HM3 Light Research Table of Contents

General Light Therapy Research

Irradiation with He-Ne laser increases ATP level in cells cultivated in vitro.

The ability of monochromatic red light to induce an increase in the cellular ATP level was found to depend on the growth phase of the culture, being insignificant in the lag phase of cultured cells, increasing in the log phase of cultured cells and reaching a maximum (about 190%) in cells at the late logarithmic and early plateau phase.

Laser Technology Centre, Academy of Science, Troitsk, Moscow Region, Russia.

https://www.ncbi.nlm.nih.gov/pubmed/7769534

Photobiomodulation directly benefits primary neurons functionally inactivated by toxins: role of cytochrome c oxidase.

The results are consistent with our hypothesis that the mechanism of photobiomodulation involves the up-regulation of cytochrome c oxidase, leading to increased energy metabolism in neurons functionally inactivated by toxins.

Department of Cell Biology, Medical College of Wisconsin, Milwaukee, Wisconsin 53226, USA.

https://www.ncbi.nlm.nih.gov/pubmed/15557336

Clinical and Experimental Applications of NIR-LED Photobiomodulation

NIR-LED light treatment stimulates the photoacceptor cytochrome c oxidase, resulting in increased energy metabolism and production. Furthermore, NIR-LED light treatment prevents the development of oral mucositis in pediatric bone marrow transplant patients. The experimental results demonstrate that NIR-LED light treatment stimulates mitochondrial oxidative metabolism in vitro, and accelerates cell and tissue repair in vivo. NIR-LED light represents a novel, noninvasive, therapeutic intervention for the treatment of numerous diseases linked to mitochondrial dysfunction.

Department of Clinical Laboratory Sciences, University of Wisconsin-Milwaukee

https://www.researchgate.net/publication/7074338_Clinical_and_Experimental_Applications_of_NIR-LED_Photobiomodulation

Shining light on the head: Photobiomodulation for Brain Disorders

This review will cover the mechanisms of action of photobiomodulation to the brain, and summarize some of the key pre-clinical studies and clinical trials that have been undertaken for diverse brain disorders. The PBM group had improvement in cerebral microcirculation leading to permanent (from 1 to 7 years) reduction in dementia and cognitive recovery.

Wellman Center for Photomedicine, Massachusetts General Hospital, Boston, MA 02114

https://www.sciencedirect.com/science/article/pii/S2214647416300381

Brain Photobiomodulation Therapy: A Narrative Review.

This article reviews the state-of-the-art preclinical and clinical evidence regarding the efficacy of brain PBM therapy. Brain photobiomodulation (PBM) therapy using red to near-infrared (NIR) light is an innovative treatment for a wide range of neurological and psychological conditions. Red/NIR light is able to stimulate complex IV of the mitochondrial respiratory chain (cytochrome c oxidase) and increase ATP synthesis. Moreover, light absorption by ion channels results in release of Ca2+ and leads to activation of transcription factors and gene expression.

Department of Dermatology, Harvard Medical School & Wellman Center for Photomedicine, Boston, MA, 02115, USA.

Harvard-MIT Division of Health Sciences and Technology, Cambridge, MA, 02139, USA.

Neurosciences Research Center (NSRC), Tabriz University of Medical Sciences, Tabriz, Iran. & Department of Medical Physics, Tabriz University of Medical Sciences, and Neurosciences Research Center, Tabriz, Iran.

School of Medical Sciences, University of Aberdeen, Aberdeen, UK.

https://slideheaven.com/queue/brain-photobiomodulation-therapy-a-narrative-review.html

The Nuts and Bolts of Low-level Laser (Light) Therapy

The range of diseases, injuries, and conditions that can be benefited by LLLT will be summarized with an emphasis on those that have reported randomized controlled clinical trials. Serious life-threatening diseases such as stroke, heart attack, spinal cord injury, and traumatic brain injury may soon be amenable to LLLT therapy.

Wellman Center for Photomedicine, Massachusetts General Hospital, Boston, MA, USA.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3288797/

Low-level light therapy of the eye and brain

LLLT has potential significant applications against retinal and brain damage by counteracting the consequences of mitochondrial failure. Upon transcranial delivery in vivo, LLLT induces brain metabolic and antioxidant beneficial effects, as measured by increases in cytochrome oxidase and superoxide dismutase activities. Increases in cerebral blood flow and cognitive functions induced by LLLT have also been observed in humans. Importantly, LLLT given at energy densities that exert beneficial effects does not induce adverse effects. This highlights the value of LLLT as a novel paradigm to treat visual, neurological, and psychological conditions, and supports that neuronal energy metabolism could constitute a major target for neurotherapeutics of the eye and brain.

Departments of Psychology, Pharmacology and Toxicology, University of Texas at Austin

Department of Neurology and Neurotherapeutics, University of Texas Southwestern Medical Center, Dallas, TX

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5436183

Anxiety & Depression Studies

Psychological benefits 2 and 4 weeks after a single treatment with near infrared light to the forehead: a pilot study of 10 patients with major depression and anxiety

At 2-weeks post treatment 6 of 10 patients had a remission (a score </= 10) on the HAM-Depression test and 7 of 10 achieved this on the HAM-Anxiety test.

The Department of Psychiatry, Harvard Medical School and the Developmental Biopsychiatry Research Program, McLean Hospital

https://www.ncbi.nlm.nih.gov/pubmed/19995444?dopt=Abstract

Review of transcranial photobiomodulation for major depressive disorder: targeting brain metabolism, inflammation, oxidative stress, and neurogenesis.

There is also clinical preliminary evidence suggesting the efficacy of PBM in treating MDD, and comorbid anxiety disorders, suicidal ideation, and traumatic brain injury. Based on the data collected to date, PBM appears to be a promising treatment for depression that is safe and well-tolerated.

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Harvard Medical School, Department of Psychiatry, 401 Park Drive, Boston, Massachusetts 02215, United States.

Mount Sinai Medical School, Mood and Anxiety Disorders Program & Department of Psychiatry and Neuroscience, 1428 Madison Avenue, New York, New York 10029, United States

https://www.ncbi.nlm.nih.gov/pubmed/26989758

Alzheimer And Dementia Studies

Beneficial neurocognitive effects of transcranial laser in older adults.

These preliminary findings support the use of TILS for larger randomized clinical trials with this non-invasive approach to augment neurocognitive function in older people to combat aging-related and vascular disease-related cognitive decline.

Department of Psychology and Institute for Neuroscience & Electrical Engineering & Kinesiology and Health Education, University of Texas at Austin, Austin, TX, 78712, USA.

https://link.springer.com/article/10.1007%2Fs10103-017-2221-y

Significant Improvement in Cognition in Mild to Moderately Severe Dementia Cases Treated with Transcranial Plus Intranasal Photobiomodulation: Case Series Report.

There was significant improvement after 12 weeks of PBM (MMSE, $p < 0.003$; ADAS-cog, $p < 0.023$). Increased function, better sleep, fewer angry outbursts, less anxiety, and wandering were reported post-PBM. There were no negative side effects. Precipitous declines were observed during the follow-up no-treatment, 4-week period. This is the first completed PBM case series to report significant, cognitive improvement in mild to moderately severe dementia and possible AD cases.

Saltmarche Health & Associates, Inc. , Orangeville, Ontario, Canada .

VA Boston Healthcare System , Boston, Massachusetts.

Department of Neurology, Boston University School of Medicine, Boston, Massachusetts.

Harvard Medical School, Boston, Massachusetts.

Wellman Center for Photomedicine, Massachusetts General Hospital, Boston, Massachusetts.

https://www.ncbi.nlm.nih.gov/pubmed/28186867

Low-level laser therapy rescues dendrite atrophy via upregulating BDNF expression: implications for Alzheimer's disease.

Together, these studies suggest that upregulation of BDNF with LLLT by activation of ERK/CREB pathway can ameliorate Aβ-induced neurons loss and dendritic atrophy, thus identifying a novel pathway by which LLLT protects against Aβ-induced neurotoxicity. Our research may provide a feasible therapeutic approach to control the progression of AD.

MOE Key Laboratory of Laser Life Science and Institute of Laser Life Science, College of Biophotonics, South China Normal University, Guangzhou 510631, China.

https://www.ncbi.nlm.nih.gov/pubmed/23946409

670 nm Laser Light and EGCG Complementarily Reduce Amyloid-b Aggregates in Human Neuroblastoma Cells: Basis for Treatment of Alzheimer's Disease?

The aim of the present study is to present the results of in vitro experiments with possible relevance in the treatment of Alzheimer's disease (AD). One root cause of AD is the extra- and intracellular deposition of amyloid-beta (Ab) fibrils in the brain. Recently, it was shown that extracellular Ab can enter brain cells, resulting in neurotoxicity. Irradiation with moderate levels of 670-nm light and EGCG supplementation complementarily reduces Ab aggregates in SH-EP cells. Transcranial penetration of moderate levels of red to near-infrared (NIR) light has already been amply exploited in the treatment of patients with acute stroke; the blood–brain barrier (BBB) penetration of EGCG has been demonstrated in animals.

Institute of Micro and Nanomaterials, Nanobionic Laboratory, University of Ulm, Ulm, Germany

https://www.ncbi.nlm.nih.gov/pubmed/22029866

Photobiomodulation with Near Infrared Light Helmet in a Pilot, Placebo Controlled Clinical Trial in Dementia Patients Testing Memory and Cognition.

Results showed changes in executive functioning; clock drawing, immediate recall, praxis memory, visual attention and task switching (Trails A&B) as well as a trend of improved EEG amplitude and connectivity measures. Neuroplasticity has also been reported with NIR light stimulation and mitochondrial enhancement.

P.I. Quietmind Foundation, 1016 Greenwood Ave, Wyncote PA 19095, USA.
Board, Quietmind Foundation, CNDD Hanover PA 17331, USA.
Department of Neurosurgery, Baylor Scott and White, Temple, Texas 76502, USA.

https://www.ncbi.nlm.nih.gov/pubmed/28593105

Headache and Migraine Studies

Light therapy modulates serotonin levels and blood flow in women with headache. A preliminary study.

Our findings indicated that LLLT regulates blood flow in the temporal artery after irradiation and might control 5-HT levels in patients suffering with tension-type headache associated to TMD contributing to pain relief.

Professional Master Programme Lasers in Dentistry, IPEN-CNEN/SP, São Paulo 05508-000, Brazil.

Center for Lasers and Applications, IPEN-CNEN/SP, São Paulo 05508-000, Brazil.

Department of Biomedical Engineering, UFABC, São Paulo 09210-180, Brazil.

https://www.ncbi.nlm.nih.gov/pubmed/26202374

Multi-watt near-infrared light therapy as a neuroregenerative treatment for traumatic brain injury

Clinically, this results in decreased symptoms of headache, cognitive impairment, sleep disturbance, anxiety, and depression (Morries et al., 2015). Functional neuroimaging demonstrates increased cortical function.

Neuro-Laser Foundation, The Synaptic Space, Neuro-Luminance, Centennial, CO, USA

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4870908/

Effectiveness of Low-Level Laser Therapy in Temporomandibular Joint Disorders: A Placebo-Controlled Study

Application of 10 J/cm2 or 15 J/cm2 was significantly more effective in reducing pain compared to placebo, and the results suggest that LLLT (application of 10 J/cm2 and 15 J/cm2) can be considered as a useful method for the treatment of TMD-re- lated pain, especially long lasting pain.]]>

Institute of Biophysics and Informatics, 1st Medical Faculty, Charles University, Prague, Czech Republic.

https://www.ncbi.nlm.nih.gov/pubmed/17803388

Insomnia and Sleep Problem Studies:

Red Light and the Sleep Quality and Endurance Performance of Chinese Female Basketball Players

The 14-day whole-body irradiation with red-light treatment improved the sleep, serum melatonin level, and endurance performance of the elite female basketball players ($P < .05$). We found a correlation between changes in global Pittsburgh Sleep Quality Index and serum melatonin levels ($r = -0.695$, $P = .006$). Our study confirmed the effectiveness of body irradiation with red light in improving the quality of sleep of elite female basketball players and offered a nonpharmacologic and noninvasive therapy to prevent sleep disorders after training.

Sport Biological Center, China Institute of Sport Science, Beijing, China
Department of Kinesiology, Macao Polytechnic Institute, China
Department of Kinesiology, Beijing Sport University, China

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3499892/

The effect of endonasal low energy He-Ne laser treatment on insomnia on sleep EEG.

The first documented use of a similar intranasal light therapy device to directly observe melatonin level was conducted by Xu C et al in 2001. They treated 38 subjects that had insomnia with intranasal low level laser therapy once a day over 10 days. They found that serum melatonin had increased.

The same group of researchers further treated another group of 128 patients with insomnia and found that the polysomnogram (sleep study that includes data on brain waves as electrical activity) data had improved.

Xu C, Wu Z, Wang L, Shang X, Li Q. 2002. The effect of endonasal low energy He-Ne laser treatment on insomniaon on sleep EEG. Prac J Med Pharm. 19(6): 407-408 (in Chinese).

Therapeutic effect observation and nurse of intranasal low intensity laser therapy on insomnia.

Reported that they had treated 50 patients with insomnia with intranasal low level laser therapy that is of similar specifications to Vielight's laser device for 60 minutes per session. Each session was conducted once a day over between 10 to 14 days. They found that the condition had improved significantly in 41 (82%) of the cases, mild for 4 (8%) of the cases, and none for 5 (10%) of the cases.

Wang F. 2006. Therapeutic effect observation and nurse of intranasal low intensity laser therapy on insomnia. Journal of Community Medicine. 4(3): 58 (in Chinese).

MS – Autoimmune Studies

Effect of photobiomodulation treatment in the sublingual, radial artery region, and along the spinal column in individuals with multiple sclerosis: Protocol for a randomized, controlled, double-blind, clinical trial.

DISCUSSION:

Treatment for MS is directed at the immune response and slowing the progression of the disease. This is one of the first clinical trials involving photobiomodulation in the sublingual region and along the spinal cord, which could help establish a promising new form of nonpharmacological treatment for autoimmune diseases. This is one of the first clinical trials with sublingual photobiomodulation and along the spinal cord that could help establish a new form of promising treatment of the disease associated with pharmacological treatment.

Nove de Julho University (UNINOVE).
University Metropolitana de Santos (UNIMES) University, Santos, Brazil.

https://insights.ovid.com/pubmed?pmid=29742699

Beneficial neurocognitive effects of transcranial laser in older adults.

These preliminary findings support the use of TILS for larger randomized clinical trials with this non-invasive approach to augment neurocognitive function in older people to combat aging-related and vascular disease-related cognitive decline.

Department of Psychology and Institute for Neuroscience & Electrical Engineering & Kinesiology and Health Education, University of Texas at Austin, Austin, TX, 78712, USA.

https://link.springer.com/article/10.1007%2Fs10103-017-2221-y

Parkinson Studies

Maloney R., Shanks S., Maloney J. The application of low-level laser therapy for the symptomatic care of late stage Parkinson's disease: a non-controlled, non-randomized study (abstract) Lasers Surg. Med. 2010;185

Although very much in its infancy, with the bulk of results still at the basic science “proof of concept” stage, red to infrared light therapy has the potential to develop into a viable treatment option for patients with Parkinson’s disease (and other neurodegenerative diseases). Light therapy would offer patients the advantage of neuroprotection, something that dopamine replacement drug therapy does not do. If light therapy was applied at early stages, for example at first diagnosis, it could potentially slow the progression of the disease by rescuing the critical neurons from damage and death. Consequently, over time, the greater survival of neurons would lessen the clinical signs of tremor, akinesia, and/or rigidity. Light therapy may not only be effective in slowing the progression of the disease, but also in treating the signs.

Conference Paper in Lasers in Surgery and Medicine

https://www.dovepress.com/the-potential-of-light-therapy-in-parkinson39s-disease-peer-reviewed-fulltext-article-CPT

Reduced axonal transport in Parkinson's disease cybrid neurites is restored by light therapy.

The results from this study support our proposal that axonal transport is reduced in sporadic PD and that a single, brief treatment with near-infrared light can restore axonal transport to control levels. These results are the first demonstration that LLLT can increase axonal transport in model human dopaminergic neuronal cells and they suggest that LLLT could be developed as a novel treatment to improve neuronal function in patients with PD.

University of Virginia, Morris K Udall Parkinson's Research Center of Excellence and Department of Neurology, Charlottesville, Virginia, USA.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2711937/

Turning On Lights to Stop Neurodegeneration: The Potential of Near Infrared Light Therapy in Alzheimer's and Parkinson's Disease

If NIr was applied at early stages of the disease process, for example at first diagnosis, it could potentially slow further progression by protecting neurons from death. Consequently, over time, the greater neuronal survival would lessen the clinical signs and symptoms. Further, NIr therapy—because of its lack of side-effects and neuroprotective potential—is amenable to use in conjunction with other treatments.

Department of Physiology, University of Sydney, Sydney, NSW, Australia
University Grenoble Alpes, CEA, LETI, CLINATEC, MINATEC Campus, Grenoble, France
Department of Anatomy, University of Sydney, Sydney, NSW, Australia

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4707222/

Pretreatment with near-infrared light via light-emitting diode provides added benefit against rotenone- and MPP+-induced neurotoxicity.

These data suggest that LED pretreatment is an effective adjunct preventative therapy in rescuing neurons from neurotoxins linked to PD. Results indicate that pretreatment with NIR-LED significantly suppressed rotenone- or MPP(+)-induced apoptosis in both striatal and cortical neurons ($P<0.001$), and that pretreatment plus LED treatment during neurotoxin exposure was significantly better than LED treatment alone during exposure to neurotoxins. In addition, MPP(+) induced a decrease in neuronal ATP levels (to 48% of control level) that was reversed significantly to 70% of control by NIR-LED pretreatment.

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https://www.ncbi.nlm.nih.gov/pubmed/18848925/

Stroke Studies

Photobiomodulation for traumatic brain injury and stroke

Clinical studies have been conducted in patients suffering from the chronic effects of TBI. There have been reports showing improvement in executive function, working memory, and sleep. Functional magnetic resonance imaging has shown modulation of activation in intrinsic brain networks likely to be damaged in TBI (default mode network and salience network).

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Department of Dermatology, Harvard Medical School, Boston, MA.
Harvard-MIT Division of Health Sciences and Technology, Cambridge, MA.

https://www.ncbi.nlm.nih.gov/pubmed/29131369

The evolution of transcranial laser therapy for acute ischemic stroke, including a pooled analysis of NEST-1 and NEST-2.

Recently, laser technology has been applied to acute ischemic stroke. This noninvasive technique uses near-infrared wavelengths applied to the scalp within 24 h of symptom onset. Pooled analysis of NEST-1 and NEST-2 revealed a significantly improved success rate in patients treated with laser therapy. Further phase 3 testing is planned and may create a new paradigm for the treatment of acute ischemic stroke.

University of California, San Diego Medical Center, Medical Office North, 3rd floor, Suite 3, 200 West Arbor Drive #8466, San Diego, CA 92103-8466, USA.

https://www.ncbi.nlm.nih.gov/pubmed/20425181

Non-invasive brain stimulation to promote alertness and awareness in chronic patients with disorders of consciousness: Low-level, near-infrared laser stimulation vs. focused shock wave therapy

In order to promote alertness and awareness in patients with severe disorders of consciousness (DOC) frontal near infrared laser stimulation (N-LT) or transcranial focused shock wave therapy (F-SWT) might be an option. Sixteen disorders of consciousness (DOC) patients were allocated to two groups (A and B). A three week baseline either followed a frontal N-LT (0,1 mJ/mm2, 10 min per session), five times a week over four weeks (group A), or a F-SWT (0,1 mJ/mm2, 4000 stimuli per session) three times a week over four weeks (group B). The primary variable was the revised Coma Recovery Scale (r-CRS, 0-23), blindly assessed. Both options might be an option to increase alertness and awareness of chronic DOC patients.

Medical Park Berlin Humboldtmühle, Neurologische Rehabilitation, Charité - Universitätsmedizin Berlin, Germany.

Haus Havelblick, Department for intensive care nursing, Havelschanze, Berlin, Germany.

https://wsleepww.ncbi.nlm.nih.gov/pubmed/27080072

Traumatic Brain Injury Studies

Photobiomodulation using low-level laser therapy (LLLT) for patients with chronic traumatic brain injury: a randomized controlled trial study protocol.

DISCUSSION:

LLLT has been demonstrated as a safe and effective technique in significantly improving the memory, attention, and mood performance in healthy and neurologic patients. We expect that our trial can complement previous finds, as an effective low-cost therapy to improve cognitive sequel after TBI.

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Institute of Biomedical Engineering, Anhembi Morumbi University, Sao Jose dos Campos, Sao Paulo, Brazil.

https://www.ncbi.nlm.nih.gov/pubmed/29310710

Low-level light in combination with metabolic modulators for effective therapy of injured brain.

Vascular damage occurs frequently at the injured brain causing hypoxia and is associated with poor outcomes in the clinics. We found high levels of glycolysis, reduced adenosine triphosphate generation, and increased formation of reactive oxygen species and apoptosis in neurons under hypoxia. Strikingly, these adverse events were reversed significantly by noninvasive exposure of injured brain to low-level light(LLL).

Department of Dermatology, Harvard Medical School, Wellman Center for Photomedicine, Massachusetts General Hospital, Boston, Massachusetts, USA

https://www.ncbi.nlm.nih.gov/pubmed/25966949

Improved cognitive function after transcranial, light-emitting diode treatments in chronic, traumatic brain injury: two case reports.

RESULTS:

Seven years after closed-head TBI from a motor vehicle accident, Patient 1 began transcranial LED treatments. Pre-LED, her ability for sustained attention (computer work) lasted 20 min. After eight weekly LED treatments, her sustained attention time increased to 3 h. The patient performs nightly home treatments (5 years); if she stops treating for more than 2 weeks, she regresses. Patient 2 had a history of closed-head trauma (sports/military, and recent fall), and magnetic resonance imaging showed frontoparietal atrophy. Pre-LED, she was on medical disability for 5 months. After 4 months of

nightly LED treatments at home, medical disability discontinued; she returned to working full-time as an executive consultant with an international technology consulting firm. Neuropsychological testing after 9 months of transcranial LED indicated significant improvement (+1, +2SD) in executive function (inhibition, inhibition accuracy) and memory, as well as reduction in post-traumatic stress disorder. If she stops treating for more than 1 week, she regresses. At the time of this report, both patients are continuing treatment.

VA Boston Healthcare System, Boston, Massachusetts

https://www.ncbi.nlm.nih.gov/pubmed/21182447

Traumatic brain injury, neuroimaging, and neurodegeneration.

An adverse synergistic influence of TBI with aging may predispose the brain injured individual for the development of neuropsychiatric and neurodegenerative disorders long after surviving the brain injury.

Department of Psychology, Brigham Young University Provo, UT, USA ; Neuroscience Center, Brigham Young University Provo, UT, USA ;

Department of Psychiatry, University of Utah Salt Lake City, UT, USA ; The Brain Institute of Utah, University of Utah Salt Lake City, UT, USA.

https://www.ncbi.nlm.nih.gov/pubmed/23964217

Role of low-level laser therapy in neurorehabilitation.

Activation of transcription factors then leads to expression of many protective, anti-apoptotic, anti-oxidant, and pro-proliferation gene products. Animal studies and human clinical trials of LLLT for indications with relevance to neurology, such as stroke, traumatic brain injury, degenerative brain disease, spinal cord injury, and peripheral nerve regeneration, will be covered.

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https://www.ncbi.nlm.nih.gov/pubmed/21172691

Shining light on the head: Photobiomodulation for brain disorders

This review will cover the mechanisms of action of photobiomodulation to the brain and summarize some of the key pre-clinical studies and clinical trials that have been undertaken for diverse brain disorders.

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https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5066074/

Treatments for traumatic brain injury with emphasis on transcranial near-infrared laser phototherapy.

In ten patients with chronic TBI (average time since injury 9.3 years) given ten treatments over the course of 2 months using a high-power NIR laser (13.2 W/0.89 cm(2) at 810 nm or 9 W/0.89 cm(2) at 810 nm and 980 nm), symptoms of headache, sleep disturbance, cognition, mood dysregulation, anxiety, and irritability improved. Symptoms were monitored by depression scales and a novel patient diary system specifically designed for this study. NIR light in the power range of 10-15 W at 810 nm and 980 nm can safely and effectively treat chronic symptoms of TBI. The clinical benefit and effects of infrared phototherapy on mitochondrial function and secondary molecular events are discussed in the context of adequate radiant energy penetration.

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Harvard Medical School, Depression Clinical and Research Program, Massachusetts General Hospital, Boston, MA, USA.
Neuro-Laser Foundation, Lakewood, CO, USA ; The Synaptic Space, Centennial, CO,

https://www.ncbi.nlm.nih.gov/pubmed/26347062