

PEMF THERAPY FOR PAIN AND INFLAMMATION



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Chronic pain, which can result from injury or illness, has a serious impact on quality of life. At the root of most chronic pain is chronic inflammation, but conventional treatments for pain don't target that inflammation. Instead, they cover up the symptom - the pain. But covering up symptoms doesn't actually address the problem, and can make things a whole lot worse. Pain medications carry the risk of serious side effects, including addiction and internal bleeding.

Addressing inflammation, the root cause of pain, allows for true healing. PEMF therapy is a safe, effective treatment for healing pain without the adverse side effects. PEMF therapy has been associated with pain reduction and faster healing. PEMFs work at a cellular level to regulate physiological processes in the body that impact inflammation and autoimmune disease, including major causes of pain, among many other things.

WHAT IS INFLAMMATION?



Inflammation is your body's natural response to perceived danger. It helps your body protect itself and repair cellular damage in tissues, restoring those tissues to their normal function. So although you may hear a lot about the damage inflammation can do, it's important to know that some inflammation is a good thing.

Some signs of inflammation include:

- Redness in the area that results from increased blood flow.
- Skin that is warm to the touch, as a result of the actions of leukocytes and macrophages that have been called to the afflicted area.
- Swelling (edema)
- Pain caused by the pro-inflammatory prostaglandins produced.

A cascade of biologic processes is generated and supported by a number of immune cells communicating with each other to repair the body. These include lymphocytes, macrophages and neutrophils. Other cell types such as the fibroblasts, endothelial cells and vascular smooth muscle cells play a regulatory role in the cascade.

Inflammation is your body's attempt to heal from injury or the detection of other cell disruption. Inflammation is necessary and helpful when cell

damage is present. The problem with inflammation is when it sticks around too long.

The difference between Acute and Chronic Inflammation

Although inflammation is beneficial and necessary, sometimes the intensity during the acute phase is exaggerated, and this inflammation can persist long after the injury has improved. This is chronic inflammation and can lead to major longer-term health issues.

Chronic inflammation happens when there is dysfunction in one or more parts of the immune system. The body is interpreting an internal threat when none actually exists, and begins attacking healthy tissue. This can lead to ongoing tissue damage like that found in tendonitis, arthritis or psoriasis. Chronic inflammation can also lead to cancer, Alzheimer's disease, and many other chronic diseases.

Where Does Inflammation Come From?

There are many things that can prompt the inflammatory response in the body. Understanding the various cell types and metabolic pathways that generate inflammation can help develop therapeutic approaches that will be effective in controlling acute inflammation and preventing chronic inflammation.

One cause of inflammation is bacterial infection. When bacterial infections occur, early infiltration of the affected tissues by polymorphonuclear neutrophils (PMNs), a type of white blood cell, is followed by the arrival of T cells, an event that is required to kill bacteria. In this circumstance, eliminating T cells too soon can delay or stop healing.

Trauma-induced injury is another common cause of inflammation. In this case, T cells are less important for healing tissue damage, and may be harmful if present for long periods. Earlier elimination of T cells in the acute phase of inflammation could minimize the unwanted effects of inflammation, accelerate healing, and reduce the risk of chronic inflammatory disease. In chronic inflammatory diseases such as rheumatoid arthritis, psoriasis, and chronic tendinitis, persistence of the disease state depends on the presence of T cells. Here, removing T cells would be a favorable approach of therapy for

these and similar chronic conditions.

PEMFs and cellular balance



T cells are a major regulator of the inflammatory cascade. Research has shown that PEMFs can induce the appropriate and timely inactivation of T lymphocytes, by actions on T cell membranes and key enzymes in cells. For example, PEMFs have been found to affect ion flow through specific cell membrane channels, including those for sodium, potassium and calcium, that positively affect these enzymes. These appropriate effects help with reducing chronic inflammation.

Normal cells are not usually impacted by magnetic fields. Compromised cells, called meta-stable cells, are more likely to be affected by these fields. This means that PEMFs have more impact in circumstances where there is imbalance in tissues or cells, i.e. where there is pathology or chronic inflammation.

Where homeostasis in the body is robust, PEMFs, especially weaker PEMFs, are not needed and unlikely to have effects. When T cell receptors are activated, which is what happens with PEMFs, other processes that are activated but not needed return to normal levels within five minutes of removal of the activating signal..

Adenosine: The “Guardian Angel” of Inflammation

A very important element in controlling inflammation is a molecule in the body called adenosine, which acts through the adenosine receptor (AR). Adenosine is a building block for RNA/DNA and a part of the energy molecule ATP (Chen). Adenosine regulates the function of every tissue and organ in the body and is considered a “guardian angel” in human disease (Borea).

All cells release ATP at low levels. Release is increased with PEMF stimulation, inflammation, pH change, hypoxia, tissue damage, or nerve injury in all the tissues of the body. The mitochondria need adenosine to make ATP in all the cells of the body. Through various metabolic processes, ATP is broken down to create energy and then is re-used to create more ATP in a perpetual cellular cycle.

The Link Between Adenosine, Inflammation and PEMFs

Adenosine concentrations are naturally at physiologically low levels in body fluids between the cells of unstressed tissues. When cells face injury-causing stress conditions such as low oxygen (hypoxia), lack of blood supply (ischemia), inflammation, or trauma, the concentration of adenosine increases rapidly. Adenosine has a short half-life in the blood (a few seconds) and in spinal cerebrospinal fluid (10 to 20 minutes) (Antonioli). Adenosine is released from within the cell after production of ATP by mitochondria inside the cell (intracellular space) and then passes through the cell wall into the spaces between cells (extracellular space). Once released into the extracellular space, adenosine functions as an alarm or danger signal; hence a “guardian angel.” It then activates specific adenosine receptors, causing numerous cellular responses that aim to restore tissue homeostasis.

Adenosine acts through four subtypes of adenosine receptors (ARs): A1, A2A, A2B and A3. These receptors are widely distributed throughout the body and have been found to be part of both physiological and pathological biological functions. At the very least, they affect cardiac rhythm and circulation, breakdown of fat, kidney blood flow, immune function, regulation of sleep, development of new blood vessels, inflammatory diseases/inflammation, blood flow, and neurodegenerative disorders. ARs are found in many types of immune cells, including neutrophils, macrophages, dendritic cells, and mast cells.

The role of adenosine receptors and adenosine in modifying inflammation is well accepted (Varani, 2017). A2A receptors are plentiful in the membranes of neutrophils. Neutrophils play a major role in inflammation and tissue repair. Neutrophils are about 40% to 70% of white blood cells in most mammals. They form an essential part of the innate immune system. The innate immune system is one of the two main immunity strategies; the other is the acquired or adaptive immune system. Like the innate system, the acquired system includes both circulating and cell-based immunity. Neutrophils are recruited to a site of injury within minutes following trauma and are the hallmark of acute inflammation. Neutrophils are one of the first responders of inflammatory cells that migrate toward the site of inflammation.

PEMFs stimulate the production of adenosine by stimulating A2A and A3 receptors, A2A being especially helpful in chronic inflammation (Palmer). A2A receptor stimulation and adenosine produce most of their immune benefits through the T cell immune system. A2A receptors' inhibitory effects on immune and inflammatory processes are very complex. Basically, the A2A receptor is, normally, naturally stimulated by acute inflammation-producing molecules to inhibit or control the inflammation. When adenosine production drops off or is low, inflammation persists and produces chronic inflammation.

In fact, PEMFs, by increasing ARs, enhance the functional efficiency of adenosine, resulting in a stronger physiological action than the use of drugs. The anti-inflammatory effect of adenosine enhanced by PEMF is less likely to have the side effects, desensitization, and receptor resistance than drugs used to act on adenosine receptors. Prolonged stimulation of adenosine receptors with a drug can dampen the ability of the receptor to function. Prolonged use of drugs decreases the quantity of receptors, thereby reducing the effectiveness of the drug over time. As a result, PEMFs are the preferred way to reduce inflammation.

PEMFs Reduce Pain and Inflammation



PEMF therapy specifically targets cells that are meta-stable as a consequence of disease or other ongoing therapies. Thus, PEMFs are an important cellular therapy across many diseases, including cancer, psoriasis, wound healing, and bacterial infections because of their effects on reducing chronic inflammation. It is important that normal homeostatically stable cells are not harmed by PEMFs, allowing other treatments to be more effective without proportional increases in side effects.

Various intensity and -frequency PEMFs and DC/permanent magnetic fields can create significant changes in white blood cells called lymphocytes. This means that varying frequency and/or intensity does not always produce a one-to-one change in reaction intensity.

PEMFs inhibit growth and the natural death of unwanted lymphocytes, which decreases inflammation. The impact of PEMFs on lymphocytes and the inflammatory processes appears to be most obvious 48 and 72 hours after PEMF treatment. After that, the PEMF effect seems to disappear. As a result, recurrent or continual use of PEMF therapy will be needed to maximally benefit chronic inflammation and PEMF effects will be even better along with other natural treatments in managing inflammation and pain.

In chronic inflammatory diseases, cells are characteristically maintained in meta-stable states, as a consequence of cytokine secretions and other stressors associated with the disease. In these cases, PEMFs can work as a

stand-alone anti-inflammatory therapy. Even weaker, low-frequency PEMFs induce apoptosis in activated T cells, thereby reducing chronic inflammation without negatively affecting acute inflammation.

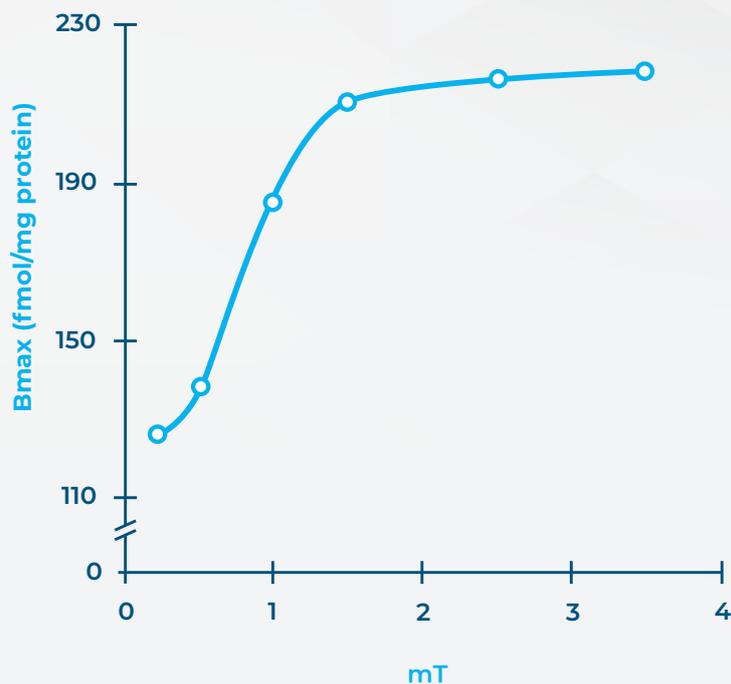
Overall, PEMF is an ideal therapy for both acute and chronic inflammation and pain conditions due to the way that it interacts with our biology on a cellular level. By correcting physiological imbalances pain is reduced in the short term while long term healing and recovery is optimized, preventing pain from returning.

Ideal PEMF therapy for pain and inflammation

PEMF use for inflammation needs to be optimized so that exposure will lead to long-lasting, therapeutically relevant outcomes. This means that both intensity and frequency must be considered.

Stimulating the A_{2A} adenosine receptor on the neutrophil is an essential part of controlling inflammation. Because PEMFs stimulate the A_{2A} receptor, determining the appropriate dose of the magnetic field is critical for optimal benefits. PEMFs applied in the lab at the surface of neutrophils have been found to significantly increase the binding of adenosine to the A_{2A} receptor. This effect was time, intensity, and temperature dependent. PEMF dose-response studies have found that after 30 minutes of exposure, the receptors become saturated with a 1.5 mT magnetic field (Massari). The effect plateaued with intensities greater than 1.5 mT (Figure 1). This means that intensities above 1.5 mT produce no additional benefit, although they do not appear to have any negative actions either.

Figure 1. Saturation binding of A_{2A} adenosine receptor as a function of magnetic field peak intensity (mT) in human neutrophil membranes. B_{max} = receptor binding capacity. Adapted from Massari (2007).



The PEMFs used in this research had an intensity range from 0.1 to 4.5 mT; frequencies ranged from 10 Hz to 120 Hz. The most used peak intensity of the magnetic field was 1.5 mT (15 Gauss) at 75 Hz.

Armed with this information, 1.5 mT would be the optimized intensity of a magnetic field needed to help with reducing inflammation, at least as far as neutrophil involvement is concerned.

Inflammation occurs at various depths within the body, depending on the target organ and tissue. Thus, the intensity of the magnetic field of the applicator always needs to be considered when making decisions about PEMF therapy for the reduction of inflammation.

To achieve the 1.5 mT goal, PEMF intensity acting on neutrophils at various distances from the applicator—that is, at various depths into the body—the clinician must be aware of the inverse square law governing the loss of magnetic field intensity with distance from the applicator.

Table 1 was calculated for the 1.5 mT goal intensity at various depths in the body, using Newton's inverse square rule.

Calculated for the 1.5 mT goal intensity at various depths in the body using Newton's inverse square rule

Target Depth (in)	0	0.4	0.8	1.2	1.6	2	2.4	2.8	3.2	3.6	4
Target Depth (cm)	0	1	2	3	4	5	6	7	8	9	10
Intensity needed (mT)	1.5	6	14	24	38	54	74	96	122	150	182
Intensity needed (G)	15	60	140	240	380	540	740	960	1220	1500	1820

Calculated for the 1.5 mT goal intensity at various depths in the body using Newton's inverse square rule

Target Depth (in)	4.4	4.8	5.2	5.6	6	6.4	6.8	7.2	7.6	8	8.4
Target Depth (cm)	11	12	13	14	15	16	17	18	19	20	21
Intensity needed (mT)	216	254	294	338	384	434	486	542	600	662	726
Intensity needed (G)	2160	2540	2940	3380	3840	4340	4860	5420	6000	6620	7260

From the tables, it can be seen, for example (in the blue areas), that to deliver 1.5 mT (15 Gauss) to the target tissue 2 cm (0.8 in) from the applicator, a 14 mT (140 Gauss) intensity magnetic field would be required. At 20 cm (8 in), 662 mT (6620 Gauss) would be required to deliver 1.5 mT (15 Gauss) at the target tissue.

The location of the organ in the body is important in determining the intensity required to treat the problem. For example, inflammation in the kidneys is common, and the kidneys have been found to have adenosine receptors. We know that neutrophils are present within the kidney circulation when

there is inflammation. The depth of the center of the kidneys into the body is typically from 5 to 7 cm (2 to 2.8 in) from the front of the abdomen (Xue). The thickness of the kidneys is typically about 5 cm (2 in) from the center of the kidney to the back of the kidney (Moorthy). If a PEMF applicator is placed over the anterior abdomen and the expected depth to reach the back of the kidney is 9.5 cm—or rounding up, 10 cm (3.9 in)—with the goal intensity being 1.5 mT, the maximum PEMF intensity would need to be 182 mT (1820 Gauss). This means that a PEMF system would need to be selected that can deliver at least this much magnetic field intensity to adequately target the kidneys.

Similar calculations can be done for any organ or tissue in the body to determine the optimal PEMF intensity needed. All one needs to figure out is the depth of the tissue needing treatment, not only at the surface of the organ but also across the diameter of the organ or tissue farthest from the PEMF signal. In treating the brain, for example, the skull may be 15.2 cm (6 in) front to back and 12.7 cm (5 in) side to side. That means to treat the brain from front to back would require a magnetic field intensity of around 384 mT (3840 Gauss), to deliver 1.5 mT (15 Gauss) to the back of the brain. Side-to-side treatment would require about 294 mT (2940 Gauss).

Targeting the anti-inflammatory effects of adenosine receptor stimulation is only one possible consideration for selection of magnetic field intensity. Because there are so many different physiologic effects and actions of PEMFs (see *Power Tools for Health* book <https://www.drpawluk.com/product/power-tools-health/>), dosing calculations for each of these effects are not available for the PEMF user. In addition, it is unlikely that any specific physiologic action – for example, enhanced circulation, accelerated healing, pain reduction – can be uniquely and specifically selected. Experience suggests that multiple actions are at play any time a PEMF is used.

It's important to talk with an experienced professional when selecting a PEMF system to be sure the device can deliver the proper frequency and intensity of fields for your specific problem.

Targeting Chronic Pain Conditions with PEMF Therapy



Because of the influence that PEMF therapy has on inflammation, it's a safe, effective choice for the management of conditions that include chronic pain. The targeting of the root causes of the inflammation makes PEMF therapy more effective than pain medications in healing, rather than simply covering up, these conditions. Research has clearly indicated that PEMF therapy is an effective treatment for chronic conditions, including those discussed in this section - and many more.

Musculoskeletal disorders

The vast majority of pain commonly treated with PEMFs comes from musculoskeletal disorders, such as arthritis, tendonitis, sprains and strains, fractures, osteoporosis, hip disorders, muscle spasms, spinal cord injury, and trauma, among others.

A wide body of research has shown that PEMFs have an impressive success rate on treating pain resulting from these conditions. One orthopedic practice documented decreased pain in 240 patient cases (Schroter, 1976) with a clinical success rate of nearly 80%.

Back pain caused by conditions such as spinal stenosis and arthritis of the back are often chronic, lifelong conditions that progressively worsen. PEMF

has been demonstrated to provide relief from these and other chronic conditions that result in back pain even after other modalities have not.

Research demonstrating the effectiveness of PEMF therapy has also been conducted for many other musculoskeletal conditions, such as lumbar osteoarthritis, failed back syndrome following back surgery, lumbar radiculopathy, and osteoporosis. My book *Power Tools for Health* details this research and offers an extensive bibliography of over 500 references.

Neuropathies

Neuropathy is damage to nerves outside the brain and spinal cord (the peripheral nervous system) which causes weakness, tingling and pain. Diabetic neuropathy is the most common, but there are many other forms of neuropathy.

A study that used PEMF therapy for at least 12 minutes daily to treat patients with intense diabetic neuropathy symptoms showed that pain improved, paresthesia and vibration sensations were reduced, and muscle strength increased in 85% of patients compared to control groups. (Cieslar, Sieron, & Radelli, 1995).

Studies have shown similar improvements in pain and other symptoms for other neuropathies as well, such as carpal tunnel syndrome and complex regional pain syndrome (CRPS).

Back pain

Two prospective randomized studies found that PEMFs have considerable and significant potential for reducing pain in subjects with lumbar radiculopathy and whiplash syndrome.

A total of 100 patients with lumbar radiculopathy and 92 with whiplash syndrome were studied. Patients with prolapsed intervertebral discs, systemic neurological diseases, epilepsy and pregnancy were excluded. In one group, patients received the standard medications diclofenac and tizanidine and magnetic field treatment twice a day for two weeks. The other group received only medications.

With the magnetic field treatment, patients suffering from lumbar

radiculopathy had pain relief and painless walking an average of four days earlier (average 8 days as compared to 12 for the control group).

Patients with whiplash syndrome were assessed for pain on a ten-point scale. In patients receiving magnetic field treatment, pain dropped at the following average rates: Head, 4.6 to 2.1 after treatment; neck, 6.3 to 1.9; and shoulder/arm 2.4 to 0.8. For those in the control group head pain went from average of 4.2 to 3.5 after treatment; neck pain from 5.3 to 4.6; and shoulder/arm pain from 2.8 to 2.2.

Another randomized controlled clinical trial evaluated the impact of a PEMF system in managing pain caused by lumbar disc radiculopathy. In this condition, the nerve root is affected, resulting in pain that can radiate to other areas of the body.

In this study, 40 patients were randomly assigned to either a group that received PEMF therapy or a control group that received placebo treatment. Both groups were assessed at baseline and again three weeks later, using a ten-point visual analogue pain scale (VAS), objective electrical somatosensory evoked potentials (SSEPs), and a questionnaire using a Modified Oswestry Low Back Pain Disability scale (OSW).

The assessments showed significant differences between the groups relative to overall pain. Oswestry Low Back Pain, personal care, lifting, walking, sitting, sleeping, social life and employment all saw improvement. Additionally, objective measures of improvements in tissue pain related brain sensations could easily be seen in the data. The authors concluded that PEMF therapy is an effective method for the conservative treatment of many forms of back pain.

Centralized pain and complex pain conditions

The source of many pain conditions can be complicated and multi-faceted, making treatment difficult. Research on many of these conditions has shown that PEMFs can be effective where other treatments are not. For instance, one study of patients with headaches who were resistant to medication or acupuncture showed that PEMF therapy applied for 20 minutes a day for 15 days provided relief for 60% of those with classic migraines, 68% of those with cervical migraines, and 88% of those with tension headaches. (Prusinski,

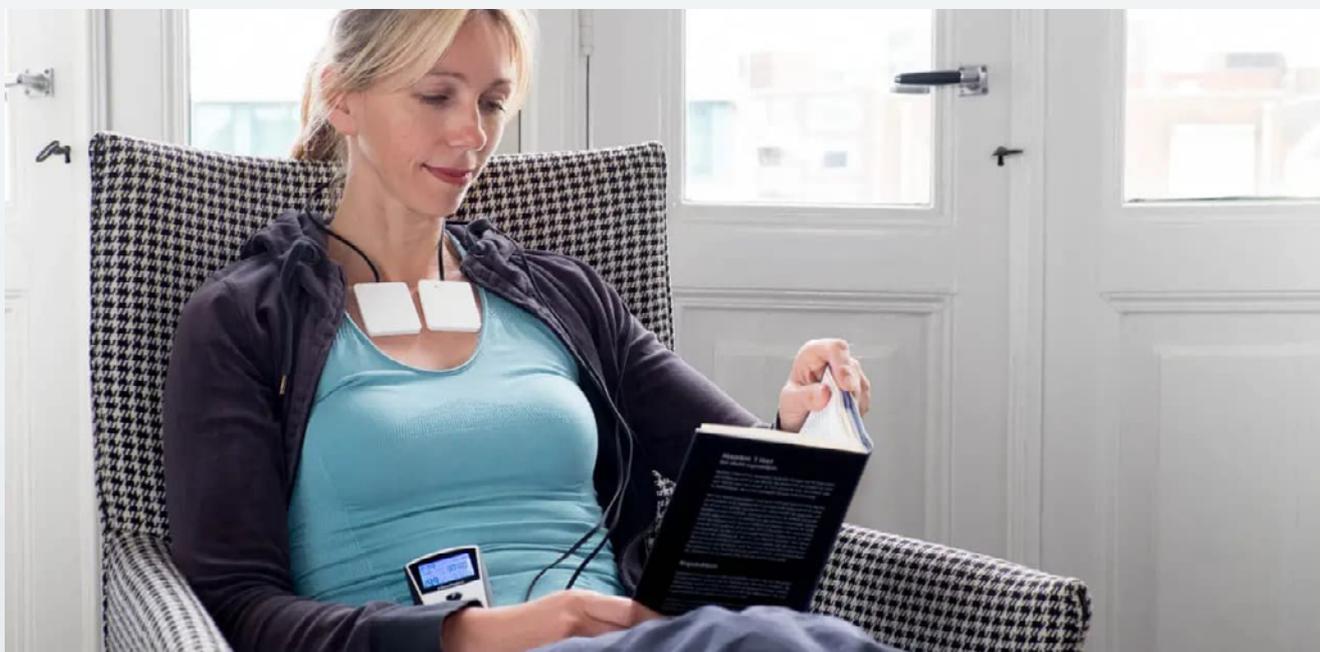
Wielka, & Durko, 1987).

Fibromyalgia results in hypersensitivity to pain due to abnormalities in central brain structures that process pain sensations, impairment in the ability to activate natural pain inhibition, and/or altered CNS processing of pain signals. Studies show that PEMF therapy has significantly improved pain, depression and anxiety, and general functioning in individuals with fibromyalgia, and results remained positive even several weeks after treatment.

Centralized pain is pain that is amplified in the brain, rather than being solely at the original source. Many chronic pain conditions result in centralized pain fairly quickly due to faulty pain signals. I call this the “chronic pain brain.”

Treatment of both the localized source of pain and the brain can produce positive results more quickly and effectively. Identifying the source of the pain can be tricky when pain signals are crossed, so a combination approach of local treatment and treatment along the spine or to the brain can provide the best pain management results.

Indirect action leading to relief



In addition to treating the brain to help relieve chronic pain and inflammation, there is evidence that treating areas of the body other than the affected area can also lead to relief. In one study (Cañedo), results showed that treatment to other parts of the body helped heal diabetic foot ulcers.

This kind of indirect action can take longer (up to 60 days) to produce results than direct PEMF stimulation at the ulcer site. This means that stimulating neutrophils in one part of the body may activate the adenosine receptors circulating under the magnetic field sufficiently to benefit inflammation in other parts of the body. Direct stimulation of the ulcer would activate other mechanisms of healing action of PEMFs to result in faster healing, such as increased collagen production.

What this means is that even local treatment with a PEMF at sufficient intensities may help inflammation in the rest of the body indirectly. However, because of the short half-life of the adenosine stimulated by PEMFs, frequent repeat treatments or treatments over extended periods would be required. That's why purchasing a PEMF device for home use is a great investment for chronic inflammation and pain.

A better approach than conventional pain treatments

This information about how PEMFs work on inflammation and chronic pain is important because the typical treatments for pain are ineffective at best, and dangerous at worst. The default treatments for management of chronic pain are often medications, surgical procedures, or physical therapy.

Medications, as I have said, are simply covering the pain instead of addressing the actual problem. With the potential serious side effects, such as permanent damage to your kidneys or liver, stomach bleeding, and addiction, medications are clearly not the best solution..

The risks of complications with surgery are great, and I've seen far too many patients come to me after surgical procedures have failed. Physical therapy can be expensive and time-consuming; while it can be a good short-term solution for an acute problem, it's not practical for treating chronic conditions.

Other alternative treatments, like chiropractic care and acupuncture, can provide some relief, but nothing has changed at the cellular level. When the treatment wears off, the pain returns, sending you back for treatment again and again.

Finding the Right PEMF Device to Treat Pain and Inflammation

The first step in selecting the best PEMF device is to know the source of your pain and inflammation. That's because there is no one best system. What you need will depend on the problem you are treating.

PEMF Therapy is a developing medical field and there are no clear-cut guidelines available for the myriad of conditions and circumstances for which people can and are likely to want to use PEMF therapy. One thing is clear though, one "size" does not fit all.

Intensity of the magnetic fields is one important factor to consider. You also need to understand what that intensity will be at the target organ. As the magnetic fields move away from the applicator, their intensity will reduce rapidly.

Low intensity PEMF systems will require longer courses of treatment, and for some conditions high intensities are necessary to be able to adequately reach the source of pain deep within the body. Even after symptoms have resolved, continued treatment can help heal the source of the problems so they won't recur.

Each PEMF device is designed with specific frequencies and intensities. Many devices available for clinical and home use are extremely low frequency devices, ranging from 3 to 1000 Hz. These include familiar frequencies from delta (1-4 Hz), theta (5-8 Hz), alpha (9-13 Hz), beta (14-25 Hz) and gamma (26-100 Hz).

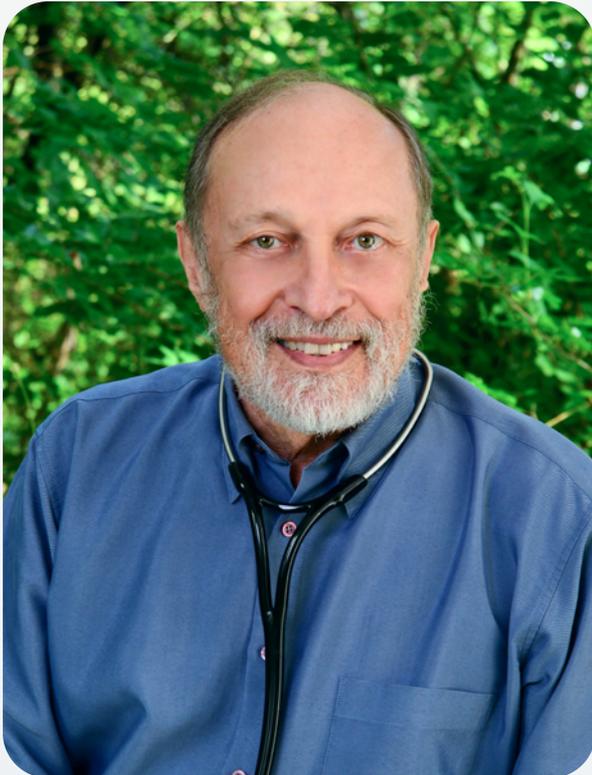
The intensity of therapeutic PEMF devices ranges from <math><0.1\text{ mT}</math> (<math><1\text{ gauss}</math>) to 800 mT (8,000 gauss). In contrast, a standard MRI unit is 1,000 to 2,000 mT (10,000 to 20,000 gauss) or 1 – 2 Tesla. Repetitive transcranial magnetic stimulation (rTMS) units provided in hospitals and psychiatry practices typically have a strength of 800 mT (8,000 gauss). While some conditions require high intensity to be most effective, even very low intensity PEMFs can still impact the perception of pain. Neuroimaging research has revealed changes in specific areas of the brain with pain stimuli that were modified to some extent even by low-intensity PEMF exposure (Robertson et al., 2010).

For home use, PEMF devices are a solid investment in health for those who suffer from chronic pain. Owning a device allows for convenient treatment;

some can even be used overnight. Units are relatively affordable, especially when the cost of repeated visits to a clinic are considered. And because PEMFs are effective for so many indications, the entire family can benefit from the purchase of a PEMF device.

An effective alternative for treating inflammation and pain

Since the vast majority of health conditions involve inflammation, the use of PEMFs to reduce this inflammation is a safe, more effective way



to help manage these conditions. Inflammation is impacted by the “guardian angel,” adenosine and the adenosine receptors. Research showing the impact of PEMFs on this receptor gives important guidance in choosing the magnetic field intensity necessary, in any areas of the body with inflammation, to produce the best results. Guesswork is no longer necessary in choosing the best intensity to help the body heal.

Consultations are available to help in the selection of the best PEMF to get at drpawluk.com/consultation.

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