Introduction to UV Surface Disinfection

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Abstract:

Healthcare Acquired Infections (HAIs) are a major cause of preventable death throughout the world. It is believed the physical environment may play a more significant role in disease transmission than previously thought. New materials and technologies are now being introduced into healthcare facilities in an attempt to reduce the environmental route of disease transmission. UV surface disinfection is proving to be one of the most promising of the new technologies.

Main Article:

UV-C has been a proven technology for disinfecting air, water and instruments for over a century[1,2]. Niels Finsen was awarded the Nobel Prize for Medicine in 1903 for being the first to use “light therapy” to treat disease with direct disinfection of skin. By the 1930s, UV had come into common use throughout hospitals for air and water treatment and by WWII, UV was in widespread use in processing plants, water treatment facilities, and anywhere microbial contamination was a concern. UV gained fame in the 1950’s for helping to eradicate TB before fading in use in the 1960s with the proliferation of antibiotics and chemical disinfectants.

Now with the current focus on solving the crisis of rising multidrug resistant organisms (MDROs), healthcare acquired infections (HAIs), and treatment costs, UV has once again risen to the top of the list in the war against superbugs. After 100 years in healthcare use, UV has found a new application in hospitals providing surface disinfection of patient rooms, bathrooms, operating rooms (ORs), equipment rooms, and mobile devices.

> Uv Has Once Again Risen To The Top Of The List In The War Against Superbugs

UV photons penetrate cell membranes and cause thymine molecules in DNA and RNA to bond, preventing replication. Bacteria and viruses have known but limited repair mechanisms that are easily overwhelmed. Unlike antibiotics and chemical disinfectants, bacteria and viruses have not been shown to systematically develop further resistance to UV.[3,4,5]

UVC disinfection constants have been published for most organisms allowing easy calculation of time and distance

required for deactivation. In general, bacteria and viruses have little protection from UV and may be deactivated in seconds, however, deactivation of bacteria in a spore state takes much longer than bacteria while in a vegetative state.

UV disinfection time varies directly with light intensity and varies inverse exponentially with the distance from the source to the target.

Typical disinfection times:

Bacteria	**Distance**	**5 ft.**	**6 ft.**	**7 ft.**	**8 ft.**	**9 ft.**	**10 ft.**
	mW/cm^2	**1314**	**999**	**778**	**620**	**504**	**417**
Klebsiella Pneumonia	Seconds	18	24	30	42	48	60
Vancomycin-Resistance *Enterococci (VRE)*	Seconds	30	36	42	54	66	78
Methicillin-resistance *Staphylococcus aureus (MRSA)*	Minutes	1.2	1.6	2.1	2.6	3.2	3.8
Clostridium difficile Spores (CDI)	Minutes	4.6	6.0	7.7	9.7	11.9	14.4

It's well known that the odds of becoming infected with an HAI increases if the previous room occupant had a known infection[6,7] confirming the belief that the physical environment is a significant source of HAIs[8-15]. Beginning in 2010, studies started showing that UV significantly reduced bioburden in patient rooms.[15,16] By 2013 studies were showing HAI reductions in the order of 50% when mobile UV devices were used during terminal clean.[17,18] Similarly impressive results can also be achieved with fogging disinfection systems but UV is the clear winner in the category of total room disinfection for reasons of speed, safety and ease of use[19]. Well-trained housekeeping staff can completely disinfect 20 to 50 patient rooms per day depending on the speed of the mobile UV system chosen.

The most definitive UV study to date is the CDC-funded randomized controlled trial (RCT) presented by Andersen and associates of Duke University Medical Centre in October 2015. Over 600,000 patient stays across 9 hospitals were documented over a 28 month period. There were 19,000 patients who were exposed to a patient room where the previous occupant had a known MDRO including MRSA, VRE and CDI. There were four study arms: 1) For six months, quaternary ammonium disinfectants (quats) were used exclusively to disinfectant patient rooms during terminal cleans; 2) For six months, UVC was added to quats as an additional measure; 3) For six months bleach was used exclusively as a disinfectant; 4) For six months UV was added to the bleach disinfection protocol. During all four study arms, bleach was used in lieu of quats for suspected CDI cases. The results were impressive. Adding UV to "quats" (ammonium-based cleaning compounds) at terminal clean led to a 32% reduction in HAIs. Adding UV to bleach led to a 37% reduction in HAIs[20]. Chemical disinfection alone is not enough.

Mobile UV room disinfection began as a concept 12 years ago with one manufacturer. There are now 30 or more manufacturers worldwide. In addition to patient rooms, mobile UV disinfection should be considered for ORs,

equipment storage rooms, nursing stations, and any other areas that may harbor pathogens.

A new twist on mobile UV room disinfection is an inexpensive, fixed, fully automatic UV disinfection system recently developed for disinfecting both bathrooms and equipment storage rooms. Using smart sensor technology, the system automatically disinfects the room and all equipment in sight after every room entry. Some rooms could be disinfected 10, 20, 30 times per day. No user intervention is required making implementation simple and easy and close to 100% effective. Given that VRE and *C. difficile* are both intestinal bacteria, it is expected that introduction of this technology into patient bathrooms will have a significant impact in reducing outbreaks. Cross-contamination of patients by equipment held in both clean and soiled utility rooms as well as equipment storage rooms should also be significantly reduced.

Around the world we advocate daily cleaning of patient rooms in an attempt to manage the physical environment for infection prevention. Housekeeping staff are generally allotted 15 minutes to declutter, clean, and disinfect each patient room. It would seem the next logical step in the evolution of infection prevention practise would be daily UV disinfection of patient rooms, “every room every day”. In an ideal world this process would also be automated, and allow for patient engagement and activation. There are significant challenges to this paradigm but it is certainly worth exploring.

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