

Light therapy

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Light therapy or **phototherapy**, classically referred to as **heliotherapy**, consists of exposure to daylight or to specific wavelengths of light using polychromatic polarised light, lasers, light-emitting diodes, fluorescent lamps, dichroic lamps or very bright, full-spectrum light. The light is administered for a prescribed amount of time and, in some cases, at a specific time of day.

One common use of the term is associated with the treatment of skin disorders, chiefly psoriasis, acne vulgaris, eczema and neonatal jaundice.

Light therapy which strikes the retina of the eyes is used to treat diabetic retinopathy and also circadian rhythm disorders such as delayed sleep phase disorder and can also be used to treat seasonal affective disorder, with some support for its use also with non-seasonal psychiatric disorders.

Light therapy

Intervention

ICD-10-PCS [1] (<http://www.icd10data.com/ICD10PCS/Codes/>), [2] (<http://www.icd10data.com/ICD10PCS/Codes/>)

ICD-9 99.83 (<http://icd9cm.chrisendres.com/index.php?srctype=procs&srchtext=99.83&Submit=Search&action=search>), 99.88 (<http://icd9cm.chrisendres.com/index.php?srctype=procs&srchtext=99.88&Submit=Search&action=search>)

MeSH D010789

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Medical uses

Skin conditions

The treatments involve exposing the skin to ultraviolet light. The exposures can be to small area of the skin or over the whole body surface, like in a tanning bed. The most common treatment is with narrowband UVB (NB-UVB) with a wavelength of 311-313 nanometer. It was found that this is the safest treatment^[1] Full body phototherapy can be delivered at doctor's office or at home using a large high power UVB booth.^[2]

Psoriasis

For psoriasis, UVB phototherapy has been shown to be effective.^[3] A feature of psoriasis is localized inflammation mediated by the immune system.^[4] Ultraviolet radiation is known to suppress the immune system and reduce inflammatory responses. Light therapy for skin conditions like psoriasis usually use NB-UVB (311 nm wavelength) though it may use UV-A (315–400 nm wavelength) or UV-B (280–315 nm wavelength) light waves. UV-A, combined with psoralen, a drug taken orally, is known as PUVA treatment. In UVB phototherapy the exposure time is very short, seconds to minutes depending on intensity of lamps and the person's skin pigment and sensitivity. The time is controlled with a timer that turns off the lamps after the treatment time ends. William H. Goeckerman pioneered

Vitiligo

One percent of the population suffer from vitiligo, and narrowband UVB phototherapy is an effective treatment. "NB-UVB phototherapy results in satisfactory repigmentation in our vitiligo patients and should be offered as a treatment option."^[5]

Acne vulgaris

Evidence for light therapy and lasers in acne vulgaris as of 2012 is not sufficient to recommend them.^[6] There is moderate evidence for the efficacy of blue and blue-red light therapies in treating mild acne, but most studies are of low quality.^{[7][8]} While light therapy appears to provide short term benefit, there is a lack of long term outcome data or data in those with severe acne.^[9]

Cancer

According to the American Cancer Society, there is some evidence that ultraviolet light therapy may be effective in helping treat certain kinds of skin cancer, and ultraviolet blood irradiation therapy is established for this application. However, alternative uses of light for cancer treatment – light box therapy and colored



High intensity blue light (425nm) used for the treatment of acne.

light therapy – are not supported by evidence.^[10] Photodynamic therapy (often with red light) is used to treat certain superficial non-melanoma skin cancers.^[11]

Other skin conditions

Phototherapy can be effective in the treatment of eczema, atopic dermatitis, polymorphous light eruption, cutaneous T-cell lymphoma^[12] and lichen planus. Narrowband UVB lamps, 311–313 nanometer is the most common treatment.^[13]

Wound healing

Low level laser therapy has been studied as a potential treatment for chronic wounds.^[14] Reviews of the scientific literature do not support the widespread use of this technique due to inconsistent results and low research quality.^{[14][15]} Higher power lasers have also been used to close acute wounds as an alternative to stitching.^[14]

Retinal conditions

There is preliminary evidence that light therapy is an effective treatment for diabetic retinopathy and diabetic macular oedema.^{[16][17]}

Mood and sleep related

Seasonal affective disorder

Full sunlight or exposure to bright light from a light box is used to treat seasonal affective disorder (SAD). Light boxes for SAD are designed to filter out most UV light, which can cause eye and skin damage.^[18] Mayo Clinic states that light therapy is a proven treatment for seasonal affective disorder.^[19] It is considered a first-line treatment.^[20] Controlled-trial comparisons with antidepressants show equal effectiveness, with less expense and more rapid onset of therapeutic benefit, though a minority of patients may not respond to it.^[21] Direct sunlight, reflected into the windows of a home or office by a computer-controlled mirror device called a heliostat, has also been used as a type of light therapy for the treatment of SAD.^{[22][23]}

The effectiveness of light therapy for treating SAD may be linked to the fact that light therapy makes up for lost sunlight exposure and resets the body's internal clock.^{[24][25]} Studies show that light therapy helps reduce the debilitating and depressive behaviors of SAD, such as excessive sleepiness and fatigue, with results lasting for at least 1 month. Light therapy is preferred over antidepressants in the treatment of SAD because it is a relatively safe and easy therapy.^[26]

It is possible that response to light therapy for SAD could be season dependent.^[27] Morning therapy has provided the best results because light in the early morning aids in regulating the circadian rhythm.^[26]

Non-seasonal depression

Light therapy has also been suggested in the treatment of non-seasonal depression and other psychiatric disturbances, including major depressive disorder,^[28] bipolar disorder and postpartum depression.^{[29][30]} A

meta-analysis by the Cochrane Collaboration concluded that "for patients suffering from non-seasonal depression, light therapy offers modest though promising antidepressive efficacy."^[31] A 2008 systematic review concluded that "overall, bright light therapy is an excellent candidate for inclusion into the therapeutic inventory available for the treatment of nonseasonal depression today, as adjuvant therapy to antidepressant medication, or eventually as stand-alone treatment for specific subgroups of depressed patients."^[20] A 2015 review found that supporting evidence for light therapy was weak due to serious methodological flaws.^[32] However, a 2016 randomized double blind clinical trial (which used a sham light treatment) found that light therapy in combination with Prozac for 8 weeks as well as light therapy alone resulted in a significantly superior decrease in depression scores than placebo.^[33]

Circadian rhythm sleep disorders and jet lag

Chronic Circadian Rhythm Sleep Disorders (CRSD)

In the management of circadian rhythm disorders such as delayed sleep phase disorder (DSPD), the timing of light exposure is critical. Light exposure administered to the eyes before or after the nadir of the core body temperature rhythm can affect the phase response curve.^[34] Use upon awakening may also be effective for non-24-hour sleep–wake disorder.^[35] Some users have reported success with lights that turn on shortly *before* awakening (dawn simulation). Evening use is recommended for people with advanced sleep phase disorder. Some, but not all, totally blind people whose retinae are intact, may benefit from light therapy.

Situational CRSD

Light therapy has been tested for individuals with shift work sleep disorder,^[36] and for jet lag.^[37]

Sleep disorder in Parkinson's disease

Light therapy has been trialed in treating sleep disorders experienced by patients with Parkinson's disease.^[38]

Neonatal jaundice (Postnatal Jaundice)

Light therapy is used to treat cases of neonatal jaundice^[39] through the isomerization of the bilirubin and consequently transformation into compounds that the newborn can excrete via urine and stools. A common treatment of neonatal jaundice is the bili light or billiblanket.



A newborn infant undergoing white-light phototherapy to treat neonatal jaundice.

Techniques

Photodynamic therapy

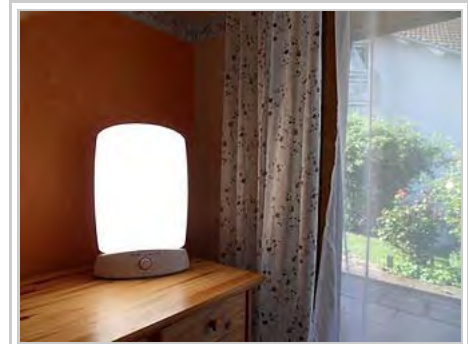
Photodynamic therapy is a form of phototherapy using nontoxic light-sensitive compounds that are exposed selectively to light, whereupon they become toxic to targeted malignant and other diseased cells

One of the treatments is using blue light with aminolevulinic acid for the treatment of actinic keratosis. This is not a U.S. FDA-approved treatment for acne vulgaris.^[40]

Light boxes

The production of the hormone melatonin, a sleep regulator, is inhibited by light and permitted by darkness as registered by photosensitive ganglion cells in the retina. To some degree, the reverse is true for serotonin, which has been linked to mood disorders. Hence, for the purpose of manipulating melatonin levels or timing, light boxes providing very specific types of artificial illumination to the retina of the eye are effective.

Light therapy uses either a light box which emits up to 10,000 lux of light at a specified distance, much brighter than a customary lamp, or a lower intensity of specific wavelengths of light from the blue (460 nm) to the green (525 nm) areas of the visible spectrum.^[41] A 1995 study showed that green light therapy at doses of 350 lux produces melatonin suppression and phase shifts equivalent to 10,000 lux white light therapy,^{[42][43]} but another study published in May 2010 suggests that the blue light often used for SAD treatment should perhaps be replaced by green or white illumination, because of a possible involvement of the cones in melatonin suppression.^[44]



The brightness and color temperature of light from a light box are quite similar to daylight.

In treatment, the patient's eyes are to be at a prescribed distance from the light source with the light striking the (lower) retina. This does not require looking directly into the light.

Considering three major factors – clinical efficacy, ocular and dermatologic safety, and visual comfort, the Center for Environmental Therapeutics (CET) recommends the following criteria for light box selection:^[45]

- Light boxes should have been tested successfully in peer-reviewed clinical trials.
- The box should provide 10,000 lux of illumination at a comfortable sitting distance. Product specifications are often missing or unverified; illuminance can be controlled using a light meter.
- Fluorescent lamps should have a smooth diffusing screen that filters out ultraviolet (UV) rays. UV rays are harmful to the eyes and skin.
- Blue light is known to be superior to red light in managing depressive symptoms which have a seasonal pattern.^[46]
- The light should be projected downward toward the eyes at an angle to minimize aversive visual glare.
- Smaller is not better; when using a compact light box, even small head movements will take the eyes out of the therapeutic range of the light.

Risks and complications

Ultraviolet

Ultraviolet light causes progressive damage to human skin and erythema even from small doses.^{[47][48]} This is mediated by genetic damage, collagen damage, as well as destruction of vitamin A and vitamin C in the skin and free radical generation. Ultraviolet light is also known to be a factor in formation of cataracts.^{[49][50]} Ultraviolet radiation exposure is strongly linked to incidence of skin cancer.^{[51][52][53]}

Visible light

Optical radiation of any kind with enough intensity can cause damage to the eyes and skin including photoconjunctivitis and photokeratitis.^[54] Researchers have questioned whether limiting blue light exposure could reduce the risk of age-related macular degeneration.^[55] It is reported that bright light therapy may activate the production of reproductive hormones, such as testosterone, luteinizing hormone, follicle-stimulating hormone, and estradiol.^{[56][57]}

Modern phototherapy lamps used in the treatment of seasonal affective disorder and sleep disorders either filter out or do not emit ultraviolet light and are considered safe and effective for the intended purpose, as long as photosensitizing drugs are not being taken at the same time and in the absence of any existing eye conditions. Light therapy is a mood altering treatment, and just as with drug treatments, there is a possibility of triggering a manic state from a depressive state, causing anxiety and other side effects. While these side effects are usually controllable, it is recommended that patients undertake light therapy under the supervision of an experienced clinician, rather than attempting to self-medicate.^[58]

Contraindications to light therapy for seasonal affective disorder include conditions that might render the eyes more vulnerable to phototoxicity, tendency toward mania, photosensitive skin conditions, or use of a photosensitizing herb (such as St. John's wort) or medication.^{[59][60]} Patients with porphyria should avoid most forms of light therapy. Patients on certain drugs such as methotrexate or chloroquine should use caution with light therapy as there is a chance that these drugs could cause porphyria.

Side effects of light therapy for sleep phase disorders include jumpiness or jitteriness, headache, eye irritation and nausea.^[61] Some non-depressive physical complaints, such as poor vision and skin rash or irritation, may improve with light therapy.^[62]

History

Many ancient cultures practiced various forms of heliotherapy, including people of Ancient Greece, Ancient Egypt, and Ancient Rome.^[63] The Inca, Assyrian and early German settlers also worshipped the sun as a health bringing deity. Indian medical literature dating to 1500 BCE describes a treatment combining herbs with natural sunlight to treat non-pigmented skin areas. Buddhist literature from about 200 CE and 10th-century Chinese documents make similar references.

The Faroese physician Niels Finsen is believed to be the father of modern phototherapy. He developed the first artificial light source for this purpose. Finsen used short wavelength light to treat lupus vulgaris, a skin infection caused by *Mycobacterium tuberculosis*. He thought that the beneficial effect was due to ultraviolet light killing the bacteria, but recent studies showed that his lens and filter system did not allow such short wavelengths to pass through, leading instead to the conclusion that light of approximately 400 nanometers generated reactive oxygen that would kill the bacteria.^[64] Finsen also used red light to treat smallpox lesions. He received the Nobel Prize in Physiology or Medicine in 1903.^[65] Scientific evidence for some of his treatments is lacking, and later eradication of smallpox and development of antibiotics for tuberculosis rendered light therapy obsolete for these diseases.^[66]

Since then a large array of treatments using controlled light have been developed. Though the popular consumer understanding of "light therapy" is associated with treating seasonal affective disorder, circadian rhythm disorders and skin conditions like psoriasis, other applications include the use of low level laser, red light, near-infrared and ultraviolet lights for pain management, hair growth, skin treatments, and accelerated wound healing.

See also

- Blood irradiation therapy
- Free-running sleep
- Low level laser therapy
- Sun tanning
- UV-B lamps

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- Our Friend, the Sun: Images of Light Therapeutics from the Osler Library Collection, c. 1901–1944 (<http://digital.library.mcgill.ca/sun/>). Digital exhibition by the Osler Library of the History of Medicine, McGill University

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