Choosing your (next) laser

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As the volume of clinical evidence and anecdotal support swells, many practitioners are on the verge of adding a therapy laser to their toolkit. Therapy lasers come in a wide range of configurations and while this has the advantage of providing options to meet a wide variety of needs, it can be bewildering to the buyer who is trying to make an informed product choice.

Vendors will often differentiate their products on the strength of their brand, the volume of supportive research, training and unique features of their product. As helpful as this information may be, it does not clarify which device specifications influence treatment outcomes, nor does it clarify what type of laser is best suited to a type of practice or modality.

This article provides information that you won't easily find elsewhere. Namely, how to determine what kind of laser device you need as well as being able to compare products side-by-side on an objective basis. Laser therapy is extremely versatile, so this article confines itself to therapy lasers used for neuromusculoskeletal treatments. This article is also limited to laser-only devices, and does not cover combined devices such as laser / electro-therapy.

There are many factors that influence your choice of laser. This article groups them into regulatory, therapeutic and non-therapeutic.

Regulatory Considerations

Check if the governing board in your state places restrictions on lasers in your practice. Some will require that devices be FDA-cleared, others not. For example, the California licensing board for chiropractic introduced this requirement and it is foreseeable that other states will follow in time. A device that does not have medical device clearance is not implicitly less effective. An absence of clearance simply means that the device vendor may not make claims of a medical nature and may only sell for research purposes. If a device is not FDA-cleared, ensure that it at least complies with the FDA laser safety standards 21 CFR 1040.10 and 1040.11.

Therapeutic factors – laser light parameters

Aside from the application of treatment (including dose and frequency), the only factors that determine the therapeutic outcome are the properties of the laser light that enters the tissue. These are the wavelength in nanometers (nm), power in watts or milliwatts (W, mW), and the modulation (or pulsing) of the light in Hertz (Hz).

Power: Class 3 or Class 4?

The laser class is different to the medical device class rating, although they both pertain to human risk of injury. The laser class is a rating system developed by the FDA for all laser devices, medical or otherwise. Even your laser printer is assigned a laser class. A higher number implies a greater risk of injury, and consequently determines the safety measures that must be employed in its construction and use. The laser class is purely a risk rating and does not equate to therapeutic performance.

The laser class is determined by beam power. Class 3 ranges from 1mW to 500mW (½ W). Class 4 is anything above 500mW. There is no upper limit on Class 4. Note that the laser class of a device is

independent of total device power. A Class 3 laser device can produce more than 500mW if the light is emitted over an area. For example, some laser therapy devices employ a "cluster head" with multiple laser diodes whereby the total device power exceeds 500mW, but the individual diodes do not. Such a device is still a Class 3 laser device.

Class 4 devices are unfairly criticized as being dangerous, that you can burn your patients. This is a marketing tactic used for competitive advantage. If used as directed, Class 4 devices are not dangerous. However, there are more stringent safety requirements for Class 4 devices. Reflective surfaces, doorways and windows that can leak light are factors that may limit where you can use such a device in your practice.

Vendors of Class 4 therapeutic lasers will often state that more power is better because higher, more effective doses can be applied in a shorter time. Industry consensus is that increased power is often advantageous in pain management, but this is not true for all conditions (1) (2). Therefore, it is essential to be able to control the output power of a Class 4 device. Power control of Class 3 devices is desirable for the same reasons, but not essential due to their lower maximum power.

Comparable results can often be obtained with lower power levels at the expense of longer treatment time (or more frequent treatment). Some claim that Class 3 devices are too weak to produce results, but this opinion conflicts with favorable research findings over the last 30 years, most of which was performed with Class 3 devices.

A treatment *dose* using laser is the total energy delivered to the tissue and is calculated as the product of average power and time. Dose is measured in Joules (J). Sometimes dose is specified with respect to the surface area treated (usually in cm^2) and this version of dose in J/cm^2 is often referred to as *fluence*.

Some manufactures specify the peak power as well as the average power. Ensure that you are using the average power specification when comparing different devices. Super pulsed lasers are a notable exception in that their penetration is around twice that of a continuous or pulsed device at the same power (3). For super pulsed lasers, double the specified average power for comparative purposes.

As might be expected, device cost increases with power.

Wavelength

Cells of various tissue types contain photoreceptors (3) that convert light energy at specific wavelengths into signals that can stimulate biological processes (4), (5). In addition, chromophores within cells cause them to absorb light at specific wavelengths which is converted to heat. This heat is reradiated in the form of fluorescence and is also consumed in photobiochemical reactions.

Most laser therapy devices produce light in the red spectrum (typically 630..660nm) and/or near infrared spectrum (800..1000nm). Some newer devices use violet lasers (405nm), but other than their anti-bacteria properties, there is little in the literature on such devices.

Infrared devices provide topical and deep heating that relieves pain, increases joint mobility and relaxes muscles. Local heating also increases circulation to stimulate healing. The absorption properties of various tissue types are well known, and therefore it is simple to determine what wavelength will produce the greatest heating effect for a particular tissue type. However, you will be using the laser to treat patients, so the laser light will pass through skin, fat, muscle, vascular, connective tissue and bone. As a result of the averaging effect of passing through various tissue types, laser wavelengths from 800..1000nm produce similar results. Some devices include 808nm and 980nm lasers in order to provide greater control of where the energy is delivered. (980nm will be more superficial.)

Whereas laser devices in the infrared range are available with power output of tens of watts, those in the red spectrum (630..660nm) only have tens of milliwatts up to a few Watts. This does not mean that they are thousands of times less effective than their infrared cousins. The modality of operation is different, and red lasers are best seen as a different kind of medical device. Similar technology, but a different tool. These low power red lasers do not deliver sufficient energy to elevate tissue temperature high enough to induce photo-thermal reactions. Instead the light is consumed directly by biological process that stimulate cellular repair, growth and proliferation (6). Red laser light also appears to have a significant effect on nerve function, as observed by improved motor control and joint function. Although the mechanisms are not yet fully understood, the clinical evidence prompted the FDA to create a new medical device category of "NHN" for light therapy devices that are a "non-thermal instrument with non-heating effect".

Modulation, or Pulsing

Pulsing switches the laser light on and off repetitively. The frequency or speed of pulsing can be very slow and observable, or much faster than the eye can detect. Devices that support pulsing typically cover the range of 1..10,000Hz (10,000 pulses per second). Clinical evidence has demonstrated that pulsing the laser light can improve outcomes over a continuous illumination, and that the frequency of pulsing also effects treatment outcomes (7) (8).

It is not yet known why pulsing makes a difference and which specific frequencies are best for an indication or tissue type. Frequencies are often provided in courses and in literature for a range of indications. Although these frequencies may have years of clinical use that supports their efficacy, there is still no guarantee that they are the *best* frequencies for those conditions.

As the science of laser therapy evolves, we can expect to gain more understanding of pulsing and how to make the best use of this capability. In order to apply this knowledge as it unfolds, ensure that your laser has some flexibility to accommodate new pulse settings, either via the panel or through software updates.

Non-therapeutic Factors

Other factors such as portability, size and weight, corded or cordless operation, ease of use and cost are considerations that factor into device selection. They matter to you, but not to the patient. These factors are influenced by the modalities used in your practice and to some extent by personal taste.

Size and weight are important considerations. It is not uncommon to use the laser throughout the work day, so the associated occupational strain should be considered.

There are times when you may want to have both hand free for manual therapy while delivering laser treatment. Or you may want the option to deliver unattended treatment. For either of these situations a stand to hold the device is a valuable feature. This is often not relevant for Class 4 devices, since the treatment approach requires that the device be swept over the area of treatment.

While portability might seem unnecessary for an office-bound practitioner, if you have multiple treatment rooms or a device that is shared, then one that requires an outlet can be an encumbrance. Portability usually carries a cost premium and thus needs to be weighed up against other factors. If you're looking at a portable unit, ensure that it can either be used while charging or has sufficient battery capacity to last for a day of typical use.

A cable between a base unit and treatment head that drags across your patient can be a distraction to them, and an encumbrance to you if you are moving around your patient during treatment. Bear in mind that cordless units can be heavier as a result of having everything in the treatment head.

Other than the initial purchase cost, be mindful of hidden costs. Many lasers are recommended for recalibration on an annual basis. For portable units, check the expected battery life and replacement cost, and if the unit needs to be returned to the manufacturer. Laser diodes wear out like any other light source. Laser diodes typically have a life of more than 6,000 hours, although failure before that time due to non-ideal operating environment is possible. Laser diodes are also more susceptible to random failure than other semiconductors. For a device that may well be with you for 10 years, it is worth knowing what it costs to replace the laser diodes if they fail. In addition to factoring these costs into your budget, check if a loaner is available while yours is in for repair. You are likely to become quite dependent on your laser and will not want to be without it.

Summing up

There are many areas of overlap, so the following statements are a guide rather than a definitive position:

- Infrared lasers are used where the priority is pain relief.
- Red lasers are used as an adjunctive where the goal of treatment is functional recovery.
- More power is often advantageous (for red and infrared), but not always.
- Pulsing can improve efficacy, but experimentation is required to find the best settings.

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