Contaminated surfaces play an important role in transmitting healthcare-associated infections (HAIs), a significant problem in healthcare.\textsuperscript{1,2} Pathogens are capable of persisting in the environment for hours to months, often contaminating surfaces, medical equipment and the hands of healthcare personnel.\textsuperscript{4,5} Unfortunately, research suggests that routine and terminal disinfection of room surfaces and medical equipment is often inadequate and current cleaning methods are microbiologically ineffective.\textsuperscript{6,8} Automated portable “no-touch” room disinfection technologies, developed to address the problem of HAIs, are increasingly being implemented in healthcare settings to bolster infection prevention and control.\textsuperscript{9} One type of “no-touch” system consists of units (sometimes called robots) that produce ultraviolet C (UV-C) radiation with pulsed xenon or mercury lamps. The high-energy, short-wave, germicidal light produced by these systems incapacitates microbes by destroying the nucleic acids in their DNA.

Pulsed xenon and mercury lamp UV-C systems have been noted to vary in delivery mechanism, efficacy, process time and ease of use.\textsuperscript{10-11} However, most importantly, they have both been shown to kill dangerous pathogens such as Clostridium difficile (C. diff), methicillin-resistant Staphylococcus aureus (MRSA), vancomycin-resistant Enterococci (VRE), Gram-negative rods (Acinetobacter spp. and Enterobacteriaceae) and norovirus, and lower infection rates.\textsuperscript{12-15} Overall, UV-C systems have been called simple, fast and effective.\textsuperscript{16} One study showed that UV-C irradiation reduced counts of vegetative bacteria on surfaces by more than 99.9
Automated portable “no-touch” room disinfection technologies, developed to address the problem of HAIs, are increasingly being implemented in healthcare settings to bolster infection prevention and control.

percent within 15 minutes. And a study reported that implementing UV-C disinfection following discharge cleaning of high-risk areas led to a 20 percent decrease in rates of HAIs involving multidrug-resistant organisms. Research also indicates that UV-C disinfection systems may be becoming more affordable.

One UV-C disinfection system, the Clorox Healthcare™ Optimum-UV™ System, uses mercury lamps to produce UV-C light at a wavelength of 254 nm, which falls within the range of maximum bactericidal effect (240-280 nm). The units are operated remotely while decontaminating a room, which varies in technique and duration between devices.

Infection Control Today spoke with Keri Lestage, PhD, tech solutions group manager for Clorox Healthcare, about UV-C disinfection technology:

**Q. How does UV surface treatment work?**

**A.** There are several different types of automated UV surface treatment devices, so it is important for facilities to do their research to find the system that will be the best fit for their specific infection control needs.

The Clorox Healthcare™ Optimum-UV™ System utilizes UV-C, the highest-energy form of ultraviolet light to inactivate pathogens that may pose a threat or present a danger to the healthcare environment. When the DNA of a microorganism absorbs UV-C energy, molecular reactions occur, resulting in the disruption of the DNA sequence. This renders the cell unable to grow or reproduce. Without the ability to reproduce, the cell cannot infect, and it rapidly dies.

The amount of UV-C energy needed to inactivate a given microorganism is determined by a combination of distance from the source and exposure time. The Optimum-UV™ System produces UV-C light via ultraviolet lamps that emit a predominately discrete wavelength at approximately 254 nm, which is in the ideal range for killing microorganisms by inactivating their DNA.

**Q. How do “no-touch” room disinfection systems supplement manual cleaning techniques?**

**A.** It is important to remember that UV devices should only be used to supplement – not replace – manual surface cleaning and disinfection with Environmental Protection Agency (EPA)-registered disinfectants, which still play an important role in infection control protocols.

Manual surface disinfection is essential for removing soils and killing pathogens on surfaces and UV devices offer an extra layer of protection by inactivating microorganisms in high-risk settings or hard-to-reach areas that may have been missed by manual cleaning. When implemented correctly, this bundled approach can have a big impact. One recent study found an 89 percent decrease of C. diff prevalence on environmental surfaces in rooms, following enhanced daily and terminal disinfection with bleach wipes using a dedicated...
EVS team and followed by the use of a UV device.

Q. What are the different modalities of UV surface treatment? How are these modalities alike and how do they differ? What are some of their strengths and weaknesses?

A. The different modalities of UV surface treatment in the marketplace today include continuous low-pressure mercury lamps, pulsed xenon ultraviolet lamps and visible violet-blue technology.

The primary difference between continuous UV lamps and pulsed xenon devices is the chemistry used to generate the ultraviolet light. Pulsed xenon technology uses xenon gas to generate a broad spectrum of light, of which only a fraction is in the germicidal range. Continuous low-pressure UV lamps are analogous to fluorescent lamps that are used in commercial buildings all over the world except instead of glass they are made of quartz to allow UV to pass through. The other key difference is the coating used on the inside of the lamp (tube), which in the case of the Optimum-UV™ System is absent, resulting in the emittance of a narrow band of germicidal UV.

Visible violet-blue technology uses a longer wavelength and therefore the germicidal efficacy is lower than UV light, however this limitation is offset by its continuous use in occupied environments. In other words, it too inactivates pathogens on the surface and in the air but at a slower rate.

Q. What are some considerations in choosing a modality?

A. In recent years, many new technologies using ultraviolet (UV) light have come to market, offering facility managers a wide variety of options and making due diligence and research an even more crucial part of purchasing decisions. Hospital facility managers need to think about a number of factors when purchasing and implementing an automated surface treatment system to find the device that will be the best fit for their specific infection control needs.

Among the most important considerations are efficacy and performance, quality of design, safety and affordability. Purchasers should also ask vendors about other factors such as training and support offered by the manufacturer to ensure they select a partner that is committed to providing in-person training and in-servicing to educate end users and help with both the device operation and implementing a comprehensive surface disinfection bundle.

Q. Is UV surface treatment associated with any risks and is it safe?

A. Safety is an important consideration when evaluating any UV device and, as with all our Clorox products, the Optimum-UV™ System is safe to use when used as directed.

The Optimum-UV™ System’s lamps contain a nominal amount of mercury (similar to the amount in a standard overhead fluorescent bulb) and, in the unlikely event of breakage,
they contain a proprietary encapsulation that protects against shattering and allows for easier and safer disposal. The bulbs also passed the EPA’s Toxicity Characteristic Leaching Procedure (TCLP) test, with a mercury level that is a full order of magnitude below the limits set by this test.

To protect users and patients from accidental UV exposure, the device features four infrared motion sensors that can detect the presence of anyone in the room and stop operation of the system for enhanced safety. Since the device does not generate any byproducts or leave residual substances behind that could cause harm, the room may be immediately occupied after completion of the treatment cycle.

Q. How long have UV surface treatment systems for healthcare settings been on the market? How long has the Optimum-UV™ system been on the market?
A. Clorox Healthcare partnered with Ultraviolet Devices, Inc. (UVDI) in February 2014 to introduce the Clorox Healthcare™ Optimum-UV™ System. While UV surface treatment systems have been on the market for some time, this partnership marked the first time a manufacturer has been able to offer healthcare customers a comprehensive bundled approach that combines EPA-registered surface disinfectants with UV-C technology to help facilities reduce the risk of infection and make the environment of care safer for patients, staff and visitors.

Q. What are the dimensions of the Optimum-UV™ system? How do you usually describe it to people?
A. The Optimum-UV™ system has a 36 inch-diameter circular base and is 76 inches tall. The device is small and easy to maneuver so it works well in a variety of healthcare settings.

Q. What are some of the benefits of the Optimum-UV™ system? For example, UV-C has been called simple, fast and effective. Why should healthcare facilities implement the Optimum-UV™ system?
A. The Optimum-UV™ System provides the optimal balance of strong performance, quality, user-friendly design and affordability. It offers an extra layer of protection by treating high-touch surfaces that may have been missed during routine cleaning, such as bed rails, doorknobs and handles, as well as areas that may be difficult to clean manually and thoroughly, such as walls, light fixtures, windows and floors.

Q. Is the Optimum-UV™ system backed by independent clinical research and third-party/peer-reviewed studies? What are some

The primary difference between continuous UV lamps and pulsed xenon devices is the chemistry used to generate the ultraviolet light.
of the specific pathogens that Optimum-UV™ kills?

A. Independently verified third-party laboratory testing of the Optimum-UV™ System has shown a greater than 5-log reduction of eight key healthcare pathogens in five minutes at a distance of 8 feet from the device, including Acinetobacter baumannii, Escherichia coli (E. coli), influenza A virus, Klebsiella pneumoniae, methicillin-resistant Staphylococcus aureus (MRSA), norovirus, Pseudomonas aeruginosa and vancomycin-resistant Enterococci (VRE).

Q. How long does a surface treatment session take?

A. The Optimum-UV™ System recommended protocol for most standard size hospital rooms is three 5-minute cycles.

Q. Are UV-C systems cost effective?

A. The Clorox Healthcare™ Optimum-UV™ System is priced with end users in mind and is designed with four 62” maximum-output UV-C lamps to deliver high performance at a lower cost, which is an increasingly important consideration in today’s market. This is a cost-effective option to help hospitals achieve quality mandates to address the burden of HAIs and ultimately to improve patient safety and promote quality care.

Q. Is the Optimum-UV™ device able to precisely measure variables including UV-C reflective properties, dose delivery and bulb degradation over time?

A. The Optimum-UV™ device uses patent-pending Dose Verify System cards that change color when exposed to UV-C energy. The cards are placed on surfaces throughout the room and once the device cycle is complete, the end-user can observe the color changes to verify dose delivery.

The Optimum-UV™ lamps are rated for 4,000 hours of cycled use – which is an important distinction. Other manufactures rate their bulbs for the number of hours of continuous use, which isn’t reflective of how the devices are actually used. There is greater wear and tear on the lamp components as the device is turned on and off, so when choosing a device, be sure to ask for the cycled lamp life.

Q. Does the surface treatment cycle take place from a single location in the room or does it require movement to multiple places for complete terminal disinfection?

A. Recommended device deployment includes three five-minute cycles. For standard patient rooms, this includes one placement on both sides of the bed, and one placement inside the patient bathroom. A similar protocol is recommended for operating rooms following end of day terminal cleaning.

It is important to remember that UV devices should only be used to supplement – not replace – manual surface cleaning and disinfection with EPA-registered disinfectants.
Q. Does the device treat all surfaces including shadowed areas?
A. The Optimum-UV™ System emits UV-C energy in a full 360 degrees to deliver a programmed dose of UV light for treating a room’s target surfaces. The UV device utilizes “line-of-sight” pathogen reduction technology, so the target surface(s) must be directly exposed to the device’s UV energy.

Q. What hospitals are using this technology? Is the market for surface treatment systems expected to grow?
A. We have seen an increase in the number of hospitals implementing the Clorox Healthcare™ Optimum-UV™ System and believe UV technology will continue to play a crucial role in successful infection prevention interventions, coupled with best practices in hand hygiene, antibiotic stewardship, monitoring protocols and environmental disinfection.

References


