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The Institute of Registered Veterinary & Animal Physiotherapists

Photobiomodulation Therapy – The Importance of Power and Dosing

What is Photobiomodulation Therapy?

Photobiomodulation therapy is defined as a form of light therapy that utilizes non-ionizing light sources, including lasers, light emitting diodes, and/or broadband light, in the visible (400 – 700 nm) and near-infrared (700 – 1100 nm) electromagnetic spectrum. It is a nonthermal process involving endogenous chromophores eliciting photophysical (i.e., linear and nonlinear) and photochemical events at various biological scales. This process results in beneficial therapeutic outcomes including but not limited to the alleviation of pain or inflammation, immunomodulation, and promotion of wound healing and tissue regeneration. The term photobiomodulation (PBM) therapy is now being used by researchers and practitioners instead of terms such as low-level laser therapy (LLLT), cold laser, or laser therapy.

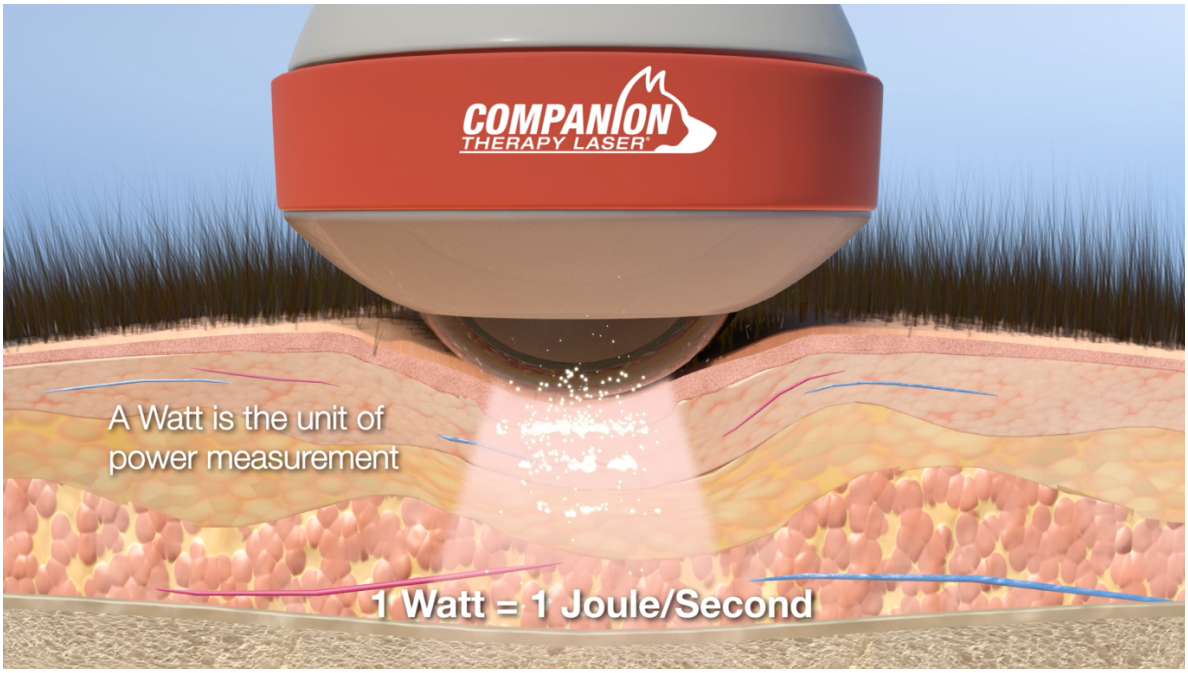
The fundamental principles that underpin photobiomodulation (PBM) therapy, as currently understood in the scientific literature, are relatively straightforward. There is consensus that the application of a therapeutic dose of light to impaired or dysfunctional tissue leads to a cellular response mediated by mitochondrial mechanisms that reduce pain and inflammation and speed healing.

The primary target (chromophore) for the process is the cytochrome c complex, which is found in the inner membrane of the cell mitochondria. Cytochrome c is a vital component of the electron transport chain that drives cellular metabolism. As light is absorbed, cytochrome c is stimulated, leading to increased production of adenosine triphosphate (ATP), the molecule that facilitates energy transfer within the cell. In addition to ATP, laser stimulation also produces free nitric oxide and reactive oxygen species. Nitric oxide is a powerful vasodilator and an important cellular signaling molecule involved in many physiological processes. Reactive oxygen species have been shown to affect many important physiological signaling pathways including the inflammatory response. In concert, the production of these signaling molecules has been shown to induce growth factor production, to increase cell proliferation and motility, and to promote extracellular matrix deposition and pro-survival pathways. Outside the cell, nitric oxide signaling drives vasodilation, which improves microcirculation in the damaged tissue, delivering oxygen, vital sugars, proteins, and salts while removing wastes.

How Does Laser Power Affect Photobiomodulation (PBM)?

The laser light energy is measured by the laser power.

Power seems simple but simply stating the output power does not relate the whole story when discussing therapy laser treatment. Not only is power important, but also the size of the area that is being treated. Typical power units for a laser are watts (abbreviated as W). Power is a measure of the number of photons emitted from the laser each second. Early therapeutic lasers had very low powers (less than 0.5 W) and very small beam areas (or spot sizes); consequently, early studies were often disappointing because the low powers were not able to provide sufficient number of photons to reach deeper affected tissue.

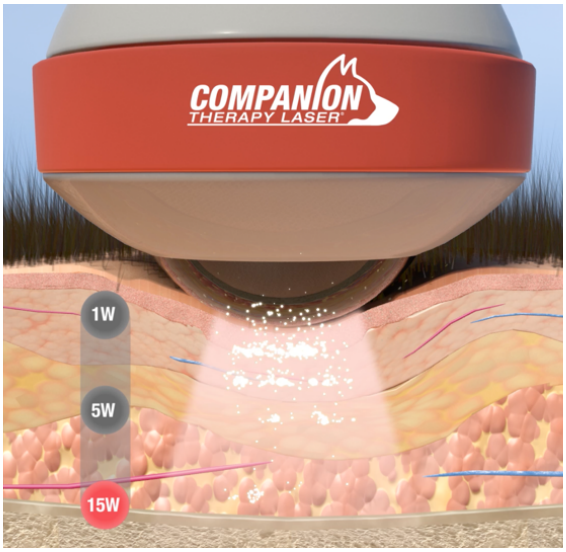


The Food and Drug Administration (FDA) classifies laser according their potential for eye damage and recognizes four major classes (I to IV) of lasers, including three subclasses (IIa, IIIa, and IIIb). In December 2003, the FDA approved the first class IV laser for the relief of minor muscle and joint pain. In October 2006, LiteCure (Companion's parent company) was formed and FDA approval for the LCT-1000 a class IV medical therapy laser was granted in February, 2007. Companion lasers are class IV lasers; they have an output power that is greater than 0.5 W.

Because class IV lasers have a higher output power, there are some additional safety considerations that should be followed when using a class IV laser. Eye safety is the most important consideration and the laser light should not be directed into an eye. The practitioner and patient should wear approved safety glasses for further protect from inadvertent beam reflections.

It is important to note that the Companion lasers not only have higher power but also have a larger beam area, making them better capable of delivering therapeutic dose to larger treatment areas.

Why are Higher Powers Needed?



Simply stated, the greater the number of photons delivered to the surface, the greater the number of photons at any tissue depth. There is a threshold, a minimum number of photons that are needed to "turn on" the therapeutic effects of laser light. Hundreds of scientific studies have been done in vitro and have characterized the dosages needed to achieve a cellular response with light. These studies provide a baseline for the amount of laser energy needed to achieve results at the cellular level. PBM therapy is non-invasive; the light is applied to the surface of the skin. Some of that light is reflected by the skin or absorbed by other chromophores that are not associated with the injured cells and therefore do not contribute to PBM. Sufficient dose needs to be applied to the skin so that despite these losses sufficient dose reaches the skin and PBM occurs at the target tissue.

Furthermore, physiotherapists are aware that the site of pain is not always the source of pain. Higher powers also enable treatment of much larger areas, allowing the therapist to address both immediate and referring sites of pain in a reasonable amount of time.

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Understanding Dosing

Companion lasers are not designed for spot treatment. The treatment area is larger than the beam area and the PBM treatment is delivered by scanning the treatment head over the treatment area in a continuous movement. Companion laser treatments are non-invasive and it is not possible to measure the dose delivered to the target tissue; it is only possible to measure the dose delivered to the surface.

However, we do know from cadaver, animal studies, and modeling that absorption of the laser in the skin and fat layers can significantly reduce the dose that gets to the target tissue. The most prevalent method of indicating laser therapy dosage is to measure the density of energy applied to the tissue surface. This is typically expressed in J/cm^2. Some variation in clinical effects can be observed; particularly at very high (>50W) or very low (<1 W) power settings using the same J/cm^2 dose.

Recent advancements in laser technology, such as the new Companion CTX-IQ Therapy Laser with the Empower IQ Delivery System, have made it easier than ever for users to deliver the correct dose, for every patient, every treatment, every time. The Empower IQ is designed to support both new and experienced laser therapy users to ensure patients get the most effective treatments. Therapists treat with confidence knowing they have the right amount of energy calculated being administered with the correct mechanism of delivery at the appropriate scanning speed. Pets benefit from optimized treatments, owners experience consistent results and are more compliant with plans of care, and staff is empowered to deliver effective treatments with confidence. Treat smarter. The future is here with the Empower IQ Delivery System.

For more information or to book a demonstration of a Companion Therapy Laser, please contact Georgina MacPhail on 01646 603878 or georginam@litecure.com.

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