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In Vitro Bactericidal Effects of 405-nm and 470-nm Blue Light

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ABSTRACT

Objective: **The aim of this study was to determine the bactericidal effect of 405- and 470-nm light on two bacteria, *Staphylococcus aureus* and *Pseudomonas aeruginosa, in vitro*. *Background Data:* It is well-known that UV light kills bacteria, but the bactericidal effects of UV may not be unique since recent studies indicate that blue light produces a somewhat similar effect. The effects of blue light seem varied depending on wavelength, dose and the nature of the bacteria, hence this study. *Methods:* Two common aerobes, *Staphylococcus aureus* and *Pseudomonas aeruginosa*, and anaerobic *Propionibacterium acnes* were tested. Each organism was treated with Super Luminous Diode probes with peak emission at 405 and 470 nm. Treatment was timed to yield 1, 3, 5, 10, and 15 Jcm^{-2} doses. Colony counts were performed and compared to untreated controls. *Results:* The 405-nm light produced a dose dependent bactericidal effect on *Pseudomonas aeruginosa* and *Staphylococcus aureus* ($p < .05$)), achieving as much as 95.1% and nearly 90% kill rate for each, respectively. The 470-nm light effectively killed *Pseudomonas aeruginosa* at all dose levels, but only killed *Staphylococcus aureus* at 10 and 15 J cm^{-2}. With this wavelength, as much as 96.5% and 62% reduction of *Pseudomonas aeruginosa* and *Staphylococcus aureus* was achieved, respectively. Neither of the two wavelengths proved bactericidal with anaerobic *Propionibacterium acnes*. *Conclusion:* The results indicate that, *in vitro*, 405- and 470-nm blue light produce dose dependent bactericidal effects on *Pseudomonas aeruginosa* and *Staphylococcus aureus* but not *Propionibacterium acnes*.**

INTRODUCTION

LIGHT THERAPY has been suggested as a potentially effective treatment for a variety of human conditions. Suggested amenable conditions range from sleep disorders,[1] photoaged facial skin,[2] depression in the elderly,[3] and treatment of acne vulgaris[4] to a variety of neuromusculoskeletal conditions such as peripheral neuropathy,[5] second degree ankle sprains,[6] and osteoarthritis of the knee[7] and cervical spine.[8]

Papageorgiou et al.[9] reported a significant improvement in the condition of patients suffering from acne vulgaris resulting from exposure to a combination of red (660-nm) and blue (415-nm) light. They postulated that this combination provided both an anti-inflammatory benefit (red light) and an antibacterial benefit (blue light). Blue light has been shown to kill bacteria in the tissue.[16] Studies[10,11] have demonstrated bactericidal results using light therapy at 810 and 630 nm. Low-level light therapy at 685 and 830 nm has recently been shown to increase collagen production and organization resulting in improved wound repair.[12]

Not all studies dealing with the application of light therapy have demonstrated a bactericidal effect. The results seem to be associated with wavelength and type of organism. Nussbaum et al.,[13] while reporting a bactericidal effect at 630 nm for *Pseudomonas aeruginosa* and *E. coli*, also found that a wavelength of 810 nm facilitated growth of *E. coli.* These researchers also noted that growth of *Staphylococcus aureus* was facilitated by exposure to a wavelength of 905 nm.

With such an intriguing array of conditions that might respond to light therapy, we attempted to evaluate blue light therapy in terms of its bactericidal potential. As mentioned above, some studies[4,9–11,16] have suggested that light therapy may retard

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