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UV-C

for Infection Control

Also known as hospital-acquired infections or nosocomial infections, healthcare associated infections (HAIs) are transmitted by a variety of means, including person-to-person, through the injection or insertion of medical devices, airborne contact of open wounds, and by respiration of airborne particles. The most dangerous HAI pathogens are those that have the potential to spread by air.

Many of these HAI-causing pathogens, such as Methicillin-resistant Staphylococcus Aureus (MRSA), are now called “superbugs” because they are virtually invincible to standard drug treatments. Favourable indoor environments tend to self-perpetuate these agents, adding to the concern of infection control specialists everywhere.

Engineering controls for infection-control systems in healthcare facilities plays a pivotal role in combatting HAIs. Ultraviolet germicidal irradiation (UV-C) kills all known microorganisms and can be applied to continuously reduce, or in some cases prevent, infectious pathogens from growing on or circulating in hospital spaces and HVAC systems.

There are three primary strategies for applying UV-C systems against infectious agents: upper-air, airstream disinfection and HVAC coil irradiation.



DID YOU KNOW?

The UV-C wavelength is a supplemental and extremely effective approach to fighting infectious diseases.



Applying Ultraviolet Germicidal Irradiation

The installation of UV-C units can be done relatively inexpensively throughout healthcare facilities. Upper-room units can help protect interior spaces; lamps in HVAC ducts and exhaust systems can be used for airstream disinfection; and lamps in air handlers can help disinfect airstreams, coils, air filters, drain pans and other potential reservoirs for microbial growth and proliferation.

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■ AIRSTREAM DISINFECTION

Airstream disinfection systems employ UV-C lamps to target pathogens from outdoor and return air. Kill ratios of over 99.9 per cent on a first-pass basis have been modelled and, as air is recirculated, concentrations are further reduced by each subsequent pass.

Airstream disinfection is often used in high-risk areas, such as surgical suites, neonatal care centres, and isolation rooms and wards. Guidance may be found in ASHRAE handbooks, as well as the *Ultraviolet Germicidal Irradiation Handbook*.

In addition to augmenting existing infection control systems, the 254-nm ultraviolet germicidal wavelength significantly improves HVAC airflow and heat-exchange efficiency levels, which can not only reduce energy use, but also ensure that other infection control practices, such as room-pressurization systems, operate as designed.

Pressurization systems protect against the infiltration and possible cross-contamination of air from one space type to another. When one space is said to be negatively pressured, it assumes that the adjoining spaces are all positively pressurized.

This pressure differential is of great importance in healthcare settings, but very difficult to control. Frequently opened or propped-open doors are all too common, making corridors a conduit of contaminated air to other spaces. Although operating rooms and other areas are designed to be under positive pressure, this may not be the case when an air handler's airflow has been compromised.



As air volume drops, so too does the ability of an HVAC system to provide adequate air pressure to protect against cross-contamination. As an air handler's total resistance increases, there is a corresponding reduction in the air volume output and system pressure, although fan RPM remains constant.

These reductions in a system's design pressure occur very frequently without much apparent impact. As performance degrades, so too does the quality, amount and pressurization capability of air supplied to conditioned spaces. Therefore, a higher coil pressure drop will potentially permit the infiltration of contaminated air into protected spaces and out of isolation rooms, negating room-pressurization controls.

In other words, a fouled coil impacts HVAC efficiency and infection control measures.

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■ UPPER-AIR UNITS

Upper-air (upper-room) UV-C units can be installed anywhere infectious agents may exist, including in patient rooms, emergency rooms, waiting rooms, isolation rooms and wards, surgery suites, and childcare rooms.



Studies have revealed that by applying upper-air UV-C units, the equivalent of 10 to 16 air changes per hour (ACH) can be accomplished.

These systems work by creating an irradiation zone within the upper region of the space. As convection or mechanical air currents lift airborne infectious agents into the upper air, they are exposed to the UV irradiation where they are killed.

Because people generate many of the infectious airborne pathogens in a hospital, which fall out or plate out onto equipment surfaces and floors, these upper-air systems are very effective at killing in-room, airborne microorganisms.

Another use is to intercept microorganisms from other sources or where cross-contamination pathways exist. An upper-air UV-C unit kills pathogens circulated into its irradiation zone by drafts, pressure differentials or the movement of people entering, exiting or cleaning a room. They are also effective against droplet nuclei from coughing, sneezing or the changing of bed linens.

■ HVAC COIL IRRADIATION

HVAC systems provide an excellent growth area for mould and some bacteria in and around cooling coils, drain pans, plenum walls and filters. Growth of these microbial deposits also leads to coil fouling, which will increase coil pressure drop and reduce airflow and heat exchange efficiency. This pressure drop can compromise the infection control effectiveness of room-pressurization systems.

Because hospital codes call for high-efficiency filters to be located downstream of the cooling coil, they can also become damp and wet from saturated air. As such, air filters are considered a growth medium for mould and bacteria, and can be an infectious-disease agent reservoir.

Since ASHRAE recommends that UV-C lighting be installed downstream of the cooling coil, a 360-degree UV-C system will simultaneously disinfect both the coil and the filter.

In addition to destroying all microbes in the HVAC coil and the filter, a 360-degree lamp will also kill infectious diseases in the airstream. It is exactly this 24/7 pathogen-killing operation that makes UV-C technology such an ideal supplement to a facility's overall infection control strategy.

Another benefit of installing UV-C within HVAC units or duct runs is its ability to prevent HVAC generated or recirculating microorganisms from surfaces within a space.