RE-THINKING HVAC AND HAIS

CHAIR's strategies for enhancing patient protection

By Richard Dixon

Healthcare acquired infections (HAI's) are increasing each year in our Canadian healthcare facilities. Meanwhile, the traditional approaches to HAI reduction are becoming less effective while bacteria is becoming more resistant to our effects to contain its spread.

THE STANDARD APPROACH

The first antibiotic "penicillin" was discovered by Sir Alexander Fleming in 1928. Since then, antibiotics have become widely used (and frequently overused) in the treatment of infections. Unfortunately, the increased use of antibiotics in healthcare facilities, and in community use, decreases the patient's immune system and increases their likelihood of contracting a HAI.

The traditional defense is for all clinical staff to wash their hands with soap and water to clean the hands of visible dirt, and use a hand sanitizer to kill any remaining organisms. If the skin is visibly soiled, hand sanitizers will not work effectively by themselves. For equipment, it's the same principle: clean before you disinfect. The effectiveness of the hand washing process is measured at reasonably high rates when audits are done, but effectiveness is less when the audit staff is not present (aka the Hawthorne Effect). Thus, when hand washing is not effective, bacteria are easily spread from contaminated touch surfaces though the hands of visitors and care givers to immune-compromised patients.

Also at the front line of defense are the environmental services departments. Herein, staff are required to do extensive disinfections with a wide variety of products that are becoming less effective since the bacteria is becoming more resistant to these disinfection processes. Also, the time associated with the actual clean is not necessarily long enough due to scheduling and budget restrictions. Audits of their cleaning effectiveness with ATP meters (adenosine triphosphate) or glow lights indicate a significant amount of the patient touch surfaces to be contaminated with bacteria. These ATP meters are a verification that provides accurate and meaningful results that can help a healthcare facility define and monitor a cleaning standard to make sure it is maintained.

ENTER: CHAIR

Canadian healthcare facilities spend $2 billion on infection prevention and control salaries, hand washing practices, and audits -- plus another $4 billion treating HAIs. More importantly, there are 160,000 to 200,000 annual infections in Canada, with upwards of 12,000 deaths. Just cutting the HAIs by 50% would save $2 billion and thousands of seriously ill patients, many of whom would have died.

In short, patients are getting infections within environments that are supposedly built to keep them safe. It's time to try another approach.

The Coalition for Healthcare Acquired Infection Reduction (CHAIR) is a new organization that was formed to combat HAI's through the built environment and with engineered solutions. CHAIR believes that with help from healthcare management and staff, we can all work to reduce HAIs by 80% by 2014. Thus, healthcare heating, ventilation, and air conditioning (HVAC) system people have to re-think their traditional approaches.

ROOM FOR IMPROVEMENT

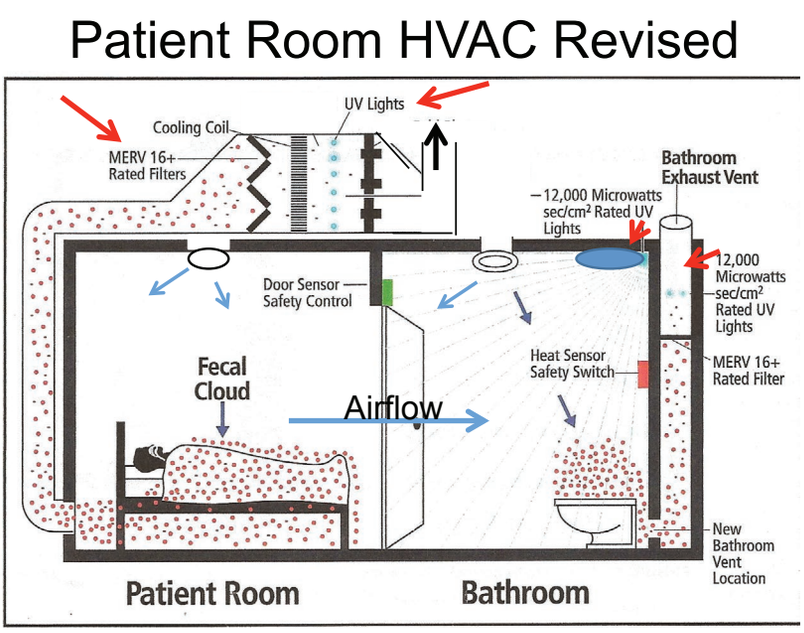
The Canadian Standards Association Z8000-11 standard requires hospitals build inpatient rooms as "one patient per room", which is a great advantage in the infection control world. However, there are a few issues to re-think.

Let's start with the HVAC system in one of these new rooms. The air is supplied within temperature ranges of 22 C to 24 C and 30% to 60% relative humidity. However, the supply air is set at minimum two outdoor air changes per hour (ACH), and minimum six total ACH. Thus, re-circulated air is being used between all the patients in the care unit. As a result, there are single rooms for patients, but some of the air is re-circulated to all the patients. What about raising the

relative humidity minimum to 40%, providing we could maintain a clean humidification system? The clinical evidence suggests that the optimal conditions to enhance human health by minimizing the growth of biological organisms and the spread of chemical interactions occur in the narrow range of 40% to 60% relative humidity at room temperature.

On the filtration side of the typical HVAC system there are two filters: MERV 8 (#1) and MERV 14 (#2). In combination, these filters take out 95% of the skin, air, dust, etc., and some bacteria out of the air down to one micron. Some of the bacteria is still recirculated, but these filters effect no virus containment or kill.

Now, imagine if the air was HEPA filtered so that 99.97% of the particles were removed down to 0.3 microns. We should be considering the benefits of HEPA filtering general patient rooms. Even if this system was implemented in high risk areas of a hospital like the intensive care unit or even the operating room, the HAI rate could be reduced. Cost is an issue, and we will get to that soon.



RETHINKING BATHROOM HVAC

In a patient bathroom, the return air grill is traditionally on the ceiling and most likely directly over the toilet. According to engineers, this placement above the toilet is an efficient way of pulling the "odour" out of the bathroom because the duct work is placed in the ceiling structure. That sounds reasonable, but what is that "odour"? It is bacteria from the aersolization of toilet water, fecal matter, and/or urine (aka fecal cloud)?

Think of a patient with C. difficile infection and continual diarrhea. The associated continual flushing of the toilet and the resulting fecal cloud with the exhaust grill in the ceiling pulls the bacteria-laden air from the toilet and up past the patient's mouth and nose where they can be re-infected over and over. Some of the fecal cloud also escapes into the patient room as the bathroom door may be left open – minimal draft from the return grill and a large open door. This fecal cloud can easily drift into the pressure neutral corridor and beyond.

A simple solution is to place the exhaust grill behind or adjacent to the toilet at approximately 300mm above the floor which is closer to the source of the fecal cloud so the air will flow away from the patient's hands, mouth, and nose, thereby decreasing the risk of reinfection of airborne diseases. So let's go back into the patient room and put that exhaust grill behind the bed at that same height to collect the fecal cloud from the patient "off gassing", or the use of bed pans. That's an easy solution.

CLEANING THE AIR

Here's a harder example. The frequency of supply duct cleaning in healthcare facilities is realistically seldom or never. Why is this situation happening, especially in older facilities? Is it because of budgets? Are staff too busy? It is time to re-think this issue, since old supply ducts (as well as return ducts) need investigation of how much dust, bacteria, insects, etc. they have accumulated; the costs and logistics associated with the cleaning process; as well as the benefits of air that is supplied by sophisticated HVAC systems through clean ducts to patients.

Another way to clean the air is by using ultraviolet light; specifically, UV-C lights which have a wavelength of 100 to 280 nanometers. This technology has actually been around for years, but now studies have shown it to be a very beneficial part of the re-thinking of how the air (and touch surfaces) can be cleaned.

Did you know that UV-C systems are widely used in the meat and fish processing industries to keep the air and surfaces free from bacteria? These state of the art UV-C systems can be installed as in-duct, coil mount, and stand-alone systems to target specific high risk rooms. What's more, controls consultants can link a few UV-C issues to the building management system (BMS). Again, the patient gets the benefit of receiving air that is not only virtually free of unwanted particles from our previously noted filter issues, but the UV-C is killing bacteria and viruses at 99%.

These modern UV-C systems are cost effective to purchase and install, and have long lasting UV-C bulbs that do not emit ozone and systems that can be put in place for safe operational use. Portable UV-C systems are also available that can clean patient rooms post discharge at a disinfection rate typically higher than environmental services in only 15 minutes. That was easy too!

HVAC UNDER PRESSURE

Now that we have safe air, it's time to discuss pressurization issues. A typical hospital is a delicate balance of negative, neutral, and positive pressurized zones – and for very good reasons. The operating room is pressurized as positive to push unwanted air from other zones away from patients who are in a vulnerable state with their insides literally opened up. Meanwhile, the endoscopy department is pressurized as negative to prevent the fecal cloud from migrating into adjacent zones. However, the typical in-patient unit (medical, surgical, paediatric, etc.) is pressurized as neutral.

The patients inside these units, as by the nature of the admission reason and antibiotic use, are reasonably immune suppressed and thus vulnerable to common HAIs like VRE, MRSA, and C. difficile. Let's then re-think this issue as to keep air from migrating room to

room via the open door to the corridor or through the HVAC system. Why not make the air flow in a more common sense manner: from corridor to patient room to bathroom? Not a lot of effort is needed to make this happen. HVAC engineers can design the system in this manner and balancing contractors can verify its performance.

Truly, we must think ahead to what may be coming next, like Middle Eastern Respiratory Syndrome (MERS) or H5N7 or just control the common HAI's of VRE, MRSA and C. difficile. This negative balancing of in-patient rooms would be a safer place for all of our patients. It would go a long way towards not having the 'fecal cloud' migrate from one patient room to another via the currently neutral corridor. Once again, that was easy.

Another easy engineered solution is to make key humidification components (i.e. coils) out of copper or a copper alloy to reduce the potential for the growth of bacteria. Health Canada has now registered copper as an 'antimicrobial' product following the United States' registration with the Environmental Protection Agency. As an alternate, the water for humidification system could be reverse osmosis which would also reduce bacteria growth.

POSITIVE HVAC RESULTS

Naturally, this article is about HVAC in healthcare facilities such as hospitals, nursing homes, long term care centres, and respite homes; as well as specialized facilities like In-Vitro Fertilization (IVF) clinics. As for the latter, a recent study at an IVF clinic in the United States indicated the success rate of fertilizations went up from 38.9% to 62.3% with just the introduction of UV-C cleaning systems in key rooms. No doubt, this is a dramatic improvement, and it was easy. Understanding this, it's a good idea to focus on not just hospitals, but all of the healthcare facilities across Canada.

Additionally, many surgeons in Canada have procedure rooms in their office building to perform minor surgical procedures that can be done easily outside of a hospital. Besides building the procedure room to the local building code, they should be following the Canadian Standards Association requirements for HVAC, medical gas piping, etc.

As more and more surgical procedures move from an in-patient to out-patient status, there is also a significant trend to move the out-patient procedures from the traditional hospital building to free standing surgery centres operated by the hospital itself or to physician-based practices. Therefore, another opportunity exists in these physician-based practices for the innovations noted above.

It's important to be realistic about the capital costs for implementing these key findings that came through CHAIR's process of re-thinking traditional approaches to the built environment and the potential cost savings. Again, cutting the HAI's by 50% of the estimated $4 billion in costs would save $2 billion annually that could be directed towards a Health Acquired Infection Reduction fund. So there is not a requirement to increase healthcare budgets to combat the problem. The "Return on Investment" (ROI) does this by itself. In fact, we should actually call it "Return on Innovation".

And for the last time…that was easy! ■

Richard Dixon is deputy chair of CHAIR and president R&C Dixon Consulting Ltd.(www.ChairCanada.org). He can be contacted at richarddixon@chaircanada.org.