According to the Centers for Disease Control and Prevention (CDC), health care-associated infections (HAIs) are a major cause of morbidity and mortality in the U.S. In a 2011 survey of acute care hospitals, the CDC found that on any given day, about one in 25 hospital patients had at least one health care-associated infection and about 75,000 hospital patients with HAIs died during their hospitalizations. Considering this survey did not take into account HAIs found in other health care settings, such as ambulatory surgery (outpatient) clinics or long-term care facilities, and it is easy to see why infection control is receiving increased scrutiny by those working in the health care industry, as well as the federal government.

When an infection occurs in a health care facility, it is usually very difficult to determine where it came from, as sources may include medical instruments, patients, staff, visitors, as well as the airborne transmission of infectious agents. It is the last point that is of concern to HVAC professionals as they are often tasked with making sure the mechanical equipment is providing the cleanest possible air to the health care facility. This often includes upgrading a facility’s HVAC systems to include advanced filtration, UV lights, precise temperature/humidity control, and proper pressurization.

HVAC and HAIs

As noted in ASHRAE’s “HVAC Design Manual for Hospitals and Clinics – 2013,” the nature of infectious pathogens, the modes of transmission, the causation of infections, and their relationship to HVAC system design are complicated and not fully understood. But, most agree about 90 percent of HAIs are transmitted by direct contact, with about 10 percent resulting from airborne transmission.

“Everyone seems to agree that the percentage of airborne infections is still pretty low, but even in the 10-15 percent range, that is acceptable!” said Brent Stephens, Department of Civil, Architectural, and Environmental Engineering, Dewberry, Chapel Hill, North Carolina. “One of the biggest sources of surgical site infections (SSIs) is thought to be skin particles. You can put the cleanest air in the world in the room, but if skin particles are falling off the doctors and nurses into the surgical site, that’s a problem that can’t be solved by the HVAC system. At about 10 microns, skin particles are affected by gravity and will not be swept away by the airflow.”

One way to fix this problem is to make operating rooms run the same way that cleanrooms do, said Koenigshofer. “Why are we more worried about our wafers than our grandmothers? We should be building cleanroom-level HVAC systems for operating rooms, and the medical staff should be gowning up in bunny suits. If we can make cleanrooms really clean, we can make operating rooms really clean.”

That is not likely to happen any time soon, but health care facilities are interested in making other upgrades to their HVAC systems to help mitigate airborne infections. “We are putting UV lights in just about every air-handling unit,” said Koenigshofer. “There are also heightened concerns about filter quality and making sure the racks are tight and have no holes. Filter racks should be sufficiently rigid so they don’t bend with pressure drop across them. And magnetonic gauges should be used, so filters are changed based on the pressure drop across them, rather than the calendar. The CDC recommends final filters be downstream of humidifiers, so we prefer to place humidifiers in the air-handling unit. There, they are also easier to maintain and control than in the ductwork near the operating rooms.”

Low-efficiency filtration and filter bypass can be issues with any airborne transmission of infectious agents that may lead to HAIs, which is why some hospitals are approaching the issue more aggressively, said André LeBlanc, director of operations, ConEdison Solutions, Tampa, Florida, who regularly helps hospitals upgrade their HVAC systems in order to reduce infection risk. “Once you get relative humidity levels above 65 percent, there are quite high air-exchange rates and total airflow rates relative to the room volumes — higher than what is required by ASHRAE standards.”

“In addition to making sure the correct air changes per hour are taking place, it is important for hospitals to maintain precise levels of temperature and humidity,” said André LeBlanc, director of operations, ConEdison Solutions, Tampa, Florida, who regularly helps hospitals upgrade their HVAC systems in order to reduce infection risk. “Once you get relative humidity levels above 65 percent, there are quite high air-exchange rates and total airflow rates relative to the room volumes — higher than what is required by ASHRAE standards.”

By Joanna R. Turpin
Of The NEWS Staff

HVAC Upgrades Part of Overall Strategy to Eliminate IAQ Issues

Proper service and maintenance practices at hospitals may help uncover various hidden problems such as this coil frame, which is completely rusted through.

As part of an overall strategy, hospitals are starting to replace equipment – such as this rusted air handling unit – in order to reduce HAIs. (Feature Photos on this page courtesy of Dan Koenigshofer, Dewberry)

Deteriorating fiberglass lining in air handling units and ductwork is driving a lot of replacement work in hospitals and other health care settings.

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As an example, Stephens points to a hospital he recently worked on that used a series of particle filters, starting with MERV 7 and MERV 13 on the return side (mixed with outside air) and HEPA filtration on the supply side of the HVAC systems serving patient rooms. “There is a long-standing notion that HEPA will have higher pressure drop and increased fan energy use when used in a variable air volume (VAV) system, but this particular hospital was designed in an aggressive way to reduce the risk of transmitting particles from one room to another via the ventilation system. They also had quite high air-exchange rates and total airflow rates relative to the room volumes — higher than what is required by ASHRAE standards.”

In addition to making sure the correct air changes per hour are taking place, it is important for hospitals to maintain precise levels of temperature and humidity,” said André LeBlanc, director of operations, ConEdison Solutions, Tampa, Florida, who regularly helps hospitals upgrade their HVAC systems in order to reduce infection risk. “Once you get relative humidity levels above 65 per-
cent or below 20 percent, your infectious control rates or complications related to the environment go way up. I see a lot of humidity problems in older hospitals, in particular, where little attention was given to the infrastructure.

Another reason why hospitals experience so many problems with humidity, said LeBlanc, is that sensors are not regularly checked to make sure they are working properly. “It really has to start with the engineers specifying the correct types of accurate devices and then making sure those devices are actually installed. It’s really common to use relative humidity sensors that are between 3 and 5 percent accuracy, and, a lot of times, I’ll find those sensors are not even that accurate. They drift over time, and they’re not replaced.”

Commissioning could help with this issue, said LeBlanc, but it rarely happens the way it should, especially in retrofit projects. “If you’re building a hospital or a wing from the ground up, retrofit jobs have a tendency to not be inclusive of commissioning. You need to look at continuous commissioning to make sure that, over time, the useful operational life of the equipment is operating as it was intended within the parameters that it was designed within. I don’t see that happening very often at all.”

Proper pressurization is another concern in terms of infection control, particularly in sterile processing departments, which is where instruments are decontaminated, sterilized, and then packed for use. “Getting the pressurization correct is very important because they’re bringing in contaminated instruments into a space that should be highly negative,” said Koenigshofer. “This negative space is situated right next to a positive space, and there are cart washers, sterilizers, and maybe even a window or door between the spaces, so it’s hard to maintain pressurization, low temperatures, and low humidity.”

In situations such as these, Koenigshofer advises hospitals to install canopy hoods over the cart washers and sterilizers in order to remove the heat and humidity generated by the sterilizing process. “We need to get the hot and humid air out right away, rather than try to overpower it with supply air. You need to calculate the supply and exhaust airflows needed to get sufficient offsets in order to get a pressure differential, then a testing and balancing company can come in and set it up.”

UVC and More

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UV System Keeps Germs Away

Geary Community Hospital in Junction City, Kansas, recently underwent a $34 million expansion that included the addition of a 15,000-square-foot surgery suite. The HVAC system for this suite is comprised of a conventional four-pipe chiller and boiler loop concept and UV germicidal irradiation (UVGI) lamps in each of the five air handlers. The Fresh-Aire UV Commercial Series UVGI systems use 32-inch-long UV lamps in modular racks affixed to the supply side of every coil. UVGI alters the DNA and disables the reproductive capabilities of any microbe passing through its UV field in the air handler. Microbes later become entrapped in each unit’s HEPA filters, which are manufactured by Camfil Farr. Combined with each air handler’s 30 percent pre-filter and 65 percent filter, the HEPA filters deliver 99.9 percent particle-free filtration, providing optimum IAQ.
infection, hospitals are not always eager to implement them, particularly in older facilities. UV lights are a perfect example, as they have been broadly accepted for the last decade, but LeBlanc noted he still does not see them installed in the majority of hospitals in his area. "The reason is cost. A lot of times we’re dealing with hospitals that have old air-handling units, so UV lights aren’t even considered until it’s time to replace the equipment. And it’s too bad, because they really work well," LeBlanc said. "Unfortunately, health care is an industry that is primarily driven by a first-cost mentality."

Portable UV disinfection systems such as the Germ-Zapping Robots™ from Xenex are also gaining in popularity, said Stephens. These systems use patented pulsed xenon UV light designed to destroy harmful bacteria, viruses, fungi, and bacterial spores in any location within a hospital, from operating rooms to isolation rooms to offices and utility rooms. The Xenex germ-zapping robot can disinfect a typical patient or procedure room in five to 10 minutes.

Xenex robots use xenon (not mercury) to create UV light, and, according to the company, its patented technology is 25,000 times more intense than mercury UV systems. Pulsed xenon emits high-intensity UV light across a broad germicidal spectrum (200-280 nanometers versus the single spectrum of 253.7 nanometers for mercury bulbs), which enables Xenex devices to eliminate a wider range of pathogens at a much faster rate than mercury devices.

David N. Schurk, director of health care accounts, Heat Transfer Solutions, an independent manufacturer’s representative in Houston, is particularly excited about the needlepoint bipolar ionization systems from Global Plasma Solutions (GPS), which use a plasma field to break down harmful gases, fibers, bacteria, and allergens into simple, safe, and naturally occurring molecules. "I strongly promote these systems because they perform multiple duties," said Schurk. "First, they keep the coil clean. We mount the system on the entering air side of the cooling coil, so the air is basically being sterilized before it enters the coil. That keeps the coil clean from front to back. Second, if there is no downstream filtration, the system will keep the rest of the air handler and ductwork clean and ions can flow into the space and mix with the room air, so it can keep surfaces clean."

The GPS system costs about twice as much as UV lights, but Schurk noted it uses less electricity and requires less maintenance as there are no bulbs to replace. Some hospitals have already installed the GPS system, but most are still researching the technology and waiting to learn more about its long-term impact. "Hospitals are not pioneers — there are very few of them that are willing to embrace the latest and greatest of anything until it’s been vetted and tested. Most of the ‘latest technologies’ employed today had been implemented commercially for five to 10 years already."

While it is likely a very small percentage of HAIs can be attributed to HVAC systems, hospitals are increasingly looking for ways to reduce that risk even further. Advanced filtration, UV lights, and precise temperature/humidity controls are just a few of the upgrades hospitals are looking to incorporate as part of an overall strategy aimed at reducing rates of infection.