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SPECIAL REPORT

The Economics of Hand Hygiene Compliance Monitoring

Hospital executives, infection preventionists and healthcare epidemiologists are by now familiar with a number of givens relating to healthcare-associated infections (HAIs): HAIs are happening, HAIs cost money, and HAIs can be controlled and prevented. This report examines the costs associated with HAIs and explores the benefits of healthcare worker hand hygiene compliance monitoring.

By Kelly M. Pyrek

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By Kelly M. Pyrek

Hospital executives, infection preventionists and healthcare epidemiologists are by now familiar with a number of givens relating to healthcare-associated infections (HAIs):

HAIs are happening: The CDC healthcare-associated infection (HAI) prevalence survey provides an updated national estimate of the overall problem of HAIs in U.S. hospitals. Based on a large sample of U.S. acute care hospitals, the survey found that on any given day, about 1 in 25 hospital patients has at least one healthcare-associated infection. There were an estimated 722,000 HAIs in U.S acute care hospitals in 2011. About 75,000 hospital patients with HAIs died during their hospitalizations. More than half of all HAIs occurred outside of the intensive care unit.

> "Based on a large sample of U.S. acute care hospitals, the survey found that on any given day, about 1 in 25 hospital patients has at least one healthcare-associated infection.

HAIs cost money: Any discussion of HAI-related costs usually mentions the 2007 study from Klevens, et al. which endeavored to provide a national estimate of the number of healthcare-associated infections (HAI) and deaths in U.S. hospitals. The authors' main source of data was the National Nosocomial Infections Surveillance (NNIS) system, data from 1990-2002, conducted by the Centers for Disease Control and Prevention (CDC). Data from the National Hospital Discharge Survey (for 2002) and the American Hospital Association Survey (for 2000) were used to supplement NNIS data. The percentage of patients with an HAI whose death was determined to be caused or associated with the HAI from NNIS data was used to estimate the number of deaths. HAIs in hospitals are a significant cause of morbidity and mortality in the United States. In 2002, the estimated number of HAIs in U.S. hospitals, adjusted to include federal facilities, was approximately 1.7 million: 33,269 HAIs among newborns in high-risk nurseries, 19,059 among newborns in well-baby nurseries, 417,946 among adults and children in ICUs, and 1,266,851 among adults and children outside of ICUs. The estimated deaths associated with HAIs in U.S. hospitals were 98,987; of these, 35,967 were for pneumonia, 30,665 for bloodstream infections, 13,088 for urinary tract infections, 8,205 for surgical site infections, and 11,062 for infections of other sites.

HAIs can be controlled and prevented: HAIs are the most common complication of hospital care. However, recent studies suggest that implementing existing prevention practices can lead to up to a 70 percent reduction in certain HAIs. The financial benefit of using these prevention practices is estimated to be $25 billion to $31.5 billion in medical cost savings, according to Scott (2009).

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The Economic Burden of HAIs

Let's take a closer look at the economic burden and impacts of HAIs.

As the Pennsylvania Patient Safety Authority (2010) summarizes, "HAIs consume resources, prolong patients' hospital stays, and are only partially reimbursed at best." In 2007, the Pennsylvania Health Care Cost Containment Council reported hospital charges of $35,168 in cases without an HAI to $191,872 in cases with an HAI, with a difference of 15.3 days in the average length of stay. Effective infection prevention and control programs demonstrate a valuable return on investment by releasing hospital resources for alternative uses and beds for new admissions.

As another example, an economic analysis of central line-associated bloodstream infections (CLABSIs) at Allegheny General Hospital in Pennsylvania from 2002 to 2005 examined hospital revenues and expenses in 54 cases of patients with CLABSIs in two intensive care units (ICUs). The average payment for a case complicated by CLABSI was $64,894, and the average expense was $91,733 with a gross margin of minus $26,839 per case and a total operating loss of nearly $1.5 million from the 54 cases. In addition to revenue loss, there are hidden costs and lost financial opportunities associated with HAIs. For example, when patients are brought back to the operating room (OR) for an incision and drainage of a postsurgical site

AVERAGE CHARGE FOR CARE AND LENGTH OF STAY IN PENNSYLVANIA HOSPITALS

	AVERAGE CHARGE FOR CARE	AVERAGE LENGTH OF STAY
Cases Without An HAI	$35,168	4.4 days
Cases With An HAI	$191,872	19.7 days

Source: Pennsylvania Health Care Cost Containment Council (PHC4) report 2007 infection, both the surgical suite and the OR team are tied up, and new cases cannot be scheduled. Primary procedures are often reimbursed at a higher rate than follow-up procedures. The 2007 Pennsylvania Health Care Cost Containment Council (PHC4) report on HAIs in Pennsylvania hospitals shows that the average charge for care grew from $35,168, with an average length of stay of 4.4 days, for cases without an HAI to $191,872 for those cases with an HAI, with an average length of stay of 19.7 days. PHC4 reported that in almost all cases, hospitals do not receive full reimbursement of charges; on average, in 2006 and 2007, hospitals statewide were paid approximately 27 percent of established charges.

> The CDC has reported that the cost of HAIs per patient (based on the 2007 consumer price index) ranges from approximately $20,000 to $25,000.

The CDC has reported that the cost of HAIs per patient (based on the 2007 consumer price index) ranges from approximately $20,000 to $25,000. Diagnosis-related group (DRG) based reimbursement is not increased when a patient develops an HAI, as there are no specific DRG codes available for HAIs. Hospitalized patients may be covered by Medicare and Medicaid, which in most cases reimburse fixed amounts based on diagnosis. The hospital then has to absorb the additional costs associated with HAIs, while the HAIs simultaneously prevent the hospital from taking new admissions with reimbursable conditions. The Centers for Medicare and Medicaid Services (CMS) regulations, effective in 2008, now refuse reimbursement to hospitals for the excess costs of certain types of infections (as outlined in the HHS Action Plan to Prevent Healthcare-Associated Infections). As the Pennsylvania Patient Safety Authority notes, "The current legal and regulatory landscape has changed in a large part due to the success of hospitals across the country with HAI prevention programs. HAIs that were previously thought of as defensible are now considered to be preventable adverse events. IPs will play a larger role in protecting their hospitals against liability in the future."

The right data can be hard to come by, but researchers are addressing this. Scott (2009) outlines the misconceptions regarding the financial significance of HAIs in a report on the direct medical costs of care related to secondary infection diagnosis, increased length of stay and expensive HAI outbreaks. The report also describes additional cost components, which reflect the socioeconomic consequences of HAIs such as indirect and intangible costs of HAIs related to diminished quality of life such as permanent disability or lost wages.

Scott (2009) provides estimates of the annual direct medical costs associated with five major sites of HAIs as calculated by taking estimates of the number of infections and then multiplying these estimates with both a low and a high average patient cost estimate from the published literature. The patient cost estimates can be adjusted for the rate of infection using two different inflation indexes: the Consumer Price Index (CPI) for all urban consumers (CPI-U) and the CPI for inpatient hospital services with all cost estimates adjusted to the most current dollar value. (An important reminder is that because studies in the literature were conducted at different points in time, cost estimates must be adjusted to 2012 dollars in order to make them comparable.) The CPI-U is constructed by the U.S. Bureau of Labor

Statistics (BLS) and is a measure of the average change over time in the prices paid by all urban consumers for a market basket of consumer goods and services purchased for day-to-day living. As an estimate of the percent change in prices between any two price periods, the CPI-U is the most widely used measure of inflation and is used by federal and state governments to adjust government income payments or to make cost-of-living adjustments to wages. As Scott (2009) notes, because both indexes measure price changes for broadly defined expenditure groups, there is no research to date on which measure would be most appropriate to use to accurately adjust for inflation in the prices of the hospital resources used to treat HAIs. In his whitepaper, Scott (2009) adjusted all cost estimates using both indexes.

Scott (2009) points to systematic reviews of the published literature on the costs associated with various HAIs in hospitals; updating a previous review from 2002, Stone, et al. derived the following attributable cost estimates: $25,546 for SSI, $36,441 for BSI, $9,969 for VAP and $1,006 for CAUTI. These authors did note that there was considerable variation in the cost methodology used by the studies incorporated in their review which included results from vaccination studies as well as studies on community-acquired infections. Anderson et al. also developed estimates of the cost of HAIs from published studies but used a more stringent inclusion criterion by including only studies that estimated the attributable costs of getting an HAI.

Scott (2009) calculated estimated ranges of the total annual costs associated with specific sites of HAI infection in U.S. hospitals adjusted by the two CPI indexes. The infection site with the largest range of annual costs is SSI ($3.2 billion to $8.6 billion using the CPI-U and $3.5 billion to $10 billion using the CPI for inpatient hospital services) while the site with the smallest annual cost is CAUTI ($340 million to $370 million using the CPI-U and $390 million to $450 million using the CPI for inpatient hospital services). The costs associated with the remaining infection sites are also significant with the direct medical cost of CLABSI, VAP, and CDI ranging from $590 million (adjusted by CPI-U) to $2.68 billion (adjusted by CPI for inpatient hospital services), $780 million (adjusted by CPI-U) to $1.5 billion (adjusted by CPI for inpatient hospital services), and $1.01 billion to $1.62 (adjusted by CPI for inpatient hospital services), respectively.

Anderson, et al. (2007) estimated the cost of HAIs in a network of 28 community hospitals and to compared this sum to the amount budgeted for infection control programs at each institution and for the entire network. The researchers reviewed literature published since 1985 to estimate costs for specific HAIs. Using these estimates, they determined the costs attributable to specific HAIs in a network of 28 hospitals during a one-year period. Cost-saving models based on reductions in HAIs were calculated. The weight-adjusted mean cost estimates for HAIs were $25,072 per episode of ventilator-associated pneumonia, $23,242 per nosocomial blood stream infection, $10,443 per surgical site infection, and $758 per catheter-associated urinary

COST-SAVING MODELS BASED ON REDUCTIONS IN HAIS

The weight-adjusted mean cost estimates for HAIs:

Per episode of ventilator-associated pneumonia

$25,072

Per nosocomial blood stream infection

$23,242

Per surgical site infection

$10,443

Per catheter-associated urinary tract infection

$758

tract infection. The median annual cost of HAIs per hospital was $594,683 (interquartile range [IQR], $299,057-$1,287,499). The total annual cost of HAIs for the 28 hospitals was greater than $26 million. Hospitals budgeted a median of $129,000 (IQR, $92,500-$200,000) for infection control; the median annual cost of HAIs was 4.6 (IQR, 3.4-8.0) times the amount budgeted for infection control. An annual reduction in HAIs of 25 percent could save each hospital a median of $148,667 (IQR, $74,763-$296,861) and could save the group of hospitals more than $6.5 million.

Kilgore, et al. (2008) collected data on discharge diagnoses, cost, LOS, and nosocomial infections (NIs) for 1,355,347 admissions from March 30, 2001 through Jan. 31, 2006 in 55 hospitals. The cost effects of NIs (in 2007 dollars) were estimated using multivariable regression models. Restricted models were applied to determine how cost estimates are confounded by disease severity and LOS. The researchers found that NIs are associated with $12,197 (95% CI, $4,862 to $19,533, P < 0.001) in incremental cost. A lower bound estimate of infection cost, controlling for LOS, is $4,644 (95% CI, $1,266 to $7,391).

Roberts, et al. (2010) sought to estimate the costs attributable to HAIs and conduct a sensitivity analysis comparing analytic methods. A random sample of high-risk adults hospitalized in the year 2000 was selected. Measurements included total and variable medical costs, length of stay (LOS), HAI site, APACHE III score, antimicrobial resistance, and mortality. Medical costs were measured from the hospital perspective. Analytic methods included ordinary least squares linear regression and median quantile regression, Winsorizing, propensity score case matching, attributable LOS multiplied by mean daily cost, semi-log transformation, and generalized linear modeling. Three-state proportional hazards modeling was also used for LOS estimation. Among 1,253 patients, 159 (12.7 percent) developed HAI. Using different methods, attributable total costs ranged between $9,310 and $21,013, variable costs were $1,581 to $6,824, LOS was 5.9 to 9.6 days, and attributable mortality was 6.1 percent. The semi-log transformation regression indicated that HAI doubles hospital cost. The totals for 159 patients were $1.48 to $3.34 million in medical cost and $5.27 million for premature death. Excess LOS totaled 844 to 1,373 hospital days.

Neidell, et al. (2012) compared differences in the hospital charges, length of hospital stay, and mortality between patients with healthcare- and community-associated bloodstream infections, urinary tract infections, and pneumonia due to antimicrobial-resistant versus -susceptible bacterial strains. A retrospective analysis of an electronic database compiled from laboratory, pharmacy, surgery, financial, and patient location and device utilization sources was undertaken on 5,699 inpatients who developed healthcare- or community-associated infections between 2006 and 2008 from four hospitals in Manhattan. The main outcome measures were hospital charges, length of stay, and mortality among patients with antimicrobial-resistant and -susceptible infections caused by Staphylococcus aureus, Enterococcus faecium, Enterococcus faecalis, Klebsiella pneumoniae, Pseudomonas aeruginosa, and Acinetobacter baumannii. Controlling for multiple confounders using linear regression and nearest neighbor matching based on propensity score estimates, resistant healthcare- and community-associated infections, when compared with susceptible strains of the same organism, were associated with significantly higher charges ($15,626; $4,339–$26,913 and $25,573; $9,331–$4,1816, respectively) and longer hospital stays for community-associated infections. Patients with resistant healthcare-associated infections also had a significantly higher death rate.

In more recent years, studies have added to the knowledge about the fiscal impacts of HAIs.

Zimlichman, et al. (2013) acknowledge that HAIs account for a large proportion of the harms caused by healthcare and are associated with high costs. They add that better evaluation of the costs of these infections could help providers and payers to justify investing in prevention. For an estimation of attributable costs, the researchers conducted a systematic review of the literature using PubMed for the years 1986 through April 2013. For HAI incidence estimates, they used the CDC's National Healthcare Safety Network (NHSN). Inclusion criteria included a robust method of comparison using a matched control group or an appropriate regression strategy, generalizable populations typical of inpatient wards and critical care units, methodologic consistency with CDC definitions, and soundness of handling economic outcomes. They generated point estimates and 95% CIs for attributable costs and length of hospital stay. On a per-case basis, central line-associated bloodstream infections were found to be the most costly HAIs at $45,814 (95% CI, $30,919-$65,245), followed by ventilator-associated pneumonia at $40,144 (95% CI, $36,286-$44,220), surgical site infections at $20,785 (95% CI, $18,902-$22,667), Clostridium difficile infection at $11,285 (95% CI, $9118-$13,574), and catheter-associated urinary tract infections at $896 (95% CI, $603-$1189). The total annual costs for the five major infections were $9.8 billion (95% CI, $8.3-$11.5 billion), with surgical site infections contributing the most to overall costs (33.7% of the total), followed by ventilator-associated pneumonia (31.6%), central line-associated bloodstream infections (18.9%), C difficile infections (15.4%), and catheter-associated urinary tract infections (<1%).

> "As one of the most common sources of preventable harm, health care-associated infections (HAIs) represent a major threat to patient safety.

Eyal Zimlichman, MD, MSc, of Brigham and Women's Hospital and the Harvard Medical School, says that, "As one of the most common sources of preventable harm, healthcare-associated infections (HAIs) represent a major threat to patient safety. The purpose of this study was to generate estimates of the costs associated with the most significant and targetable HAIs. While quality improvement initiatives have decreased HAI incidence and costs, much more remains to be done. As hospitals realize savings from prevention of these complications under payment reforms, they may be more likely to invest in such strategies." This study was sponsored by the Texas Medical Institute of Technology, Austin, as part of a donation promoting research on patient safety.

Marchetti and Rossiter (2013) sought to update, combine, and expand previous cost estimates to determine the annual societal burden of illness (direct medical, non-medical, and indirect costs) arising from HAIs in U.S. acute-care hospitals. Their research approach encompassed literature and internet searches; reference identification, selection, and review;

then data abstraction, compilation, and analyses to estimate full societal costs. Previously published systemic reviews, surveillance reports, and individual clinical studies, along with newly computed component costs, all contributed to final estimates. They found that HAIs in U.S. acute-care hospitals lead to direct and indirect costs totaling $96 billion to $147 billion annually, noting that this data "mandates further research and greater efforts to contain a pressing healthcare problem."

"Before this report, economic research into HAIs mostly focused on hospitals or insurers instead of the patients they served," says Albert Marchetti, MD, president and medical director of MedERA. "Full societal costs, which are more inclusive than commonly reported direct hospital costs, have never been fully measured or reported. We believe patients rightfully deserve attention, too, because they not only bear out-of-pocket expenses for HAIs but also suffer the unacceptable clinical consequences of heightened morbidity and mortality as well as resultant losses of productivity and wage."

Marchetti believes these costs could actually be even higher and calls for new epidemiologic research to update infection rates and patient mortality. By comparison, an earlier report by the Centers for Disease Control and Prevention estimated the direct medical costs of HAIs to U.S. hospitals as $28.4 billion to $33.8 billion per year. "The MedERA research updates these numbers and calculates the full economic impact of HAIs on all of America – one that comprises a toll not only on the hospitals in which they occur but also on others, namely payers, patients and society at large," Marchetti says.

"An important function of the hospital epidemiologist and the infection preventionist (IP) is to demonstrate the value of infection prevention and control programs to healthcare executives.

MedERA's estimates are based on 20 years of published data and newly expanded calculations. The total economic burden encompasses direct and indirect costs. Direct costs include hospitalization costs, healthcare professional fees and other medical costs generally billed outside the hospital; nonmedical costs include those related to such things as medical malpractice-wrongful death as well as nonmedical hospital expenses. Indirect costs include lost wages, incapacitation and lost future earnings for patients.

Being able to make an effective business case for infection prevention and control is essential. As the Pennsylvania Patient Safety Authority (2010) explains, "An important function of the hospital epidemiologist and the infection preventionist (IP) is to demonstrate the value of infection prevention and control programs to healthcare executives. The most important aspect of a business case for prevention is reduction of harm and loss of life. But from a financial health perspective, boards, executives, and healthcare managers are interested in cutting costs and getting maximum value for expenditures. They may not see the benefit of new infection prevention and control programs if the return on investment is not realized within a certain time frame. An infection control business case analysis of the excess cost of HAIs and of the excessive length of stay can help gain needed resources and physician support. Practical methods are needed to engage healthcare executives in evaluating the true cost of HAIs in their organizations. Hospital leaders' awareness that HAIs impact their patients may not always lead to understanding the extent of the financial burden of HAIs or the cost-effectiveness of infection prevention and control programs. Organizations may have inadequate methods to investigate the true cost of HAI in their institutions. Executives and clinicians in hospitals with HAI rates at or below nationally published rates may become complacent, accepting that a certain degree of patient harm from infections is an unavoidable price of caring for older, sicker patients. Common misconceptions about HAIs need to be dispelled. These misperceptions include the fallacy that the incidence of HAI in most institutions is insignificant; the erroneous belief that additional cost of HAIs is largely offset by reimbursement, making cost savings associated with reduction of HAIs not worth the investment, and the misperception that HAIs are an expected outcome of treating an older, sicker patient population with escalating use of invasive procedures."

"Only one-third of U.S. hospitals are in full compliance with key guidelines to prevent HAIs, and only 40 percent of healthcare providers follow basic hand hygiene measures.

Hand Hygiene Compliance Monitoring

Despite knowing the heavy toll that HAIs take on human life and hospitals' bottom line, Klevens (2002) says that healthcare institutions have not followed or implemented guidelines that have shown significant impact on HAIs. Only one-third of U.S. hospitals are in full compliance with key guidelines to prevent HAIs, and only 40 percent of healthcare providers follow basic hand hygiene measures. In fact, some 70 percent of infections are preventable, resulting in a potential savings of between $25 billion to $31.5 billion for inpatient services.

One intervention that can help address HAIs and their costs is hand hygiene, and ensuring compliance among all healthcare professionals, as part of a multi-modal approach to infection prevention and control. As we have seen with the HAI-related costs above, there are a number of givens relating to hand hygiene compliance:

Healthcare professionals' hand hygiene is subpar at many institutions: The Joint Commission (2009) notes that "Following effective hand hygiene practices has long been recognized as the most important way to reduce the transmission of pathogens in healthcare settings. Many studies, however, have shown that adherence to hand hygiene recommendations remains low and that improvement efforts frequently lack sustainability."

There are many self-reported and observed barriers to hand hygiene practice: Pittet (2000) enumerated a number of these barriers, including: Skin irritation caused by products; inaccessible hand-hygiene supplies; interference with HCW-patient relationship; patient needs take priority; wearing gloves negates the need for hand hygiene; forgetfulness; busyness; lack of knowledge of guidelines; lack of scientific information on effect of hand hygiene on nosocomial infection rates; significant work load or lack of appropriate staffing;

working in high-risk areas (such as ICUs); activities with high risk for cross-transmission; lack of hand-hygiene promotion at individual or institutional level, lack of role model for hand hygiene; lack of institutional priority for hand hygiene; lack of administrative sanction of non-compliers or rewarding of compliers; and lack of an institutional safety climate.

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There are ways to significantly boost hand hygiene compliance: Pittet (2000) outlines the parameters associated with successful hand hygiene promotion, including: Education; routine observation and feedback; engineering controls that make hand hygiene possible, easy and convenient; patient education; reminders in the workplace; administrative sanctions and rewards; promotion and facilitation of healthcare worker skin care; obtaining active participation at the individual and institutional levels; maintain an institutional safety climate; enhancing individual and institutional self-efficacy; and avoiding understaffing and excessive workload among healthcare workers.

A number of hospitals are adding technology to their arsenal against HAIs and considering automated hand hygiene compliance monitoring systems as part of their infection prevention protocols. Hospitals are becoming more diligent about monitoring hand hygiene, moving toward automated compliance monitoring systems over direct observation if they can provide a solid business case for this technology-driven intervention. Automated systems have the capacity to potentially eliminate inaccuracy and unreliability in hand hygiene compliance monitoring, thus enhancing patient safety and improving outcomes.

Boyce (2008) enumerates the various approaches to monitoring hand hygiene compliance: direct observation of healthcare workers, self-reporting by healthcare personnel, measurement of hand hygiene product usage as a proxy for compliance, and electronic methods for monitoring hand hygiene practices. Even with all of these methods available, the Joint Commission (2009) outlines some of the specific challenges to measuring hand hygiene adherence:

- Contact with patients or their environment takes place in many locations within organizations.
- Opportunities for hand hygiene occur 24 hours a day, seven days a week, 365 days a year and involve both clinical and nonclinical staff.
- The frequency of hand hygiene opportunities varies by the type of care provided, the unit, and patient factors.
- Monitoring is often resource intensive; infection preventionists, quality improvement staff, and other healthcare workers face numerous competing demands for their time and expertise.
- Observer bias (for example, the Hawthorne effect) is difficult to eliminate.
- The Joint Commission (2009) advises clinicians that before selecting a measurement method, determine the answers to a few key questions:
- Why do you want to measure hand hygiene practices, and what are your organization's goals?

- What elements of hand hygiene do you want to measure?
- How do you want to measure hand hygiene?

There are three main methods for measuring hand hygiene performance, each of which has advantages and disadvantages:

1 Directly observing	**2** Measuring product use	**3** Conducting surveys

As the Joint Commission (2009) explains, "Observation involves directly watching and recording the hand hygiene behavior of healthcare workers and the physical environment. Product measurement indirectly assesses hand hygiene guideline adherence by allowing healthcare workers to calculate the amount of liquid soap, alcohol-based handrub, and paper towels used in a given area of the organization. Surveys gather information on healthcare worker perceptions, attitudes, and practices related to hand hygiene, as well as patients' and families' attitudes and perceptions of the hand hygiene practices of healthcare workers. Using more than one method to measure hand hygiene performance is likely to yield more reliable results than using a single method."

Automated electronic hand hygiene monitoring systems, of course, move hospitals away from direct observation of healthcare professionals to ensure they clean their hands when required. Proponents of automated systems emphasize the flaws of direct observation:

- The Hawthorne Effect, which describes how people act differently when they know they are being observed, can artificially increase compliance rates. Technology eliminates human observation completely. Automated systems are often replacing "secret shoppers"; when using secret shopper sampling methods, hospitals may overestimate their actual hand hygiene compliance rates.
- Direct observation can harbor observer bias. Technology can standardize the data reporting process.
- Direct observation requires additional time for compliance rates to be calculated, thus reducing opportunity for more immediate feedback to healthcare professionals. Technology can capture hand hygiene data in real time and can generate reports on compliance rates immediately.
- Direct observation can be resource-intensive and time-consuming. Technology can be more efficient.
- Direct observation inherently has a smaller sample size because human observers can only observe a portion of the hospital's total workforce. Technology can improve statistical reliability of compliance rate results. An automated system may provide more constant and consistent results, because they are designed for 24/7 active monitoring. Unlike human observers, automated systems capture most patient room entry and exit episodes. However, according to the World Health Organization (WHO)'s "Systematic literature review of automated/electronic systems for hand hygiene monitoring" whitepaper, "…most of

these systems fail to distinguish between a hand hygiene indication and opportunity and to identify standard indications. Thus, the electronic/automated systems currently available are not able to detect moments when microbial transmission most likely occurs. These systems are also usually unable to identify HCWs and individual hand hygiene opportunities and actions, and to evaluate glove use or the appropriateness of the hand hygiene technique. Finally, cost-effectiveness remains unknown and suitability for use in settings with limited resources is quite unlikely."

In terms of automated systems' benefits, the same WHO whitepaper notes, "Several advantages of automated monitoring systems are recognized: the possibility of continuous monitoring, a lower Hawthorne effect, saving in terms of human resources and the possibility of downloading and analyzing data automatically for repeated measurement. Apart from monitoring, the implementation of these systems has also been studied as an intervention to improve hand hygiene with successful results." The whitepaper adds, "… these new technologies are promising and could be part of the future approach to hand hygiene compliance monitoring when available resources permit it and provided that they reflect the WHO Five Moments for hand hygiene indications. Additional research is needed to support their adoption as a standard. However, direct observation of hand hygiene compliance and performance technique, as well as continuing education at periodic intervals are still needed."

So while automated electronic hand hygiene monitoring systems can boost objectivity, they can be expensive, require a learning curve among staff, and require information technology-related infrastructure. Additionally, there is a wide range of systems in the marketplace with differing levels of features. Considerations to bear in mind when evaluating systems are:

- How the system fits into the existing clinical workflow
- Is it easy to implement and work with existing dispensers
- Can it track individual compliance
- Will there be support for the behavior change after installation of the technology

When evaluating a system, consider the following questions:

- What are our hospital's goals for hand hygiene and infection prevention?
- How will the system impact staff workflow and culture?
- What resources are required to install and roll out the system?
- What are implications for staff time? How is the system maintained?
- What data is generated and how can my hospital use it?

Additional clinical questions to consider are as follows:

- Does the system add steps to the healthcare worker workflow?
- Does the system provide real-time data?
- What compliance data is important to you?

Additional technical questions to consider are as follows

- What are the power requirements (wires, outlets, batteries, etc.)?
- Does the system work with your existing soap/ sanitizer dispensers or products?
- Can the company support a system-wide implementation?

> "A number of hospitals are adding technology to their arsenal against HAIs and considering automated hand hygiene compliance monitoring systems as part of their infection prevention protocols.

- What clinical reports and maintenance support are provided after installation?
- What will IT need to understand?

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