The Emergence of Low Level Light (Laser) Therapy in Clinical Veterinary Practice

Ronald E Hirschberg, DVM
reh1006@gmail.com

Arguably the first recorded use of Low Level Light (Laser) Therapy (LLLT) in veterinary medicine occurred in 1967 in Budapest, Hungary when Endre Meister irradiated the dermis of mice to assess whether use of LLLT would lead to the development of cancer [1]. Though his attempts were unsuccessful in proving oncogenic capability of LLLT he did note that the shaven hair on the dorsum of treated mice grew back more rapidly than that on the untreated mice. Thus the clinical use of LLLT in veterinary medicine was born. Nearly five decades later the use of photobiomodulation in clinical veterinary practice is expanding at a rapid rate.

Though multiple references can be found regarding some early work in equine medicine in the late 1980's the primary focus was equine lameness secondary to injury. In the post millennium decade use of LLLT in veterinary practice has grown dramatically as more manufacturers have found a niche in the area of companion animal practice.

FACTORS INFLUENCING ADAPTATION OF LLLT TO CLINICAL PRACTICE

Multiple factors have led to the recent boom in popularity of photomedicine in clinical veterinary practice. As technology advances the cost and size of the units have declined dramatically. Combined with increased portability, safety and ease of operation, LLLT units have found their place in an increasing number of clinical practices.

In addition to the physical and logistical changes that have led to this increased usage of light therapy in practice, simplification of application has enhanced its use. In many practices the responsibility of providing light therapy has been delegated to a veterinary technician or other trained staff member. This has occurred as manufacturers have created “fail safe” protocols in that many units have preprogrammed exposure parameters that limit, in most circumstances, the capability of injuring a patient. Although these protocols may not be the most effective for every range of condition, they reduce the requirement that a practitioner be well versed in the calculation of various treatment parameters. Whether this is positive or negative in the field of photobiomodulation is debatable. However the manufacturers of Class IV lasers are well familiar with the burning of some patients and have taken steps to reduce that likelihood. By not having the treatment probe in direct skin contact or continually scanning it over the treatment area one can reduce the injury possibility. However this also makes the dosage nearly impossible to accurately calculate.

LLLT continues to surface in the literature as an effective veterinary treatment in a multitude of conditions. As reports of efficacy become more common the clinical practitioner feels more comfortable adding this modality to the treatment arsenal. In addition, peer pressure creates urgency on the part of the veterinarian to offer at least a similar level of care as his or her colleague. As many practices have seen a decline in client visits the practitioner looks for other new means of income generation within the hospital setting. LLLT can be a potent driver of practice profits as it offers a “novel approach” for a variety of conditions that previously have eluded effective solutions. Though pharmaceutical treatments have been offered to treat many of these ailments, often they only reduce the symptoms while being accompanied by potentially serious side effects. Light therapy, however, allows for symptomatic relief while accelerating healing without fear of side effects. Medical consumers, who are often aware of pharmaceutical risks, ask for “natural” cures and treatments in increasing
frequency. LLLT provides this solution while branding a practice as one that continually examines methods to provide the best alternative for the patient. A practice that offers LLLT is seen as one that embraces high technology while existing on the cutting edge of new treatment alternatives. Most veterinary clients find this a very appealing approach to patient care.

1.1.1 Clinical Applications

As our knowledge has increased regarding the mechanism of LLLT, likewise clinical applications have expanded. We know that light in the red and near infrared spectrum are both effective wavelengths in exerting action on the cytochrome C oxidase system. We have also learned that red light, although very effective in exerting its actions on mitochondria tends to be quickly absorbed as it enters the superficial tissue layers [2]. Near infrared light with a wavelength in the 810nm range strongly effects nitric oxide uncoupling and is capable of deeper penetration [3]. Interestingly it also appears that the effectiveness of light once it enters the mitochondria is independent of whether the light is coherent (laser) or non-coherent (LED). If we are looking to use light therapy to reduce inflammation and enhance healing it can be LED generated or Laser generated depending on the depth of the target we wish to treat. Laser light is capable of deeper penetration while superficial tissues are effectively treated with LED light. However when we are seeking pain relief by reducing noicoceptive input and slowing c fiber transmission, coherent light in a continuous wave format is the treatment of choice.

1.1.1.1 Soft Tissue, Wound Healing and Ophthalmological Applications

The initial clinical application of light therapy in veterinary patients was to relieve inflammation in joints and other associated soft tissue structures such as tendons and ligaments. In companion animal medicine LLLT was utilized to treat chronic osteoarthritis and its associated pain. Wound healing became another favorite in the light therapy treatment arena as the stimulatory effect of photons became clearer [4]. The practitioner’s attention next turned to non-healing wounds and superficial hot spots, skin lesions that occur from a variety of causes yet persist as the patient tends toward self-trauma. While these initial applications still comprise the substantial part of a veterinary laser practitioner’s focus the current and future applications grow rapidly. Since most disease of animals involve inflammation of one or more structures there appears to be no limit to potential use of LLLT as a potent anti-inflammatory tool. This coupled with abovementioned knowledge of LED as an equally effective anti-inflammatory source allows for novel application to such laser sensitive structures as the eye. In ophthalmology, treatment for anterior uveitis and keratitis has become somewhat common. Perhaps the single most important ophthalmological application in our practice is in the area of corneal ulcers. Although simple corneal ulcers generally are not problematic, descemetoceles and indolent or Boxer ulcers present a treatment challenge. Though not a substitute for currently accepted treatment for this condition, the bio stimulatory effect of LLLT in speeding up fibroblastic activity results in a far shorter duration. In several instances we have had patients with indolent ulcers that were previously treated without light therapy and subsequently developed a similar ulcer in the same or contralateral eye. In the initial instance the time to cure without light therapy was several weeks utilizing appropriate surgical and medical procedures. LLLT shortened the course of the disease significantly in the recurrent cases from nearly six
weeks in one particular case to ten days in the subsequent ulcer. Though traditional medications were prescribed in all cases light therapy clearly is capable of significantly shortening length of time required to heal these ulcers.

1.1.1.2 Spinal Cord Disease

Besides ophthalmological applications LLLT, is emerging as a favored treatment in a multiple of disease conditions that previously had minimal options available. Degenerative Disc Disease with disc herniation currently has few reliable treatments other than surgical decompression. Medical anti-inflammatory and analgesic therapy is often used with minimal benefit yet frequent gastrointestinal side effects. Light therapy, however, can exert its influence by reducing inflammation and swelling of the traumatized and inflamed spinal cord. We can further mitigate the pain with use of continuous wave laser application to spinal nerve roots (inhibition) and use bio stimulation to speed up healing of weakened or damaged connective tissue structures of the vertebral bodies. Light treatment of degenerative disc disease has become one of the most common LLLT applications in our practice. These patients can often achieve a degree of comfort and mobility within a matter of hours that previously had taken days to accomplish with medications. In the only published veterinary specific study to date, Dr. Tom Shubert of the University of Florida found that LLLT significantly shortened the interval required for post laminectomy canine patients to walk without support. Specifically, dogs that had surgery but no post surgical light treatments required 10-14 days before being capable of taking a few steps. Patients who received LLLT post surgically shortened that interval to 3-4 days [5].

Figure 1.1. The MRI images reveal a severely herniated disc at L3-L4. The patient (6 year old Staffordshire Terrier) presented with severe back pain and bilateral hind leg paresis. Improvement was noted within 72 hours of two LLLT treatments and the dog was clinically normal after three light therapy treatments over seven days.

Additionally, in the area of spinal cord and CNS disease several other conditions have shown promise in their response to light therapy. Brain and spinal trauma, a common condition in feline medicine, responds well to LLLT particularly when treatment is instituted in the course of the disease. Veterinary patients often present with unclear history yet symptoms that are suggestive of spinal cord disease. The pathology may have one of many etiologies yet the effect is usually inflammatory in nature. Meningitis,
syringomyelia, spondylosis, granulomatous meningoencephalitis (GME) and cervical vertebral instability are a few of the CNS diseases that have been treated successfully with light therapy. Unfortunately as of this writing there have been few randomly controlled blinded studies. We as practitioners are limited by the current treatment information available, often anecdotal in nature. Encouraging further study by veterinary teaching facilities would greatly enhance the knowledge base in treating many of these conditions.

1.1.1.3 Orthopedic Conditions

Orthopedic applications are one of the most common areas of utilization of LLLT. Since Cranial Cruciate Ligament Rupture is often preceded by earlier bouts of trauma to this structure. The condition is thought to be a disease with an insidious course. It is suspected that application of light therapy after early strains or partial tears may promote healing and thereby prevent subsequent total tear. When the catastrophic event occurs and surgery is required, recovery, namely is time to weight-bearing, can be reduced dramatically by pre-and post-surgical application of LLLT. In addition other orthopedic conditions such as elbow and hip dysplasia, biceps brachii tendonitis, soft tissue trauma and fracture repair have all shown to benefit from the application of light. The anti inflammatory positives of light therapy can be utilized to decrease discomfort while the stimulatory effect accelerates bone healing allowing for earlier weight bearing. Accelerated migration of fibroblasts and osteoblasts, as well as increase in osteoclastic activity have all been shown to occur after the absorption of light [6]. Callous formation is sped up significantly by LLLT when applied post surgically.
1.1.1.4 Dermatology and Light Therapy

Dermatologic problems are one of the most common reasons that owners present their pets to veterinarians. Since most of the dermatologic conditions of companion animals are a superficial inflammatory process, it is easy to deliver light to target tissue. The discomfort associated with otitis externa is greatly mitigated by application of LLLT a few times after diagnosis and medical treatment of the condition. Hot spots, a self traumatic lesion that occurs secondary to a variety of etiologies, is one of the most frustrating and upsetting conditions that an owner can witness. Application of light several times during the first few days of medical treatment will significantly speed up tissue healing (biostimulation) while reducing inflammation and discomfort. Lick granulomas a chronic, relentless disease evidenced by thickened, pigmented and proliferative nodules usually on the distal part of the limbs of canines is also self traumatic in nature. Etiology is often behavioral but once initiated becomes a cyclic habit. Culture/Sensitivity yielding the appropriate antibiotics for the secondary infection is of some benefit. When LLLT is added to the regimen, resolution occurs much more quickly.

Allergic skin disease includes Inhalant Dermatitis (Atopy), Contact Dermatitis, Flea Bite Allergy as well as food allergy. Though this condition tends to be multifocal with frequently widespread signs and symptoms, it is primarily immune in nature. Recently there have been reports of improvement noted after phototherapy is administered to multiple regional lymph nodes. Hot spots, as mentioned above, have shown favorable response to LLLT and are known, in part, to be caused by allergic antigenic initiation. As more knowledge and experience is gained in the light therapy field the area of allergic skin
disease is surely one that will gain critical attention. If the early signs of effectiveness are substantiated this is sure to be one of the most frequently LLLT treated diseases in companion animal practice.

1.1.1.5  **LLLT and Metabolic Disease**

Perhaps currently one of the most controversial questions that needs answering is can we achieve adequate penetration with appropriate light doses to internal organs? Pancreatitis, Cholangiohepatitis, Inflammatory Bowel Disease and Chronic Kidney Disease are frequently diagnosed in the feline patient. There are LLLT veterinary practitioners that have related anecdotal reports of seemingly miraculous recovery in patients with these often fatal diseases. Though no randomly controlled blinded studies have been initiated as of this date, these claims raise consciousness of light therapy. Since the basis of most metabolic disease in companion animals involves primary or secondary inflammation it encourages the likelihood of finding benefit from light therapy.

Although obesity has become a major problem in our feline population, the kidneys remain one of the most superficial and accessible organs to irradiate. Chronic renal disease is often sequelae to an acute renal event resulting in injury. An inflammatory process subsequently occurs and promotes further necrosis to the parenchyma of the renal cortex. As nephrons are destroyed kidney function decreases. Kidneys with their tremendous reserve capacity compensate until nearly seventy five percent of functional tissue has been destroyed. At this point some degree of renal failure will occur. Logic dictates that irradiation of the kidneys would reduce inflammation and prevent further damage. In several cases within our practice long term light therapy (greater than six months) appears to have slowed progression of illness. Patients with chronic renal disease frequently succumb within a few days to a few months. We have now managed several light therapy patients that have survived for longer than a year and continue to have a good quality of life. One particular patient who receives bi weekly LLLT treatments at home has seen a significant decrease in serum creatinine levels as well as increased activity and engagement with the family.

Other practitioners have reported similar light therapy benefit in hepatic, gastrointestinal and pancreatic disease. Clearly this is an area of interest that has tremendous potential. It is incumbent on the academic veterinary community to recognize the importance of this science and engage in much needed high quality randomized research.

1.1.2  **Treatment Parameters**

Though there is far from uniform agreement of the precise "best" treatment protocols for any and all conditions, there are basic parameters that have shown promise. In laboratory studies as well as blinded trials in human medicine, wavelength, frequency of pulsation, irradiance, time and treatment frequency and interval are all critical in accurately describing the specific dosage of any application [7]. Though not officially recognized as a treatment parameter application pressure is also of essential importance. Since most veterinary treatments rely primarily on LED therapy, it is important to apply adequate pressure in order to gain sufficient doses at the target tissue [8].
Though it is beyond the scope of this chapter to completely discuss all the aspects of these parameters, there are a few facts that should be noted. For biostimulation and inhibition red and near infrared light 600nm-860nm is the most effective due to its penetration and absorption by cells [9]. Though red light is highly stimulatory it achieves only minimal penetration due to absorption by hemoglobin. The near infrared, however, bio stimulates nearly as well as red but is much less likely to get absorbed until it reaches some depth. Of course for superficial dermatologic lesions red wavelength is more than adequate as the target is superficial. For deeper target tissues near infrared is more practical and if these targets are deeper than 1-1.5 cm then coherent light (laser) needs to be utilized [10].

The discussion of pulsed versus continuous wave is one that has taken place over a period of several years. Pulsating light appears may be more beneficial for stimulation than continuous wave [11]. Continuous wave appears to be more effective when desiring inhibition for analgesia [12]. However one must consider frequency (speed of pulsation) as well as duty cycle (percentage of time that light source is on during one pulsation) when discussing the parameters of light therapy. It is likely that future research will yield different parameters for certain tissues, such as neural as compared to connective, muscle, dermal and osseous targets. As the use of LLLT expands to include treatment of internal organs, these parameters will need to be refined to maximize the benefit of therapy.

Irradiance or power density speaks to the uniqueness of light therapy and its observed bi-phasic dose response. The power density, as expressed in milliwatts per square centimeter can be manipulated to stimulate as well as inhibit cellular activity. When applied in the stimulatory range (5-100 mW/cm²) we accelerate healing, through a variety of pathways. Usage of a greater irradiance (300-1730 mW/cm²) results in decreasing the rate of transmission in Alpha Delta (need symbol) and C fibers as well as reducing nociceptive input, hence promoting analgesia.

The duration or time of each particular probe placement needs to be sufficient to achieve the energy density required for either stimulation (healing) or inhibition (analgesia) as prescribed for the particular LLLT unit. Energy is merely the power density or irradiance multiplied by the time in seconds. Optimum energy density is thought to be in the range of (2-3 joules/cm²) [12]. Though the above may seem a bit complicated to the new laser therapist, in many cases these parameters are preset in the treatment unit and guidelines provided by the manufacturer. However, a thorough understanding enables a practitioner to become more successful by coordinating clinical judgment, response to treatment and knowledge of the science of light therapy. Only then can the veterinarian avail him or herself of the vast treatment opportunities that LLLT provides to the patient.

1.1.3 Therapeutic Outline

Therapeutic Outline

Treatment protocols vary by time and placement of the probes depending upon the condition, severity and location of the disease being treated. In nearly all cases therapy begins by treatment of the regional lymph nodes. Though the pathway is unclear there seems to be immune modification by exposure of the lymphatics to the correct parameters of light for biostimulation. The treatment next continues to direct exposure of the target tissue with LED light if sufficient penetration can be achieved. In the event that the target is deeper than the LED penetration then a laser source may be used to sufficiently treat the target. To briefly recall it is essential to understand that penetration is dependent on the wavelength and the power density of the source not merely whether the source is coherent (Laser) versus non coherent (LED) or has a high total output. Once the target tissue is sufficiently treated the presence of edema should be addressed. If, for example, one is treating a limb, then by continuing irradiation of the venous return pathway of the affected limb he or she can considerably reduce swelling. Trigger points may then be treated if desired. Lastly a "neural blockade" to control pain is initiated by utilizing inhibitory levels of light (see above range) over the spinal segments that innervate the target area. For example if one is treating stifle osteoarthritis a neural blockade would be effected from the L1-L2 (space between the first and second lumbar vertebrae) continuing along each space until reaching L6-L7.

The frequency of treatment is dictated by the severity and the specifics of the condition. Generally the "loading dose" for light therapy requires two to three treatments per week for the first two weeks with
subsequent sessions being reduced in frequency “to effect”. For chronic conditions requiring long term maintenance, it becomes incumbent on the client to assess the effect of time as the intervals are prolonged. The treatment schedule becomes a partnership between the practitioner and the client. Prolonged intervals stretching to once every four to six weeks in frequency are often enough to achieve ongoing management of a chronic condition

1.1.4 Safety and Contraindications

When using a laser light source it is imperative that all that are present in the treatment area wear protective glasses. One should never stare directly into a laser light source. When using a Class III laser unit, the probe may be held stationary and in contact with a target tissue without risk of burning. Occasionally a patient with a solid black coat may show some mild discomfort when treated with a Class III laser source. Wetting the fur with water will reduce this sensation.

If a Class IV laser unit is utilized for therapy it is mandatory to ensure that the light source never directly contacts the tissue surface. Additionally the laser probe needs to be continually in motion to “scan” the target area. Though dose calculation becomes problematic in this scenario it is essential to avoid burning the patient.

LED light requires no special protection for any target tissue and, as outlined above, may even be utilized to treat certain ocular conditions.

The effect of LLLT on neoplasia is unknown at this point in time. Understanding that light therapy enhances circulation and accelerates some growth factors logic would dictate to avoid use in any area that neoplasia is present or suspected.

1.1.5 Clinical and Practical Benefits of LLLT

For the clinical veterinary practice the benefit of light therapy extends far beyond its effectiveness in treating a wide variety of illnesses. It satisfies many other requirements essential to successfully operate a veterinary facility in the modern world of the informed medical consumer. At a time when medical treatments have continually distanced both the practitioner and the client from the hands on interaction necessary to answer the complex question “What is best for me and my pet?”, LLLT steps up.

First and foremost light therapy offers a safe and effective treatment for many of the most common diseases that we see as veterinarians. Musculoskeletal disorders such as osteoarthritis, ligament and tendon injuries, degenerative disc disease and soft tissue traumas of all types previously have utilized non steroidal anti inflammatory drugs (NSAID’s) as the gold standard of treatment. Side effects are frequent and, if clients are casual, often result in serious gastrointestinal side effects. In some instances these complications can be life threatening. When NSAID’s are used chronically they require periodic blood monitoring and may, over long term, cause degradation of joint surfaces. In the current environment clients are frequently bombarded with media advertising outlining the effectiveness of certain pharmaceuticals but then overwhelming us with the narrative of danger. For owners whose pet companions are a central and critical part of their life, this pharmaceutical approach is unacceptable. LLLT offers them an extraordinary alternative.
LLLT is “targeted” modality. By this we mean it is essential that the practitioner becomes adept at identifying and locating the specific site of a problem. We cannot use light therapy as a “shotgun” treatment such as is often done in practice with antibiotics, steroids and other pharmaceuticals. Using a targeted therapy such as LLLT we increase our understanding of the pathogenesis of the disease. We are thus able to relieve symptoms for the patient while providing a greater comfort for the client as they know we have more specifically identified the origin of the problem.

Furthermore this enhanced understanding of the disease process enables us to involve the client in the wellness of their pet to a much greater degree. Since the life expectancy of animal companions is considerably shorter than that of humans, the speed with which the disease process progresses is greatly accelerated. This requires the client to be much more observant in partnering with the veterinary health professional in providing input as to the status of the patient. Often the client makes the decision as to how often the pet requires treatment in managing the disease. By placing a certain responsibility on the client we are encouraging “ownership” of the treatment plan and decisions. When the pet owner is asked to step into this role treatment compliance increases dramatically. The client is much more likely to attend to scheduled appointments as they have an understanding that prolonging therapy intervals may result in relapse of the patient.

The time spent in the examination room treating the patient is an invaluable educational opportunity. Whether the veterinarian or trained veterinary technician attends to the patient during the treatment, the ten minutes or so during therapy invites medical questions from the client. It also provides time for the practitioner to follow up on services that may have been suggested in the past yet not scheduled. This intimate session with client, patient and doctor or technician becomes an opportunity to connect with the client, answer questions or address other areas of concern. The physically “hands on” approach to patient care is comforting to the owner in that they observe the doctor or nurse touching the pet to a much greater degree than is usually witnessed. The pet is generally very receptive to the LLLT and in most instances becomes so conditioned to the sense of comfort and well being that (suggested to be a result of endorphin release) they fall asleep. For the client this is reassuring seeing their companion so relaxed in the hands of a practitioner. The whole experience is a great opportunity to build client and patient rapport and hospital reputation.

Concluding, LLLT provides a highly effective yet minimally invasive form of treatment for a variety of diseases that, in many instances have no other alternative therapy. In providing this modality to the patient we can rapidly reduce symptoms, modify the course of disease, and significantly reduce pain and suffering. As the pet owner is present during the treatment process, light therapy offers an opportunity to showcase our skill, caring and scientific knowledge. We involve the client in decision making enhancing their understanding of the disease process. We must not forget that all of the above can be easily provided with a minimal investment in technology without fear of any harmful side effects.

### 1.1.6 Future of Photobiomodulation in Veterinary Practice

So where will we go from here in the field of LLLT? As we gain greater understanding of tissue response to given parameters of light, it seems as if few conditions will elude exposure to this therapy. Current work with metabolic and neurological disease has been most encouraging. As inflammation is often “the root of all evil” in the disease process, the universal use of light treatment in nearly every disease can be imagined. Inflammatory liver disease in felines, seizure disorders in canines, cognitive dysfunction, chronic renal disease, ophthalmological disorders, traumatic brain injury and perhaps every type of orthopedic disorders known to medicine will likely come under the exposure of light at some time in the near future. It is now incumbent that our academic institutions answer the challenge of LLLT. RCT’s, education of students as well as continuing education for all veterinarians in the field of light therapy must be the next logical step in bringing this science and technology to the position it deserves in the practice of veterinary medicine.
1.1.7 References and citations:

7. Thor study on LED vs. 1W penetration.