Comparison of UVB and UVC irradiation disinfection efficacies on Pseudomonas Aeruginosa biofilm

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Disinfection routines are important in all clinical applications. The uprising problem of antibiotic resistance has driven major research efforts towards alternative disinfection approaches, involving light-based solutions. Ultraviolet (UV) radiation, photodynamic therapy, blue and near infrared light have been proposed to have the advantage of non-invasiveness and the ability to extinguish antibiotic resistant species. However, light-based solutions demand effective light delivery. Thus, the potential applications of optical technologies are confined by penetration depth of light to the region of interest. For this reason, branches of medicine like dermatology and dentistry were the first to adopt the optical technology, due to the easier optical access to the region of interest. *Pseudomonas aeruginosa* (*P. aeruginosa*) is a common bacterium that can cause skin, soft tissue, lungs, kidney and urinary tract infections. Moreover, it can be found on and in medical equipment causing cross infections in hospitals.

The aim of this study was to test the efficiency, of two different light-based disinfection treatments, namely UVB and UVC irradiation, on *P. aeruginosa* biofilms at different growth stages.

New types of UV light emitting diodes (LEDs) were used to deliver UV irradiation on the biofilms, in the UVB (296nm) and UVC (266nm) region. The strains were grown on AB-trace glucose medium and incubated for 24 hours (h) and 72h at 37°C. All tests, on 24h and 72h grown biofilms, were repeated respectively 3 or 2 times (triplet or doublet determination). Serial dilutions were made and plated onto lysogeny broth medium. The inactivation rate was studied as a function of dose for the 24h grown biofilms after overnight incubation at 37°C. The dose was ramped from 72J/m2 to 10000J/m2.

A 1 log inactivation was achieved for a dose of 10000J/m2 with the UVC diode, while the UVB diode achieved a 3 log inactivation at a dose of 1440J/m2 for the 24h grown biofilms. No colony forming units (CFU) were observed for the UVB treated biofilms when the dose was 10000 J/m2 (CFU in control sample: 7.5×10^4).

UVB irradiation, at a dose of 20040J/m2, on mature biofilms (72h grown) showed that CFU were reduced in average from 4.0×10^7 (untreated) to 4.65×10^3 (UVB treated), resulting in a 3.9 log inactivation.

These results show that UVB irradiation was more effective than UVC irradiation in inactivating *P. aeruginosa* biofilms. Though, UVB irradiation is known to be much less effective than UVC in disinfecting most examined bacteria species. It is believed that the obtained result is observed due to the larger penetration depth of UVB into the biofilm. Moreover, the efficiency of killing is reduced when the target biofilm is mature (left to grow for 72h). That supports the hypothesis about the importance of penetration depth, since mature biofilms create a compact matrix expected to be less penetrable by light.

The fact that the wavelength of 296nm exists in daylight and has such disinfection ability on biofilms gives new perspectives for applications within disinfection at hospitals.