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PHOTOMODULATION OF CYTOCHROME OXIDASE

C Amlie-Lefond[1], J Eells[1], M Wong-Riley[1], R Das[1], M Jett[1], J VerHoeve[1], H Whelan[1]

[1] Medical College of Wisconsin, Milwaukee, WI, United States

Objectives: Photobiomodulation by red to near infrared light is believed to activate mitochondrial respiratory chain components promoting cytoprotecton. Recent studies in our laboratory demonstrate that the action spectrum for stimulation of cytochrome oxidase activity and cellular ATP parallels the near-infrared absorption spectrum of cytochome oxidase and that 660–680 nm irradiation upregulates cytochrome oxidase activity in cultured neurons. Methanol intoxication injures the retina and optic nerve. Via formic acid, a mitochondrial toxin of cytochrome oxidase. KCN (potassium cyanide) also poisons cytochrome oxidase, and has been used to assess the efficacy of 660–680 nm irradiation for mitochondrial neuroprotection. **Methods:** We hypothesized that exposure to monochromatic red radiation from light-emitting diode (LED) arrays would protect the retina against formate toxicity, and improve mitchondrial function in a rodent model of methanol toxicity.

Results: 670 nm LED treatment significantly attenuated the retinotoxicity of methanol-derived formate. Gene expression profiles in the retina of untreated rats compared with those from the retina of methanol-intoxicated rats and LED-treated methanol-intoxicated rats showed striking differences in genes from cytochrome oxidase family, peroxiredoxin family and genes involved in cell growth and maintenance which may play an important signaling role in the activation of retinoprotective processes following LED treatment. Mitochondrial membrane potential and mitochondrial dehydrogenase activity were also increased, and apoptosis was attenuated, by LED treatment of neuronal cells exposed to the mitochondrial toxin KCN.

Conclusion: The results suggest that photobiomodulation with red to near infrared light augments cellular energy production and neuronal function following mitochondrial injury linking the actions of red to near infrared light on mitochondrial oxidative metabolism in vitro and cell injury in vivo. We propose that NIR-LED photobiomodulation represents an innovative therapeutic approach for disease processes in which mitochondrial dysfunction is postulated to play a role including Leber's hereditary optic neuropathy and Parkinson's disease.

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