

Nitric Oxide and Its Role in Health and Diabetes.

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Part 9. How Light (Photo Energy) May Increase Local NO and Vasodilation

Light mediated vasodilation was first described by R F Furchgott, in his nitric oxide research that led to his receipt of a Nobel Prize in 1998. Later studies conducted by other researchers confirm and extend Furchgott's early work and demonstrate the ability of light or photo energy to influence the localized production or release of NO and stimulate vasodilation through NO's effect on cGMP (as discussed in detail in Part 4). This finding suggests that properly designed illumination devices may be effective, noninvasive therapeutic agents for patients who would benefit from increased localized NO availability.

At first blush, some might question that something as simple as light can have such a profound biological effect. However, the biological importance of light has been recognized for quite some time. Various wavelengths of light are absorbed by chemical compounds, which then lead to biologic responses. Sunlight absorbed by chloroplasts in plant cells permits formation of starch. Sunlight absorbed by human skin generates vitamin D. Blue light applied to the back of the knee will alter human circadian rhythm. Some wavelengths of light, including near infrared and ultraviolet (UV) light cannot be seen with the human eye, and yet UV causes biologic effects, especially in the skin. Near infrared photo energy also exerts biologic effects

All light, visible or invisible, consists of photons. The size or mass of the photons is dependent on the specific wavelength of the light. Considerable research has been conducted about light (photo energy). This research shows that the target tissues must first absorb light in order to have a biological effect. Additionally, absorption is best achieved when the light is 1) directed perpendicular to the skin, and 2) placed in direct contact with the skin. Moreover, photo energy emitted from a source that produces of a homogenous wavelength is often more effective therapeutically than light composed of several wavelengths (for example white light)

Recent research supports the hypothesis that some wavelengths of photo energy are absorbed by hemoglobin and that intense illumination can release the NO from hemoglobin (specifically from the nitrosothiols in the beta chain of the hemoglobin molecule) in red blood cells (RBCs). This finding provides the basis of a potentially

profound noninvasive therapeutic device for patients who would benefit from increased localized NO availability. Since RBCs are continuously delivered to the area of treatment, there is a natural supply of NO that can be released from each new RBC that passes under the light source and is exposed to the appropriate wavelength of photo energy. Since the half life of the NO released under the area of illumination is only 2 to 3 seconds, NO release is very local, preventing the effect of increased NO from being manifested in other portions of the body. What's more, dosage is taken care of the body itself. As you will recall, vasodilation from NO is based its effect on the enzyme Guanylate Cyclase (GC), which forms cGMP to phosphorylate myosin and relax smooth muscle cells in the vascular system. Once available levels of GC are saturated with NO, or once maximum levels of cGMP are achieved, further vasodilation through illumination will not occur until these biologic compounds return to their pre-illumination status.

One device that employs illumination to apparently increase the localized levels of NO is The Anodyne Therapy System. This FDA cleared medical device delivers near infrared (890 nm) photo energy from 60 super luminous diodes mounted on flexible pads that can be placed in direct skin contact; in addition, the flexible pads assure that the photo energy is delivered perpendicular to the skin to maximize absorption. Tests conducted with a scanning laser Doppler (Moor Instruments) demonstrate that the near infrared photo thermal energy delivered by the Anodyne Therapy system can increase localized microcirculation by as much as 3200% after just 30 minutes. Further tests show that increased microcirculation achieved by the Anodyne Therapy System on neuropathic feet is 10 times more than that achieved with warmth alone.

In summary, intense illumination of the skin may non-invasively increase the localized release of NO from hemoglobin. The effectiveness of the illumination is dependent upon absorption by the targeted tissues, which is based on wavelength, skin contact, and perpendicular delivery. The potential net effects of skin contact illumination are those we have previously discussed in relation to NO, i.e., better blood flow via stimulation of GC, acute delivery of growth factors and white blood cells, fibroblastic differentiation and proliferation, angiogenesis, reduced edema, and mediation of pain.

The next article will be a summary of the biology of NO, as outlined in previous parts of this series; in addition, we will discuss how this very important molecule regulates so many other important biologic functions which are important for the health of diabetic patients.

Dr. Tom Burke received his PhD in Physiology from University of Houston, Post Doctoral Training at Duke Medical School, He was an Associate Professor of Medicine and Physiology at the University of Colorado Medical School. He has authored more than 70 published scientific clinical articles and has been a visiting scientist at the Mayo Clinic, Yale University, University of Alabama, and University of Florida. He is a recognized international lecturer on cell injury and nephrology.