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AN OVERVIEWOF THERAPEUTIC BENEFITS OF FAR INFRA RED RADIATIONS

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ABSTRACT

Recent biomedical research studies have demonstrated the applications of Far Infra-Red (FIR) radiation (λ=3–100μm), a subdivision of the electromagnetic spectrum, in producing beneficial response in control of diseases of varied nature. Sun is said to be a great reservoir of far infrared (FIR) radiation. Other sources of such kind of radiation may be lamps and saunas. Technological innovations have proved that lamps and saunas are capable of delivering pure FIR radiation (eliminating the near and mid infrared bands).These have been found safe and effective sources to produce beneficial actions in disease conditions. Besides above mentioned sources, it has been argued that fibers impregnated with FIR emitting ceramic nanoparticles and woven into fabrics are being used as garments and wraps to generate FIR radiation, and attain health benefits from its effects that far infrared rays can be helpful for enhancing blood circulation, reducing pain, strengthening the cardiovascular system, easing joint stiffness and inflammation, and revitalizing skin cells. Going way beyond the old heat lamps, recent technological research and innovations have been able to develop products like infrared saunas, mineral lamps, as well as knee, ankle, and elbow wraps. Many of these products are enhanced with far infrared-emitting elements composed of oxides of zirconium, aluminum, zinc, titanium, and antimony. These products have been undergoing extensive investigation for their ability to retain body heat and emit safe far infrared rays that penetrate deep into joints and surrounding tissues. The present review is an attempt to focus on recent developments on the use of Far infra-red in disease conditions particularly towards treatment of chronic ailments for which our modern systems of medicine have not permanent remedy. Extensive scientific and clinical research studies are needed in this important area in order to develop far infrared radiation (FIR) based tools and products which can be used as alternative or complementary therapy in prevention and treatment of chronic diseases.

Keywords: Far infrared (FIR); Infrared saunas; Chronic pain; Chronic inflammation; Depression & insomnia; Diabetes; Renal disease; Cancer; Cardiovascular disease

INTRODUCTION

The modern lifestyles and changing patterns in dietary habits have made the human population vulnerable to various kinds of lifestyle diseases/complex chronic diseases such as type 2diabetes,heart disease, metabolic syndrome ,chronic renal failure, osteoporosis, stroke, depression, obesity, arthritis, atherosclerosis ,asthma, autoimmune disorders, neurode-generative syndromes, cancers, cirrhosis, chronic obstructive pulmonary diseases etc. indeveloping as well as in developed countries. It has been observed that the drugs and treatments presently available in modern system of medicine are not providing permanent cure for these diseases due to their adverse reactions making the patients immunologically deficient and more prone to diseases. Thus, scientific efforts are being made throughout the world to search for alternative approach, which can provide safe and affordable treatments for such disorders. Nature has provided vast resources which can be used to develop alternative or complimentary therapy to treat these disease conditions in a holistic manner.

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dietary habits have made the human population vulnerable to various kinds of lifestyle diseases/complex chronic diseases such as type 2diabetes,heart disease, metabolic syndrome ,chronic renal failure, osteoporosis, stroke, depression, obesity, arthritis, atherosclerosis ,asthma, autoimmune disorders, neurode-generative syndromes, cancers, cirrhosis, chronic obstructive pulmonary diseases etc. indeveloping as well as in developed countries. It has been observed that the drugs and treatments presently available in modern system of medicine are not providing permanent cure for these diseases due to their adverse reactions making the patients immunologically deficient and more prone to diseases. Thus, scientific efforts are being made throughout the world to search for alternative approach, which can provide safe and affordable treatments for such disorders. Nature has provided vast resources which can be used to develop alternative or complimentary therapy to treat these disease conditions in a holistic manner.

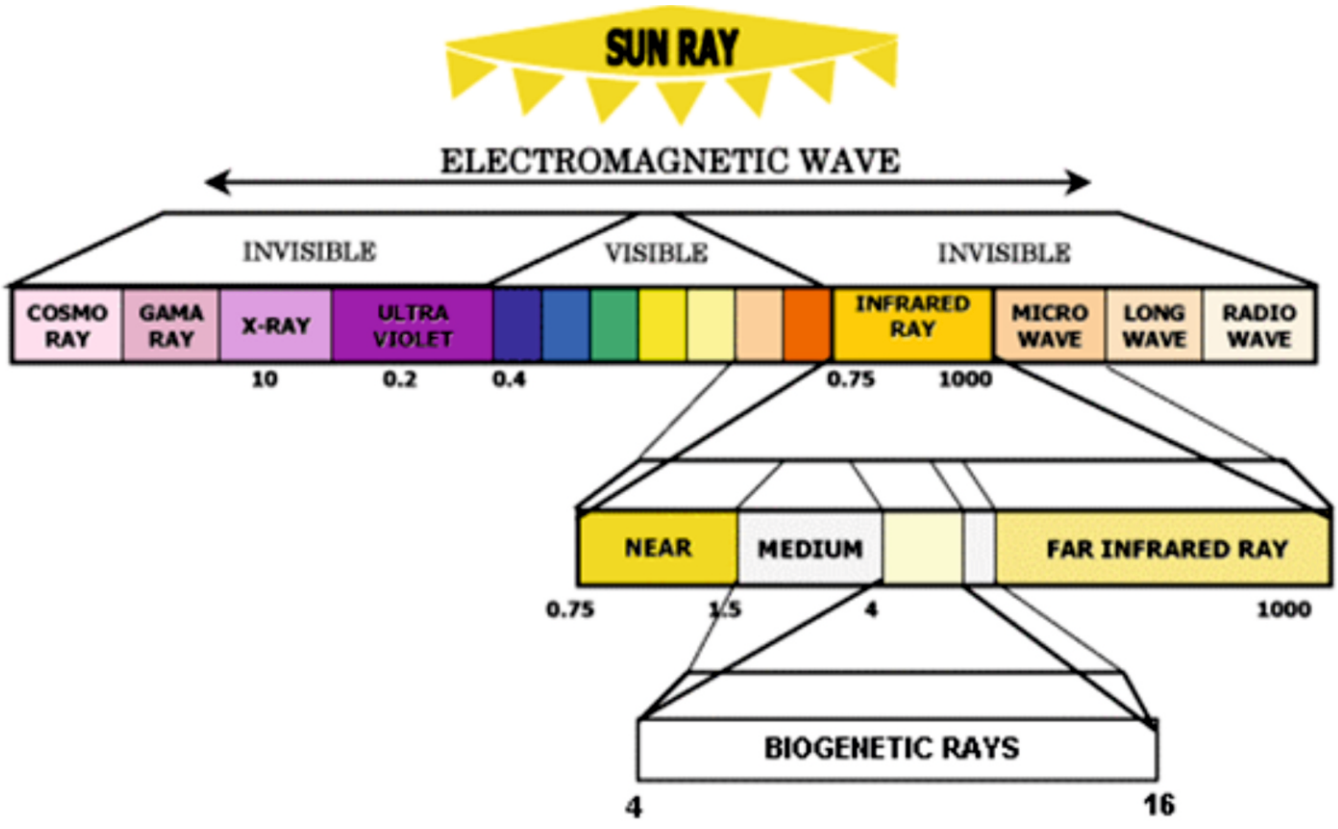
The sunlight was considered healthy since ancient times, one of the important reasons is because the sunlight contains far infrared (FIR). However, due to the development of human industrialization, our atmosphere contains many pollutants like carbon dioxide, dust, etc. which greatly absorb the far infrared, causing the benefits of the sunlight disappear. Now, people are unable to effectively and fully receive the blessings of nature, so we must seek for more direct, more convenient and more secure far Infrared sources. (Another concern is that we will also receive destructive cosmic rays such as ultraviolet, GAMMA rays and x-rays while having the sun light, and because of the air pollution, the far infrared received on earth is too low in both quality and quantity).It has been well documented that Far infrared (FIR) radiation (λ=3–100μm) is a subdivision of the electrom-agnetic spectrum. Sun is said to be a great reservoir of far infrared (FIR) radiation. Other sources of such kind of radiation may be lamps and saunas. Technological innovations have proved that lamps and saunas are capable of delivering pure FIR radiation (eliminating the near and mid infrared bands).These have been found safe and effective sources to produce beneficial actions in disease conditions. Besides above mentioned sources, it has been argued that fibers impregnated with FIR emitting ceramic nano particles and woven into fabrics are being used as garments and wraps to generate FIR radiation, and attain health benefits from its effects.

Far Infrared therapy (FIR) involves the use of Far Infrared rays to gently heal, soothe, stimulate and detox the physical body, as well as the mind. Far Infrared Rays are invisible waves of energy that have the ability to penetrate all layers of the human physical body, penetrating into the inner-most regions of the tissues, muscles and bone. An ancient technique, Far Infrared Therapy uses these waves, or rays, of energy to slightly elevate the surface temperature of the body. When we slightly induce a very small temperature increase, we can enhance our body's functioning on multiple levels. Our hands, bodies and the sun emit FIR energy at all times. In Ancient China, palm healing was used to pass these infrared rays from one person to another. The Yogis of Ancient India also used FIR in palm healing, and particularly found it useful to place palms over the eyes in the case of eye dryness or strain. Many types of thermal healing have been used in ancient civilizations including Japan, China, India, the Americas, Northern Europe and ancient Rome. As is evident from scientific studies humans absorb the sun's rays through the skin and eyes, and the sun helps stimulate the metabolism. Without light, our bodies cannot properly absorb certain nutrients. Suppressed immune function, fatigue, depression, sleep disorders, and other ailments may be other consequences of a lack of sufficient exposure. Aside from what we can see (visible light), a large portion of the sun's energy is in the invisible, infrared part of the spectrum. It has been found that ordinary light transmits some heat, but the effect is even more marked beyond the red end of the spectrum, in the far infrared band. Unlike high-frequency ultraviolet rays, which can provoke sunburn or cancerous changes in the skin, far infrared rays have beneficial effects. Far infrared rays do not damage the skin. Therefore, far infrared rays can help us derive some of the benefits of sunshine even when we do not have regular access to it. Far infrared rays and their therapeutic properties have been studied in China and Japan for over 30 years. Researchers have found that far infrared rays can be helpful for enhancing blood circulation, reducing pain, strengthening the cardiovascular system, easing joint stiffness and inflammation, and revitalizing skin cells.[1-7]Going way beyond the old heat lamps, recent technological research and innovations have been

able to develop products like infrared saunas, mineral lamps, as well as knee, ankle, and elbow wraps. Many of these products are enhanced with far infrared-emitting elements composed of oxides of zirconium, aluminum, zinc, titanium, and antimony. These products have been undergoing extensive investigation for their ability to retain body heat and emit safe far infrared rays that penetrate deep into joints and surrounding tissues. The present review is an attempt to focus on recent developments on the use of Far infra-red in disease conditions particularly towards treatment of chronic ailments for which our modern systems of medicine have not permanent remedy. Extensive scientific and clinical research studies are needed in this important area in order to develop far infrared radiation (FIR) based tools and products which can be used as alternative or complementary therapy in prevention and treatment of chronic diseases.

FAR INFRA RED (FIR) RADIATION

The light of sun plays a major role in maintaining the equilibrium of human body. It has been scientifically proven that humans absorb the sun's rays through the skin and eyes, and the sun helps stimulate the metabolism.[8] Without light, we cannot able to function properly and even certain important nutrients essential for body growth could not be properly absorbed in our complex body system. So much so insufficient exposure of sun light could lead to suppressed immune function, fatigue, depression, sleep disorders, and other disease conditions.[9-11] As we know aside from what we can see (visible light), a large portion of the sun's energy is in the invisible, infrared part of the spectrum. In 1800, English astronomer Sir William Herschel experimented with putting a thermometer at various points in a prismatic spectrum.[12] He found that ordinary light transmits some heat, but the effect is even more marked beyond the red end of the spectrum, in the far infrared band.[13] Unlike high-frequency ultraviolet rays, which can provoke sunburn or cancerous changes in the skin, far infrared rays do not damage the skin. Far infrared can, therefore, help us derive some of the benefits of sun shine even when we do not have regular access to it.



Infrared is the light energy we get from the sun that makes us feel warm. NASA technology is used to generate far infrared waves, using special compounds of alumina and silica, which can convert any normal energy into infrared rays very efficiently at room temperature. Japanese kurare's super fiber is used in the construction to generate far infrared. Scientific studies have documented that the human body both sends and receives infrared. The body emits infrared wavelengths between 3 and 50 microns with the greatest output around 9.4 microns, which happens to be the resonant frequency of water. (1 micron = 1 millionth of a meter) Within the infrared spectrum, in the 6-14 micron range, are rays known as the "Vital Rays." These rays have been shown to be most beneficial to the body. The amethyst modulation of infrared is unique. It creates soothing, and deeply penetrating warmth that the body craves. According to NASA research, human infrared normalizes a variety of important physiological functions.

It has been established that FIR energy (photons with quantum energy levels of 12.4 meV –1.7 eV) is absorbed by vibrational levels of bonds in molecules. There are six vibrational modes covering symmetric and anti-symmetric stretching, scissoring, rocking, wagging and twisting. Considering the high concentration of water in biological systems, association of water molecules with ions (solvation effect), the dielectric properties of the water and the large dipole moment that this effect generates, this will be a dominant factor in biological solutions. It is known that at lower frequencies water molecules are able to rotate freely in an oscillating electric field with little or almost no energy loss.[14]

It has been documented that far infrared is one kind of electromagnetic (EM) wave like visible light. Generally, EM wave with wavelength between 4 and 1000 microns are called far infrared ray (FIR). Wavelength of Visible light is between 0.4 to 0.7 microns, thus the far infrared cannot be seen by our naked eyes. The application of far infrared was firstly developed in Japan. After years of medical research and clinical trials, it is generally acknowledged that the wavelength of far infrared is similar to the resonance of human body (4~14microns). Thus it will penetrate deeply into the skin about 2 to 4 cm. Besides, its heating effect can increase the blood circulation and activate cells. Water content of our body is about 65 to 70% within the biological tissue is about 60 ~ 95%, resonant wavelength of water is about 8 to 10 microns which also belongs to the far infrared range.

Besides old heat lamps, there are now products available like infrared saunas, mineral lamps, as well as knee, ankle, and elbow wraps. Many of these products are enhanced with far infrared-emitting elements composed of oxides of zirconium, aluminum, zinc, titanium, and antimony. These products have been undergoing extensive investigation for their ability to retain body heat and emit safe far infrared rays that penetrate deep into joints and surrounding tissues. A growing body of clinical evidence supports the use of far infrared as a non-invasive health-promoting therapy. As far back as 1989, researchers found convincing evidence that when far infrared was applied to local areas or to the entire body, it had a sleep-modulatory effect on patients suffering from insomnia. Additionally, far infrared therapy produced a blood circulation-enhancing effect in human skin. Questionnaires to more than 500 users of far infrared devices revealed that the majority reported an overall improvement in health. The effects appeared to be triggered by far infrared-induced increase in body tissue temperature, as well as enhanced blood circulation in human skin.[1,15]

An infrared sauna uses infrared heaters to emit infrared radiant heat which is absorbed directly into the human body, unlike traditional saunas which heat the body indirectly via air or steam. New science is proving that a simple, ancient method of cleansing the body used by Native Americans for centuries has widespread positive effects on health and can help lose weight, lower blood pressure, reduce inflammation, enhance detoxification, and experience less joint pain. Heat therapy is a significantly underutilized treatment in medicine. However, with the growing movement to find more self-directed, more natural, less invasive ways to overcome health problems and lose weight, it's becoming more popular among the American public. And that's a good thing! As we will see in a moment, the science bears out the use of heat as a treatment modality for a wide variety of health conditions.

Infrared saunas, in particular present an interesting and powerful opportunity for people to take advantage of the latest advances in heat therapy. These saunas, which can be installed in home, use infrared light instead of conventional heat to bring up body temperature. The difference is important because infrared saunas can increase the core body temperature by 2-3 degrees-enough to improve the health results as compared to conventional saunas. Most infrared saunas on the market produce only far infrared. However, a new development in the field is full-spectrum infrared. These are saunas that provide all the health benefits associated with far- mid- and near infrared rays. Over the last decade science has finally caught up with what ancient societies have realized for millennia regarding the use of heat therapy, and the evidence that's surfacing about the benefits of regular use of saunas is impressive.

THERAPEUTIC APPLICATIONS

Chronic Pain

The effects of far infrared rays on chronic pain was studied where investigations were carried out to evaluate the efficacy of far infrared in patients suffering from fibromyalgia, a condition characterized by sleep disturbances and widespread pain with tenderness in specific areas. In the study thirteen female patients received far infrared therapy once per day for two or five days per week. All of the patients experienced a significant reduction in pain (by about half) after the first session. The effects of treatment became stable after 10 sessions, with participants experiencing up to a 78% reduction in their pain.[19] Another study backed up these findings, suggesting that an approach of multidisciplinary treatment that included far infrared therapy could be a promising method for treating chronic pain.[20]

Chronic Inflammation

A recent study in Taiwan[4] found that *far infrared* radiation exerts a potent anti-inflammatory effect via induction of heme oxygenase-1, an enzyme that confers cellular protection against oxidative stress.[21] The possible benefits of *far infrared* treatment for arthritis, a disorder associated with chronic inflammation, are also the subject of ongoing promising research. A Chinese study found that infrared radiation exerts anti-inflammatory effects by inhibiting the release of the inflammatory chemokine interleukin-8. Researchers believe a fuller understanding of the process could serve as the basis for improved treatment of rheumatoid arthritis patients.[22]

Obesity

Studies have shown that far infrared rays are capable of stimulating weight loss by improving the body's basic metabolic and eliminative functions. By correcting a number of very common conditions that can lead to weight gain, this therapy achieves two major goals: it makes adherence to a regimen of healthy exercise and diet easier, and it optimizes the body's response to these stimuli. The patient will notice that they crave sugar, fat and simple carbohydrates less, that they have more energy and vitality when exercising, and that recovery from exertion is faster. Many people are incorporating far infrared ray treatment into their weight-loss program with excellent results. And they're self-administering their treatment from the comfort of their own homes, with an FDA-approved product called a BioMat. The BioMat harnesses far infrared ray technology in a safe, comfortable treatment pad. The pad can be placed on a treatment table, a couch or bed, so that the treatment can be administered while the user relaxes, watches television, reads or even enjoys a restful sleep. The treatment is painless, and in fact produces a comfortable, soothing warmth that penetrates the body and leaves the person feeling totally relaxed and refreshed.

Depression and Insomnia

A study was conducted to assess the effect of far-infrared rays on depressed people with insomnia where a randomized design with 70 patients with the clinical diagnosis of depression with sleep disturbance was used to determine this effect and in the experimental group, FIR was applied to three chosen acupuncture points Nei-Kuan (PC6), Shenmen (HT7) and Sanyinjiao (SP6)by a patch-like sticker for a period of 15 minutes twice a week over a period of four weeks. The results of the study indicated the involvement of serotonin pathway in the pathophysiological mechanism responsible for the damaging effects of MDA on depressed patients with insomnia as evidenced by increase in serotonin level and decrease in MDA level in

experimental group.[23] A study to clarify the effects of repeated thermal therapy in mildly depressed complaints was conducted where twenty-eight mildly depressed patients with general fatigue, appetite loss, and somatic and mental complaints were randomly assigned to thermal therapy group (n = 14) or non-thermal therapy group (n = 14).The results of the study revealed that repeated thermal therapy may be useful for mildly depressed patients with appetite loss and subjective complaints. [24]
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Diabetes

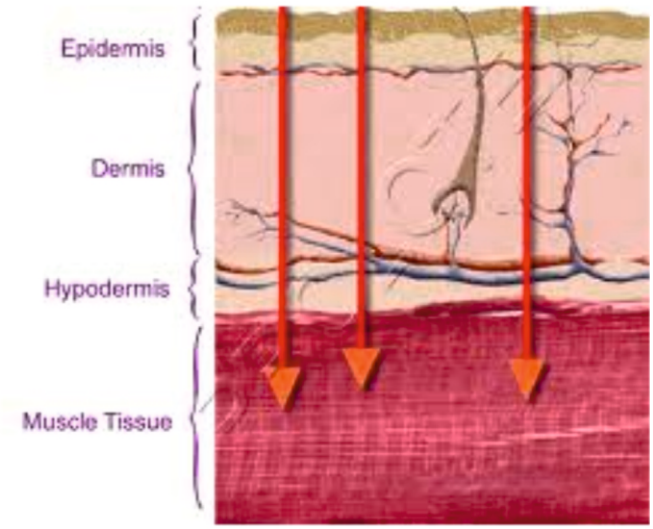
A study was conducted to evaluate the effect of leg hyperthermia on oxidative stress in bedridden subjects/ patients with type 2 diabetes mellitus using 15-min sessions of far infrared rays over a two-week period where fasting plasma glucose, HbA1c, tumor necrosis factor (TNF)alpha, free fatty acid, leptin, adiponectin and plasma 8-epi-prostaglandin F2alpha (8-epi-PGF2alpha) levels as a marker of oxidative stress were measured on admission, just before and 2 weeks after local heating of the leg. Results of the study showed that plasma total 8-epi-PGF2alpha levels were decreased significantly while TNF alpha levels were increased significantly. On the other hand, glucose, HbA1c, free fatty acid, leptin and adiponectin levels were not changed during the study period suggesting the beneficial effect of repeated leg hyperthermia in protection against oxidative stress. [25]

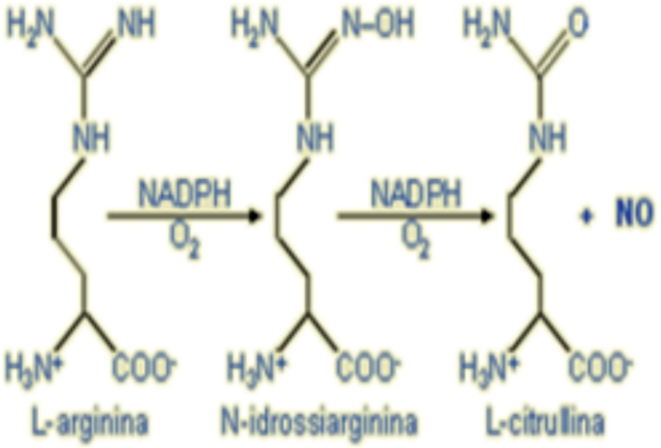
Cardiovascular Disease

The recent studies in China have suggested that far infrared therapy could be useful in improving inadequate blood circulation in patients with vascular access malfunction, a leading cause of morbidity and mortality in hemodialysis patients. During the study, it has been observed that study subjects treated with far infrared showed measurable blood flow improvement after a single session and the test results were consistent after one year of therapy.[15] A similar study performed on laboratory rats found that treatment with far infrared could help reduce the prevalence of ischemia (shortage of the blood supply to an organ) and ischemic diseases.[16] In cases of trauma, reconstructive surgery, and diabetes, insufficient microcirculation in skin can lead to acute tissue ischemia. The study found that far infrared therapy produced a significant increase in skin microcirculation in the treated animals. Repeated far infrared therapy has also been shown to improve impaired vascular endothelial function in patients with atherosclerosis and other coronary risk factors.[17,18]

Beever has reviewed health benefits of far-infrared sauna (FIRS) use and it was observed that FIRS therapymay be useful forthose with congestive heart failure with coronary risk factors.[26]Kihara et al.[27] developed a Waon therapy (soothing warm therapy) and reported that repeated Waon therapy improves hemodynamics, peripheral vascular function, arrhythmias, and clinical symptoms in patients with chronic heart failure (CHF). Waon therapy reduced cardiac events in patients with CHF. This therapy is a promising non-pharmacological treatment for CHF.A prospective multicenter case-control study was conducted to confirm the clinical efficacy and safety of Waon therapy on chronic heart failure (CHF) where patients (n=188) with CHF were treated with standard therapy for at least 1 week, and then were randomized to Waon therapy (n=112) or a control group (n=76).All patients continued conventional treatment for an additional 2 weeks. The Waon therapy group was treated daily with a far infrared-ray dry sauna at 60 degrees C for 15min and then kept on bed rest with a blanket for 30min for 2 weeks. The results showed that Waon therapy is safe, improves clinical symptoms and cardiac function, and decreases cardiac size in CHF patients suggesting that Waon therapy is an innovative and promising therapy for patients with CHF.[28] A study conducted to assess the effectiveness of repeated Waon therapy on the improvement of pulmonary hypertension (PH), cardiac function, exercise tolerance, and the quality of life (QOL) in patients withchronic obstructive pulmonary disease (COPD) revealed that repeated Waon therapy improved right ventricular positive dP/dt, PH during exercise, exercise tolerance and the QOL in patients with severe COPD. No adverse effects were observed related to Waon therapy.[29] Another study revealed that FIR therapy exerts a NO-related biological effect to increase skin microcirculation in rats which might bring into perspective the clinical application of FIR to treat ischemic disease by augmenting L-

arginine/NO pathway. [30]Nitric oxide (NO), constitutively produced by endothelial NO synthase (eNOS), plays roles in angiogenesis. Having reported that thermal therapy up-regulated the expression of arterial eNOS in hamsters, a study was conducted whether thermal therapy increased angiogenesis in mice with hindlimb ischemia and it was found that angiogenesis was induced via endothelial NO synthase (eNOS)using thermal therapy in mice with hindlimb ischemia . [31] As vascular endothelial dysfunction is involved in the pathophysiology of chronic heart failure (CHF) and sauna therapy, which allows thermal vasodilation, improves vascular endothelial dysfunction in patients with CHF, a study was conducted to investigate the mechanisms through which sauna therapy improves endothelial dysfunction induced by CHF using normal control and male TO-2 cardiomyopathic hamsters as experimental animal model. The results of the study revealed that repeated sauna therapy increases eNOS expression and NO production in cardiomyopathic hamsters with heart failure. [32] Kihara et al.[33] studied whether repeated 60 degrees C sauna treatment improves cardiac arrhythmias in chronic heart failure (CHF) patients, because ventricular arrhythmias are an important therapeutic target in CHF. The results have shown that repeated sauna treatment improves ventricular arrhythmias in patients with CHF. As evidenced by earlier studies on repeated sauna therapy in improvement of impaired vascular endothelial function in a patient with coronary risk factors, a randomized controlled study was conducted where systolic blood pressure and increased urinary 8-epi-PGF(2alpha) levelsas a marker of oxidative stress in the sauna group were significantly lower than those in the non-sauna group at two weeks after admission (110 +/- 15 mmHg vs 122 +/- 13 mmHg, $P < 0.05$, 230 +/- 67 pg/mg x creatinine vs 380 +/- 101 pg/mg x creatinine, $P < 0.0001$, respectively) suggesting that repeated sauna therapy may protect against oxidative stress, which leads to the prevention of atherosclerosis. [34] A study was conducted to determine whether sauna therapy, a thermal vasodilation therapy, improves endothelial function in patients with coronary risk factors such as hypercholesterolemia, hypertension, diabetes mellitus and smoking. The results showed that repeated sauna treatment improves impaired vascular endothelial function in the setting of coronary risk factors, suggesting a therapeutic role for sauna treatment in patients with risk factors for atherosclerosis.[35] A study was conducted whether the improvements observed with sauna therapy are through modulation of arterial endothelial nitric oxide synthase (eNOS) expression where eight male Syrian golden hamsters underwent sauna therapy, using an experimental far infrared-ray dry sauna system, at 39 degrees C for 15 min followed by 30 degrees C for 20 min daily for 4 weeks. The results showed that repeated thermal therapy up regulates eNOS expression in arterial endothelium.[36]





Renal Disease

Patients receiving regular hemodialysis sessions have been known to suffer from fatigue and depression. A study was conducted to determine the effects of far infrared ray (FIR) stimulation onacupoints of patients suffering from renal failure who are receiving regular hemodialysis. The results of the study showed that FIR therapy decreases both stress and fatigue levels of these patients. It also stimulates autonomic nervous system (ANS) activity in patients who are diagnosed with end-stage renal disease (ESRD) and are receiving regular hemodialyses (HD)thereby suggesting the benefits of FIR stimulation on these patients.[37]Vascular access malfunction, usually presenting with an inadequate access flow (Qa), is the leading cause of morbidity and hospitalization in hemodialysis (HD) patients. Many methods of thermal therapy have been tried for improving Qa but with limited effects. A randomized trial was designed to evaluate the effect of far-infrared (FIR) therapy on access flow and patency of the native arteriovenous fistula (AVF) where a total of 145 HD patients were enrolled with 73 in the control group and 72 in the FIR group and a WS TY101 FIR emitter was used for 40 min, and hemodynamic parameters were measured by the Transonic HD(02) monitor during HD. The study suggests that FIR therapy, a noninvasive and convenient therapeutic modality, can improve Qa and survival of the AVF in HD patients through both its thermal and its non -thermal effects.[38]In Taiwan, more than 85% of patients with end-stage renal disease undergo maintenance hemodialysis (HD). The native arteriovenous fistula (AVF) accounts for a prevalence of more than 80% of the vascular access in these patients. Some mechanical factors may affect the patency of hemodialysis vascular access, such as surgical skill, puncture technique and shear stress on the vascular endothelium. Several medical factors have also been identified to be associated with vascular access prognosis in HD patients, including stasis, hypercoagulability, endothelial cell injury, medications, red cell mass and genotype polymorphisms of transforming growth factor-beta1 and methylene tetrahydrofolate reductase. According to previous study, AVF failure was associated with a longer dinucleotide (GT)n repeat (n > or = 30) in the promoter of the heme oxygenase-1 (HO-1) gene. The recent study also demonstrated that far-infrared therapy, a noninvasive and convenient therapeutic modality, can improve access flow, inflammatory status and survival of the AVF in HD patients through both its thermal and non-thermal (endothelial-improving, anti-inflammatory, anti-proliferative, anti-oxidative) effects by up-regulating NF-E2-related factor-2-dependent HO-1 expression, leading to the inhibition of expression of E-selectin, vascular cell adhesion molecule-1,and intercellular adhesion molecule-1.[39]Survival of arteriovenous fistulas (AVFs) in hemodialysis patients is associated with both far infrared (FIR) therapy and length polymorphisms of the heme oxygenase-1 (HO-1) promoter. A study was conducted to evaluate whether there is an interaction between FIR radiation and heme oxygenase-1(HO-1) in regulating vascular inflammation. The results showed that FIR therapy exerts a potent anti - inflammatory effect via the induction of heme oxygenase-1 (HO-1). The ability of FIR therapy to inhibit inflammation may play a critical role in preserving blood flow and patency of AVFs in hemodialysis patients.[40]

Fibromyalgia

Fibromyalgia syndrome (FMS) is a chronic syndrome characterized by widespread pain with tenderness in specific areas. A study was conducted to examine the applicability of Waon therapy (soothing warmth therapy) as a new method of pain treatment in patients with FMS. The study revealed that all patients experienced a significant reduction in pain by about half after the first session of Waon therapy (11-70%), and the effect of Waon therapy became stable (20-78%) after 10 treatments. Pain VAS and FIQ symptom scores were significantly ($p<0.01$) decreased after Waon therapy and remained low throughout the observation period. The results suggest that Waon therapy is effective for the treatment of fibromyalgia syndrome.[41]

Allergic Rhinitis

Allergic rhinitis (AR) is the sixth most common chronic illness worldwide, which has a significant impact on patients' quality of life.AR is an IgE-mediated inflammation, which symptoms are likely due to increased vascular permeability.

Current therapeutic options such as avoidance of allergen, medication and immunotherapy are unsatisfactory. A study was conducted to evaluate the clinical effects of FIR therapy in patients with AR where thirty one patients with AR were enrolled in the study and a WS TY101 FIR emitter was placed to face the patient's nasal region at a distance of 30 cm. The treatment was performed for 40 min every morning for 7 days. During the period of FIR therapy, the symptoms of eye itching, nasal itching, nasal stuffiness, rhinorrhea and sneezing were all significantly improved. Smell impairment was not improved until after the last treatment. Further, it is also stated that no obvious adverse effect was noticed in the patients during treatment and follow-up. The results suggest that FIR therapy improving the symptoms of AR might serve as a novel treatment modality for Allergic rhinitis (AR).[42]

Cancer

As is evident from different research studies on infrared radiation in disease conditions, infrared radiation has been widely used in physical medicine for treatment of sports injuries, muscle aches, pain, and some chronic diseases. [43, 46] In recent years there has been an interest in the use of IR-A sources for hyperthermic treatment of cancers.[44,45,46,47,48] Because of the deeper penetration of IR-A, this is used almost exclusively, and water filtering of IR to achieve pure IR-A has been recommended in therapeutics. There are also special IR-A therapeutic apparatuses that have been used for hyperthermic treatment of cancers and Raynaud's syndrome (i.e., white finger disease). The typical treatment irradiance of several therapeutic IR devices fall in the range of 800 W m-2. A German standard (DIN 5031-10; DIN 2000) limits IR-A to 1,200 W m-2 in therapeutic equipment.

A tissue culture incubator has been developed that can continuously irradiate cells with far-infrared radiation (FIR) of wavelengths between 4 and 20 microm with a peak of 7-12 microm, and found that FIR caused different inhibiting effects to five human cancer cell lines, namely A431 (vulva), HSC3 (tongue), Sa3 (gingiva), A549 (lung), and MCF7 (breast). Then, in order to make clear the control system for the effect of FIR, the gene expression concerned to the inhibition effect by FIR were analyzed. In consequence, basal expression level of HSP70A mRNA was higher in A431 and MCF7 cells than in the FIR-sensitive HSC3, Sa3, and A549 cells. Also, the over expression of HSP70 inhibited FIR-induced growth arrest in HSC3 cells, and an HSP70 siRNA inhibited the proliferation of A431 cells by irradiation with FIR. These results indicate that the effect of a body temperature range of FIR suppressing the proliferation of some cancer cells is controlled by the basal expression level of heat shock protein (HSP) 70A. This finding suggested that FIR should be very effective medical treatment for some cancer cells which have a low level of HSP70. Still more, if the level of HSP70 in any cancer of a patient was measured, the effect of medical treatment by FIR can be foreseen for the cancer. [49]Yamada et al.[50] evaluated the efficacy and safety of M-VAC chemotherapy combined with mild hyperthermia, a new therapeutic strategy for advanced metastatic transitional cell carcinoma of the urothelium. In the study, 12 patients diagnosed with advanced metastatic transitional cell carcinoma of the urothelium were taken and for mild hyperthermia, the patients' oral temperature was elevated to about 38 degrees C by heating for 20 min and retaining the heat for 20 min with a far-infrared heater.The results of the study suggest that M-VAC chemotherapy combined with mild hyperthermia, which potentiates the anticancer effect and reduces adverse drug reactions such as gastrointestinal symptoms,may be a useful and safe method for the treatment of advanced transitional cell carcinoma of the urothelium.

Whole body hyperthermia (WBH) has been used clinically as an adjunct to radio- and chemotherapy in patients with various cancers. Recently, it has been reported that an activation of the immune system has recently been reported as a possible contributor to the therapeutic effects of WBH. Conversely, the glycolipid alpha-galactosylceramide (alpha-GalCer) is recognized by natural killer (NK) T cells together with the monomorphic MHC-like antigen, CD1d, in mice and humans.Hattori et al. conducted a study to investigate the antitumor effects of WBH combined with alpha-GalCer in a mouse subcutaneous tumor model of colon cancer and it was found that WBH showed antitumor effects in a mouse subcutaneous tumor model of colon cancer.

There is a clear rationale for using hyperthermia in cancer treatment. Treatment at temperatures between 40 and 44 degrees C is cytotoxic for cells in an environment with a low pO(2) and low pH, conditions that are found specifically within tumour tissue, due to insufficient blood perfusion. Under such conditions radiotherapy is less effective, and systemically applied cytotoxic agents will reach such areas in lower concentrations than in well perfused areas. Therefore, the addition of hyperthermia to radiotherapy or chemotherapy will result in at least an additive effect.[55]Falk MH and Issels RD[56] described the current clinical application of hyperthermia combined with conventional treatment modalities (e.g. ionizing radiation, chemotherapy) in the treatment of malignant disease emphasizing that the clinical application of hyperthermia with increase of tissue temperatures (range 40-44 degrees C) has been integrated in multimodal anti-cancer strategies. In his review, selected phase I or II (n = 17) and phase III trials (n = 16) investigating the effect of hyperthermia combined with radiotherapy (n = 10 trials), chemotherapy (n = 15 trials), or both (n = 8 trials) in a total of more than 2200 patients have been given where the trials were performed in a variety of solid tumours (e.g. melanoma, head and neck cancer, breast cancer, cancer of the gastrointestinal or urogenital tract, glioblastoma, sarcoma) in paediatric or adult patients producing a scientific basis for the simultaneous application of hyperthermia in combination with ionizing radiation and/or systemic chemotherapy. Hyperthermia is becoming more accepted clinically, due to the substantial technical improvements made in achieving selected increase of temperatures in superficial and deep-seated tumours. At present, the combination of hyperthermia and chemotherapy or radio-chemotherapy is further tested within clinical protocols (phase II/III) in order to improve local tumour control and relapse-free survival in patients with high-risk or advanced tumours of different entities. In a study, the effect of combined treatment with HAP and FIR on mammary tumorigenesis was examined in SHN mice. The administration of a diet containing 5% hydroxyapatite (HAP) derived from pig and cattle bones, and exposure to far-infrared rays (FIR) markedly inhibited spontaneous mammary tumorigenesis in SHN mice.[57]

Chronic Fatigue Syndrome

Thermal therapy using far-infrared ray dry sauna was performed for patients with chronic fatigue syndrome (CFS) where symptoms such as fatigue, pain, sleep disturbance and low-grade fever were improved suggesting that repeated thermal therapy may be a promising method for the treatment of CFS.[58,59]

Wound Healing

A study was conducted to investigate not only the hyperthermic effect of the FIR irradiation, but also the biological effects of FIR on wound healing where the speed of full-thickness skin wound healing was compared among groups with and without FIR using a rat model. Histological findings revealed greater collagen regeneration and infiltration of fibroblasts that expressed transforming growth factor-beta1 (TGF-beta1) in wounds in the FIR group than in the group without FIR. The results of the study suggest that stimulation of the secretion of TGF-beta1 or the activation of fibroblasts may be a possible mechanisms for the promotive effect of FIR on wound healing independent of skin blood flow and skin temperature.[60]

Anorexia Nervosa

The results of heat treatment in three cases of anorexia nervosa (AN) with marked over activity and/or strenuous exercising as prominent clinical features, where heat was supplied in three ways: continuous exposure to a warm environment, wearing a thermal waistcoat, and sauna baths in an infrared cabin, have shown disappearance of hyperactivity followed by progressive recovery.[61]

Reproduction

The effects of chronic exposure to far-infrared ray (FIR) on reproduction, growth, behaviour, survival time and some related parameters were studied in SHN mice suggesting that FIR has 'normalization effects' on the organisms.[62]

Raynaud's andScleroderma

Seven female systemic sclerosis patients (all from acrosclerosis type, with intestinal involvement, and marked Raynaud phenomenon) were treated with

infrared A whole body irradiations (wavelengths between 800 and 1,400 nm, 12 W/dm2 maximally). The single exposure lasted for 30 minutes and resulted in an0.9 degrees C rise of central body temperature. Acral skin re-warming became regular immediately after irradiation and kept improved, as compared with pre-treatment values, for at least 18 weeks. All the patients told about a comfortable feeling of warmth after each treatment lasting for one two days. Three out of the seven reported lower frequency and severity of Raynaud attacks.[63]

Infrared saunas in disease conditions

(a) Infrared saunas are useful in reducing body weight as reflected by the results of a study. In a two-week study of twenty-five obese adults, body weight and body fat were reduced after daily infrared sauna treatments of 15 minutes. Interestingly the study also reported on one obese patient who couldn't exercise due to arthritis in the knee yet lost 17.5 kg, and decreased body fat from 46 to 35 percent after 10 weeks of sauna therapy.[64]

(b) Infrared saunas are useful in enhancing detoxification. The Environmental Protection Agency has shown that sauna therapy increases excretion of heavy metals (lead, mercury, cadmium) and fat-soluble chemicals like PCBs, PBBs, and HCBs. In fact, toxins stored in fat can prevent us ineffectively losing weight.

(c) Infrared saunas are useful in reducing blood pressure. Scientific studies have revealed that infrared sauna therapy lowers blood pressure significantly. [65]

(d) Infrared saunas are helpful in reducing complications and improving cardiac performance in heart disease patients.

(e) Infrared saunas are effective in improving brain function. The results of a study have also shown that infrared saunas can actually improve the function of neurons that have been damaged by toxins.[66]

In addition to the health benefits above, infrared saunas have also been shown to help blood sugar, reduce joint pain, improve skin, and more. Research studies show heart-healthy, pain-reducing, life-extending benefits of infrared saunas. Whether overweight, suffering from chronic illness, burdened by constant stress, or simply want to optimize the body and protect the health for the long terms, infrared saunas appear to be an excellent way to do it.

DISCUSSION

Far infrared rays have been discovered to stimulate a range of positive responses in the human body and are successfully being used to treat a range of health conditions. Originally developed by NASA, this powerful technology has since been adopted by the medical community because of its ability to penetrate the human body safely and deliver a wide array of therapeutic effects at the cellular level. Far Infrared is thought to be 7 times more effective at detoxifying heavy metals such as mercury, aluminum, and even cholesterols, nicotine, alcohol, ammonia, sulfuric acid and other environmental toxins, as opposed to conventional heat or steam saunas.

The human body is a reservoir of all kinds of bio-toxins which cannot be expelled immediately and become stored in the body, thereby triggering illness. When toxic gases such as sulphur dioxide and carbon dioxide, or potentially fatal heavy metal toxins such as mercury, lead and chlorine, meet large water molecules, they are encapsulated by clusters of water and trapped in the body. Where these toxins are accumulated, blood circulation is blocked and cellular energy is impaired. However, when a 7 to 14 micron FIR wave is applied to these large water molecules, the water begins to vibrate. This vibration reduces the ion bonds of the atoms which are holding together the molecules of water. As the water evaporates, the encapsulated gas and toxins can be released. Far infrared radiations have been found to produce amazing health benefits to patients suffering from chronic ailments. Far Infrared therapy increases blood circulation and oxygen supply to damaged tissues (aiding reduction of chronic joint and muscle pain or sport injuries), promotes relaxation and comfort, induces sleep and relieves stress. It has been found to promote health benefit response in wide range of chronic disease conditions including chronic pain, chronic inflammation, obesity, depression & insomnia , diabetes, cardiovascular disorders, renal diseases, allergic rhinitis, cancer, chronic fatigue syndrome, Raynaud's & scleroderma etc. Interestingly, Far Infrared lasers such as Smooth beam or Cool Touch are becoming a very popular

method to treat acne, particularly in very resistant cases. They seem to work by shrinking the sebaceous glands and provide relatively quick results. HTE's Far infrared Hot House 'sauna' or a far infrared lamp treatment appears to open pores that have been malfunctioning for years, forcing out clogging cosmetics and loosening dry outer skin, healing acne and scars, without pain.[67]

Researchers have been studying the effects of saunas for decades when it comes to pain management and relaxation. Infrared saunas are relatively new compared to conventional saunas but have picked up attention recently for helping naturally treat multiple health problems with little to no side effects. Some studies have shown benefits of infrared sauna therapy for people with cardiovascular disease, diabetes , high blood pressure, congestive heart failure, rheumatoid arthritis, chronic fatigue, poor digestion, depression and anger, chronic muscle and joint pains.

Use of far infra red (FIR) in disease conditions are enormous. Medical practitioners make use of infrared radiant heat to treat sprains, strains, bursitis, peripheral vascular diseases, arthritis, and muscle pain. It has been reported that infrared heat therapy may be helpful in decreasing joint stiffness, relieving muscle spasms, increasing blood flow, relieving pain, affecting soft tissue injury, increasing the extensibility of collagen tissue, assisting in resolution of inflammatory infiltrated, edema, and exudes. Far infrared treatment on regular basis have been found useful in dental diseases like gum inflammation and post dental pain suppression. When the normally smooth, firm lining of the arteries becomes thickened and roughened by deposits of fat, fibrin, calcium and cellular debris, it lessens the arteries ability to expand and contract, and slows the blood movement through narrowed channels. These conditions make it easier for blood clots to form, blocking the arteries and stopping blood flow completely. FIR has been found to neutralize blood toxicity and smooth the walls of arteries, capillaries and veins. Infrared therapy in both Japan and China has proven to be outstanding for asthma, bronchitis, colds, flu, sinusitis and congestion as it clears inflammation, swelling and mucous clogged passages as confirmed by scientific studies.

One of the biggest benefits of infrared saunas is that they are comfortable and simple to use, even for people who struggle with pain or who have sensitive skin and stomachs when it comes to heat, all with no need for medications or doctor visits. Many people are incorporating far infrared ray treatment into their weight-loss program with excellent results. And they're self-administering their treatment from the comfort of their own homes, with an FDA-approved product called a Bio Mat. The Bio Mat harnesses far infrared ray technology in a safe, comfortable treatment pad. The pad can be placed on a treatment table, a couch or bed, so that the treatment can be administered while the user relaxes, watches television, reads or even enjoys a restful sleep. The treatment is painless, and in fact produces a comfortable, soothing warmth that penetrates the body and leaves the person feeling totally relaxed and refreshed.

In the present scenario of increasing environmental pollution around us , where our important organs like heart , kidney , lung, liver , brain are at risk, far infrared therapy appears to be a powerful alternative therapeutic approach in treating chronic disease syndromes .The Environmental Protection Agency has shown that far infrared sauna therapy increases excretion of heavy metals (lead, mercury, cadmium) and fat-soluble chemicals like PCBs, PBBs, and HCBs responsible for causing chronic disease conditions for which our modern systems of medicine have not permanent remedy. Technological advances have provided new techniques for delivering FIR radiation to the human body. Specialty lamps and saunas, delivering pure FIR radiation (eliminating completely the near and mid infrared bands), have become safe, effective, and widely used sources to generate therapeutic effects. Fibers impregnated with FIR emitting ceramic nanoparticles and woven into fabrics, are being used as garments and wraps to generate FIRradiation and attain health benefits from its effects. Despite all these different uses of FIR in medical applications, the exact mechanisms of the hyperthermic effects and biological activities of FIR irradiation are still poorly understood. Extensive scientific and clinical research studies on animal models and human subjects employing modern pharmacological / biotechnological techniques are needed in this

biotechnological techniques are needed in this important biomedical field in order to develop far infrared radiation (FIR) based tools / products which can be used as alternative or complementary therapy in prevention and treatment of chronic diseases and to understand molecular and cellular mechanisms of FIR effects.

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