

# ELECTRONIC MONITORING SYSTEMS— THE NEXT GENERATION APPROACH TO MONITORING HAND HYGIENE COMPLIANCE

By John M. Boyce, MD

## The evolution of hand hygiene

There have been significant changes in hand hygiene practices in the last few decades. In the early 1980s and 1990s, very few hospitals in the United States used alcohol-based hand rubs (ABHR). With the advent of the Centers for Disease Control and Prevention (CDC) Guideline for Hand Hygiene in Health-Care Settings in 2002 and more recently, the World Health Organization's (WHO) Guidelines for Hand Hygiene in Health Care in 2009, virtually all hospitals in the United States use ABHR as the primary method for performing hand hygiene. Globally there is greater use as well. A focus on hand hygiene compliance by accrediting agencies, particularly the Joint Commission beginning in 2004, has placed expectations on healthcare facilities to create programs around hand hygiene and improve compliance.

Evidence of an increased emphasis on hand hygiene can be seen at medical conferences where hand hygiene progress is routinely presented and in the number of medical publications addressing hand hygiene, which has increased to nearly five times of what it was in the early 1990s. Because hand hygiene is viewed as the cornerstone of infection prevention, much effort has gone into not only increasing hand hygiene compliance on the part of healthcare facilities, but developing better products and methods for measuring compliance by industry. Measuring hand hygiene compliance is fundamental to demonstrating improvement, and providing healthcare workers (HCWs) with timely feedback regarding their performance is a critical element of an effective hand hygiene program.<sup>1,2</sup> There are currently challenges to providing timely feedback, and progress to improve this process has been slow. Technologies are beginning to emerge that can help healthcare facilities change the way hand hygiene compliance is measured and enable them to devote less time to direct observation. They can also help facilities gain more quantitative data that can be used to further improve hand hygiene compliance.

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## Why is hand hygiene so important?

Healthcare facilities are facing major challenges. Multi-drug resistant organisms are on the rise,<sup>3</sup> and reimbursement policies stemming from the Affordable Care Act (ACA) are, and will be, withholding reimbursement based on quality measures. There is often debate about the “true cost” of HAIs, particularly at the facility level. However, the fact that 2% of Centers for Medicare and Medicaid Services (CMS) reimbursement will be tied to performance under the Value-Based Purchasing program in 2017 and that Medicare payments will be cut by 1% across all diagnosis related groups (DRG) to hospitals that are in the highest quartile of national rates for certain HAIs, leaves little doubt that the financial impact of HAIs will increase.

That is why it is imperative that we improve the quality of care by reducing the number of HAIs. As a result, increasing transparency around patient outcomes and increasing consumer expectations are placing pressure on healthcare facilities to improve quality while simultaneously managing cost. Healthcare facilities are interconnected now more than ever as patterns of healthcare have shifted from the hospital to other settings, such as ambulatory care facilities and outpatient facilities, in an effort to manage cost. With hand hygiene being the cornerstone of preventing the spread of infection,<sup>2</sup> it is necessary to increase the level of attention to hand hygiene both in inpatient and outpatient settings.

Compliance with hand hygiene is a complex issue, and many healthcare facilities continue to struggle with poor compliance rates,<sup>4</sup> while others may have a false sense of security due to high reported compliance rates that may not be accurate. While both are a problem, overly inflated compliance rates can hinder the already slow progress of improvement in hand hygiene in healthcare settings because HCWs may not believe that hand hygiene practices need improvement.<sup>5</sup> Facilities must decide whether to continue to report high rates of compliance, or take on the difficult task of reassessing hand hygiene compliance in a novel way. Poor compliance and overly inflated compliance rates are problems that can have a significant effect on performance, including but not limited to, patient satisfaction, healthcare-associated infections, and a culture of safety. Fortunately, there is increasing evidence that facilities which have successfully increased hand hygiene compliance have seen a simultaneous decrease in healthcare-associated infections.<sup>6</sup> Such hand hygiene programs employ a multi-modal approach, which is recommended by the CDC, WHO, Joint Commission, and others.<sup>7,8</sup> The elements of a multi-modal approach include: system change, training and education, evaluation and feedback, reminders in the workplace, and an institutional safety climate.<sup>1</sup>

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## The Future of Hand Hygiene Compliance Monitoring

Direct observation of hand hygiene compliance has historically been considered the “gold standard” and involves trained observers who directly watch and record hand hygiene opportunities and events (use of a hand sanitizer or soap and water). Advantages of direct observation include the fact that it provides an opportunity for on-the-spot education and evaluation of technique and timing of hand hygiene in the clinical workflow.

Also, in facilities with limited financial resources, the fact that direct observation does not require wireless or hardwired network systems is an advantage. However, direct observation can require considerable personnel resources and may be subject to issues such as observer bias, the Hawthorne Effect, concerns with patient privacy, and the ability to capture only a small percentage of total opportunities (0.2% to 1.5%).<sup>9-12</sup> In addition, the methodology utilized (e.g., type of observer, training, validation of observers, length of observation periods, frequency and distance between observer and those observed),<sup>11,13,14</sup> and results can vary considerably between institutions, which makes inter-hospital comparisons and external benchmarking challenging. Nonetheless, direct observation will continue to be useful because monitoring using this method can provide information that no other method can currently provide. However, many facilities are searching for additional hand hygiene monitoring methods that will provide more robust estimates of hand hygiene compliance and avoid issues such as observer bias and the Hawthorne Effect. Technology can be a complement to direct observation and is likely to be a better quantitative measure.

Technologies have been developed that can assist healthcare facilities with estimating hand hygiene compliance in new ways.<sup>15-17</sup> Electronic compliance monitoring (ECM) systems are relatively new to the market and are beginning to be adopted by healthcare facilities. There are several categories of hand hygiene monitoring systems, including: electronic monitoring of hand hygiene product usage, dedicated hand hygiene monitoring systems that provide group-level data, video-based direct observation, and real-time locating systems (RTLS) for tracking healthcare worker hand hygiene compliance down to the individual level (Table 1). These technologies are rapidly developing and improving. I will briefly discuss these types of systems and their intended uses within healthcare facilities.

Electronic monitoring of hand hygiene product usage provides information regarding the number of times that healthcare workers clean their hands (hand hygiene events). The approach is free of observer bias and Hawthorne Effect, and can provide data on far more hand hygiene events than direct observation.

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In one study, it was found to be more responsive to interventions and direct observation.<sup>12,18</sup> However, it does not provide information regarding the number of hand hygiene opportunities that have occurred, which is required to calculate hand hygiene compliance rates. To estimate hand hygiene compliance rates using electronic product usage data, limited studies have developed methods for estimating the number of hand hygiene opportunities that have occurred, based on the type of nursing unit involved, patient census, and patient to nurse ratios.<sup>19,20</sup> Further studies of this type are warranted to determine the extent to which this strategy can be used in facilities of varying size, type and complexity.

Dedicated hand hygiene monitoring systems, sometimes referred to as activity monitoring systems, utilize motion sensors that detect room entry and exit, and sensors attached to soap and alcohol-based hand sanitizer dispensers to detect hand hygiene events. If an HCW enters or exits a room and performs hand hygiene using either soap or sanitizer, this is considered a compliant event. If they enter or exit the room without using either product, this is recorded as a non-compliant event. A numerator (hand hygiene events) and denominator (estimated hand hygiene opportunities) are collected in this fashion, providing an estimated overall hand hygiene compliance rate for the unit, area, or facility. Compliance data for the group or community (e.g., nursing unit) are recorded, but not at the individual HCW level. (refs)

A third type of technology, which utilizes badge-based RTLS, allows hand hygiene compliance to be tracked at the individual and community level.<sup>15-17,21</sup> HCWs wear an electronic badge that can communicate wirelessly with dispensers and sensors located in high-risk units where the system is implemented or throughout the hospital. The badges worn by HCWs relay information to either hardwired or wireless sensors. Data can be communicated to a central server for real-time analysis of compliance rates. This type of technology can be integrated into a facility's existing RTLS infrastructure. RTLS may already be used in a facility for asset tracking, temperature monitoring for medication refrigerators, and nurse or patient location. With any type of compliance system, leadership support from the C-Suite and at the local (nursing unit) level is imperative.

Such a system must align with the hospital's patient safety and infection control initiatives, and consideration must be given to how the system will be communicated to front-line HCWs and how issues with non-compliance will be handled. HCWs must be fully aware of the indications for hand hygiene, expectations for hand hygiene compliance and be given timely, direct feedback. One study reported that there were differences in comfort levels and familiarity with ECM, with leadership being more aware and comfortable with ECM than front-line

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and midlevel HCWs.<sup>22</sup> Concerns about the accuracy of the system in estimating compliance rates, who will have access to compliance data and how the information will be used, would need to be addressed before such a system is installed.<sup>17,21-23</sup> Installing a new ECM system without HCW buy-in is a recipe for failure.

Another factor that needs to be taken into consideration when installing a new ECM system is HCW acceptance of any change in hand hygiene products that may occur at the time of the installation. Previous studies have demonstrated that the major determinant of compliance is HCW acceptance, especially when it relates to skin damage from products.<sup>24</sup>

To maximize acceptance, HCWs should be involved in both the evaluation of the aesthetics of products and the evaluation of any ECM technology under consideration by the facility.

## Table 1. Types of Electronic Monitoring System Technologies

The matrix below contains the various technologies used in hand hygiene compliance measurement systems. While these technologies can be used independently, they are often combined to improve overall system performance.

Technology	Advantages	Disadvantages
<b>Non-Real Time Location System (RTLS)</b>		
Electronic Monitoring of Hand Hygiene Product Usage, without use of sensors to track HCW movements	Easy to install. Does not require room entry/exit sensors. Less expensive than RTLS if RTLS infrastructure doesn't already exist.	Does not provide electronic estimates of hand hygiene opportunities. Requires estimation of opportunities by using patient census and nurse-patient ratios for specific type of nursing unit and facility.
Activity Monitoring System	Easy to install, less expensive than RTLS if the RTLS infrastructure doesn't already exist. Collects compliance for a group (community).	Does not report compliance at the individual level. Patients and visitors can also affect estimated compliance rates.
Video-based direct observation	Video cameras record use of dispensers by HCWs, and video is reviewed by on-site or off-site persons. When used in conjunction with motion sensors at doorways, can be used to calculate compliance rates.	Does not report compliance at the individual level. Patients and visitors can also affect estimated compliance rates.

Technology	Advantages	Disadvantages
<b>RTLS</b>		
Wi-Fi (802.11)	<p>By far the most ubiquitous and pervasive technology in healthcare and growing in use.</p> <p>Since most hospitals today have already deployed Wi-Fi for work stations on wheels (WOWs) and medical devices, this technology is already in place.</p> <p>Penetrates walls and clothing to track equipment, patients, and to record temperature readings.</p> <p>Maximizes ROI of existing I.T. network investments.</p>	<p>Dependent on stability and network infrastructure installed at hospital (can go down, or be over-saturated with wireless devices causing slowness and dropped connections).</p> <p>Penetrates walls and clothing, does not allow for specific location tracking (e.g., near a patient bed, in a room, near an infusion pump).</p>
Infrared	<p>Provides detection of humans versus equipment through infrared light (identifies heat signatures of people).</p> <p>Does not require connection to existing hospital network.</p>	<p>Utilizes line-of-sight to communicate with devices. Tag must be visible at all times for sensors to register and locate equipment or person.</p> <p>Requires installation of an entirely separate network.</p>
Generation II Infrared	<p>Does not require connection to existing hospital network.</p> <p>Gen II can penetrate clothing tag.</p>	<p>Requires installation of an entirely separate network.</p> <p>Does not pass through/around objects; a badged worker will need to have badge positioned toward an IR sensor especially when IR is used to detect use of a soap or sanitizer dispenser. Having a badge that is not in direct line-of-sight of a sensor will provide a challenge for IR-based systems.</p>
Zigbee (802.15)	<p>Low-power requirements; lower cost for devices.</p> <p>Easy to deploy.</p> <p>Does not require connection to existing hospital network.</p>	<p>This technology has been reported by some hospitals to interfere with the operation of medical devices.</p> <p>Slower data transmission speeds.</p> <p>Requires installation of an entirely separate network.</p>
Ultrasound	<p>This technology is confined by walls and is not pervasive; allows for accurate room entrance/exit by HCW or tagged asset.</p> <p>Does not require connection to existing hospital network; installation of an entirely separate network.</p>	<p>Requires installation of exciters to track equipment and people.</p> <p>Does not maximize investment in existing Wi-Fi network.</p>
Radiofrequency	<p>Does not require connection to existing hospital network.</p> <p>Fast data transmission; rugged and used in harsh environments; very reliable.</p> <p>Widely adopted in marketplace.</p>	<p>Does not maximize investment in existing Wi-Fi network.</p> <p>Requires installation of an entirely separate network.</p> <p>Lack of standardization on frequency and protocol.</p> <p>Higher cost of radiofrequency devices.</p>



## Assessing Your Facility’s Readiness for an ECM System: Lessons Learned From the Field

A decision to implement an ECM system in high-risk units or hospital-wide should be based on organizational goals shared by facility administrators, clinical leaders and front-line staff. A healthcare facility could purchase the most technologically advanced hand hygiene measurement system, but if the system doesn’t align with the purpose, priorities, and culture of the organization, then the goals will not be achieved. Key pre-conditions and considerations for ECM systems can be found in Table 2.

**Table 2. Key Pre-Conditions and Considerations for Electronic Compliance Monitoring Systems**

Key Pre-Conditions	Considerations
Leadership commitment and support	Ensure that leadership at the highest level and at the local level are on board with, are willing to visibly support the initiative, have thought about what they want out of this type of system, and have identified a leadership sponsor and clinical leader. Sponsorship is needed to provide legitimacy to the process. Commitment at various levels of the organization is crucial to ensuring that the process works. In addition, leadership needs to be ready for, and embrace a new “baseline” which is likely to be very different and significantly lower than compliance rates generated by observations.
Ensure organizational alignment	Align program strategy, organizational capacity, strategic planning and performance assessment to achieve success. Without the alignment within the organization, implementation can quickly be derailed by a myriad of issues and getting the benefit of the investment will be more difficult.
Assess internal capacity	Assess all aspects of internal capacity before taking on the initiative, including leadership and management, operations, human resources, financial resources, information technology, expected costs and benefits, and most importantly, ways to overcome any expected barriers. Ensure that driving and supportive forces for the project are robust enough to overcome any restraining and complicating forces that might hinder the project.
Identify goals and expectations	Determine the organization’s goals and expectations from the system. Short-term and long-term goals should be identified. Keep in mind that such an effort is like a marathon, and the organization will need to commit to a continued focus on the effort. Goals may be improvements in hand hygiene compliance rates or broader goals such as an enhanced culture of safety.
Assemble a multidisciplinary team	Assemble a multidisciplinary team to evaluate the system before it is purchased. This should include senior leadership, unit managers, infection prevention, information technology, human resources, environmental services, front-line HCWs from various disciplines, and others.
Assess organizational culture	Assess the culture within the organization. If an organization is not ready to address poor compliance in an equitable and transparent manner, then they should reconsider investing in such a system.

Key Pre-Conditions	Considerations
Select favorable unit(s)	Selecting the worst performing nursing unit for the initial trial or installation may set the project up for failure. Poor hand hygiene may be a symptom of a greater problem. High performing units may be better equipped to commit to the project and make significant improvements. Selecting a nursing unit with a supportive head nurse or nurse manager can increase the likelihood of success when the ECM system is initially installed.
Ensure dispenser and product acceptance	High compliance will not be achieved with any system if HCWs do not like the accompanying products.

If healthcare facilities want to impact hand hygiene compliance either by increasing low compliance rates or discrediting inflated rates that are often obtained by the direct observation method, then it is time for personal accountability and transparency. As hospitals evolve toward publicly sharing infection rates and other metrics, they need to embrace the realities and transparency surrounding the current state of hand hygiene performance without being fearful of a “lower number.” Working toward accountability and transparency will take time and a concerted effort on all fronts. Small, incremental changes will need to be made in order to sustain improvement. For a majority of healthcare facilities, achieving high levels of hand hygiene compliance and ultimately, reduction in HAIs, will require the use of a variety of new strategies. ECM systems can help change the way we think about hand hygiene compliance and provide more robust, real-time, actionable data.



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## References

<sup>1</sup>World Health Organization. WHO guidelines for hand hygiene in healthcare. Geneva: World Health Organization; 2009.

<sup>2</sup>Boyce JM, Pittet D, Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Guideline for hand hygiene in healthcare settings. *MMWR* 2002;51(RR-16):1-45.

<sup>3</sup>Centers for Disease Control and Prevention. Antibiotic resistance threats in the United States, 2013. 2014.

### Ref Type: Unpublished Work

<sup>4</sup>The Joint Commission. Measuring hand hygiene adherence: overcoming the challenges. 2009. 2014.

### Ref Type: Unpublished Work

<sup>5</sup>Larson E. Monitoring hand hygiene: meaningless, harmful, or helpful? *Am J Infect Control* 2013;41:S42-S45.

<sup>6</sup>Boyce JM. Update on hand hygiene. *Am J Infect Control* 2013;41:S94-S96.

<sup>7</sup>Kirkland KB, Homa KA, Lasky RA et al. Impact of a hospital-wide hand hygiene initiative on healthcare-associated infections: results of an interrupted time series. *BMJ Qual Saf* 2012;21:1019-1026.

<sup>8</sup>Pincock T, Bernstein P, Warthman S, Holst E. Bundling hand hygiene interventions and measurement to decrease healthcare-associated infections. *Am J Infect Control* 2012;40:S18-S27.

<sup>9</sup>Srigley JA, Furness CD, Baker GR, Gardam M. Quantification of the Hawthorne Effect in hand hygiene compliance monitoring using an electronic monitoring system: a retrospective cohort study. *BMJ Qual Saf* 2014.

<sup>10</sup>Cheng VC, Tai JW, Ho SK et al. Introduction of an electronic monitoring system for monitoring compliance with Moments 1 and 4 of the WHO "My 5 Moments for Hand Hygiene" methodology. *BMC Infect Dis* 2011;11:151.

<sup>11</sup>Fries J, Segre AM, Thomas G et al. Monitoring hand hygiene via human observers: how should we be sampling? *Infect Control Hosp Epidemiol* 2012;33:689-695.

<sup>12</sup>Sodre da Costa LS, Neves VM, Marra AR et al. Measuring hand hygiene compliance in a hematology-oncology unit: a comparative study of methodologies. *Am J Infect Control* 2013;41:997-1000.

- <sup>13</sup>Kohli E, Ptak J, Smith R et al. Variability in the Hawthorne Effect with regard to hand hygiene performance in high- and low-performing inpatient care units. *Infect Control Hosp Epidemiol* 2009;30:222-225.
- <sup>14</sup>Sharma D, Thomas GW, Foster ED et al. The precision of human-generated hand-hygiene observations: a comparison of human observation with an automated monitoring system. *Infect Control Hosp Epidemiol* 2012;33:1259-1261.
- <sup>15</sup>Boyce JM. Measuring healthcare worker hand hygiene activity: current practices and emerging technologies. *Infect Control Hosp Epidemiol* 2011;32:1016-1028.
- <sup>16</sup>Marra AR, Edmond MB. Hand Hygiene: State-of-the-Art Review With Emphasis on New Technologies and Mechanisms of Surveillance. *Curr Infect Dis Rep* 2012;14:585-591.
- <sup>17</sup>Ward MA, Schweizer ML, Polgreen PM et al. Automated and electronically assisted hand hygiene monitoring systems: a systematic review. *Am J Infect Control* 2014;42:472-478.
- <sup>18</sup>Morgan DJ, Pineles L, Shardell M et al. Automated hand hygiene count devices may better measure compliance than human observation. *Am J Infect Control* 2012;40:955-959.
- <sup>19</sup>Steed C, Kelly JW, Blackhurst D et al. Hospital hand hygiene opportunities: where and when (HOW2)? The HOW2 Benchmark Study. *Am J Infect Control* 2011;39:19-26.
- <sup>20</sup>Diller T, Kelly JW, Blackhurst D et al. Estimation of hand hygiene opportunities on an adult medical ward using 24-hour camera surveillance: validation of the HOW2 Benchmark Study. *Am J Infect Control* 2014;42:602-607.
- <sup>21</sup>Pineles LL, Morgan DJ, Limper HM et al. Accuracy of a radiofrequency identification (RFID) badge system to monitor hand hygiene behavior during routine clinical activities. *Am J Infect Control* 2014;42:144-147.
- <sup>22</sup>Ellingson K, Polgreen PM, Schneider A et al. Healthcare personnel perceptions of hand hygiene monitoring technology. *Infect Control Hosp Epidemiol* 2011;32:1091-1096.
- <sup>23</sup>Levchenko AI, Boscart VM, Fernie GR. Automated Monitoring: A Potential Solution for Achieving Sustainable Improvement in Hand Hygiene Practices. *Comput Inform Nurs* 2014.
- <sup>24</sup>Larson E, Girard R, Pessoa-Silva CL et al. Skin reactions related to hand hygiene and selection of hand hygiene products. *Am J Infect Control* 2006;34:627-635.

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