UVD ROBOTS®

CLINICAL STUDIES

Klebsiella pneumoniae

report id: uvdr-ict/kp

EVALUATION OF THE EFFICACY OF THE UVD ROBOT TO REDUCE NUMBERS OF KLEBSIELLA PNEUMONIAE AT SHORT TIME PERIODS

SUMMARY

Stainless steel coupons containing approximately 108 colony forming units (cfu) of Klebsiella pneumoniae (carbapenemase producing NDM-1 - CPE) (dried) were placed on a surface. They were exposed to UV-C emitted by a UVD robot for different time periods ranging from less than 10 seconds (drive by) up to three minutes stationary. The numbers of organisms remaining were calculated compared to control coupons, which were placed in exactly the same positions but were shielded from the UV-C by tin foil. The numbers of organisms remaining after the test period were counted and compared to the control and the log reduction calculated.

The UVD robot caused a greater than 3 log reduction (99.9%) as it drove by the samples. An even greater reduction was observed at 20 seconds. The log reduction in numbers increased 2 fold to a greater than 6 log reduction (99.9999%) at three minutes.

1.0 INTRODUCTION

Globally there is a threat to society in the form of multiple antimicrobial resistant (AMR) microorganisms (1). In healthcare environments, these organisms have been found on high touch areas such as chair arms, taps, hospital equipment and so on. There is a high infection control risk that they could be transmitted to a susceptible patient, either through touch or by airborne transmission. Although manual cleaning should reduce numbers of organisms, it is known that they often persist and current practice in many hospitals uses hydrogen peroxide vapour to eliminate persistent organisms (2). However, this method is expensive to use and can be time consuming. UV-C is known to kill microorganisms on surfaces and in the air through DNA/RNA disruption and it does this very rapidly. Using UV-C as a final disinfection process post cleaning, could reduce the risk of acquiring healthcare associated infections and hopefully reduce the need for antibiotics.

UVD robots use eight UV-C emitting lamps placed vertically on top of an automated guided vehicle (robot), which moves either autonomously or can be controlled remotely by a smartphone or tablet from outside the disinfection area. The eight x Philips UV-C lamps (wavelength 254nm) give 360 degree coverage. Each lamp generates five joules of UV-C energy per second and there is always a minimum of four lamps facing any given surface a 1 m. distance. The speed of the robot in disinfection mode is 10 cm per second. This delivers an intensity of 20 joules per sq. metre per second.

Typically, a UVD robot will take approximately 10-15 minutes to disinfect a single occupancy patient room. Following disinfection, the robot will return to it's charging station until it is called upon again.

2.0 METHOD

2.1 Preparation of the inoculum on stainless steel coupons

Klebsiella pneumoniae carbapenemase producer NCTC 13443 containing the NDM1 plasmid was used to prepare the inoculum in-Maximum Recovery Diluent (MRD) (Lab M Ltd, LAB103) using log phase cultures (approximately 108 cfu/ml). As per EN 14561, 1ml of interfering substance (BSA - 3g/l)) and 9ml of test organism was mixed to simulate light soil. Accurate viable counts were undertaken using a standard dilution method at the various time periods.

Stainless steel coupons (of the type and grade specified in BS EN 13697 – namely 1.5mm depth /20mm diameter stainless steel, manufacturer code 304 2B) were inoculated with 50µl of the inoculum and dried for approximately 40 minutes at 36°C. All log reductions were calculated against their own controls at the same time period.

Dried suspensions of each organism on stainless steel coupons (held at a 70 degree angle); test coupons (n=3) and unexposed control coupons (n=3) were placed at the same locations. The unexposed control was prepared by wrapping with 3 layers of aluminium foil (to shield from UV-C irradiation) around the petri dish containing the coupons.

2.2. Exposure to the UVD robot

The UVD Robot was allowed to 'warm up' for three minutes behind a screen before moving past the samples without stopping (drive by) at a distance of 1m at normal disinfecting speed.
This test was repeated moving the robot to a 1 metre distance and allowing the robot to remain stationary for 20 seconds and three minutes before the device was remotely shut down.

2.3 Processing the coupons

On completion of each UV-C disinfection cycle, the coupons were processed within the laboratory. Each coupon was aseptically transferred to 2ml sterile Maximum Recovery Diluent (MRD) in a sterile bottle containing sterile glass beads. The MRD was vortexed mixed at full power for 30 seconds.

1ml was transferred to 9ml MRD, mixed and a ten-fold dilution series undertaken to determine an accurate viable count. 1ml of each dilution was added to 12ml molten Tryptone Soy Agar (Lab M Ltd, LAB011) as a pour plate and allowed to set. All plates were transferred to the relevant incubation conditions (36oC in air for 48hrs).

Following the 48hrs incubation, all colonies were counted and recorded. All testing was done in triplicate and the log reductions were calculated by comparison of the test mean log viable count and the control mean log viable count.

3.0 RESULTS

3.1 Antimicrobial effect of UV-C

The starting viable count on the stainless steel coupons was approximately 1 x 108 cfu/ml (mean 8 log). There was a greater than 3 log reduction (99.9%) seen at the drive by to 20 seconds which increased to a greater than 6 log reduction (99.9999%) at 3 minutes.
The log reduction at each time point is shown in Table 1.

Table 1; Log reduction at different time intervals.

	DRIVE BY	20 SECONDS	3 MINUTES
Mean Log reduction	3.16	3.55	>6.0*

Key: * limit of detection

4.0 DISCUSSION

This was a snap shot study undertaken to determine whether an effective log reduction could be attained at a low time period. K. pneumoniae NCTC 13443 was chosen because it was a multidrug resistant strain and seen in a variety of healthcare associated infections across the globe. The UVD robot rapidly reduced organism numbers in light soil by greater than 3 log, as the robot drove past the samples without stopping. This reduction increased within 20 seconds and increased twofold to a greater than 6 log reduction at three minutes. Shading was not an issue because the robot could move between positions and reposition itself so that sufficient UV-C was emitted on to the samples.

If a UVD robot can reduce organism numbers very effectively by merely driving around a patient room, operating theatres or entire department, then this gives the hospital staff the ability to effectively disinfect without causing too much disruption to the operational status of the environment.

5.0 REFERENCES

1.WHO Global list of antibiotic resistant bacteria- https://www.who.int/medicines/publications/WHO-PPL-Short_Summary_25Feb-ET_NM_WHO.pdf?ua=1

2.Literature Review and Practice Recommendations: Existing and emerging technologies used for decontamination of the healthcare environment. Airborne Hydrogen Peroxide. https://hpspubsrepo.blob.core.windows.net/hps-website/nss/1810/documents/1_hpv-lr-v1.1.pdf

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Dated: 25th February 2020

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