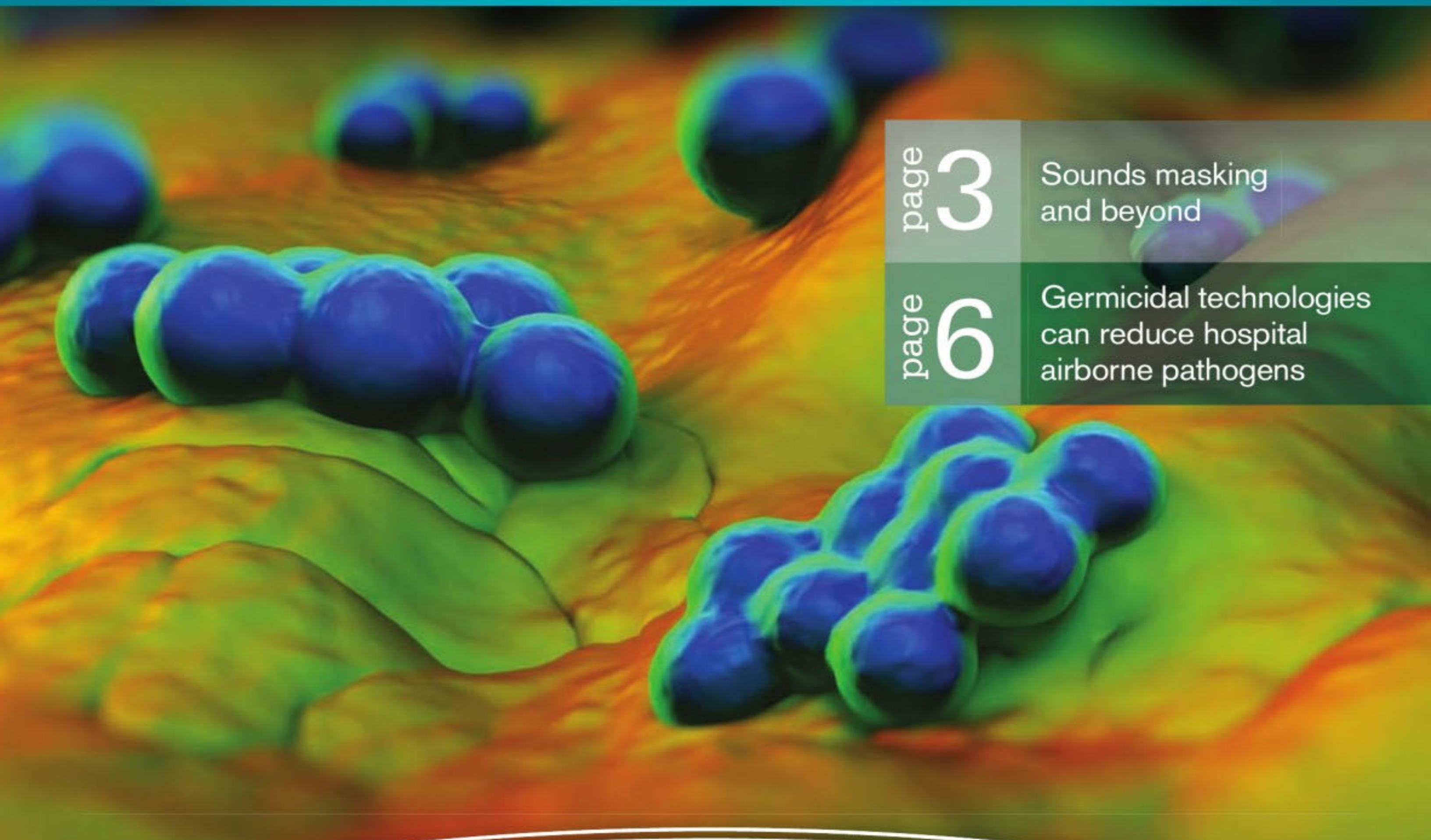
JUNE 2019

HEALTHCARE FACILITIES TODAY®



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AD INDEX

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Germicidal technologies can reduce hospital airborne pathogens

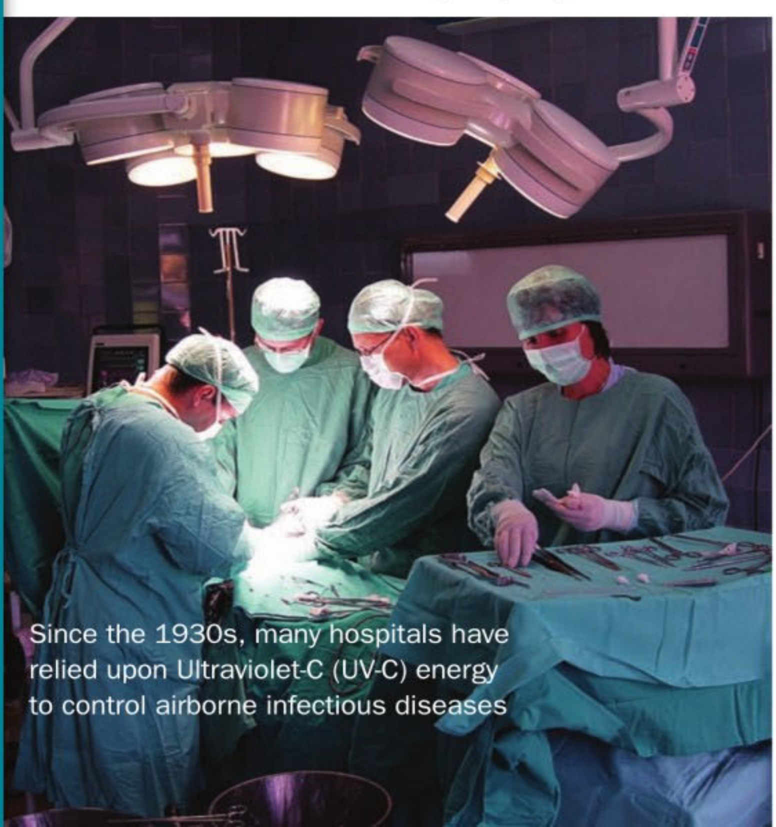
UV-C energy can fortify hospital defenses against infectious diseases by reducing their concentrations without increasing their resistance to medicines

By Daniel Jones / Special to Healthcare Facilities Today

Hospital-associated infections (HAI) kill more than 72,000 people in the United States every year. This astounding death rate is greater than the annual combined deaths from AIDS and auto accidents.

What is equally astounding is that HAIs can be mitigated through relatively low cost and readily available technologies. These same technologies are also capable of helping slow the rising death rate from antibiotic-resistant microbes (ARMs), which the World Health Organization (WHO) has characterized as a global concern.

Since the 1930s, many hospitals have relied upon Ultraviolet-C (UV-C) energy to control airborne infectious diseases, but use waned with the arrival and proliferation of antibiotics. In the 1990s, demand for the technology returned following a resurgence of drug-resistant infectious microorganisms, which required additional infection control measures.



Since the 1930s, many hospitals have relied upon Ultraviolet-C (UV-C) energy to control airborne infectious diseases

Ultraviolet light in the 254-nm wavelength "C" band (UV-C), is particularly effective at killing microbes as it breaks the bacteria or virus DNA chain, rendering the cell incapable of reproducing. Applying UV-C lamps for such a purpose is often called ultraviolet germicidal irradiation (UVGI) and typically includes:

- Disinfecting the air in the upper region of individual rooms (ER waiting rooms, cafeterias, surgical suites, patient rooms, etc.)
- Surface disinfection in hospital patient rooms
- Sterilizing medical equipment
- Disinfecting ventilation air streams in HVAC systems
- Cleaning and keeping clean the surfaces of air-handler cooling coils and drain pans

Airborne HAIs

HAIs, also called nosocomial infections, are transmitted by a variety of vectors, including person-to-person, through injection/insertion of medical devices, airborne contact of open wounds, and by respiration of airborne particles.

While this article focuses on airborne pathogens, recent research complicates our understanding of transmission vectors and engineering appropriate preventive measures. For example,

C. difficile, which is picked up from surfaces and person-to-person contact, is responsible for 500,000 infections each year and is linked to at least 15,000 American deaths each year according to a 2015 Centers for Disease Control and Prevention (CDC) study. Recent studies have shown that while understood primarily as a contact pathogen, C. difficile can be transmitted as an airborne infectious agent. While C. difficile infections can happen anywhere, most deaths from antimicrobial resistant forms are from hospital associated infections.

Some gains are being made in reducing HAI rates . However, new threats emerge, and old ones reemerge almost every year, such as Severe Acute Respiratory Syndrome (SARS), Middle East Respiratory Syndrome (MERS) and more recently the reemergence of Measles. Emerging diseases require time and resources to develop protocols for diagnosing, isolating and treating associated illnesses. During these developmental phases, healthcare workers are particularly vulnerable to emerging diseases, as was the case in Saudi Arabia and the United States with respect to MERS. Note: Although the means of MERS transmission is not known, current protocols require standard, contact, and airborne isolation precautions.

The current scare over the measles virus, is another good case-in-point. Nearly a century ago, Harvard University sanitary engineer, William F. Wells, documented that UV-C killed airborne microorganisms, including measles. Wells installed UV-C fixtures in several suburban Philadelphia day schools to combat a measles outbreak. He discovered that children in schools with the germicidal technology experienced a 13.3 percent infection rate, compared to 53.6 percent in schools without these fixtures.

In other words, vaccines and antibiotics are not the only epidemiological tools available. UV-C as an engineering control can assist in supplementing existing infection-control protocols with another "fortification" layer of protection. Again, UV-C is effective against all pathogens from either emerging or known diseases, and it does not contribute to drug resistance or secondary contamination.

Airborne antibiotic-resistance microbes

The CDC estimates that in the United States, more than two million people are sickened every year with antibiotic-resistant infections, with at least 23,000 dying as a result. The most dangerous are those that have the potential to spread by the airborne route. Many of these pathogens are now called "superbugs" since they are virtually invincible to standard drug treatments.

ARMs are worth mentioning in the context of UVGI because UVGI is a mechanical means for destroying microbes. UVGI disrupts microbe DNA sequencing at the cellular level, which causes cell death. Microbes cannot build resistance to UVGI.

ARM infections are on the rise, threatening not only patients, but healthcare professionals and facility staff, as well.

Support for the claim that the rate of airborne transmission of infections is also growing. Evidence exists for airborne nosocomial transmissions of Acinetobacter, Pseudomonas, and MRSA. Airborne transmission is a significant threat because it can cause infections to spread rapidly and extensively through a non-immune population.

UVGI disrupts microbe DNA sequencing at the cellular level, which causes cell death

Therefore, source and pathway management should involve airborne transmission and, consequently, enhanced methods of control even though the primary route is considered to be direct contact.

Much attention is focused today on pathogenic microorganisms that have developed resistance to antibiotic treatment, or entire types or classes of antibiotics. The loss of effective antibiotic treatment undermines the ability of healthcare to fight infectious diseases and manage the infectious complications common among immunocompromised patients.

Ultraviolet germicidal irradiation

UVGI helps combat ARMs and, more generally, HAIs, by decreasing their concentration in facilities. For all ARMs classified by the CDC and U.S. Dept. of Health and Human Services, the first of a four-part strategy for combating them is "Preventing infections from occurring and preventing resistant bacteria from spreading." UVGI is particularly effective for addressing this strategy.

How UVGI systems work and how they are addressed through lifecycle considerations of design, installation, commissioning, operations, and maintenance has been described in a number of technical articles published by engineering magazines.

For all its strengths, UVGI is not a stand-alone means to combat airborne HAIs and ARMs. UVGI systems are supplemental to air filtration, air-pressure control and basic procedures for controlling particulate matter during construction and renovation activities.

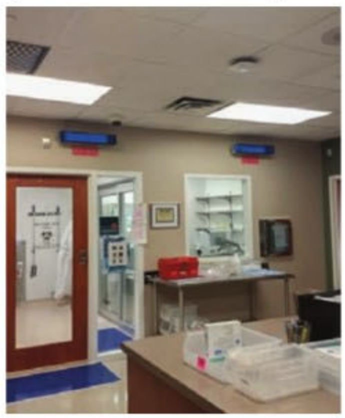
| HVAC |

UVGI is listed as a supplemental strategy for airborne infectious agents in several important guidelines, including ASHRAE Standard 170-2017, ANSI/ASHRAE/ASHE 170:Ventilation of Health Care Facilities and the ASHRAE Guideline for Indoor Air Quality, which has been incorporated into the 2018 editions of the Facility Guideline Institute (FGI) Guidelines for Hospitals and Outpatient Facilities.

UV-C applications

Upper-Air/Room

The primary objective of upper-air UV-C placement is to interrupt the transmission of airborne infectious diseases in patient rooms, waiting rooms, lobbies, stairwells, laundry chutes, and emergency entrances and corridors. All of these spaces can be effectively and affordably treated with UV-C. Airborne droplets containing infectious agents can remain in a well-ventilated room for as long as six minutes. Upper-air UV-C fixtures can inactivate them in fractions of a second. Operating 24 hours a day, upper-air systems are especially effective at significantly reducing airborne infectious microorganisms and eliminating the potential viability of surface microbes that eventually settle out of room air.



Upper-air systems are especially effective at significantly reducing airborne infectious microorganisms

Infections from airborne pathogens are usually spread by people. Upper-air systems control infections at their source by intercepting pathogens in the room where occupants generate them. Upper-air systems have been shown to be effective against airborne viruses and bacteria, including chickenpox, measles, mumps, varicella, TB, and viruses that cause colds. In a 2009 study, guinea pigs were exposed to exhaust air from a TB ward whereby 35 percent of the controls developed TB infections while only 9.5 percent (a 74 percent reduction) developed infections when upper-air UV-C was used.

Measles and influenza viruses and the tuberculosis bacteria are infectious diseases known to be transmitted by means of shared air between infected and susceptible persons. Studies indicate two transmission patterns: (I) within-room exposure such as in a waiting room or patient room; (II) transmissions beyond a room through corridors, and through entrainment within ventilation ductwork where the air is then recirculated throughout the building. Since the 1930s and continuing to the present day, numerous experimental studies have demonstrated the efficacy of upper-air UV-C for reducing concentrations of infectious agents for all three patterns. Compared to fixtures used in these studies, newer fixtures can provide greater UV-C output and coverage, are less costly, use less power and are less expensive.

Air Conditioning Systems

A/C systems provide an excellent setting for surfaces that support the growth of bacteria and mold in and around cooling coils, drain pans, plenum walls and air filters. Growth of these microbial deposits also leads to coil fouling, leading to an increase in coil-pressure drop and reduction of airflow and heat exchange efficiency. As performance degrades, so does the quality, amount and pressurization capability of air supplied to conditioned spaces.

Because most hospital codes call for the high-efficiency (HEPA) filters to be located downstream of the cooling coil, the filters can become damp or wet. As such, they should be considered as a potential growth medium and infectious disease reservoir. ASHRAE recommends UV-C lighting to be installed downstream of the cooling coil. If a 360-degree UV-C system is installed as such, it will disinfect both the cooling coil and the filter to eliminate mold and bacteria in and upon both devices. It should be noted that a common coil irradiation installation, using a 360-degree lamp system, will also provide up to a 35 percent kill ratio of tuberculosis in the airstream over and above the air filter's removal rate.

Conclusions

Although UV-C systems providing ultraviolet germicidal irradiation have been used for nearly 80 years, their application in infection control settings in hospitals has waxed and waned several times. Given the concerning rates of morbidity and mortality of hospital associated infections, and the global concern for antimicrobial resistant microorganisms, healthcare professionals may want to examine currently available UV-C technologies that address airborne infectious agents. In particular, upper-room UV-C systems and UV-C systems that irradiate interior surfaces of air handling units, both of which operate continuously, can greatly reduce concentrations of pathogens in a highly reliable and cost effective fashion.

Daniel Jones is the president of UV Resources, Santa Clarita, Calif.

An expanded vresion of this article, with citations, will be posted on HealthcareFacilitiesToday.com on June 17.