Name(s)

Joshua E. Eyre

Project Number

S1509

Project Title

Bactericidal Effects of Photosensitizers and Low-Power Lasers on E. coli

Abstract

Objectives/Goals

One of the biggest problems faced by our society is antibiotic resistant bacteria. One alternative antimicrobial strategy is photodynamic therapy (PDT), involving the use of light-activated antimicrobial agents (LAAAs). Ongoing research proposes the use of the photosensitizers (Indocyanine green (IC green), Methylene blue, and Toluidine blue O) activated by 5 mW lasers (808 nm for the IC green, 650 nm for the two blue dyes). In this experiment the three photosensitizing dyes act as LAAAs and when activated by the laser, they release free radical singlet oxygen that kills bacteria. This experiment investigates the parameters within which low-power lasers and corresponding LAAAs kill bacteria.

Methods/Materials

The effects of three different LAAAs on the bacteria (Escherichia coli) was determined by examining the zone of inhibition created by the laser and determining how much bacteria grew, if any, on plated bacteria that had been mixed with the dye and exposed to the corresponding laser. Each test was performed with several different exposure times ranging from 30 seconds to 30 minutes and different dye concentrations ranging from 100ug/l to 10g/l. Control tests were performed by growing and irradiating bacteria without any LAAA present to determine if the laser by itself had any bactericidal effect. A measurement of the zone of inhibition was recorded to determine the effectiveness of each tested application.

Results

The results clearly show that E. coli can be killed with low-power lasers and either Methylene blue or Toluidine blue, but not with Indocyanine green. It also shows that both time of laser exposure and concentration of LAAA are important, but that the time of irradiation is slightly more important in most cases. It also shows that Methylene blue and Toluidine blue are equally effective.

Conclusions/Discussion

This research has documented the effectiveness of these lasers coupled with the appropriate LAAA; however, further research is required to discover the minimum strength of the laser and the minimum concentration of dye that is still effective.
Real life applications from this experiment include utilizing this treatment for localized antibiotic resistant infections colonizing in hospitals or other places that commonly harbor antibiotic resistant bacteria, and for use with chronic pressure sores and open wounds.

Summary Statement

This project measures the relative effectiveness of laser-activated dyes as antimicrobial agents to kill the bacteria E. coli.

Help Received

Parents helped keep time with stopwatch; Dr. Southwell helped answer questions about lasers; Used lab equipment at Thousand Oaks High School under Dr. Malhotra; Dr. Wilson gave advice on experiment design; Drs. Statner, Beard, and Valusek provided bacteria and antibiotic advice; Dr. Steinhauer donated