

Effective Dosage Utilizing a Therapeutic Laser

By Mike Mathesie DC, DABFP, DACRB, and Rob Berman, MBA

We are asked regularly about what is critical for successful laser therapy treatments.

Number one is having a laser with a wavelength, measured in nanometers (nm), which is within the therapeutic window. Wavelengths from approximately 600 nm to 1,200 nm will allow the absorption of photons of energy for the production of adenosine triphosphate (ATP) through a series of photobiomodulation processes in the mitochondria's electron transport system.

Now that you have a laser that operates in the appropriate wavelength band, proper dosage is paramount. The key to successful treatment is getting the correct amount of laser energy to the target tissue.

Let's define a few terms so that we have a common basis to discuss dosage.

Watt (W): A unit of power equivalent to one joule of energy per second.

Joule (J): A unit of energy describing the work required to produce one watt of power for one second (one watt-second).

Joule per cm² (J/cm²): A unit of radiant exposure used in measuring the amount of energy per unit area of absorbing surface—also called the dose.

Peak power: The maximum pulse power output of a laser that is fixed by the laser manufacturer and measured in watts (W) or milliwatts (mW).

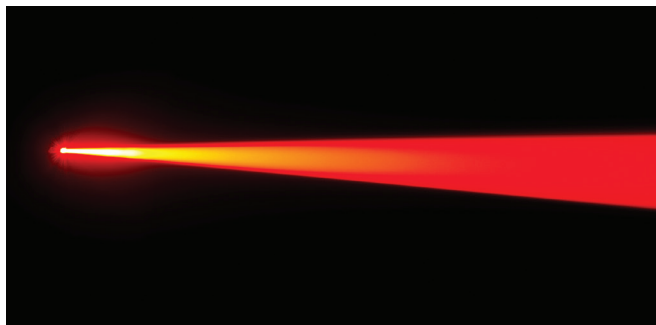
Average power: Refers to the average power per second that a laser emits during the treatment, measured in watts (W) or milliwatts (mW).

Power density: The intensity of the laser beam; average power divided by the size of beam ("spot size"); relates to the dose.

Watt per cm² (W/cm²): The unit of irradiance used in measuring the amount of power per area of absorbing surface—also called power density.

EFFECTIVE DOSAGE

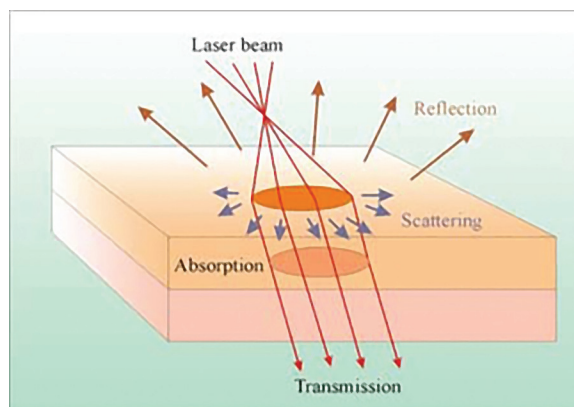
Dosage is expressed in joules per cm² (J/cm²). The following chart shows multiple ways to deliver one joule of energy.



1 J	= 1 W x 1 second
1 J	= 1,000 mW x 1 second
1 J	= 100 mW x 10 seconds
1 J	= 10 mW x 100 seconds
1 J	= 1 mW x 1,000 seconds

After reviewing the literature, we find numerous references to what the usual dosage might be. They typically range from 0.5 J/cm² to 10 J/cm² at the target tissue/organ, per location. The most often quoted is 4 J/cm² to 8 J/cm² at the target tissue/organ. The World Association of Laser Therapy (WALT) minimal dose recommendations are listed in joules not joules per cm² and are referenced from 1 J to 18 J depending on the body thickness/part and if the beam is superpulsed or continuous wave.¹ Our personal opinion is that these dosages are too low, based on clinical experience. Finally, 3 J/cm² or 5 J/cm² will be beneficial in vivo, but a large dose such as 50 or 100 J/cm² at the target will lose the beneficial effect and may even become detrimental.²

Dosage at the skin level often needs to be much higher (i.e., 0.5 J/cm² to 120 J/cm² per point/location). Why? Only some of the photons of energy penetrate the skin while most others reflect or scatter (see accompanying illustration).



LASER THERAPY

TIME IS MONEY

You need to start with a sufficiently high dosage, in joules per cm^2 , to account for reflection and scatter as well as to ensure deep penetration to underlying structures. The time to deliver each joule is dependent on the output power of the laser. Most lasers on the market are continuous wave (CW). The laser continuously emits, adding joules to the impacted body part(s). Let's take a look at the time to deliver each joule of energy based upon the average power of different continuous wave lasers. Remember, peak power and average power are identical on continuous wave lasers when utilized at their highest power setting.

The formula is $1 / \text{average power (watts)} = \text{time to deliver 1 joule}$.

- 7.5 mW takes 133 seconds
- 10 mW takes 100 seconds
- 30 mW takes 33 seconds
- 40 mW takes 25 seconds
- 100 mW takes 10 seconds
- 200 mW takes 5 seconds
- 250 mW takes 4 seconds
- 1,000 mW (1W) takes 1 second

Your staff's time and your time are valuable. The quicker the necessary joules of energy are delivered, the quicker the

treatment time.

The chart illustrates eight ways to achieve one joule of energy. All of the above parameters deliver 1 J of energy, but the clinical effects are not the same. One cannot compensate with increased treatment time for the lack of laser power or intensity.³

RULES OF THUMB TO DETERMINE TREATMENT AREA

The easiest way to consider or calculate effective dosage is to relate it to coins or playing cards. A dime is 2.52 cm^2 , a penny is 2.85 cm^2 , a nickel is 3.53 cm^2 , and a quarter is 4.63 cm^2 .

For larger areas, think of a playing card, which is 6.5 cm by 9 cm, or about 60 cm^2 . If you delivered 1,200 J by utilizing a continuous wave laser, then a 60 cm^2 area would have a 20 J/cm^2 dosage delivered at the surface of the skin. That level is a reasonable anti-inflammatory or biostimulative dosage at the surface to allow for an estimated 5 J/cm^2 at a target 2 cm deep in the body.

Again, considering the time to reach that dosage is important. Remember, peak power and average power are identical on continuous wave lasers when utilized at the highest power setting. Consider the various average powers shown below in relation to the time necessary to achieve the 1,200 J on a 60 cm^2 area of treatment.



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LASER THERAPY

Average Power	Time
30 watts	40 seconds
15 watts	80 seconds
12 watts	100 seconds
10 watts	120 seconds
1 watt	20 minutes
500 milliwatts	40 minutes
100 milliwatts	200 minutes
5 milliwatts	4,000 minutes

Our Conclusions

1. Purchase a laser with the correct wavelength (600 nm to 1,200 nm), with the understanding that each wavelength has its own limitations in ability to have an active depth of penetration.
2. Purchase a laser with sufficient average power to allow for deep penetration to targeted tissues in a reasonable time.
3. Time is money. Therefore, purchase a continuous wave laser with higher average power that allows for short treatment times.

References:

1. World Association Laser Therapy <http://waltza.co.za/>
2. Biphasic Dose Response in Low Level Light Therapy; Ying-Ying Huang, Aaron C.-H. Chen, James D. Carroll, Michael R. Hamblin; Dose Response. 2009; 7(4): 358–383. Published online 2009 September 1 doi:10.2203/dose-response.09-027.Hamblin; PMCID: PMC2790317
3. Tuner J and Hode L. The Laser Therapy Handbook. Prima Books. 2004. Sweden.



Dr. Michael Mathesie has practiced in Coral Springs, Florida for 25 years. He has taught and utilized laser therapy in his practice since 2005. During this time, he has attained two board certifications: one from the American Chiropractic Rehabilitation Board (DACRB) and the other from the American Board of Forensic Professionals (DABFP), both recognized as specialty boards of the American Chiropractic Association. Dr. Mathesie has been bestowed with the Sports Chiropractor of the Year Award, the Broward County Chiropractor of the Year Award, and the DOH Distinguished Service Award from his peers. Two governors have appointed him to the Florida Board of Athletic Training and the Florida Board of Chiropractic Medicine. He has lectured for his profession in many postgraduate subjects. He also has had a clinical case study paper accepted for publication in the peer-reviewed Journal of the North American Rehab Specialist. He can be reached at 954-755-1434.



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