The Microbiology of HVAC Biofilm

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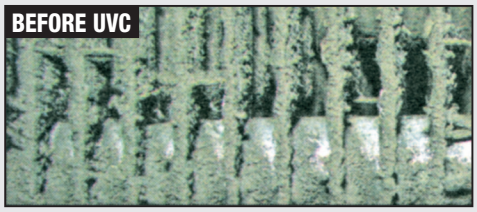

Biofilms: *A complex microbial matrix growing on coils and drain pans.*

The recent outbreak of the antibiotic-resistant superbug CPRK (carbapenem-resistant *Klebsiella pneumoniae*) in hospitals throughout the United States has put the patient population on alert once again regarding Hospital Acquired Infections (HAIs).

Combine this latest outbreak with the fact that beginning next year hospitals will be required to post their HAIs for the general public, and you have what the kids today call a "situation." One that cannot be ignored. Not only for public safety reasons (the CDC estimates that almost 100,000 Americans die every year from hospital acquired infections) but for monetary reasons as well.

According to Lisa McGiffert, Director of Consumers Union's Safe Patient Project, "The new health care reform law will save lives and dollars by arming consumers with information about each hospital's patient safety record and leveraging federal health care dollars to give hospitals a stronger incentive to prevent needless suffering and deaths."

Keeping people "well" has always been the moral obligation of hospitals. But now, reduced revenue due to patient fear as well as the fact that Medicare will no longer be footing the bill for HAIs, should have all hospitals asking "What can we do to prevent patients from getting sicker under our care and in *our* building?"

Part of the answer to that question is in developing a stronger communication between infection control personnel and facilities engineers, especially the people in charge of the heating, air conditioning and ventilation (HVAC) system. These are the people who can actually 'see' what's going on in their HVAC systems. And when you consider that at least one-third of hospital infection threats are due to airborne microorganisms, these facilities engineers can be the first line of defense. Even The World Health Organization (WHO) concurs with the idea that many infections are transmitted through the air saying "Some nosocomial infections are due to airborne microorganisms." And since the HVAC system is a known source of biofilm growth and dispersement, its maintenance needs to be a priority with hospital officials.

In fact, the WHO also clearly states that "*Legionella pneumophila*, the organism responsible for legionellosis (Legionnaire's disease; Pontiac fever), can become airborne during the evaporation of water droplets from air conditioning cooling towers and subsequently may be inhaled by patients at risk of infection." A case cited in a study from the Center for Health Design (CHD) traced an outbreak of Methicillin-resistant *Staphylococcus aureus*, or MRSA to the hospital ventilation system.

So what's going on in the HVAC system? Air conditioning coils are the source of accumulation and growth of numerous microorganisms, primarily mold and bacteria which form biofilms to permit the colonies to adhere to the fins of the coil and to help protect the organisms from biocide activity. The biofilm also protects these microorganisms against chemicals hospitals may use to destroy them.

The biofilms themselves give off products of metabolism known as volatile organic compounds (VOCs) which may range in effects on staff and patients from irritation, such as watery eyes and headaches, to more severe allergy and asthma responses. And, within that biofilm, some of the organisms that have been identified as growing on the coil and drain pans of HVAC systems are known opportunistic organisms causing infections. *Pseudomonas aeruginosa* is commonly found growing in wet drain pans and on coils and is known to be a cause of upper respiratory infections.

This biofilm may be easily spotted with the naked eye by facilities engineers. However, many facilities engineers aren't aware of the harmful effects it may be having within the hospital. That is why a tete-a-tete is called for between infection control and hospital maintenance, not only to raise awareness levels of this serious problem, but to do something about it. And there is definitely something that can be done. Install UVC lights in the HVAC system.

The C wavelength of the UV spectrum targets the DNA of microorganisms destroying their cells or making replication impossible. Directed at a cooling coil or drain pan, UVC energy destroys the surface biofilm that grows there. Not only that, the UVC light attacks microorganisms including viruses and bacterium that are being disseminated through the air-handler from sources within the hospital. UVC light installed at the coil has been shown to kill many microorganisms on each pass through the system.

Biological Warfare

UVC light can be so powerful that the Environmental Protection Agency (EPA) conducted tests on its efficacy in destroying pathogens in the event of biological warfare. Homeland Security had identified a potential method of terrorism as the intentional introduction of biological warfare agents (BWAs) into the heating, ventilation and HVAC systems of target structures.

Using several different UVC devices mounted inside HVAC systems, testing was conducted using three microorganisms, two bacteria (one spore-forming and one vegetative) and one virus that were considered surrogates for BWAs. The test microorganisms were introduced

into the duct upstream from the installed device, and as the air flowed through the duct, they were exposed to UVC. All UVC devices were more than 99% efficient at inactivating the vegetative bacteria. And three of the devices were more than 93% efficient at inactivation of all three microorganisms. When deciding upon what UVC devices to install, one needs to seek independent data to determine the efficacy of various systems with the required application.

While some UVC devices may be more efficacious than others, they are all pretty powerful. Their installation in hospitals has had some significant results. After installing UVC in the Women & Children's Hospital of Buffalo's Neonatal Care Unit, they witnessed reduced Ventilator Associated Pneumonia (VAP), reduced antimicrobial use and reduced antimicrobial resistance. UVC installations at Lower Bucks County Hospital in Philadelphia reported a 50% reduction in VAP. Florida Hospital in Orlando, witnessed a 40% reduction in nosocomial infections. And on a joyful note, when Lehigh Valley Hospital In-Vitro Fertilization Clinic installed UVC, they had an increase of clinical pregnancies of 50%.

Why all hospitals don't already have UVC protection in their HVAC systems is astounding given the high rate of HAIs and the knowledge that hospital income will be diminished as a result. However, many hospital administrators are under the perception that retrofitting their facility with UVC lights is cost prohibitive. On the contrary, studies show that they not only improve IAQ, they can improve the hospital's bottom line in energy efficiency, water conservation and most importantly, reduced medical costs due toHAIs.

Life Saving, Energy Saving

Consider this, HVAC systems in hospitals use up to 60% of its energy. Dirty coils use up to 30% more energy. The way to keep those coils clean? UVC light. As the lead engineer in the design of the state-of-the-art Muskogee Community Hospital explains, "UVC offers an important advantage: It continuously cleans the coil and drain pan surfaces of biofilm buildup, reducing or eliminating the need for costly manual cleaning and keeping the units in 'as-new' condition so they run more efficiently. As a result, UVC saves on maintenance and energy." Using UVC light is the reason Florida Hospital reported an annual energy savings of $237,500 after installing them; and it's why Rio Grande Hospital in McAllen Texas reported a $500,000 cost savings. Bottomline: It doesn't pay NOT to install UVC.

Hopefully, this information will alert the need for UVC, especially in hospital situations. Now let's talk about what to look for in a UVC application:

Output of the device. Devices marketed for commercial HVAC applications fall into two basic categories – those with new generation, high output lamps introduced in the 90s and those using conventional, older-style UVC lamps not engineered for HVAC use. The germicidal output of these devices will vary widely, especially when exposed to HVAC operating conditions.

For optimum performance, the device should be manufactured to deliver output of nine microwatts per linear inch of glass measured from a distance of one meter, tested at an air velocity of 400 feet per minute, and situated in a temperature of 50°F. This information is critical because UVC output declines over time, reaching a half-life after 9,000 operating hours or slightly over one year when running on a 24/7 basis. It is necessary to start at a high enough output, to ensure adequate output will be maintained throughout the service of the device, otherwise, it may not be able to maintain effective microbial control.

Make sure the device has been tested under HVAC conditions. Some devices are tested in warm, still air instead of cold, moving air conditions. The germicidal output varies widely, especially in HVAC operating conditions.

For optimal performance, use high-output devices manufactured to deliver output of 9 micro-watts per linear inch of glass measured from a distance of 1 meter and tested at typical HVAC operating conditions (50° F @ 400 fpm air velocity).

Install UVC Lights in the right place. For the most effective microbial control, UVC devices should be installed downstream from the cooling coil and above the drain pan. This location provides more effective control than in-duct UVC installations because it attacks contaminants at the source to deliver simultaneous cleaning of surface and airborne microbes.

See the Light

According to the CDC in 2002, one out of 20 patients acquire an infection in the hospital. While administrators have been focused on reducing this rate by preventing human error, utilizing proper waste disposal methods, sanitizing hands and rooms and reducing antibiotic overuse, many of them have literally been overlooking the air they breathe. If the goal is to see to patient well-being and eliminate preventable healthcare-associated infections, hospitals need to see the light and install UVC in their HVAC system. It's a simple and effective solution to a growing problem.

Dr. Scheir is President of Steril-Aire, a firm that specializes in the development and application of germicidal UVC energy to clean HVAC systems and the air stream. His bachelor's degree in Bacteriology is from the University of Maryland and he did graduate work in Immunochemistry at the Johns Hopkins School of Hygiene and Public Health. He earned his Doctorate in Medical Microbiology from UCLA. He was a Senior Scientist at McDonnell-Douglas Corp specializing in biological warfare detection instrumentation and he has had extensive experience in microbial air pollution, detection and remediation. He has more than 25 years' experience in the field of infectious disease detection and control in hospitals, medical laboratories and industry. He has served as a Quality Assurance Manager for Abbott Labs and as a Manufacturing Officer for Health Valley Foods. He was President of two medical products manufacturing companies, Cal Labs and CalScott.

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