UVC measurement made ridiculously simple. A summary of newly published studies on how a color changing dosimeter can facilitate UVC disinfection and improve disinfection levels.

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The UVC usage within the healthcare industry is growing and several studies have been published the last few years showing the functionality of the different UVC systems. In the same time several studies have also mentioned the difference in UVC exposure levels in shadowed and/or areas further away compared to areas in direct line of sight and/or close by where the UVC levels in shadowed areas were significantly lower.[2,3] This lowered UVC exposure levels do have a significant effect on the disinfection level achieved.[2] One efficient way to address the difference in UVC levels and to make sure a specific surface has received a sufficient amount of UVC radiation is through a color changing disposable dosimeters. Color changing dosimeters are used on a regular basis today with other disinfection and sterilization procedures in autoclaves, steam sterilizers, etc. In several countries it is regulated by law to be using a chemical color changing dosimeter with the disinfection/sterilization procedure. This is also recommended by the CDC and FDA. Several studies in recent years have mentioned and shown the benefits of using such dosimeters as an easy to use tool to assure quality UVC exposure. One paper even described it as "*Ultraviolet -C (UVC) monitoring made ridiculously simple: UV-C dose indicators for convenient measurement of UV-C dosing*". [1,3,4,5]

This summary will focus on the two most recent published studies where a color changing dosimeter was used in a lab setting and in a real live hospital environment.

Materials & Methods:

- **Lab study:** In a laboratory setting, exposed MRSA and C.diff spores on steel disk carriers to UV-C for varying fluence exposures ranging from 10,000 to 100,000 µJ/cm2. The UV-C indicators were placed adjacent to the carriers. The change in color of the indicators was correlated with dose, by radiometer reading, and log10CFU reductions.
- **Hospital study:** Disposable indicators and an electronic radiometer were positioned in different parts of an unoccupied room at the Burn Center. The UVC full room disinfection equipment (set for sporicidal decontamination at 22 000 µWs/cm²) was placed in the center of the room. The changes in the color of the disposable indicators, and radiometer readings, were noted for the different areas. No microbiology samples were used.

Fig 1 and 2 shows the results form testing a UVC disinfection device together with a color changing dosimeter in lab environment. As can be seen the colour change of the dosimeter, there is a different color change between MRSA and C.diff which is to be expected as the energy level to kill off C.diff is significantly higher compared to MRSA.

Table 1 shows the relation between lower UVC exposure levels, though radiometer readings, and shadowed areas in live hospital environment.

Results & Conclusions:

- Disposable indicators help ensure that an adequate dose has been received
- The full color change of the dosimeter can be correlated to a 3 log reduction of both MRSA and C.diff.
- Shadowed areas are exposed to significantly lower UVC levels compared to non-shadowed areas and 30% of measured surfaces did not achieve high levels of UVC.

Fig 1: Shows the color change of the dosimeter, unexposed (yellow), 10mJ/cm2 (3 log reduction of MRSA) and 46mJ/cm2 (3 log reduction of C.diff). UVC energy levels are stated on the top of each dosimeter.

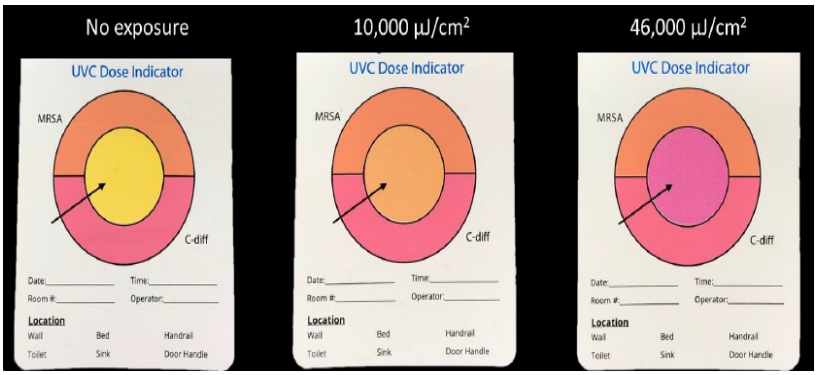

Fig 2: UVC energy levels correlated to log reduction of C.diff and MRSA

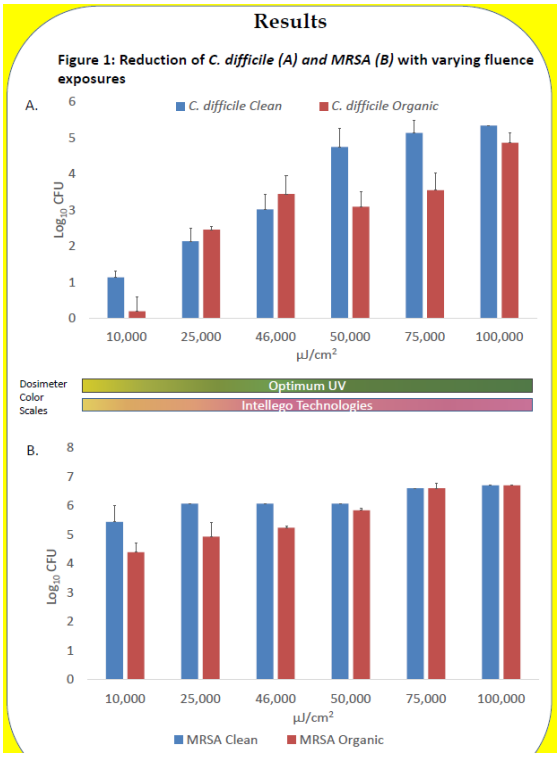

Table 1: The relation between the shadowed areas and the lower UVC exposure readings

Table 1 – Experimental set-up; location of dosimeter, distance from light source, measured UVC-dose received, conditions between the light source and dosimeter/indicators, and angle of the indicators (relative to the light source). Also, see Fig. 2.

Position	Description	Distance from the light source (cm)	mJ/cm²	Shadowed	Angle of indicator
A	On the nurse's desk	144	560	No	Horizontal
B	On the bed	134	440	Partly	Horizontal
C	Under the bed	128	867	No	Vertical
D	In the basin	415	16	Yes	Horizontal
E	In the wardrobe	502	15,9	Yes	Vertical
F	On the ledge of the wall	430	424	No	Vertical
G	In the drawer of the left ceiling mounted pendant	97	108	Yes	Horizontal
H	By the infusion pump on the right ceiling-mounted pendant	230	1068	No	Vertical
I	On the writing surface on the right ceiling mounted pendant	275	45,8	Yes	Horizontal
J	Behind the desk chair	260	92	Yes	Horizontal

References:

[1] Jennifer L. Cadnum, BS, Curtis Donskey, MD, et.al, "Ultraviolet -C (UVC) monitoring made ridiculously simple: UV-C dose indicators for convenient measurement of UV-C dosing"

[2] John M. Boyce, MD;1,2 Patricia A. Farrel, MT et.al, "Impact of Room Location on UV-C Irradiance and UV-C Dosage and Antimicrobial Effect Delivered by a Mobile UV-C Light Device", infection control & hospital epidemiology june 2016, vol. 37, no. 6

[3] Marie Lindblad, Fredrik Huss, MD et.al, "Ultraviolet-C decontamination of a hospital room: Amount of UV light needed", JBUR 5947 No. of Pages 8

[4] Jennifer L. Cadnum, BS, Curtis Donskey, MD, et.al, "A comparison of the efficacy of multiple ultraviolet light room decontamination devices in a radiology procedure room", Infection Control & Hospital Epidemiology (2019), 40, 158–163

[5] John M. Boyce MD and Curtis J. Donskey MD, "Understanding ultraviolet light surface decontamination in hospital rooms: A primer", Infection Control & Hospital Epidemiology (2019), 1–6