Blue Light and Methycillin Resistant Staph Aureus (MRSA)

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Blue 470-nm light kills methicillin-resistant Staphylococcus aureus (MRSA) in vitro.

Enwemeka CS, **Williams D**, **Enwemeka SK**, **Hollosi S**, **Yens D**.

School of Health Professions, Behavioral, and Life Sciences, New York Institute of Technology, Old Westbury, New York 11568-8000, USA. Enwemeka@nyit.edu

BACKGROUND DATA: In a previous study, we showed that 405-nm light photo-destroys methicillin-resistant Staphylococcus aureus (MRSA). The 390-420 nm spectral width of the 405-nm superluminous diode (SLD) source may raise safety concerns in clinical practice, because of the trace of ultraviolet (UV) light within the spectrum. OBJECTIVE: Here we report the effect of a different wavelength of blue light, one that has no trace of UV, on two strains of MRSA--the US-300 strain of CA-MRSA and the IS-853 strain of HA-MRSA--in vitro. MATERIALS AND METHODS: We cultured and plated each strain, and then irradiated each plate with 0, 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 25, 30, 35, 40, 45, 50, 55, or 60 J/cm2 of energy a single time, using a 470-nm SLD phototherapy device. The irradiated specimens were then incubated at 35 degrees C for 24 h. Subsequently, digital images were made and quantified to obtain colony counts and the aggregate area occupied by bacteria. RESULTS: Photo-irradiation produced a statistically significant dose-dependent reduction in both the number and the aggregate area of colonies formed by each strain ($p < 0.001$). The higher the dose the more bacteria were killed, but the effect was not linear, and was more impressive at lower doses than at higher doses. Nearly 30% of both strains was killed with as little as 3 J/cm2 of energy. As much as 90.4% of the US-300 and the IS-853 colonies, respectively, were killed with an energy density of 55 J/cm2. This same dose eradicated 91.7% and 94.8% of the aggregate area of the US-300 and the IS-853 strains, respectively. CONCLUSION: At practical dose ranges, 470-nm blue light kills HA-MRSA and CA-MRSA in vitro, suggesting that a similar bactericidal effect may be attained in human cases of cutaneous and subcutaneous MRSA infections.

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Inactivation of bacterial pathogens following exposure to light from a 405-nanometer light-emitting diode array.

Maclean M, **MacGregor SJ**, **Anderson JG**, **Woolsey G**.

The Robertson Trust Laboratory for Electronic Sterilisation Technologies, University of Strathclyde, 204 George Street, Glasgow, Scotland. michellemaclean@eee.strath.ac.uk

This study demonstrates the susceptibility of a variety of medically important bacteria to inactivation by 405-nm light from an array of light-emitting diodes (LEDs), without the application of exogenous photosensitizer molecules. Selected bacterial pathogens, all commonly associated with hospital-acquired infections, were exposed to the 405-nm LED array, and the results show that both gram-positive and gram-negative species were successfully inactivated, with the general trend showing gram-positive species to be more susceptible than gram-negative bacteria. Detailed investigation of the bactericidal effect of the blue-light treatment on Staphylococcus aureus suspensions, for a range of different population densities, demonstrated that 405-nm LED array illumination can cause complete inactivation at high population densities: inactivation levels corresponding to a 9-log(10) reduction were achieved. The results, which show the inactivation of a wide range of medically important bacteria including methicillin-resistant Staphylococcus aureus, demonstrate that, with further development, narrow-spectrum 405-nm visible-light illumination from an LED source has the potential to provide a novel decontamination method with a wide range of potential applications.

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In vitro bactericidal effects of 405-nm and 470-nm blue light.

Guffey JS, **Wilborn J**.

Physical Therapy Plus, Bauxite, Arkansas 72011, USA. drguffey@earthlink.net

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 Jcm2 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 cm2. 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.

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Effects of combined 405-nm and 880-nm light on Staphylococcus aureus and Pseudomonas aeruginosa in vitro.

Guffey JS, **Wilborn J**.

Physical Therapy Plus, Bauxite, Arkansas 72011, USA. drguffey@earthlink.net

OBJECTIVE: The aim of this study was to determine the effect of a combination of 405-nm blue light and 880-nm infrared light on Staphylococcus aureus and Pseudomonas aeruginosa in vitro. BACKGROUND DATA: Reports indicate that certain wavelengths and treatment parameters of light promote the growth of bacteria, but our earlier study indicates that light at specific wavelengths and intensities are bactericidal for specific organisms (1). METHODS: Two common aerobes, Staphylococcus aureus and Pseudomonas aeruginosa were tested because of their frequent isolation from skin infections and wounds. Each organism was treated simultaneously with a combination of 405-nm and 880-nm light emitted by a cluster of Super Luminous Diodes (SLDs). Doses of 1, 3, 5, 10, and 20 Jcm2 were used. Colony counts were performed and compared to untreated controls using Student t tests and one-way ANOVA with Tukey and Scheffe post hoc analyses. RESULTS: The results revealed significant dose-dependent bactericidal effects of the combined blue and infrared light on Staphylococcus aureus ($F_{4,94} = 5.38$, $p = 0.001$) and Pseudomonas aeruginosa ($F_{4,95} = 21.35$, $p < 0.001$). With P. aeruginosa, the treatment reduced the number of bacteria colonies at all doses, achieving statistical significance at 1, 3, and 20 J cm2 doses and reducing bacterial colony by as much as 93.8%; the most effective dose being 20 J cm2. Irradiation of S. aureus resulted in statistically significant decreases in bacterial colonies at all dose levels; the most decrease, 72%, was also achieved with 20 Jcm2. CONCLUSION: Appropriate doses of combined 405-nm and 880-nm phototherapy can kill Staphylococcus aureus and Pseudomonas aeruginosa in vitro, suggesting that a similar effect may be produced in clinical cases of bacterial infection.

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Killing of methicillin-resistant Staphylococcus aureus by low-power laser light.

Wilson M, **Yianni C**.

Department of Microbiology, Eastman Dental Institute for Oral Health Sciences, University of London.

The purpose of this study was to determine whether a methicillin-resistant strain of Staphylococcus aureus (MRSA) could be sensitised by toluidine blue O (TBO) to killing by light from a low-power helium/neon (HeNe) laser. Suspensions containing c. 10(10) cfu of MRSA were irradiated with light from a 35 mW HeNe laser (energy dose: 0.5-2.1 J) in the presence of TBO (1.6-12.5 micrograms/ml) and the survivors were enumerated. The kills attained depended on both the light energy dose and concentration of TBO employed. A 4.47 log10 reduction in the viable count was achieved with a TBO concentration of 12.5 micrograms/ml and a light dose of 2.1 J (energy density 43 J/cm2). MRSA were susceptible to killing by the laser light within 30 s of exposure to the TBO. The results of this study have demonstrated that MRSA can be rapidly sensitised by TBO to killing by HeNe laser light and that killing depends on the light energy dose and sensitiser concentration.