Technology Aids in HAI Prevention

http://www.infectioncontroltoday.com/
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Posted on: 07/23/2009

Technological advancements are beginning to revolutionize the way infection preventionists fight hospital-acquired infections (HAIs). We take a look at emerging technology and the way it is facilitating measurement and compliance with everything from hand hygiene to environmental cleaning and instrument decontamination and tracking.

ATP

Adenosine triphosphate (ATP) applications in healthcare are beginning to take off. ATP is the universal energy molecule found in all animal, plant, bacterial, yeast and mold cells. And because large amounts of ATP can be found in bioburden and contaminants left behind by hands, it makes for an efficacious test technology. While the use of a fluorescent product to evaluate hand hygiene, such as GloGerm, has been in the market for a very long time, researchers have developed a new method using an invisible fluorescent marker to target high-touch surfaces in hospital rooms to determine cleaning efficacy. Carling, et al. (2006) describe how a nontoxic target solution, which intensely fluoresces with a black light, was formulated to be inconspicuous yet readily removed by disinfectants used by hospital housekeeping staff. Small volumes of material were applied to 12 target sites in patient rooms in three hospitals following terminal cleaning. The targets were reevaluated following terminal cleaning after several patients had occupied the room. The researchers evaluated 157 rooms in which 1,404 targets were placed, and found that in the three hospitals only 45 percent, 42 percent, and 56 percent of targets were removed by routine terminal cleaning/disinfecting activities. The frequency with which various individual sites were cleaned varied widely but was similar in all hospitals. The researchers concluded that the use of a novel target compound to evaluate housekeeping practices confirmed high rates of cleaning of traditional sites but poor cleaning of many sites that have significant potential for harboring and transmitting microbial pathogens.

ATP also is the technology at the heart of a new system to measure decontamination of the inside channels of flexible and rigid scopes. The Ruhof ATP Complete Contamination Monitoring System is a rapid method for verifying the cleaning process of all scopes and cannulated instruments. An absorbent swab on a flexible wand is fed into the internal channels to test for the presence of bioburden; when ATP is picked up by the tip of the swab and the swab makes contact with a reagent in the swab tube, light is emitted by the handheld unit in direct proportion to the amount of ATP present in just 15 seconds. The handheld device can be synced to a computer and the reading downloaded to the provided software program. The data can then be used to produce detailed reports and used to monitor cleaning history.

Hand Hygiene

Industry is trying to address notoriously low hand hygiene compliance rates by offering technology-driven systems that encompass everything from automated handwashing to RFID-enabled surveillance. Automated systems can increase hand hygiene compliance because they make a tedious chore quicker and more fun, as well as thorough and more uniform than a manual "splash-and-dash" approach commonly used by rushed healthcare workers. Resurgent Health and Medical's Radius Automated Handwashing and Monitoring System is a fully automated, touchless system available in healthcare for mechanical handwashing, rinsing and sanitizing. It performs a 12-second cycle using a chlorhexidine gluconate-based sanitizing solution, delivered by high-pressure water jets that perform a consistent wash-and-sanitize cycle every time the machine is used. Healthcare professionals place their hands in the machine, which functions as a mini carwash, and the technology does the work. Resurgent's automated handwashing systems with RFID compliance verification and automated compliance reporting makes it possible to automatically monitor hand hygiene events at every Resurgent handwashing machine, record each healthcare worker's hygiene practices to a database, and generate reports that provide real-time, comprehensive data.

Wireless sensor networks (WSN) represent another emerging technology that is beginning to have an impact in the healthcare environment. A wireless sensor network is made up of a group of sensor devices that monitor some aspect of its environment and communicate its observations through other devices to a destination which data from the network is gathered and processed. An example of a WSN-enabled system is the proprietary ZigBee technology, which is being incorporated in a number of healthcare-related applications. One such application is a system created by

epidemiologists and computer scientists is a new, low-cost, green technology for automatically tracking the use of hand hygiene dispensers before healthcare workers enter and after they exit patient rooms. This novel method of monitoring hand hygiene compliance was first introduced at this year's meeting of the Society for Healthcare Epidemiology of America (SHEA).

"We know that a range of pathogens are spread from healthcare workers to patients by direct touch and that the current rates of hand hygiene compliance are suboptimal," says Philip Polgreen, MD, of the University of Iowa Health Care. "Our new method could potentially reduce cost while increasing compliance rates." Workers wear small, pager-sized badges to monitor their use of hand hygiene dispenser stations prior to entering patient rooms. The technology behind the study was developed in collaboration with computer scientists at Iowa. Ted Herman, the lead computer scientist on the project, designed badge construction and placement of small beacons inside patient rooms and other designated locations. "A novel part of our method is how data are recorded," Herman says, "data are recorded and processed in the badges rather than relying on a network." Each use of the dispenser station is automatically reported by the user's badge, which logs the time and length of use, date and dispenser ID number. The data from the badges can be automatically off-loaded multiple times, which means results are recorded and aggregated without any manual data entry. The automated monitoring system correctly identified more than 90 percent of study subjects entering and exiting patient rooms when they remained in the room for 30 seconds. When the time in the room is increased to 60 seconds, the monitoring system approaches 100 percent identification of subjects entering and exiting patient rooms.

Versus Technology, Inc. has introduced a Hand Hygiene Compliance Solution to automatically measure instances of hand hygiene compliance and noncompliance. The system includes infrared (IR) and RFID badges for caregivers. These small, lightweight badges communicate with similar IR-RFID tags placed on automated soap dispensers. When a badge-wearing staff member approaches the soap dispensing unit, the tag on the dispenser reads the badge, records who is at the handwashing station and when and where the activity is taking place. At the time of handwashing, the caregiver receives an audible acknowledgement that the Versus system has captured this HHC event. The event is recorded and available for reporting and quality improvement purposes. Because the system is based on real-time locating technology, it provides accurate, unbiased data for continual process improvement.

The ProGiene GMS system from UltraClenz is a handwashing management system designed to increase and sustain handwashing quality while providing management with both a daily and cumulative total of completed handwashes. The integrated Progiene GMS system is comprised of a touch-free faucet adapter (ProSense) and an intelligent touch-free soap dispenser. It can operate as a stand-alone system or on a network with up to 240 Progiene GMS systems. As a networked system, the Progiene GMS becomes a powerful management tool by reporting hand wash statistics and trends for the past 90 days. A networked system also allows for remote system configuration and real-time hand wash counts both daily and cumulative.

Alpha Protection Solutions, LLC is the distributor of the AlphaClean™ Hand Wash and Data Compliance System, designed to monitor employee hygiene through a proprietary data tracking system. AlphaClean Compliance System is comprised of a touch-free faucet sensor and/or touch-free dispenser sensor that works with a portable data logger device that transmit data to a computer-based system that generates reports for improved surveillance activities.

HyGenius is a complete handwashing management system that attaches to any existing hand sink or automatic wash system. Designed to provide a proper wash for each user, HyGenius not only verifies individual handwashing compliance but helps to ensure consistent handwashing technique and regular wash frequency by each user. HyGenius also helps ensure that a proper wash is performed between glove changes, helping to manage proper gloving and glove changing. HyGenius administers a step-by-step, time- and temperature-controlled wash utomatically, without having to touch bacteria-laden faucet handles or knobs. The water flow allows proper and thorough wetting, and then the flow of water is stopped and the built-in display instructs the user through the dispensing of soap, lathering/ scrubbing, rinsing and drying. Using sensors capable of detecting drugs in breath, new technology developed at the University of Florida monitors healthcare workers' hand hygiene by detecting sanitizer or soap fumes given off from their hands. The HyGreen system logs the frequency of hand cleaning and contact with patients in a database that clinical supervisors can review immediately.

"This isn't big brother, this is just another tool," says Richard J. Melker, MD, PhD, a UF College of Medicine anesthesiology professor who developed the technology along with professors Donn Dennis, MD, and Nikolaus Gravenstein, MD, of the anesthesiology department, and Christopher Batich, PhD, a materials science professor in the College of Engineering. "A hospital

worker never wants to be responsible for someone getting sick or dying from an infection acquired in the hospital."

HyGreen is now being tested in the Neuro Intensive Care Unit at Shands at UF Medical Center. The healthcare worker squirts sanitizer gel or soap into his or her hand before passing it under a wall-mounted sensor. A wireless signal from a badge worn by the worker activates a green light on the hand-washing sensor. When the worker enters a patient room, a monitor near the bed detects the status of the badge, and flashes green if the person has clean hands. If the person has not washed, or too much time has passed between washing and approaching the patient, the badge will give a gentle "reminder" vibration. "I do wash my hands more often," says Carrie McGirr, RN, who volunteered to help test the HyGreen system. "It's a fairly simple process to learn." Loretta Fauerbach, director of infection control at Shands, says, "This system is a noninvasive way of measuring; it allows for nonbiased measurement and is unobtrusive."

RFID Systems

One of the most common and maturing technologies in the marketplace is radio frequency identification (RFID). Van der Togt et al. (2008) observe, "RFID applications in healthcare have received increasing attention because of the potentially positive effect on patient safety and also on tracking and tracing of medical equipment and devices. The current expenditure levels on RFID systems within healthcare in the United States are estimated to be approximately $90 million per year with 10-year growth projections to $2 billion."

RFID technology has the potential to reduce costs, reduce errors and improve patient safety, but it also can be a costly, potentially problematic solution. Here's how it works: Medical devices, surgical instruments, drugs and equipment are tagged, and then the RFID technology allows tagged objects to be identified by a reader (often located on door frames or in other locations) using radio transmissions that detect and record interactions. RFID applications in healthcare can include patient identification as well as asset tracking and inventory management.

RFID is becoming popular as a means for the sterile processing department to track surgical instruments that must be decontaminated, cleaned, sterilized and packaged between uses. Tagged instruments and readers placed on sterilization chambers and storage cabinets work together to document that the proper reprocessing processes were followed and that the instrument is indeed available for use. Reiner and Sullivan (2005) note,

"Since medical devices are often mounted on portable carts, smart tags placed on the devices and readers installed in the doorways can enable personnel to quickly locate a crucial piece of equipment and immediately determine its fitness for use. Similarly, catastrophic errors would be completely traceable from manufacture to use, and preventive maintenance on equipment could be more accurately tracked."

One system, the V Mueller brand IMPRESS Instrument Management System, is a fully integrated, real-time, Web-based instrument management solution for hospitals and surgery centers that provides a comprehensive solution to managing instrumentation investment throughout the entire process of care, including decontamination, assembly and sterilization. IMPRESS uses barcode technology to track sets, peel packs and instruments to case carts, operating rooms and patients. The IMPRESS system helps reduce the use of flash sterilization; improve communication between the operating room, sterile processing and materials management departments; reduce instrument spend and improve resource management.

Instruments and medical devices are not the only things that can be tracked using RFID; patient identification and tracking can be achieved through the use of patient tags with embedded RFID chips. There also are RFID wristbands made of silica gel that can operate without line-of-sight while providing read/write capabilities, to enhance patient privacy. The wristband is heat-resistant and reusable after high-temperature sterilization and its memory can be wiped and written more than 100,000 times.

RFID systems are also helping hospitals reduce and eliminate the number of retained objects in patients. Studies indicate that 1 in every 1,000 to 1,500 intra-abdominal surgeries leads to a sponge left behind in a patient. A retained sponge can lead to the need for repeat surgeries, as well as serious complications including sepsis, and can even result in patient death. Patients are not the only ones who pay a steep price; as part of it pay-for-performance initiatives, the Centers for Medicare and Medicaid Services (CMS) and an increasing number of private insurers have indicated that they will no longer reimburse for procedures associated with "never" events such as left-behind surgical sponges.

To help prevent retained objects in patients, Cardinal Health is including RF Surgical Systems Inc.'s RF Surgical Detection System as part of its Presource® surgical kits and as a stand-alone offering. The RF Surgical Detection System scans for and signals an alert if any RFID-tagged sponges, gauze or towels remain in a patient prior to surgical closing. Other products

exist on the market today to prevent retained surgical objects. Among them are the ClearCount SmartSponge® System from ClearCount Medical Solutions and the SafetySponge System from SurgiCount Medical. What these systems have in common is either an RFID-based system or a bar code system that allows clinicians to more easily detect missing sponges, towels or instruments, and better reconcile counts at the surgical closing.

RFID applications also play a role during infectious outbreaks. An RFID system that can tell clinicians where, when and with whom patients and staff have interacted is of real value during an outbreak situation, whether it's a seasonal outbreak of influenza or a potential pandemic scenario. For example, Atlanta-based Emory University Hospital's ED is using Radianse, Inc.'s real-time location system (RTLS) with Smart Sense technology to be able to track patients' and staff members' interactions. Douglas Lowery-North, MD, vice chair of clinical operations for the Department of Emergency Medicine at Emory Healthcare and lead investigator of the tracking project, says that Emory is in the midst of a multi- year initiative to establish a Center of Excellence for Influenza Research and Surveillance. The hospital is gathering and using real-time location information to better understand and control the spread of influenza; researchers will then apply what they've learned to create best practices across infection control.

"Our work requires that we measure interactions among ED patients and staff to the second and do so consistently and without disruption to care," says Lowery. "We use the data in a number of ways, notably to quickly and accurately identify and contain infectious disease."

Emory's ED staff members wear small RFID tags, while patients receive a wearable badge at admission. The Radianse RTLS recognizes and records whenever patients and staff have a "meaningful" interaction, defined by Emory and programmed in the Radianse Smart Sense alerts application as "within one meter of distance, for 30 seconds or longer." This real-time interaction data is combined with clinical data: when patient diagnosis is influenza, or another infectious disease, the hospital is able to identify and thwart potential spread, analyze patterns of transmission and intervene as appropriate to protect patient and employee health.

Many hospitals already employ bar code systems, but proponents say RFID is a superior system because there are no line-of-sight requirements, it is effective in harsher conditions such as temperature extremes in the SPD, and the technology provides for more automated reading and improved read rates, as well as a bigger data capacity and the ability to "write" information on a tag.

UV Light and Air/Room Sterilization

The germicidal properties of ultraviolet light are of renewed interest to clinicians wanting to employ technology in the fight against healthcare-acquired infections (HAIs). Essentially, ultraviolet light kills bacteria and viruses by damaging their nucleic acid, thus destroying their ability to replicate and cause disease. UVC light lends itself to numerous applications in the healthcare environment. It can be employed via fixtures for coil irradiation in HVAC systems; UVC air cleaners can be used for air-stream irradiation; fixed, portable and handheld UVC-emitting devices can be used for surface sterilization; and a combination of UVC air and surface sterilization devices can be used in operating rooms and other high-risk areas in the hospital. Air and surface sterilization using UVC light is differentiated by the amount of time during which microorganisms are exposed to UVC radiation. Surface contamination is fixed in nature, so less UVC intensity is required; however, because pathogens move much more swiftly in air streams, a much greater concentration of UVC light is required for microbial kill. Efficacious sterilization by UVC light is determined by light intensity, duration of exposure, and distance of the UVC light from the surface or the air stream. There are a number of devices in the marketplace currently that harness and use UVC light as a weapon of pathogen destruction. Steril-Aire Inc. offers a full line of UVC Emitters that are used in hospitals worldwide for infection and indoor air quality control. Lumalier Corporation’s In-Duct UVGI air disinfection is designed to reduce viral and bacterial contaminate of passing air in HVAC systems to a 3-log level of disinfection. Bioscide's TRU-D rapid room sterilization system uses a real-time calibration system to adjust the dosage time to the dynamics of a room. Germgard Lighting LLC offers a shoebox-sized sanitation device for the gloved hand, based on the company’s proprietary UV-C light technology that removes pathogens after 3 seconds of exposure. The Sterilray Sanitation Wand from Healthy Environment Innovations, Inc. is a shielded UV-emitting device that can be used on high-touch items in the healthcare environment such as computer keyboards. UVDI, under its ALTRU-V brand, provides a full line-up of UV-C products for the commercial HVACR market and specializes in the application of UV technology for the treatment of surfaces, air and water.

Air/room sterilization is starting to mature in the marketplace, although many clinicians are still unfamiliar with this high-tech approach to HAI prevention. There are several technology options available currently. STERIS Corporation offers advanced room sterilization with the VaproSure Sterilizer, featuring Vaprox® Sterilant, when used as part of a room’s terminal cleaning program. The VaproSure Sterilizer is a low-temperature dry vapor designed

to destroy a full spectrum of biological contaminants, including spores, bacteria, viruses and fungi, leaving no residue and no lingering odor. The PlasmairT2006 with HEPA-MD technology from AirInSpace is a Food and Drug Administration (FDA)-cleared mobile air decontamination unit which multi-year clinical study data suggests can contribute to reducing the incidence of airborne aspergillosis infection. The AirInSpace technology is designed to demonstrate up to 99.999 percent single-pass inactivation of airborne microorganisms. Xenex Technologies, Inc. offers two portable xenon pulse UV sterilization devices that produce brief pulse of intense UV light that penetrates the cell walls of viruses, bacterium, fungi and mold to fuse the strands of DNA (creating thymine dimers), resulting in cell death. The devices are portable, can be operated by one person with minimal training and can sterilize the air and visible surfaces in a room in minutes. These devices are able to kill bacterial spores at a distance of 2 meters from the lamp in 8 minutes without the use of any chemicals. Advanced Vapor Technologies' TANCS steam vapor disinfection system is designed to disinfect surfaces colonized by the Acinetobacter baumannii, which can cause a variety of diseases, ranging from pneumonia to serious blood or wound infections.

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