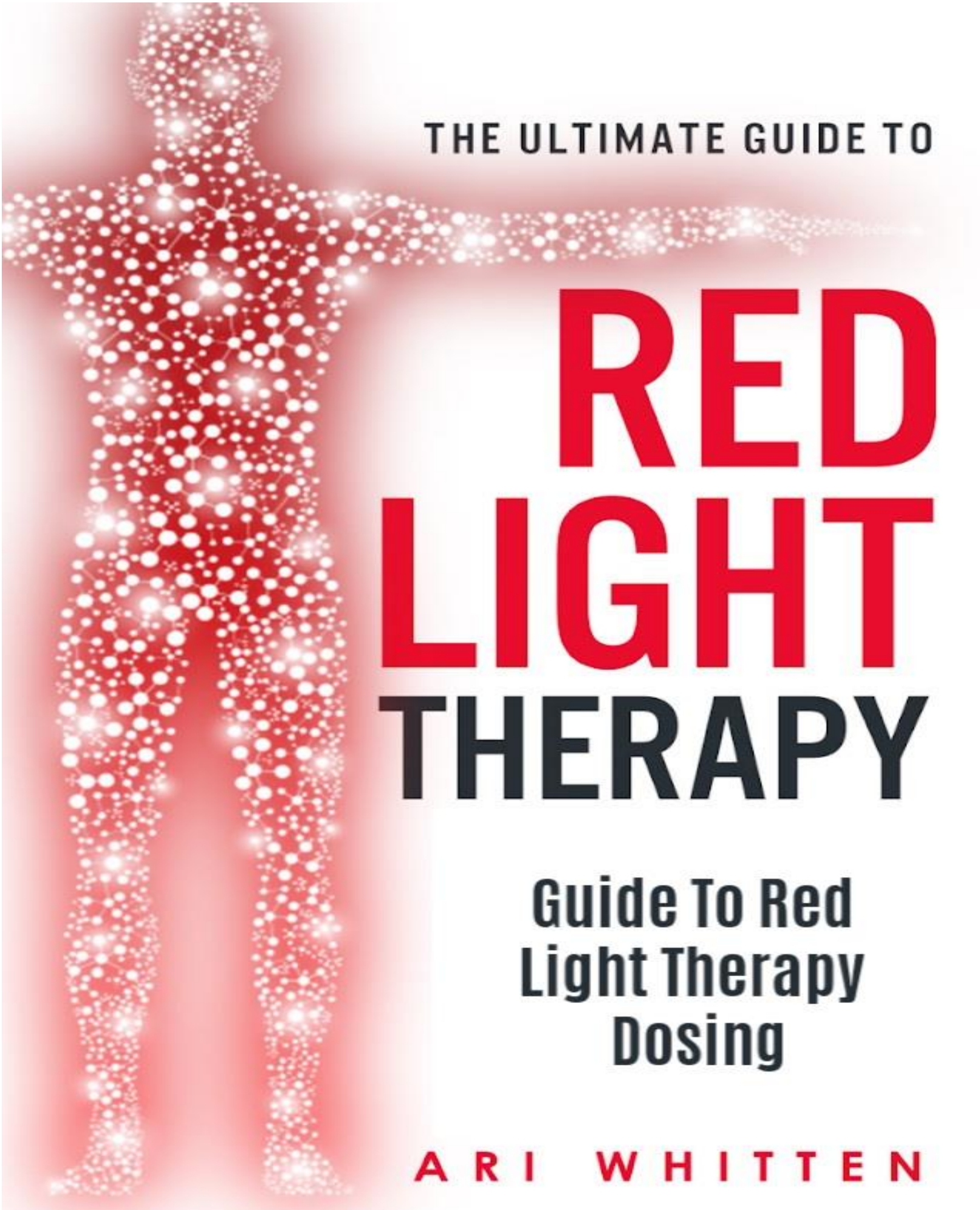


THE ULTIMATE GUIDE TO

RED LIGHT THERAPY

Guide To Red Light Therapy Dosing

ARI WHITTEN

The Ultimate Guide to Red and Near-Infrared Light Therapy

Guide to Red Light Therapy Dosing

By Ari Whitten

Guide to Red Light Therapy Dosing

Before we get into a discussion of all the factors that go into device selection and how to get the ideal dose of light, let me preface this next section by saying that **if you don't care to understand all the technical aspects of this, that is perfectly fine. You don't *need* to understand all of the factors that go into light selection, power density, joules, the nuances of the mathematical calculations and so on. If you just want the practical how-to guidance, you can skip to the summary "Key Points for Dosing."**

I will just add that you do need to pay attention to my warnings not to overdo treatments. While red/NIR light therapy is very safe, thinking that "more is better" and then overdoing treatments will actually *decrease* the effectiveness. So make sure you understand and adhere to the general guidelines for dosing.

Also, please note that dosing in red/NIR light therapy is a tricky and complex issue because of the wide variety of different types of devices (laser units vs. LED panels vs. other devices), a wide range of different doses used in various studies, the overall body surface area treated, the types of treatment (e.g. general light on an area vs. light on acupuncture points), the goals (e.g. performance enhancement vs. fat loss vs. skin anti-aging), and the specific body tissues you're trying to affect (e.g. the skin requirement is very different than that of deep tissue, and something like the brain, which sits behind the skull, may require much larger doses to deliver a significant amount of light).

Due to these complexities, different people sometimes have different views on the subject of ideal dosing. For example, I have talked to some people who recommend only very low doses, with lasers. Others who advise against lasers. Others who advise much larger doses than what I recommend here, and who think that it's basically impossible to overdose on red/NIR light therapy. So there are a number of people in this field who don't agree with each other on finer details. With all of that in mind, I am going to do my best here is to accurately represent the overall body of research and what I perceive to be general consensus of the world's most respected experts on red/NIR light therapy.

The dosing guidelines here are generally intended for use with LED panel-style light devices. (I'm assuming most people don't want to spend $2,500-$30,000 on a laser device, and want to be able to do red/NIR light therapy for less than $1,000 or $500, so I'm focusing on how to do treatments with LED panel light devices rather than lasers.)

Now, let's get into a detailed discussion of applying what we've learned.

If you want an effective light therapy session, you must have an effective dose. That requires:

- A light that is relatively powerful (i.e. has an ideal "power density")
- Ideally, a light that can treat a large area of the body at once
- An understanding of the optimal duration of time using the light to get the right total dose

Too little of a dose and you get minimal to no effects. Too strong of a dose and you get minimal to no effects.

Let's talk about power density of the light first.

As mentioned previously, most studies showing benefits of red/NIR light therapy used light outputs of 20-200mW/cm^2.

This is basically a measurement of power density – how much power the light is emitting (in watts) over how big of an area.

To put that in different terms, if you shine the light on your torso (let's say, for the sake of ease of calculation, that it's an area of 50cm x 40cm, which equals 2,000cm^2)…

And the light you're using is 200 watts (which is 200,000mW), then you have 200,000mW/2,000cm^2 = 100mW/cm^2

That's a great power density.

But, beyond this simple calculation, there are a few nuances here that make this simple calculation considerably more complex:

1. **Distance from the light.** It's also important to be aware that **this measure of power density decreases dramatically by moving further from the light source**. So you'll get the highest doses by being within a few inches of the light. Moving further away than about 3 feet from the light (as a general rule) and you'll get little to no effect on anything below the surface of the skin. (And that's using a powerful light. Many lights won't provide effective doses beyond just 12" away.) Essentially, moving closer to the light increases the potency of the light dose, and moving further away dramatically decreases the dose. However, closer is not universally better – I generally advise staying at least 6 inches away to minimize exposure to EMFs (electromagnetic fields), just to err on the side of caution. This applies to all electronic devices, from TVs to dish washers to blenders. So the sweet spot is generally between 6 - 36 inches, and we'll talk more later about when to go closer and when to move further away depending on your goals. But again, the point here is to understand that distance from the light dramatically affects the dose your cells receive.
2. **Wavelengths of the light.** Certain devices emit all the light output/wattage in the effective therapeutic wavelengths, and others emit only part of their total wattage in therapeutic wavelengths. Therefore, they may have 20-60% of their total wattage at non-therapeutic or non-optimal wavelengths. This also factors into the dose. When this is the case, it makes calculations quite complex.
3. **Claimed wattage vs. actual wattage.** The claimed wattage of a light differs from the *actual* power output of the light. This is a critical difference One thing is the claimed wattage that the light device is rated for, and another thing is the actual intensity of the light emitted. **Generally, lights emit a power density about 25-50% lower than the claimed wattage would suggest.** So the truth is that even with the calculation above, it's really just a *theory*. You don't know the *true* light intensity output of the light you get until you actually measure it. You have to rely on actual measurements using a PAR meter, rather than calculated measurements based on theoretical wattages. Don't worry – I've already done all this for you, so you don't have to worry about it. **But again, be aware that the *actual* light output of many devices may be a whopping 50% lower than what the companies are claiming! (If you're interested in learning more about this point, Platinum Grow Lights has videos on their website where they compare actual light emission from various lights that are all rated at the same wattage. They even show in the video how massively the actual light output can differ from the claimed power.)**
4. **Size of the device/treatment area.** One other nuance that's important to note here is that even if a device is technically powerful enough to create beneficial effects, it may still be too small. In other words, one can have a device that has a power density of let's say 100mW/cm^2, but it may be a device with only a few inches circumference and thus, only emits light over a small area of your body. If you're trying to treat large areas of your body, this makes things extremely inefficient and time-consuming.

Overall, the device needs to emit light above a certain power density (light intensity), needs to be at the right wavelengths, be at the proper distance away from your body, and ideally, needs to be physically large enough to emit light over a large portion of your body.

But for simplicity, let's leave all these nuances of the calculations out of it.

The next part of the equation is how long should you apply the light. The dose (duration of exposure) is calculated by:

Dose = Power Density x Time

So all we are doing is taking that number we already have (mW/cm^2) and then the "dose" can be calculated once you know how long you should apply that light for. (If this sounds complex, don't worry, because it's actually VERY simple if you get the lights I recommend). Here's the equation you need to calculate the dose:

mW/cm^2 x time (in seconds) x 0.001 = J/cm^2

Here's the critical piece of information you need to know: **The dose you want to shoot for is <u>between $3J/cm^2$ – $50J/cm^2$.</u>**

(Note: Depending on whether you're treating superficial areas like the skin or surface wounds or deeper tissues like muscles/organs, etc., you want different doses. We'll talk more about the specifics of those treatment goals in a later section of this book.)

Here are some sample calculations to show you how this works:

- $25mW/cm^2$ applied for 40 seconds gives $1J/cm^2$
- $50mW/cm^2$ applied for 20 seconds gives $1J/cm^2$
- $75mW/cm^2$ applied for 15 seconds gives $1J/cm^2$
- $100mW/cm^2$ applied for 10 seconds gives $1J/cm^2$

What that means is that if you have a device with a power output of $100mW/cm^2$ (at the distance you are using it), then you want your treatment time to be between 30 seconds-7 minutes on a given area of your body (that will equate to roughly 3-$50J/cm^2$).

If you have a device that has $50mW/cm^2$ (at the distance you are using it), your treatment time would be 1-14 minutes on each area.

That's a pretty wide range of times, so let me simplify this.

If you get either of the two top lights I recommend, they emit roughly $90mW/cm^2$ at a distance of 6" away from the light, about 55-$65mW/cm^2$ at a distance of about 12 inches away from the light, 35-$45mW/cm^2$ at 18 inches away, and 25-$30mW/cm^2$ at 24" away.

If you're a more visual person, this will help get what I'm saying here:

Irradiance at 6"	Irradiance at 12"	Irradiance at 18"	Irradiance at 24"
85-95mW/cm2	55-65mW/cm2	35-45mW/cm2	25-30mW/cm2

Now you might be wondering, "Okay, so how do I know whether to use it for 1 minute or 10 minutes? And how do I know whether to use it from 6" away or 24" away?"

Good questions!

For skin issues (e.g. anti-aging benefits) and other more superficial (near to the surface) body issues, there are a few things to note. **We want a relatively low overall dose on each area of skin, of roughly 3-15J.** Also, there is some indication that lower power densities (below $50mW/cm^2$) may actually be more optimal for treating the skin than very higher power densities. This may cause you to think that low power lights are okay, but high power lights *still* have a huge advantage because they allow you to

move the light further away (note: light spreads out and covers a larger area the further you are away from it) and thus treat a much larger area of your body at once with the optimal light intensity and dose. Smaller lights are much more inefficient and time-consuming, and limited in what they can be used for. (More on this later!)

In contrast, for treating deep tissues, you want bigger doses and higher power density (light intensity) for optimal effects. You want doses of 10-60J. So in general, you'd want to have the light much closer to your body with a much higher light intensity. That's what's needed to deliver optimal doses of light deep into your tissues.

To sum up: With skin/surface treatments, you want to be further away from the light (which lowers the light intensity and covers a broader area of your body) for an overall lower dose. With deeper tissues, you want to be closer to the light (which increases the light intensity) for an overall higher dose.

To make this very specific and practical, here are some simple guidelines:

- **FOR SKIN ISSUES:** Assuming you have one of the lights I recommend, for skin issues (e.g. anti-aging benefits) and other more superficial (near to the surface) body issues, here are my basic usage suggestions:
- Somewhere between 1-4 minutes from 12" away. (Note: For skin issues, I recommend going 12" or more away from the device, whereas with deeper tissues, you want to be closer and have higher power density to reach deeper into the tissues.)
- Or 1.5-5 minutes from 18" away.
- Or 2-8 minutes from 24" away.
- **FOR DEEP TISSUES:** For deeper issues in muscles, tendons, ligaments, bones, glands, the brain, organs, etc., you want much higher doses more in the neighborhood of 10-60J. In general, this means that you want higher power devices and you want to be 6-12" from the device (as opposed to further away as with treating the skin) to get optimal doses of light to those deep tissues. The deeper the tissue you're trying to treat, the closer to your body you want the light to be (i.e. 6" is ideal) and the higher the overall dose you want to do, so that you deliver adequate therapeutic doses to the deeper tissues. Also, for use on the brain, this may require higher doses (or doses on the higher end of the spectrum shared here) because it takes a relatively higher dose for enough light to penetrate through the skull and be delivered to the brain. Here are my general suggestions for treating deep tissues below the skin:
  - Using the light from 6" away for between 2-7 minutes per area is the ideal dose range.
  - Or 5-10 minutes per area from 12" away. (For treating deep tissues, I don't recommend going further away than 12" away from your body.)

If you get the lights I recommend, that's really all you need to know.

If you choose a different device than one I recommend, you'll have to do the calculations yourself using the above equations. And now that you know how to do all this math, you can certainly do these calculations for yourself. The only tricky part is that actual wattage is often much lower than claimed wattage for many lights, so if your calculations are based on the claimed wattage instead of actual measurements using a PAR meter, your calculations will likely be off by a fairly wide margin.

Reminder: More is not necessarily better! As you'll see below, there is something called a "biphasic dose response" whereby doing too much can actually result in a *lesser* benefit rather than more. So don't assume that "if a little is good, a lot must be better." **All you're doing is decreasing the benefit by doing more than the recommended doses**. Let me repeat that for emphasis: Doing larger doses than what I recommend will render *less* of an effect, not more.

For those of you with health struggles, if you are very ill or your health is severely compromised, be aware that you in such state you're more fragile and will not be able to tolerate as much of the light. A healthy young person may overdo the light and not really notice anything, but an ill person will

notice that they feel fatigued if they overdo it. And as an ill person is much less tolerant, their body may have a lower threshold for overdoing it compared to the younger, healthier person. So for anyone who is in very poor health (especially those who are easily overwhelmed by any type of stress or physical activity), it is very important to start with very low doses (i.e. at the bottom of my recommendations, or even lower), to make sure that your body can tolerate it. Then *slowly* increase the dose over the subsequent days and weeks to find the appropriate dose for you within the range outlined above.

Can You Overdose on Red/NIR Light Therapy? (The Biphasic Dose Response)

As I mentioned, there is something called the biphasic dose response. But what does that mean?

That means that too little red/NIR light therapy won't provide much, if any, benefit, and too much will also negate the benefit.

In other words, it's important to get the dose right and to be in the range I'm recommending. You aren't doing yourself any favors by dosing higher than my guidelines suggest.

The principle of the biphasic dose response is often explained as the Arndt-Schulz law, which dates back to the end of the nineteenth century, when H. Schulz analyzed the activity of various kinds of poisons like bromine, iodine, mercury, arsenic, etc. on yeast, where he showed that in very low doses, all of these poisons actually had a slightly stimulatory effect on the yeast metabolism. With the help of psychiatrist R. Arndt, they developed the concept (that later became the Arndt-Schulz law) which states that weak stimuli slightly increase metabolic activity, stronger stimuli increase it even more until a peak is reached, and from there, increasing the dose further suppresses the effect until a negative/harmful effect is eventually reached. Later, this concept became known as "hormesis" (which I discussed earlier.) The term "biphasic dose response" is also used.

In the context of light therapy, Hamblin et al. describe it this way:

> "Simply put, it suggests that if insufficient energy is applied, there will be no response (because the minimum threshold has not been met), and if more energy is applied, then a threshold is crossed and biostimulation is achieved. However, when too much energy is applied, then the stimulation disappears and is replaced by bioinhibition."[368]

In fact, Hamblin believes that in instances where studies don't find significantly positive effects, it's almost always because they did *too large of a dose*.

One other important aspect here is that it's much easier to do too large of doses on surface issues (like the skin) than it is for deeper tissues. The optimal doses for the skin can be reached within seconds or a few minutes with many devices, and it is very easy for people to use devices for two or three times longer than is ideal – often times, with people thinking that doing more will lead to better results – and they actually negate the benefits in the process.

Although this idea might sound odd at first, there are many common examples where we know this occurs. One example is physical exercise. In small or moderate doses, it is clearly linked with countless health benefits. But we also know that people who over-exercise can actually cause themselves a great deal of harm. It's not uncommon to hear of ultramarathon runners dropping dead from heart attacks, or developing calcification of arteries in the heart, or of female athletes over-exercising themselves into losing their menstrual cycle and fertility (hypothalamic amenorrhea). And of course, anyone who has

overdone it with exercise knows that fatigue is a common side effect. In athletes, there is "overtraining syndrome" which is associated with stalled progress, fatigue, depression, headaches, insomnia, weakened immune function, and many other symptoms.

In short, exercise is an incredible and powerful medicine for us. But only when done in the right amounts. Too much, and you may negate the benefits. And if you really overdo it in an extreme way, it actually damages your cells.

Many other things are like this too – sun exposure is associated with numerous health benefits, but if you do too much, you can get severe sunburns, accelerated aging, skin damage, and potentially skin cancer.

Red and near-infrared light are the same way. You must use them in the right dose to get the benefits. Too much and you negate the benefit.

Fortunately, red and near-infrared light are safer and have less potential for harm (when you overdo it) than either sunlight or physical exercise. Therefore, it's extremely safe! I even know some people who have used red light therapy for decades and believe that it's very hard to realistically overdo it in a way that negates the benefits. Generally, if you overdo it slightly, you won't likely notice any negative effects whatsoever. And many people won't even notice negative effects if they overdo it by a lot. But if you massively overdo the dose, it's common to feel some fatigue or get a slight headache. That's typically as bad as gets for most people. Someone with severe health issues who is more fragile may notice very significant fatigue for a day or two following overdosing it with the red/NIR light (much as they would if they overdid exercise). Basically, there is very limited potential for side effects with overdosing, particularly when compared with exercise or sun exposure.

So if you you feel a little fatigued after using it, that's usually just a sign that you overdid the dose a little. Lower the dose, and the problem is solved. Just think about this: If you got really sore and fatigued after doing an intense workout, would you conclude "exercise is terrible for you – it just makes you inflamed and fatigued… I quit!"? Or would you think along these lines: "I know that there are thousands of studies showing that exercise is highly beneficial to health, but I'm really tired and inflamed from this last workout, so I better back off the intensity/duration of the workouts and do a dose that is more appropriate for my body and my fitness level."

Hopefully the latter.

Key point: Red/NIR light is exactly the same principle.

Since this phenomenon is well-known, and we know that it applies to red and near-infrared light therapy, what causes it?

It's not completely understood, but there are several theories:

- **Excessive Reactive Oxygen Species (ROS).** All hormetic stressors produce some ROS or "free radical species." These ROS are vital for building up the internal anti-oxidant defense system (the A.R.E. or Antioxidant Response Element) and are vital for your body to gain the benefits of things like exercise or light therapy. But, they still produce free radicals that oxidize, and if they are produced in too large amounts that overwhelm the body's capacity to quench those free radicals, cell damage can occur. Also, some people may have a very weak internal antioxidant defense system that is easily overwhelmed by even small amounts of hormetic stressors like light therapy or physical exercise. In this case, the exercise or light therapy doesn't create a small stimulus that the body adapts to successfully – the body is overwhelmed by it and cannot deal with the stressor, and thus, cell damage occurs.
- **Excessive Nitric Oxide (NO).** Another potential mechanism is excessive NO release. NO serves

many vital roles in the body, and can either be protective or harmful, depending on the amount and the place it's located in the body. It's a double-edged sword. One function for example, is dilation of blood vessels. Another function is its role in the immune response to kill certain kinds of microbes that can cause infections. The right balance in the right locations is key with NO. Since it is known that red and near-infrared light affect NO release, it is possible that overdosing on red/NIR light may imbalance NO or release too much. Very high amounts of NO can lead to the formation of a highly toxic free radical called peroxynitrite, which can cause cell damage.

- **Activation of a cytotoxic pathway.** The third theory is that while low doses stimulate cells with a low dose stressor that the cells can adapt to, very high doses may activate an additional pathway that triggers apoptosis (programmed cell death). This is not unreasonable, because over-exercising can also cause severe cell damage and trigger apoptosis.[369] Hamblin et al. describe this possibility in their textbook: "high-dose LLLT was found to induce apoptosis via a mitochondrial caspase-3 pathway, and cytochrome c release was attributed to the opening of the mitochondrial permeability transition pore caused by high-level intracellular ROS generation."[370]

It is also possible (perhaps even highly likely) that these three pathways are intertwined and it's all three, rather than just one of them. But the basic idea is that much like overdoing physical activity, you can get symptoms like fatigue and headaches if you overdo red/NIR light therapy.

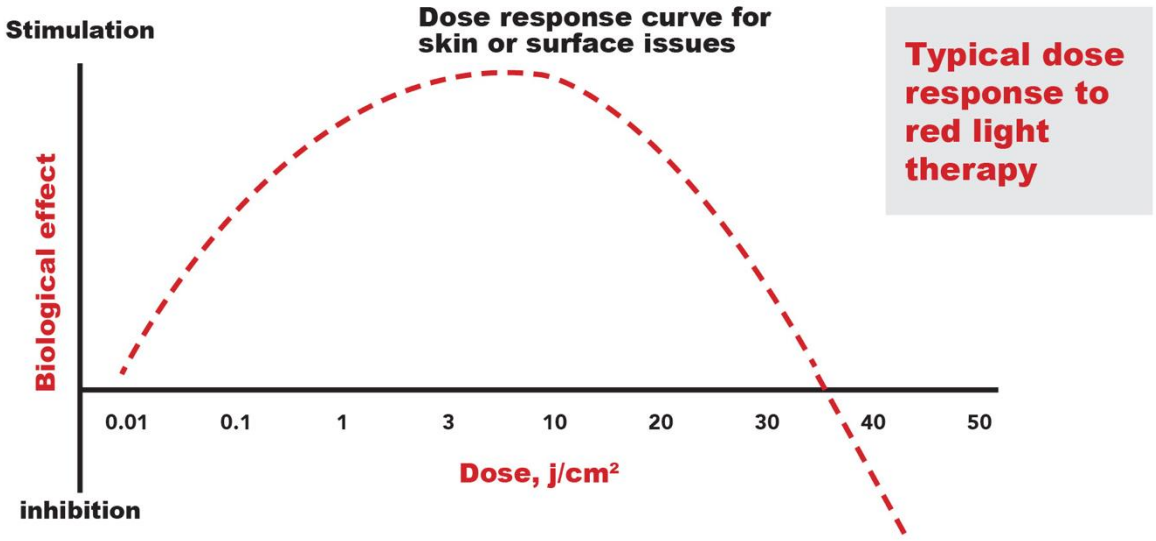
Hamblin et al. summarize the biphasic dose response by saying:

> "LLLT delivered at low doses tends to work better than the same wavelength delivered at high levels, which illustrates the basic concept of biphasic dose response or hormesis. In general, fluences of red or near-infrared as low as 3 or 5 J/cm^2 will be beneficial in vivo, but a large dose, e.g., 50 or 100 J/cm^2 will lose the beneficial effect and may even become detrimental… These advances [in our understanding of the biphasic dose response] will lead to greater acceptance of LLLT in mainstream medicine and may lead to LLLT being used for serious diseases such as stroke, heart attack, and degenerative brain diseases. Nevertheless, the concept of biphasic dose response or LLLT hormesis (low levels of light are good for you, whereas high levels are bad for you) will remain."[371]

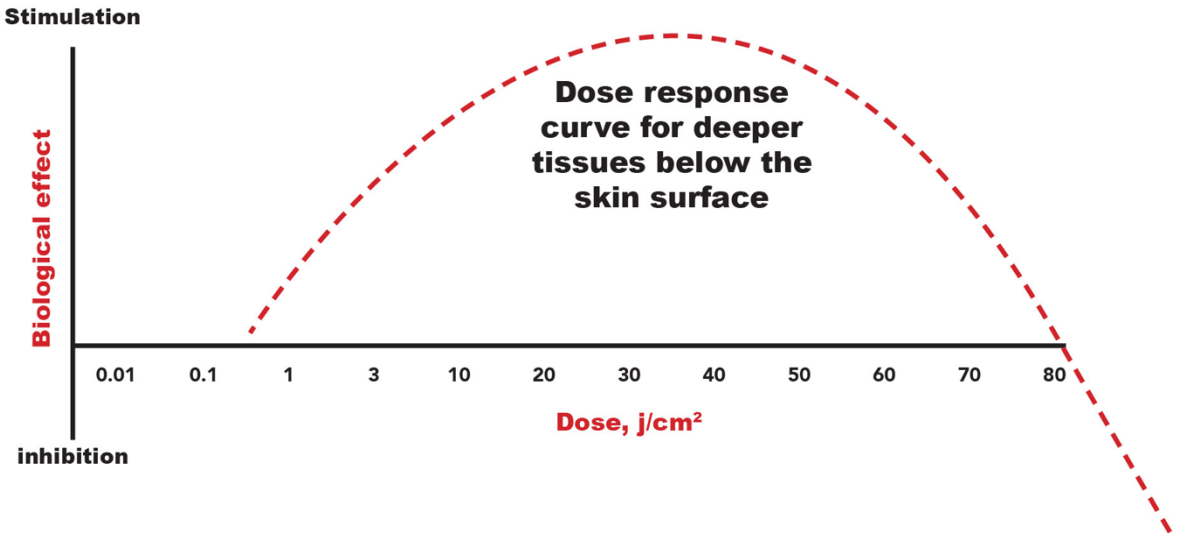
There are a number of studies that have shown that by overdoing the dose, you negate the benefits. If anything, the research indicates that smaller, more conservative doses are *superior* to very large doses.

Below are two illustrations meant to give you an idea of the surface tissues and deep tissues. (Note: These images are not exact, because actual responses differ somewhat depending on the exact tissues treated and the type of device and other parameters used – these images are intended to illustrate the general concept of the biphasic dose response and give an idea of the general range of optimal doses.)

Here is an illustration of the general optimal dose range for skin treatments (or tissues near to the surface of the body):



Here is an illustration of the general optimal dose range for deeper tissues beneath the skin:



Please know that it's perfectly fine, and may even be *better,* to stick with the lower end of my recommended ranges of doses than to try to push into the upper limits of dose ranges.

I know there is a tendency in human psychology to want to do more and think that higher amounts of something will be better – i.e. "if a little is good, a lot must be better."

So let me repeat one more time for emphasis: **With red/NIR light treatment, more DOES NOT equal better.**

Stick with the recommended dose range, start with the lowest end of the range, and don't be in a rush to do a lot more. The benefits may be most optimal in the lower to mid-range of the recommended dosage.

How Often You Should Do Near-Infrared and Red Light Therapy Treatments on Yourself

The last question to answer is "How often should you do the treatment?" The studies all use different dosing schedules, but in general, the range is from two times per week to two times per day.

As a general approach, I suggest starting slow to assess your body's response at first (with low doses done infrequently for the first few sessions) and then building up to 3-7 sessions per week.

As with the biphasic dose response (and with many other types of hormesis, like physical exercise, for example), note that it may turn out that too high of a frequency is detrimental. Although there is no consensus in the research yet, my hunch is that optimal treatment times are probably once every other day to once per day at the most. I personally do it every other day, because that's what I believe will turn out to be most optimal.

How Deep Does Red/NIR Light Penetrate Into Our Body?

The answer to this question is actually much more complex than you might imagine…

The penetration depth differs depending on many factors:

- **The type of tissues (e.g. skin vs. bone vs. fat vs. muscle).** First, it depends on exactly what part of your body you shine it on. It will penetrate much more deeply into your belly than your skull.
- **The power output of the device.** More powerful lights can deliver more light to deeper tissues of the body.
- **The distance of the device from your body.** As explained previously, the closer the light is to your body, the higher the light intensity will be and the deeper it will penetrate.
- **The wavelengths of light.** Blue light and UV light, for example, get almost completely blocked by the skin and do not penetrate much more deeply than the very surface layers of skin. Whereas red and near-infrared penetrate much more deeply. And within that category, near-infrared has significantly greater penetration depth than red light, and there are even some small differences between specific wavelengths of red and near-infrared light in terms of penetration depth.

Penetration depth is also made even more confusing due to varying claims of red/NIR light penetrating only *millimeters* into the body and other claims of it penetrating *inches* into the body.

How can we make sense of this?

Well, first of all, it is actually very easy for even a child to verify that red light penetrates much further into the human body than just a few millimeters. Take a flashlight and go into a dark room. Then shine the light through your fingers. You can see the light – specifically the red wavelengths of light –penetrates all the way through your fingers. If you have a strong enough light, some light can even penetrate all the way through the palm of your hand! So this 5-second test that you can do yourself at home can tell you that it penetrates at least an inch or more.

So why the varying claims of millimeters vs. inches?

It turns out that "penetration depth" is actually a technical scientific term within the study of light, and it has a specific definition. Most people misunderstand the meaning of this term "penetration depth."

Penetration depth "is defined as the depth at which the intensity of the radiation inside the material falls to 1/e (about 37%) of its original value at (or more properly, just beneath) the surface."

In other words, the penetration depth is technically defined as the depth that a light penetrates a specific type of substance where it loses 63% of its overall light intensity/irradiance.

In most human tissue (and this depends on the specific type of tissue, whether fat vs. bone, for example), red/NIR light may have a technically defined "penetration depth" of 3-6mm. Then over the next 3-6mm, it may lose another 63% of that remaining light, and then over the next 3-6mm, another 63% is lost, and so on. In other words, the deeper you go, the more of the overall light doesn't reach as it is absorbed in the tissues closer to the surface.

So a light may have a technically-defined "penetration depth" of 5mm, but you can take that light and shine it through your hand that is more than an inch (25mm) thick and see light coming out the other side. How does that make sense? Well, the light that penetrates all the way through your hand is not at the same light intensity as it went into your hand. That's because 63% of the light was absorbed in the first 5mm of tissue, then another 63% was lost in the next 5mm, and another, and so on, such that maybe only 5-15% of the light photons that are emitted actually penetrate all the way through your hand and out the other side. In fact, we even know that near-infrared light can penetrate through bone (like the human skull) into the brain. According to Hamblin et al.,

> "One of the best studies on penetration was provided by Tedford et al. in 2015. They performed a light-penetration study on human unfixed cadaver brain tissue … They compared 660-nm, 808-nm, and 940-nm laser penetration. 808 nm achieved the best penetration, and they concluded that 808-nmwavelength light penetrates the scalp, skull, meninges, and brain to a depth of approximately 40 mm." *372*

Penetration depth is also a confusing topic when it comes to red/NIR light because many light device manufacturers make claims about how their lights penetrate deeper than other light devices. Some also make claims about the particular pulsation of the light ("super pulses") and claim that affects penetration. (Note: Based on the evidence, pulsation of the light does not appear to affect penetration depth.) These claims make it hard to know what's really going on. But it is true that higher power devices will deliver more light to deeper tissue depths.

To sum up all the confusing concepts around penetration depth, here's what you really need to know: **Red and near-infrared light can penetrate several *centimeters* (close to 2 inches) into your body, and a high-power light with the right wavelengths (especially near-infrared) can even penetrate through the thick and dense human skull to deliver light directly into the brain.** Hamblin has given the general rule of red/NIR light penetration of "up to 5cm," which is almost exactly 2 inches. So that gives you a sense of how deep this light is actually getting into your body.

As you can see, "penetration depth" is not actually as simple a concept as one would think. But the general point here is that with high-power light sources, red/NIR light can deliver significant amounts of therapeutic light *inches* into human tissue.

The Problem with Most Devices on the Market

Now that you understand the importance of the power density of the light, here's the big problem with most lights on the market.

Most devices being sold (that you might pay $100-$900 for) are:

1. Grossly underpowered and simply too low wattage to reach therapeutic power densities of above 50mW/cm^2 with large coverage of body areas. This is especially problematic for treating deep tissues. So you'd end up having to use the light for extended periods (sometimes upwards of 20-40 minutes) to generate an effect. Moreover, the weaker lights won't penetrate deeply into the body and to even treat any deeper issues, even with extended exposure times.
2. Very small, and thus, only treat a small area of your body. Even if a small light has optimal power density, a small light that radiates light on only 5-10 square inches will require multiple treatments to cover a significant portion of your body. (Note: This is a major limitation with small LED devices.)

If I can give one piece of advice on which light to get, it's this: **Get a high-power light that reaches therapeutic power outputs, *and* is big enough to cover a significant portion of your body**.

Take it from someone who has wasted over $10,000 on underpowered red light devices (that now are just junk in my garage). I bought them before I understood everything I just explained to you about power density, dose, and how much of the body is being illuminated, thinking that just because the light was "red" that it would provide all the benefits. Nope.

I will tell you right now that 99% of the red light therapy products being sold in major outlets online are a waste of money. So please be aware of the power output and size of the light you're interested in. Not understanding those two factors caused me to waste a huge amount of money on ineffective and time-consuming lights.

I've given you all the information you need to know if a light will work or not. So if you have any interest in lights others than the devices I recommend, I suggest making sure to closely examine the wattage, wavelength, and size and do the calculations to see for yourself whether a light is quality or not. I urge you: Don't waste your money like I did!

Why You Should Get a High-Power Device

One might ask the question: "Do I really need a high-power device? Couldn't I just get a cheap low-power device and then increase the length of time I use it to get up to the recommended doses?" An alternative but similar question is: "Do I really need a large device? Couldn't I just get a small device and then just treat each area of my body separately for a few minutes – e.g. 5 minutes on my left knee, then 5 minutes on my right knee, then 5 minutes on the left cheek, and 5 minutes on the right cheek, etc.?"

This are good questions, and it's important to understand the answers to them.

Here's why low-power devices and small devices are a problem (even if you were to increase the length of time you use it):

1. **Penetration Depth:** Let's take two lights of equal size, but one light is 50W and the other is 100W. Theoretically, you could use the 50W light for twice as long (let's say 10 minutes instead of 5 minutes) and reach the same dose. And on paper, based on the simple math, this is indeed the case. **But here's the problem: More powerful lights *penetrate* more deeply into the body. They deliver more overall light deeper into the body.** So if you're trying to reach deep tissues, you may use the weaker light device for 5 or 10 times longer (than the more

powerful device) but still not deliver enough light to the target tissues to reach therapeutic levels. According to Hamblin et al.: "For example, the application of a 100-mW laser will deliver higher irradiance at a given depth than a 1-mW laser (assuming all other parameters are equal). The former might generate enough light (threshold) to produce a meaningful therapeutic effect at the required depth in the target tissue, whereas the latter will not, regardless of the length of the illumination time. Therefore, technically speaking, a claim such as 'this system penetrates deeper than others by virtue of extra-high power' may be true."[373] Simply put: If you want to treat deeper tissues below the skin, I strongly suggest getting a high power device rather than a low power device.

2. **Convenience:** Don't underestimate the simple power of being able to do an entire treatment in 1-5 minutes vs. having to do it for 10-40 minutes. A smaller and weaker light will require much longer sessions to treat a significant area (or areas) of your body. A light that can treat the entire front of your body at once and allow you to treat virtually all areas of your body in less than 5-10 minutes, whereas a smaller or weaker light may require 5-10 times longer to accomplish the same thing. (And due to differences in penetration depth, they may still be less effective.) So convenience is a huge benefit of larger and more powerful lights. For many people who are busy, this is the difference between actually *making time to do it* vs. just having another thing sitting in your garage unused because you don't have the time.

3. **Body area treated at once:** This is a huge factor as well. The bigger more powerful devices allow you to do something very cool. They allow you to stand further back from the light (2 or 3 feet away) and still have enough power output to reach therapeutic levels. This allows the light to spread out and hit a *much larger area of your body at once.* In this way, a light that is 20 or 30 inches long can effectively treat the *entire front or back of your body at once, from head to toe.* Basically, a light that size can effectively *act* the same as a light twice the size. In contrast, if you take a small light and stand 2 or 3 feet away, it's still only going to hit a relatively smaller portion of your body, but more importantly, if the light is low wattage, you have to be within 6" of it to even get therapeutic effects – so standing back 2 or 3 feet will decrease the power density so much that you're no longer getting an effective dose (even if the light is technically hitting a large portion of your body). So ideally, you want a light that is both high wattage *and* relatively large, so you can treat large areas of your body at once with effective doses.

Without getting too complicated, I should also mention that the power of the light and the distance from it also impacts the effectiveness of the dose. Even when the calculated total doses are equal between devices, results may not be the same. So if you use a powerful light for 2 minutes, the end result may be different from a much weaker device used for 20 minutes – even if the total dose of both is 10 Joules. So total dose is not the only thing that matters – the power of the light and distance from the body also influence the end result.

I believe that for both skin issues *and* deeper tissues, a high-power light is superior. This may seem counter-intuitive at first, because how could a high-power light be best for both contexts where you want to treat surface issues with low doses (and lower light intensity) *and* for deep tissues where you want higher doses (and higher light intensity)? Here's why:

- For skin issues, a high-power device gives you the ability to place it much further away from your body while still having optimal light intensities. In fact, with a high-power device, you *want* it to be further away to give a little lower power density of below 50mW/cm^2. Most importantly, the fact that light spreads as you move further from the source creates a huge advantage. By having the light source further away, it allows the light to spread and hit a *far larger area of your body at once*! So basically, it makes the treatment much more time-efficient compared to a lower power

device that is closer to your body.
- For deeper tissues, it's straightforward – you want and need high-power lights to give the intensity needed to deliver optimal doses to the deep tissues. So even if you were to use them for long periods of time, the lower power devices simply can't do the job.

Another incredibly important point is this: One of the big benefits of getting a high-power light is that – since light spreads out as you move further away – it allows you to treat much larger areas of your body while still getting an effective dose on all the parts of the body it is shining on. Remember, the power density (dose) of the light decreases as you move further away. In contrast, lower power lights need to be right next to your body for an effective dose, therefore, can only treat a much smaller area. **So with a high-power light that's less than 24" long, you can move it a little further away and treat the skin on almost the entire front or back of your body at once**! Whereas, with a lower power light of the same dimensions, it has to be much closer to your body to get an effective dose, and thus, you will only be able to treat a much smaller area. This is just one of the amazing benefit of high power lights – they allow a relatively small light less— than half the length of your body —to *function* like a light that is full body size.

In short, whether your primary objective is anti-aging skin treatments, fat loss, muscle gain, or to treat organs and glands, including the brain, high-power lights are the way to go. They allow you to do so much more and get numerous benefits, are more effective, and they can treat larger areas of the body at once, so they're far more time-efficient.

Comparing Power Densities of Light Devices from Popular Brands

Below are some photos I took of actual measurements of the power densities at different distances of several lights from the companies that I consider to be the top red/NIR light device companies on the market – the Red Rush360 by Red Therapy Co., the Bio-300 from Platinum Therapy Lights, and the Joovv Mini.

Remember what I explained previously about how actual power measurements differ from claimed measurements (which are usually based on the theoretical numbers that the lights are supposed to achieve). I wanted to provide this section for you to see the actual light intensity of these three options at various distances. Again, knowing the light irradiance (power density) of a light at a specific distance is critical to getting the dose correct. If you get any of the three lights below, you'll have the actual (rather than claimed) light output measurements at various distances, so you can dose accurately. (Note: I've already done this for you, so all you have to do is follow my dosing guidelines – you don't need to do any calculations or measure light output or anything complicated.) But if you decide to get a different light other than what I recommend, you will want to buy a PAR meter and test your device to get measurements of the actual output and dose accurately.

Before we get into the photos and measurements, I want to mention a few specifics:

For all three lights, I tested a 50-50 mix of red and near-infrared LEDs. Also note that if you get a pure near-infrared device, it will emit slightly higher outputs due to the LED bulbs themselves emitting more light output.

- If you were to measure a pure red light vs. a pure near-infrared light produced by the same company, the near-infrared device would have roughly 20-30% higher light output.
- Compared to a 50-50 mix of red and near-infrared LEDs, the pure near-infrared device would have roughly 10-20% higher light output.

- If you get a pure red light device, your light output numbers will be slightly lower, and if you get a pure near-infrared device, your light output numbers will be slightly higher.

For the sake of equal comparisons, I am using a 50-50 mix of red (660nm) and near-infrared (850nm) LEDs for each of the three brands.

(Also, please note that one might get slightly different measurements depending on the specific light output meter one uses. So you may see other people's measurements in articles online as being 5-20mW/cm^2 different than my measurements. Rather than getting caught up on the specific number, what I'm trying to demonstrate here is the differences in light output between devices, which stay the same regardless of the specific device one uses to measure light output.)

That said, below are the photos of actual light output measurements of each device at 6", 12", and 18":

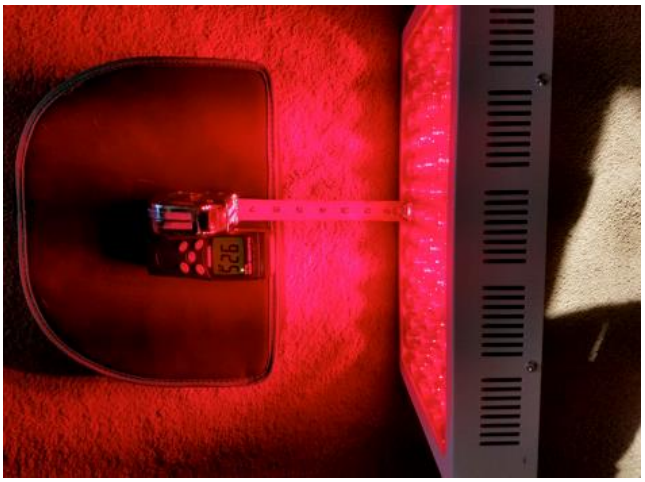
The Joovv Mini (left) Platinum BIO-300 (center) and Red Rush360 (right)

Here is a photo of all three lights side-by-side so you can get a sense of size. Note the overall number of individual LEDs – the Joovv has 60 LEDs, the Platinum BIO-300 has 100 LEDs, and the Red Rush360 has 120 LEDs. So even though they are somewhat similar dimensions in terms of casing, there is a large variance in the number of LED lamps packed within that space. Also, the Platinum light has a slight edge in terms of length, while the Red Rush360 has a significantly more expansive coverage area with its width. Also note that there are significant differences in overall wattage – the Joovv is 120W, the Platinum is 300W, and the Red Rush360 is 360W. These differences in size of the light, number of LEDs and wattage all affect how powerful the light is (especially at further distances) and how broad of an area of your body it can effectively treat at once.

Here are the light output measurements for the three lights from 6” away:

Joovv Mini (50-50 mix of red and near-infrared) from 6” – 74mW/cm2

BIO 300 (50-50 mix of red and near-infrared) from 6” – 87mW/cm2

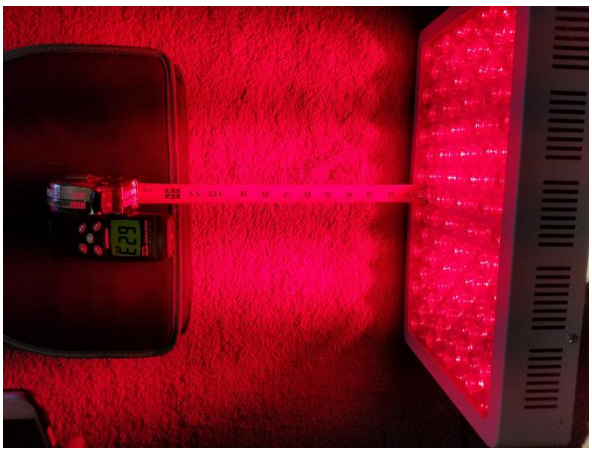


Red Rush360 50-50 mix of red and near-infrared) from 6” – 92.5mW/cm2

Here are the three lights from 12” away:

Joovv Mini (50-50 mix of red and near-infrared) from 12” – 38mW/cm2

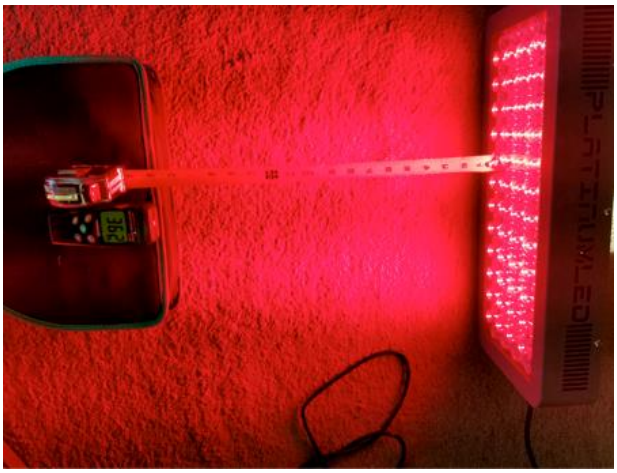
BIO 300 (50-50 mix of red and near-infrared) from 12” – 55mW/cm2



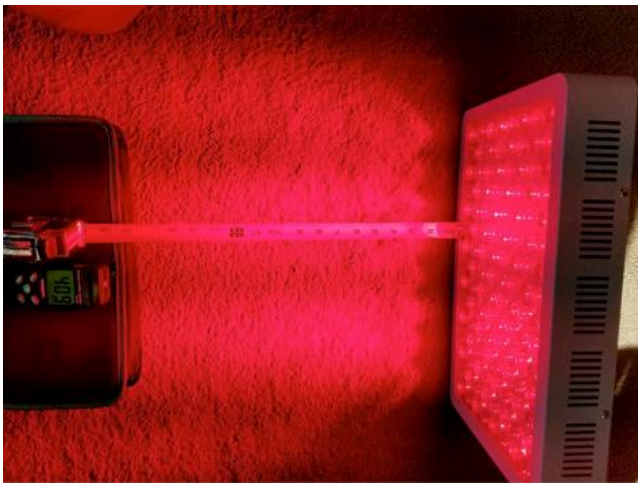
Red Rush360 (50-50 mix of red and near-infrared) from 12” – 62mW/cm2

Here are the three lights from 18” away:

Joovv Mini (50-50 mix of red and near-infrared) from 18” – 22mW/cm2



BIO 300 (50-50 mix of red and near-infrared) from 18” – 36mW/cm2



Red Rush360 (50-50 mix of red and near-infrared) from 18” – 41mW/cm2

As you can see, there are significant differences in light output between the different devices, even though they are similar in size and cost.

The Red Rush360 and Platinum BIO-300 have consistently higher light output than the Joovv. They can also treat larger areas of the body at once. All three of these lights emit enough power to be highly

effective, but do be aware of these differences in light output so that you can adjust the dose accordingly. Longer sessions are ideal with the Joovv while shorter sessions are needed with the Platinum BIO-300 and Red Rush360. Remember that my default recommended treatment times listed in this book are for the Red Rush360 and Platinum BIO-300, but I have also put notes for how to adjust the doses for anyone who wishes to purchase the Joovv Mini.

Also, notice that the further you move away, the bigger the difference between light output of each device. At 18" away, the Platinum has about 65% higher power density than the Joovv, and the Red Rush360 has about 90% higher power density than the Joovv. (Note: I didn't show photos here of 24" and 36" away, but the differences in light intensity are even larger at those distances.) These differences do have a large impact on how long you need to use them to get the right dose, so depending on the distance you're using it, the Joovv will increase session time by 20-90% to get the same dose.

The Joovv can certainly also work, but you'd want to increase the treatment times compared to the Platinum BIO-300 and Red Rush360. Also, using it from greater distances than 24" away from your body may not work well as the power density drops significantly. To adjust the dose with the Joovv, you'll want to add 20-30% more time from a close range of about 6", and if you're using the light from further away like 18" or 24", you'll want to add 60-100% more time to your session compared to the other two lights.

All three of these lights are quality devices that are certainly capable of providing effective treatments. But do note the difference in size, wattage, and light output at different distances, which impact how much of your body you can treat at once and how long you need to do each treatment.

Key Points for Dosing -- Summary:

IMPORTANT: The following recommendations are based on the lights I recommend. All these calculations change when you use lights that are less powerful than the ones I recommend. If you purchase a different light, you will need to measure the power density of that light at different distances and calculate doses for that specific light according to the guidelines in this book.

- **For general use, the light should be about 6-36 inches away from your body.**
    - Closer distances (6"-12" away from your body) are ideal for deep tissue treatments as you'll get a higher dose and much greater depth of penetration.
    - Further distances (12"-36" away from your body) are ideal for treating surface skin issues and anti-aging purposes.
- **Get a high-power light that can still deliver an effective dose from further distances.** This allows you to treat much larger areas of your body at once compared to lower power lights. This is especially important for people wanting to treat their skin for anti-aging purposes. By getting one of the high-power lights I recommend, even though they are smaller (i.e. not the size of a full human body), you can use them from a further distance away and basically treat the *entire* front or back of your body at once. Because light spreads out the further you go from the source, a light that is only 15" or 20" inches long may be able to treat 40" or 50" inches of your body at once when used at a further distance. (Again, be aware that this ONLY works with high-powered lights. If you have a low power light and you move it further away from your body, it will quickly be out of the effective range as far as the power density of the light.) This is why getting a high-powered light can be so cost-effective – even a smaller light that is high power can essentially function like a much larger light that is lower power. So take advantage of this!

- **Ideal frequency of use is likely between 3-7x/week (or up to once per day).** There are studies which have used more and less than this, but based on my experience working with hundreds of people, I believe between 3 to 7 times per week is optimal.
- **Start SLOW.** This is especially true if you are in poor health. Do not immediately assume that "more is better" by using the high end of the range of doses. It's not. It's especially not true when first starting out with red and near-infrared light therapy, or if you are in poor health. If you are in poor health, start with the lowest possible doses and SLOWLY increase the dose from there in subsequent sessions. (If you are extremely ill or severely fatigued, you can even start with lower doses than the lowest end of my recommended ranges.) Also, giving a day or two between sessions is a good idea at first.
- **Be conservative with dosing for any sensitive areas.** If you're going to use red or near-infrared light therapy on your eyes, genitals, or a raw wound on your skin (or any other particularly sensitive area), I suggest going only low doses of 2-10J (and lower may be better here).
- **For skin issues, we want between 3J to roughly 15J per area. So optimal treatment times with the lights I recommend are:**
    - 30 seconds-2.5 minutes per area (if the light is 6" inches away). (But remember, further away is likely more optimal for skin anti-aging purposes, if you get the lights I suggest. See details below.)
    - 1-3.5 minutes per area (if the light is 12" away)
    - 1.5-5 minutes per area (if the light is 18" away)
    - 2-7 minutes per area (if the light is 24" away). Remember that having it further away from the body allows you to treat much larger areas of your body at once, since light spreads out the further you move away from the light source.
    - 3-14 minutes per area (if the light is 36" away).
        - If you get the lights I recommend, for skin and anti-aging purposes, I suggest using it a little further away – from between 12" to 24" (or even 36") away from your body. Remember that moving it further away may get the light intensity in a more optimal dose for the skin, but most importantly, it has the advantage of treating larger areas of skin at once.
        - If you get the Joovv light, these tend to have lower power density than the Red Rush360 and Platinum lights. So for the Joovv lights, you'll want to add roughly 30-90% more time to the above dose ranges (especially when using the light from greater distances from your body, because the differences in power output between lights are largest from further away.) Therefore, if you would use the Red Rush360 for 5-6 minutes from 36" away, you may need to use the Joovv Mini for 8-12 minutes.
- **For deeper issues (e.g. muscle, bone, brain, organs, glands, fat, etc.), we want around 10-40J per area, so optimal treatment times and distances with the lights I recommend are:**
    - 2-7 minutes per area (if the light is 6" inches away)
    - 5-10 minutes per area (if the light is 12" away)

        - I do not recommend going further away than 12" if you're treating deeper tissues. Roughly 6" inches away is ideal for delivering the most light to the deeper tissues.
        - If you get the Joovv light, these tend to have lower power density than the Red Rush360 and Platinum lights. So for the Joovv lights, you'll want to add roughly 20-40% more time to the above dose ranges (when using them from 6-12" away from your body) E.g. If you would use the Red Rush360 for 10 minutes (from 12" away), you may need to use the Joovv Mini for 13-15 minutes to get the same dose.
        - For use on the brain, some people recommend much relatively higher doses (the high end of my recommended dose ranges), due to the fact that it's harder to deliver a significant amount of light to the brain tissues since the light has to penetrate through the skull before it can reach the brain. Thus, less overall light actually makes it to brain tissue (relative to say, treating fat or muscle tissue). As a general rule, the deeper the tissue and the more it is covered by bone, the longer doses will be needed to deliver a significant amount of light to that targeted tissue.

- **Total Treatment Dose/Time:**
    - I suggest that you limit total treatment dose for *all* areas of the body to no more than roughly 120J. So assuming the light is 6" or 12" away from your body, that means **no more than 15-20 minutes of time total with light shining on your body**.
    - There isn't adequate research on this yet, so I suggest being conservative. Here's Hamblin on this subject: *"What we don't really know is can you overdose the body on total joules or is it only when it's concentrated? That's what we don't know … Ten minutes or half an hour does no harm at all … Mostly, I tell people they can use these things for 10 or 20 minutes a day and it'll have major benefits and extremely unlikely to have any ill effects."*
    - If you use the lights I recommend for supporting muscle recovery or fat loss for example, a reasonable session might be to treat your chest and abdomen for 3 minutes from 6" away, then the front of your legs for 4 minutes from 6" away, and then your back for 4 minutes from 6" away.
        - This would give a total treatment time of 12 minutes, 24J per body area, and a **total body dose of 72J**.
    - Another example for anti-aging, would be to treat your face from 18" away for 3 minutes, the front of the legs and thighs for 3 minutes from 18" away, and the back of your legs and thighs for 3 minutes from 18" away.
        - This would be a total treatment time of 6 minutes, roughly 6J per body area, and would give a **total body dose of about 18J**.

If all of this is overwhelming, here's the quick and simple summary of the most important points for how to do red/NIR light therapy:

GENERAL RECOMMENDATIONS
FOR RED/NIR LIGHT THERAPY

- **Get a high power light that can still deliver an effective dose even when moved further away from your body**. This allows you to treat much larger areas of your body at once compared to l ower power lights.
- **Ideal frequency of use is likely between 3x-7x/ week (i.e. up to once per day).**
- **Start SLOW**. Use the lowest doses in the recommended range of doses when first starting out.
- **Be conservative with dosing for any sensitive areas.**

- **For skin issues, we want between 3J to roughly 15J per area. So optimal treatment times with the lights I recommend are:**
  - 30 seconds-2.5 minutes per area (if the light is 6” inches away)
  - 1-3.5 minutes per area (if the light is 12” away)
  - 1.5-5 minutes per area (if the light is 18” away)
  - 2-7 minutes per area (if the light is 24” away).
  - 3-14 minutes per area (if the light is 36” away).
  - For skin and anti-aging purposes, I suggest using it a little further away – from between 12” to 36” away from your body.
  - Note that having it further away from the body allows you to treat much larger areas of your body at once.

- **For deeper issues (e.g. muscle, bone, brain, organs, glands, fat, etc.), we want around 10-40J per area, so optimal treatment times and treatment distances with the lights I recommend are:**
  - 2-7 minutes per area (if the light is 6” inches away)
  - 5-10 minutes per area (if the light is 12” away)

- **Total Treatment Dose/Time:** I suggest that you limit total treatment dose for all areas of the body should be no more than roughly 120J. So assuming the light is 6” or 12” away from your body, that means **no more than roughly 15-20 total minutes of time with the light shining on your body.**

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