) applied 4 hours per day for a maximum of 3 months coupled with conventional therapies in patients suffering from trophic lesions. Results showed the treatment to have positive effects, but only on small lesions.

M. Jeran, PEMF Stimulation of Skin Ulcers of Venous Origin in Humans: Preliminary Report of a Double Blind Study, *Journal of Bioelectr*, 6(2), 1987, p. 181-188.

## **PEMF and Urinary Problems**

In this article, the authors report on their successful use of magnetic-laser therapy in inflammations of the urinary system in a urological clinic setting.

O.B. Loran, Magnetic-laser Therapy in Inflammatory and Posttraumatic Lesions of the Urinary System, *Urol Nefrol (Mosk)*, (5),September-October 1996, p. 10-14.

Results of this study showed PEMF therapy to be effective in the treatment of patients suffering from urolithiasis (stone formation). PEMF involved the use of a Milita device with a 35-mT magnetic field.

V.P. Avdoshin, Assessment of Magnetolaser Therapy in Comparison with Other Methods of Treatment of Patients with Urolithiasis, *Fiz Med*, 4(1-2),1994, p. 102-103.

## **PEMF and Wound Healing**

This study examined the effects of static magnetic fields on postoperative wounds in 21 patients undergoing plastic surgery. Magnetic patches ranging in thickness from 1 to 6 mm, and 2450 to 3950 G field strength were administered over the area of operation for a total of 48 hours. Thirteen patients received the magnets after pain or edema had appeared and 8 received them prophylactically. Results showed a decrease in pain, edema, and coloration in approximately 60 percent of patients. Such symptoms disappeared entirely in 75 percent.

D. Man, Effect of Permanent Magnetic Field on Postoperative Pain and Wound Healing in Plastic Surgery, *Second World Congress for Electricity and Magnetism in Biology and Medicine*, 8-13 June 1997, Bologna, Italy.

Results of this study indicated that treatment with pulsating electromagnetic field either alone or in combination with laser therapy exhibited healing effects with respect to peripheral nerve lesions and general wound healing relative to controls.

B. Vukovic-Jankovic, Peripheral Nerve Regeneration Stimulated Pulsating Electromagnetic (PEMF) Field and Laser, Second World Congress for Electricity and Magnetism in Biology and Medicine, 8-13 June 1997, Bologna, Italy.

This double-blind, placebo-controlled study examined the effects of a magnetic treatment device taped over the carpal tunnel against wrist pain sustained at work among a group of turkey plant employees. Results showed that the device was effective in alleviating such pain and that it was free of side effects.

M.J. McLean, Treatment of Wrist Pain in the Work Place with a Static Magnetic Device - Interim Report of a Clinical Trial, Second World Congress for Electricity and Magnetism in Biology and Medicine, June 8-13, Bologna, Italy.

Results of this controlled study showed that low-frequency pulsed electromagnetic fields produced significant beneficial cutaneous wound healing effects in rats.

O. Patino, Pulsed Electromagnetic Fields in Experimental Cutaneous Wound Healing in Rats, *Journal of Burn Care Rehabil*, 17(6 PT 1), 1996, p. 528-531.

This double-blind, placebo-controlled study found that treatment with non thermal pulsed radio frequency energy accelerated wound healing in spinal cord injury patients suffering from stage II and III pressure ulcers. RF treatment consisted of pulsed 27.12-MHz energy produced via a Diapulse device, with energy delivered via a treatment head placed in wound dressings, in 30-minute periods twice a day for 12 weeks or until sores healed.

C.A. Salzberg, The Effects of Non-Thermal Pulsed Electromagnetic Energy on Wound Healing of Pressure Ulcers in Spinal Cord-Injured Patients: A Randomized, Double-Blind Study, *Ostomy Wound Manage*, 41(3), 1995, p. 42- 51.

After a discussion of the mechanics involved in the use of pulsed electromagnetic energy in the treatment of disease, the author discusses findings from recent studies pointing to the therapy's effectiveness with respect to the treatment of acute soft-tissue lesions.

G.C. Coats, Pulsed Electromagnetic (Short-Wave) Energy Therapy, *British Journal of Sports Medicine*, 23(4), 1989, p. 213-216.

Results of this placebo-controlled study indicated that low-intensity continuous microwave radiation administered over a period of 7 days was effective in treating post-operative purulent wounds associated with abdominal surgery.

N.N. Korpan T. Saradeth, Clinical Effects of Continuous Microwave for Postoperative Septic Wound Treatment: A Double-Blind Controlled Trial, *American Journal of Surgery*, 170(3), 1995, p. 271-276.

Results of this study showed that combined magneto/laser therapy reduced inflammation and wound suppuration, and enhanced tissue healing significantly in patients suffering from gunshot wounds relative to conventional treatment only.

N. Bairamov, Magnetolaser Therapy in Complex Treatment of Gunshot Wounds," All-Union Symposium: Laser and Magnetic Therapy in Experimental and Clinical Studies, 16-18 June 1993, Obnisk, Kaluga Region, Russia, p. 184-185.

Noting that pulsed electromagnetic fields have been used in bone healing for more than 20 years, this review article cites recent results from both animal and human studies pointing to the efficacy of PEMF in the treatment of soft-tissue injuries as well.

B.F. Sisken J. Walker, Therapeutic Aspects of Electromagnetic Fields for Soft- Tissue Healing, in M. Blank, (ed.), Electromagnetic Fields: Biological Interactions and Mechanisms, Washington, D.C.: American Chemical Society, 1995, p. 277-285.

This double-blind study examined the effects of postoperative nonthermal pulsed high-frequency electromagnetic fields on edema formation and bruise healing in boys undergoing orchidopexy. Treatment involved exposure 3 times daily for the first 4 days following surgery. Significant effects with respect to rate of bruise resolution were reported in patients receiving the treatment relative to controls.

R.H.C. Bentall H.B. Eckstein, A Trial Involving the Use of Pulsed Electro- Magnetic Therapy on Children Undergoing Orchidopexy, Z. Kinderchir, 17(4), 1975, p. 380-389.

This controlled study examined the effects of pulsed electromagnetic fields in patients suffering from chronic productive inflammation of orbital tissue. PEMF treatment consisted of 7-10 minute daily exposures over a period of 10 days. Controls received conventional treatment only. Both groups showed good improvement, but patients treated with the PEMFs recovered significantly faster than did controls.

L.S. Teren'eva, Treatment of Chronic Productive Inflammation of Orbital Tissues with a Pulsed Electromagnetic Field, Oftalmol Zh, 1, 1996, p. 1-5.



## Additional PEMF Studies

The number of studies available regarding PEMF and cell health exceeds 3,000. Most are independent and scientific peer-reviewed. The science supports cell health. Do your own research and reach your own independent conclusions. The sampling below is an excellent place to begin.

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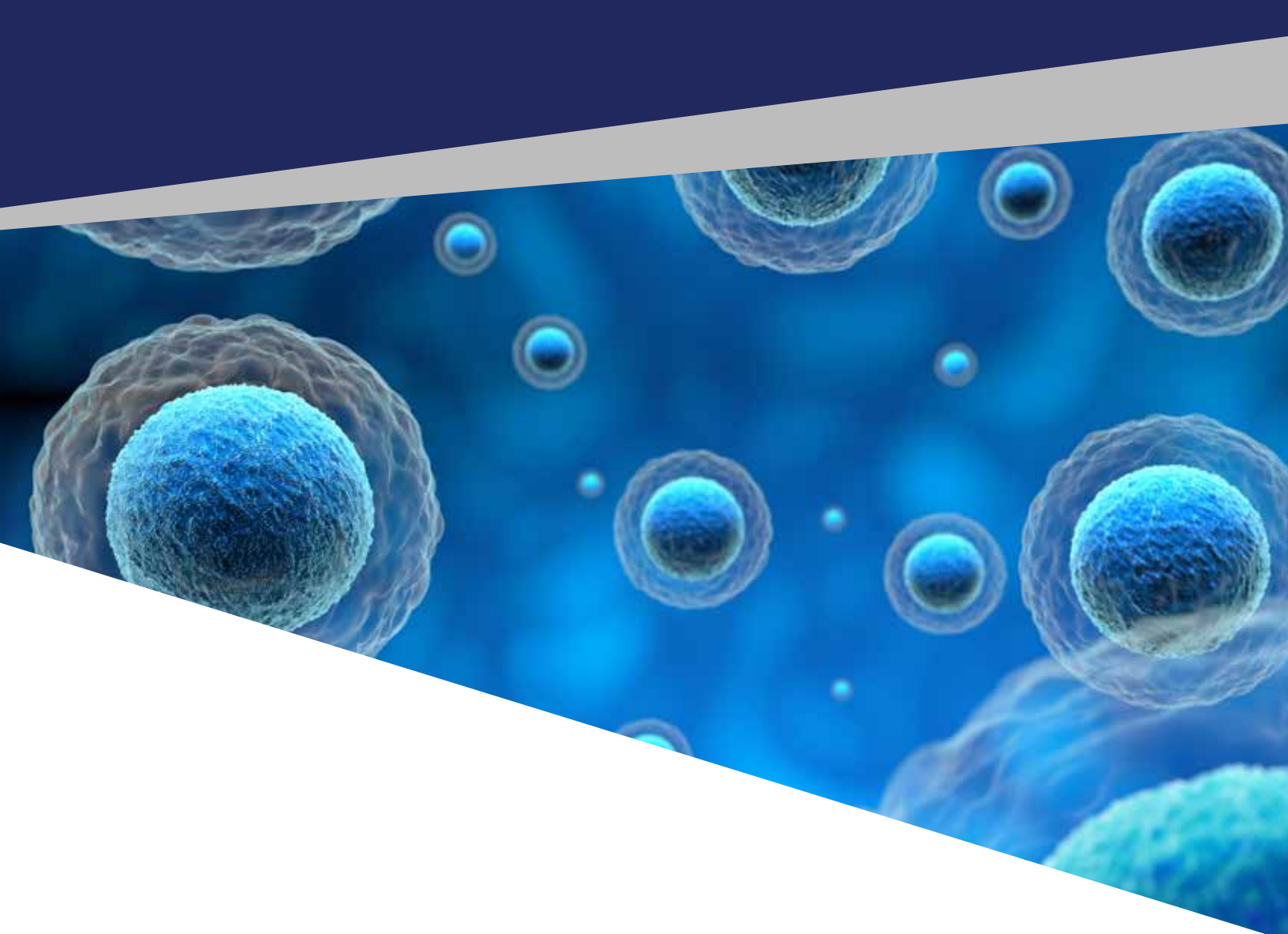
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