

# Electronic Monitoring of Hand Hygiene

## Health Problem

Healthcare-associated infections (HAIs) are infections that patients acquire in a healthcare setting that are largely preventable and contribute significant morbidity and mortality to thousands of patients each year. One of the most important prevention measures is appropriate hand antisepsis by healthcare workers (HCWs). Compliance with healthcare facility recommendations on hand washing may be difficult due to the large number of hand hygiene (HH) events that an HCW encounters daily, with the chief challenge being laxity of practice. Methods for monitoring HH compliance need to provide an accurate picture of HCW behavior in order to assist with developing and implementing quality improvement measures to improve HH compliance when it is low and HAI rates are of concern.

## Monitoring of Hand Hygiene in the Healthcare Setting

### Direct Observation

To maintain an acceptable level of HH in a facility, monitoring HCWs for adherence to hospital-based HH guidance is recommended. The usual method for HH monitoring is direct observation (DO) by a trained observer. This observer should identify the relevant HH opportunities based on professional guidance, such as the World Health Organization (WHO) My 5 Moments for Hand Hygiene, which enumerates the following HH opportunities for HCWs (WHO, 2009):

1. Before touching a patient
2. Before clean/aseptic procedures
3. After body fluid exposure/risk
4. After touching a patient
5. After touching patient surroundings

DO is labor intensive, time consuming, costly, necessitates training, samples relatively few episodes of hand washing, and assesses compliance sporadically. Other concerns include:

- DO is limited by interrater variability and observer bias and compromises patient privacy (Marra et al., 2014; Ward et al., 2014; Boyce, 2017).
- Data obtained through DO of HH can be impacted by the Hawthorne effect, which refers to the phenomenon of improved performance by workers while they are being observed and a return to baseline when observation ends (The Joint Commission, 2010; Srigley et al., 2015).

### Electronic Monitoring

An alternative to DO for the assessment of HH compliance in healthcare settings is through continuous monitoring via an automated electronic monitoring (EM) system. A variety of equipment is available for EM of HH compliance, including wireless, infrared (IR), ultrasound, radiofrequency identification (RFID), and alcohol-sensing technologies. These devices transmit signals from patient zones (surrounding patient beds), sinks, antiseptic dispensers, and doorways, among other places. Designs of these systems range from very simple (i.e., devices that track the number of times an antiseptic or soap

dispenser is utilized) to complex systems that track the location of HCWs through RFID badges. The badges transmit data about the timing of hand washing and provide an alert if hand washing is not performed. These more complex EM systems electronically detect HH opportunities, HH events, and calculate HH compliance, and they may provide feedback to individual HCWs.

### Types of Electronic Monitoring Systems

Several types of electronic, electronically assisted, or automated HH compliance monitoring systems are available. Some examples include the following (The Joint Commission, 2010; Marra et al., 2014; Ward et al., 2014; Boyce, 2017):

- Video-monitored DO systems – Remote auditors download and evaluate recorded data.
- Electronic dispenser counter – Simple EM system that records the number of times a dispenser has been used or volume of product dispensed and transmits this data for analysis.
- Badge-based or bracelet-based EM system – Networks that use transmitters and receivers to detect HH opportunities, such as entry into and exit from a patient care area, and that confirm HH events with electronic devices, such as counters of antiseptic dispensing, IR, or ultrasound transmitters around the patient’s bed, on doorways and sinks that interact with badges or tags worn by HCWs. Some systems alert the HCW if hands are unwashed. Information from the receivers is uploaded to a hospital server or an off-site storage location via wireless reader units.

**Table 1. Advantages and Disadvantages of Hand Hygiene Compliance Systems**

**Key:** DO, direct observation; EM, electronic monitoring; HCW(s), healthcare worker(s); HH, hand hygiene; WHO, World Health Organization

HH Compliance System	Advantages	Disadvantages
<b>DO</b>	Able to observe all WHO My 5 Moments for HH, can observe techniques in detail, can provide feedback in real time to HCWs, accessible without the purchase of additional HH monitoring equipment, sustainable.	Time for training, hours for trained personnel to perform DO, cost of labor, smaller number of HH events observed, observer biases (interobserver reliability), Hawthorne effect, manual data collection in the absence of EM-assisted devices, physical barriers can result in missing HH moments.
<b>Video-Based Observation</b>	Elimination of Hawthorne effect, review HH opportunities at times when DO may be challenging, can assess HH technique.	Cost for installation, maintenance, and staffing of remote observers; potential impact on patient privacy; due to placement of camera may not be able to record all HH opportunities or events; malfunctioning camera results in lost observations.
<b>Electronic Dispenser Counters</b>	Works continuously to provide a greater number of HH events, automatic data collection, low level of training time for HCWs, elimination of Hawthorne effect.	Cannot detect all HH opportunities, cannot determine the quality of the HH event, data cannot be used alone to establish compliance rates, additional cost for installing and maintaining electronic dispensers, malfunctioning dispensers yield loss of data, potential to 'game' system.
<b>Badge-Based EM System</b>	Reduced personnel resources compared with DO after installed, increased number of HH events recorded compared with DO, real-time feedback possible, elimination of Hawthorne effect, can provide data at the individual HCW level.	Installation and maintenance costs, problems with sensitivity and specificity in some systems, lack of HCW buy-in potential, HCW privacy, cannot detect all HH opportunities, misclassification due to unaccounted changes in HCW workflow (e.g., standing in a door to talk to a patient or washing hands at a location not monitored by a sensor).

## Evidence for Electronic Monitoring

There was a moderate amount of evidence identified and evaluated.

Studies in this report provide some evidence that specific EM systems are accurate and able to assess HH compliance. There is consistent evidence that compliance measured by EM improves after implementing EM; however, the durability of the increased compliance is uncertain. There was insufficient evidence from the included studies to draw conclusions regarding the effects of EM on HAI rates or HCW satisfaction with EM systems.

There is considerable variation in the features of EM systems, and not enough evidence on specific systems was identified to draw conclusions about individual systems.

Studies have shown that EM systems report fewer rates of HH opportunities, missing some of the key moments of HH entirely due to technological limitations, when compared with DO; however, the potential to measure HH events continuously and automatically collect data along with the ability to report data in real time may outweigh current technological limitations of EM systems. It is likely that, instead of replacing DO, most hospitals would still need to employ DO for auditing the EM system and providing information about HH opportunities that the system is not designed to collect.

The overall low quality of evidence for the body of evidence is considered to be low largely due to individual study limitations such as:

- Lack of robust analyses for validity outcomes
- No prespecified statistical analysis plan with power calculations for stated outcomes
- Lack of statistical comparisons between the EM and DO groups
- Small number of studies (3) pertaining to the utility of EM of HH to affect HCW behavior and patient outcomes, such as HAI rates
- Limitations of DO as a reference standard
- Diverse ways of reporting compliance outcomes
- Variability in the systems evaluated, which limits interpretation of the data presented in the evaluated studies

### Key Insights

- DO of HH is likely to have a continuing role in compliance evaluations since this method provides unique information that cannot be currently supplied by automated systems. For example, DO is needed to determine whether HH is performed at the correct times during patient care as well as assess technique and glove use. The combination of DO with EM along with interventions driven by these data (e.g., reminders, alerts) may greatly improve HH compliance.
- In the studies evaluated, the electronic HH monitoring systems were unable to detect all WHO My 5 Moments for HH. Future EM systems would be able to provide important additional information if they are able to monitor all WHO My 5 Moments for HH.
- Healthcare institutions considering acquisition of an EM system should examine the clinical and operational features of the various devices, such as automated data collection; individual HCW tracking and feedback; the type of alert; the capacity to monitor the WHO My 5 Moments for HH; the type and acceptability of receivers and badges or tags worn by staff; and placement of sensors

(patient zones, antiseptic dispensers, doorways). Particular attention should be paid to the features that will sustain HH compliance since patient safety is the ultimate goal.

- Additional studies comparing DO and EM systems as well as multimodal systems using both DO and EM in combination are needed. Further research on the optimal design, features, accuracy, and cost-effectiveness of EM systems is also necessary. Likewise, studies evaluating the use of EM systems to reduce HAIs would be considered desirable.
- Acceptance and sustained implementation of EM systems by HCWs should focus on providing transparency and confidentiality at the time of implementation, build a user attitude and environment that focuses on how the EM system can be supportive, choose devices that are accurate and tailor reminders to HCW preferences, and are smaller and lighter weight while being unobtrusive to direct patient care.

## Impact of Electronic Monitoring Systems in the Hospital

### Clinical and Operational Impact

Adopting a new EM system is a considerable undertaking that requires buy-in by hospital administration, HCWs, and supporting staff. The data provided by EM systems may aid hospitals in targeting potential problem areas, such as poorly performing shifts or units. Time currently spent training and implementing DO audits could be refocused on other hospital objectives.

The implementation of EM systems for HH compliance can also impact HCWs by initiating changes in clinical workflow (e.g., holding a hand near an alcohol-sensing badge to confirm compliance), which may be onerous to some persons. Uncertainty around how data collected by EM will be used, ability of system to not impede patient care, and the perceived efficacy of EM measurements may influence HCW adoption of the system.

Many facility-related and other factors may also influence compliance measurements, such as inpatient floors versus intensive care units, proportion of visitors relative to HCWs, the time of day, hospital architecture, and age of buildings.

### Financial Impact

The cost of automated EM of HH compliance varies depending upon:

1. The type and brand of the device or system
2. Changes to infrastructure necessitated by the system
3. Accessories or associated equipment (e.g., such as employee badges, antiseptic dispensers, and software)
4. Implementation costs (e.g., testing and employee training)

There is a need for cost-effectiveness studies of EM systems that ascertain their impact on compliance and HAI rates.

A systematic review (Boyce, 2017) identified costs associated with several types of EM systems.

- A dispenser counting system for a 15-bed intensive care unit (ICU) was estimated to cost between \$30,000 and \$40,000 (Morgan et al., 2012).

- An EM system consisting of individual RFID badges and room-based sensors was estimated to cost \$500 dollars per room for the sensors and \$150 for the wearable sensor (Sahud et al., 2010). A second study reported a cost of \$50,000 for the installation of a badge-based monitoring system in a 20-bed ICU (Marra et al., 2014).
- EM with camera-based monitoring was reported by a single study, which found that the installation cost of 21 cameras in an ICU was \$50,000, but the personnel cost was not reflected (Diller et al., 2014).

The cost for these systems includes the installation and replacement of any fixed or tag sensors, video cameras, training staff on how to use the HH monitoring system if needed, and information technology support for installation and system maintenance.

The costs of DO include the labor costs of human monitors and training, applications for recording or communicating results, and also Wi-Fi/cellular access to synchronize data. Boyce (2017) found the costs of DO were reported by 2 studies (Boyce, 2017). An Australian study found that, in 82 hospitals, the cost of DO was \$2.2 million per year, with a quarterly cost of \$16,000 for each hospital (Azim and McLaws, 2014). The second study was from Switzerland, which found that, to observe 5599 HH opportunities, it took 1600 hours with an estimated cost of \$88,000 (Bellissimo-Rodrigues and Pittet, 2015) .

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