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## Ignorance of photobiology: a major pitfall in using lasers in medicine

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Dear Editor,

Low level laser therapy, using either visible or infrared radiation, has been reported to be highly successful and has also been reported to be a dismal failure, in the management of several different kinds of pain. It is not the purpose of this note to evaluate critically every paper on this subject but rather to point out to your readers the *First Law of Photochemistry*, which states that 'light must be absorbed before photochemistry can occur.' Photobiological effects are the consequence of such photochemistry.

A recent paper published in *Pain* [2] on nerve stimulation by light as related to the low level laser therapy of pain states that 'the cornea is an ideal preparation for this investigation: (1) it is optically transparent to He-Ne laser radiation which assures that the entire nerve is actually exposed to any potential effects of this radiation: ...'

If this 'ideal' property of the cornea is really true, i.e., it is truly optically transparent to 632.5 nm radiation, then from the *First Law of Photochemistry* one can immediately prove without any doubt that the experiments will be negative, as in fact they were. By determining a simple absorption spectrum on any chemical or biological system of interest, one can immediately tell whether light of a given wave length will be absorbed by that system and, therefore, whether there is the possibility for a photobiological effect on that system.

Furthermore, to my knowledge no one has ever claimed that low level laser therapy can make normal cells perform better than normal. On the contrary, there are considerable data to show that only cells that are compromised can be stimulated by light to function more normally [e.g., 3]. Thus, normal corneas may not be the best choice of tissue on which to study the effects of low level laser therapy on pain.

A number of years ago, the phototherapy of herpes virus got a bad name because physicians just grabbed photosensitizing dyes off the shelf and tried them. These dyes turned out to be ones that photodamage DNA, not only the DNA of the virus but also the DNA of the cells of the patient, and these treatments were shown to cause transformation in human cells in culture [1]. Other photosensi-

tizing dyes act on lipids, and such dyes photoinactivate the lipid-containing herpes virus and should not produce transformation [4].

My point is that phototherapy is potentially a very good treatment for herpes infections if performed sensibly, but it was not, and now this type of therapy no longer exists. I am concerned that low level laser therapy may suffer the same fate by being denegated by people who run the wrong experiment, or who even run the right experiment, but do it badly. There are a number of cases where medical phototherapy is very successful (e.g., treatment of hyperbilirubinemia, tumor therapy), because it has been done correctly by combining good knowledge of medicine and of photobiology.

Low level laser therapy will not work for every ailment at every wave length, dose and treatment schedule. If low level laser therapy at a given wave length proves to be ineffective for a certain type of pain, I hope that it will be ineffective in its own right, and not be due to the ineffectiveness of the investigator. Before using lasers, physicians and scientists should learn the 'facts of light.' They should learn some photobiology. Photomedicine has great potential in the right hands.

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## Reply to 'Ignorance of photobiology: a major pitfall in using lasers in medicine' by K.C. Smith

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Dear Editor,

In our publication on helium–neon (HeNe) laser effects on cornea nerves [7] we state, 'it (the cornea) is optically transparent to HeNe laser radiation ...'. By this we mean that HeNe laser irradiation was not totally absorbed or reflected from the corneal surface but most penetrated through the corneal layers to reach nerve endings as well as axon regions of nerve fibers. Our study clearly demonstrated that corneal absorption of HeNe laser radiation occurs. Several other studies [2,8,15] have investigated laser energy interaction (including 632.5 nm) with corneal tissue. Our thermodynamic modeling used these data (absorption coefficient of  $1.44 \text{ cm}^{-1}$  and transmission of 92.4%) and the thermal effects of HeNe energy absorption were shown in Fig. 1 of our paper [7]. It is clearly shown that HeNe laser radiation of the cornea results in heating of the tissue and this, according to the *First Law of Thermodynamics*, requires that energy be absorbed. Therefore, the *First Law of Photochemistry* is observed and photobiological effects can occur in this tissue.

We agree with the suggestion of Dr. Smith that injured regenerating nerves could be looked at and we may pursue this. It should be pointed out, however, that we did study laser effects on stimuli which are known to be noxious when applied to human cornea and which activated both A $\delta$  and C fibers in our preparation. In addition to noxious thermal, chemical and mechanical stimuli, we also studied laser effects on electrically evoked discharge of A $\delta$  and C fibers; since electrical stimulation had been used in a previous clinical study [10]. We did not observe any effect of HeNe laser irradiation on either naturally evoked discharge or electrically activated fibers.

Whether low level laser therapy is effective for pain control was not addressed by our investigation, although clinical reports suggesting that it alters neuronal activity or is effective for pain relief prompted our study [10,12,13]. We agree with Professor Smith that further work should be done and our discussion states 'controlled prospective clinical studies need to be conducted ...'. Three such studies were in fact reported in the same issue of *Pain* [3,5,6] and all concluded that there was no significant difference between the laser and placebo. In addition, other double-blind clinical studies have

demonstrated that HeNe laser energy is not effective for pain management [1,4,9,11,14].

In summary, it is clear that our experiments were fully compatible with the *First Law of Photochemistry* and that laser effects were studied on pain fiber responses to noxious stimuli. Our study, together with others [8–15] indicates that photobiologists need to recognize the *First Law of Therapeutics* (rule out placebo effects) before advocating the use of low level laser therapy for treatment of pain. Photomedicine has too great a potential for misuse in the wrong hands.

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