IMPACT OF ELECTRONIC HAND HYGIENE MONITORING SYSTEMS: A REVIEW OF CASE STUDIES

BY SUDHANSHU GAKHAR & JASON BURNHAM

INTRODUCTION

Hospital-acquired infections (HAIs) burden patients, complicate treatments, prolong hospital stays, increase costs, and can be life-threatening. It is universally acknowledged that adequate hand hygiene is one of the most effective ways to prevent transmission of infections. However, despite tremendous effort, overall median compliance to hand hygiene protocols is 40%. Compliance rates are lower in intensive care units (30%-40%) than in other settings (50% - 60%), and are lower before (21%) than after patient contact (47%).

There have been many strategies developed to help improve hand hygiene compliance. The most effective of such strategies include monitoring hand hygiene behaviors and implementing performance-based interventions. In the last few years, a wide range of electronic or electronically assisted hand hygiene monitoring systems have been developed.

This article reviews more than 40 peer-reviewed articles and case studies that utilize electronic monitoring systems to help influence hand hygiene behaviors. We review both the clinical and financial impact to the facility by improving hand hygiene compliance, including reduction in infections, direct cost savings, and reduction in patient length-of-stay. The results from these case studies demonstrate both clinical and financial evidence for adopting electronic hand hygiene monitoring solutions.
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ECONOMIC BURDEN OF NOSOCOMIAL INFECTIONS

Annually in the U.S., approximately 750,000 patients suffer from nosocomial or healthcare-associated infections (HAIs) and an estimated 80,000 of these patients die. This accounts for approximately 1 in 25 patients that are admitted to hospitals and ranks HAIs as the 5th leading cause of death in U.S. acute-care hospitals. Five categories of infections account for more than three-quarters of all infections in acute-care hospitals, including –

1. Surgical Site Infection (SSI),
2. Blood Stream Infection (CLABSI),
3. Ventilator-Associated Pneumonia (VAP),
4. Urinary Tract Infection (CAUTI), and
5. Gastrointestinal infections, specifically Clostridium difficile (C. diff).

The substantial human suffering and financial burden of these infections is staggering. Table 1 presents recent estimates made by the US Department of Health and Human Services summarizing the burden of these infections. Estimated annual costs of HAIs in the U.S. are between $28 Billion and $45 Billion per year. Beyond direct financial costs, HAIs also contribute significantly to increased patient length-of-stay (LOS) in the hospital resulting in both operational cost loss and patient dissatisfaction.

<table>
<thead>
<tr>
<th>Infection Type</th>
<th>Estimated Annual Infections</th>
<th>Mean Hospital Cost per Infection (US$)</th>
<th>Mean Deaths per Year</th>
<th>Average LOS (Length-of-Stay)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical Site Infection</td>
<td>157,500</td>
<td>24,546</td>
<td>13,088</td>
<td>10.6</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>157,500</td>
<td>9,966</td>
<td>35,967</td>
<td>8.7</td>
</tr>
<tr>
<td>Blood Stream Infection</td>
<td>71,900</td>
<td>36,441</td>
<td>30,655</td>
<td>10</td>
</tr>
<tr>
<td>Urinary Tract Infection</td>
<td>93,300</td>
<td>1,006</td>
<td>8,205</td>
<td></td>
</tr>
<tr>
<td>Gastrointestinal Infection</td>
<td>123,100</td>
<td>12,607</td>
<td></td>
<td>14</td>
</tr>
</tbody>
</table>

Table 1: Economic Burden of Healthcare-Associated Infections
IMPACT OF HAND HYGIENE ON REDUCING INFECTIONS

Healthcare-associated infections (HAIs) are spread in a number of different ways, but contaminated hands of healthcare workers (HCW) are among the most common modes of transmission. Pitet and colleagues identified a five-step sequence leading to microbial transmission through hands during healthcare delivery:

1. Pathogens shed by infected patients can contaminate surrounding environments
2. The HCW’s hands get contaminated by contact with patient skin or surrounding environment
3. The pathogen remains viable on the HCW’s hands for at least several minutes
4. The HCW may omit hand decontamination or use inappropriate product or procedure
5. The HCW’s contaminated hands can either transfer the pathogen directly to another patient or indirectly on a medical device or objects within the patient’s immediate vicinity

To improve hand hygiene compliance, interventions need to be multimodal and should include key facets like availability of alcohol-based hand rub, education, surveillance and feedback along with consistent messaging and awareness among staff to encourage individual performance improvement. In a recent article, Huis et al conducted a systematic review of hand hygiene improvement strategies. They concluded that addressing a single determinant like “knowledge” or “education” to improve HH compliance is not enough. Addressing a combination of different determinants showed better results.

A recent literature review conducted by the World Health Organization (WHO) identified 39 studies that demonstrated a significant reduction in infections resulting from improved hand hygiene compliance. Several high-quality studies are listed in Table 2 below demonstrating consistent association of improved hand hygiene compliance (HHC) with reduction in infection rates. Pitet et al published a landmark study in 2000 using a multidisciplinary hand hygiene promotional strategy and demonstrated a sustained improvement in compliance resulting in reduction in HAI prevalence. Since then several hospital-wide and system-wide studies have been published that demonstrate similar results. For example, Lederer et al published a recent study conducted in seven acute care facilities that utilized a multimodal strategy including monitoring and reporting hand hygiene compliance for alcohol-based hand rub (ABHR) use across the facilities. They demonstrated a 49% to 98% improvement in compliance resulting in reduction of methicillin-resistant staphylococcus aureus (MRSA) rates from 0.52 to 0.24 HAIs per 1000 patient-days during the same time period.
<table>
<thead>
<tr>
<th>Country/Year &amp; Setting</th>
<th>Intervention</th>
<th>Follow-Up Duration</th>
<th>Improvement in HH Compliance</th>
<th>Resulting Reduction in Infection</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Australia 2009, Hospital-Wide in 208 public hospitals (State-Wide)</td>
<td>HH Observation and performance feedback</td>
<td>18 months</td>
<td>47% to 61%</td>
<td>6% reduction in MRSA/10000 patient days. 16% reduction in ICU sites</td>
<td>Grayson ML et al15</td>
</tr>
<tr>
<td>2 US 2008, Hospital-Wide</td>
<td>Direct Observation (DO) and performance feedback</td>
<td>10 months</td>
<td>72.5% to 90.3%</td>
<td>MRSA reduction 0.85 to 0.53/1000 days</td>
<td>Cromer et al.16</td>
</tr>
<tr>
<td>3 US 2009, Hospital-Wide 7 acute care facilities</td>
<td>HH Observation and performance feedback</td>
<td>3 years</td>
<td>49% to 98%</td>
<td>MRSA reduction from 0.52/1000 episodes to 0.24/1000 episodes</td>
<td>Lederer et al14</td>
</tr>
<tr>
<td>4 Switzerland 2007, Neonatal Unit</td>
<td>HH Observation, poster, education and performance feedback</td>
<td>27 months</td>
<td>42% to 55%</td>
<td>Overall HAI rates from 11 to 8.2 infections/1000 patient days</td>
<td>Pesso-silva et al17</td>
</tr>
<tr>
<td>5 China (Taiwan) 2004, NICU</td>
<td>HH Observation, performance feedback and rewards</td>
<td>24 months</td>
<td>43% to 80%</td>
<td>Reduction in HAI 15.1/1000 to 10.7/1000 patient days</td>
<td>Won et al18</td>
</tr>
<tr>
<td>6 US 2004, Adult Intermediate Care Unit</td>
<td>Phase I: electronic monitoring (EM) and DO, Phase II EM with voice prompts, Phase III EM</td>
<td>15 months</td>
<td>Phase II - 37%, Phase III - 41%</td>
<td>Phase I - 22% Phase III - 48%</td>
<td>Swoboda et al19</td>
</tr>
<tr>
<td>7 Switzerland 2000, Hospital-Wide</td>
<td>HH Observation, training and performance feedback</td>
<td>3 years</td>
<td>48% to 66%</td>
<td>Significant reduction of HAI - 42% and MRSA cross transmission rates down 87%</td>
<td>Pittet et al13</td>
</tr>
</tbody>
</table>

Table 2: Selected studies that demonstrate impact of HH on HAI Prevention
There are many types of electronic or electronically assisted hand hygiene monitoring systems, including video-monitored direct observation, electronic dispensing counters, and individual hand hygiene monitoring networks. Electronic monitoring can be a very effective method for improving hand hygiene compliance through data collection and individual feedback for performance improvement. Electronic monitoring is able to capture a high quantity of observations without the Hawthorne effect impact of having a human observer visible and present during the collection of data. These systems are also capable of providing analytics and feedback to individuals either immediately at the point of use or later in reports on individual or team data.

We examined more than 40 peer-reviewed articles and case studies that utilized similar electronic monitoring systems and selected eleven studies that discuss both clinical and financial impacts on the facility, including reduction in infections, direct cost savings, and reduction in patient length-of-stay (LOS). Table 3 is a summary of data presented in these studies.

Figure 1: Selected studies that demonstrate impact of HHC on HAI Prevention

### ELECTRONIC HAND HYGIENE MONITORING SYSTEMS

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<table>
<thead>
<tr>
<th>Hospital Setting</th>
<th>Type of Intervention</th>
<th>Monitored Period</th>
<th>% Improved HH Compliance</th>
<th>% Reduction in Infection</th>
<th>LOS Avoided (In Days)</th>
<th>Reference Direct Cost Savings (USD)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Regional Hospital 2 Floors 28 Beds</td>
<td>EM of HH and Performance Feedback</td>
<td>12 months</td>
<td>160.6% in UNIT 1 and 89% in UNIT 2</td>
<td>35% reduction in UNIT 1 and 22% decrease in Unit 2</td>
<td>52.4</td>
<td>$46,150</td>
<td>Meyer, et al\textsuperscript{20}</td>
</tr>
<tr>
<td>2 Neuro ICU 10 Beds</td>
<td>EM of HH and Performance Feedback</td>
<td>14 months</td>
<td>162%</td>
<td>All HAI - 24%</td>
<td>268</td>
<td>$308,451</td>
<td>Richards, et al\textsuperscript{21}</td>
</tr>
<tr>
<td>3 CPTU 12 Beds</td>
<td>EM of HH and Performance Feedback</td>
<td>20 months</td>
<td>113.6%</td>
<td>All HAI - 72.9% \ VAP - 73.9% \ CAUTI - 66.3% \ C. diff - 81.1% \ CLABSI - 69.5%</td>
<td>236</td>
<td>$463,000</td>
<td>Cantrel et al, July 2014\textsuperscript{22}</td>
</tr>
<tr>
<td>4 Cardiac ICU 22 Beds</td>
<td>EM of HH and Performance Feedback</td>
<td>16 months</td>
<td>125.5%</td>
<td>All HAI - 38.5%</td>
<td>105.6</td>
<td>$121,511</td>
<td>Sanders et al\textsuperscript{23}</td>
</tr>
<tr>
<td>5 Med Surg and MICU 52 Beds</td>
<td>EM of HH and Performance Feedback</td>
<td>29 months</td>
<td>141%</td>
<td>All HAI - 35.7%</td>
<td></td>
<td>$476,697</td>
<td>Blumstein et al\textsuperscript{24}</td>
</tr>
<tr>
<td>6 SICU 12 Beds</td>
<td>EM of HH and Performance Feedback</td>
<td>12 months</td>
<td>96.4%</td>
<td>All HAI - 16.2%</td>
<td>43.5</td>
<td>$32,216</td>
<td>Collins et al\textsuperscript{25}</td>
</tr>
<tr>
<td>7 Med Surg 31 Beds</td>
<td>EM of HH and Performance Feedback</td>
<td>12 months</td>
<td>191.2%</td>
<td>All HAI - 25%</td>
<td>49.2</td>
<td>$53,376</td>
<td>Bailey et al\textsuperscript{26}</td>
</tr>
<tr>
<td>8 Med Surg 25 Beds</td>
<td>EM of HH and Performance Feedback</td>
<td>14 months</td>
<td>236.7%</td>
<td>All HAI - 18.8%</td>
<td>97.4</td>
<td>$112,164</td>
<td>Wofford et al\textsuperscript{27}</td>
</tr>
<tr>
<td>9 Med Surg Unit 29 Beds</td>
<td>EM of HH and Performance Feedback</td>
<td>10 months</td>
<td>42.7%</td>
<td>All HAI - 59.1%</td>
<td>211.1</td>
<td>$243,022</td>
<td>Cape et al\textsuperscript{28}</td>
</tr>
<tr>
<td>10 Hematology Unit 30 Beds</td>
<td>EM of HH w/ automated alerts</td>
<td>12 months</td>
<td>36% to 70.1%</td>
<td>No Significant</td>
<td></td>
<td></td>
<td>Venkatesh et al\textsuperscript{29}</td>
</tr>
<tr>
<td>11 Adult Intermediate Care Unit 14 Beds</td>
<td>Phase 1: EM and Direct Observation, Phase II EM w/ Voice prompts, Phase III EM</td>
<td>15 months</td>
<td>Phase II - 37%, Phase III - 41%</td>
<td>Phase I - 22%</td>
<td></td>
<td></td>
<td>Swoboda et al\textsuperscript{19}</td>
</tr>
</tbody>
</table>

Table 3: Selected studies demonstrate impact of Electronic Hand Hygiene Monitoring on HAI Prevention
Most of these studies are pre- and post-intervention and demonstrate significant clinical and financial impacts from improving hand hygiene compliance utilizing electronic systems, including consistent reduction in patient length-of-stay and direct cost savings. For example, Meyer et al implemented an electronic hand hygiene monitoring solution in two floors of a regional hospital in 28 beds. Over the period of twelve months of performance monitoring and providing feedback to staff they demonstrated 160% improvement in compliance in Unit 1 and 89% in Unit 2. This resulted in 35% and 22% reduction in infections, respectively; $46,150 in direct savings, and 52.4 days length-of-stay avoided. Figures 2 and 3 below summarize results from several similar case studies.
CONCLUSION

Performance monitoring, data collection of hand hygiene observations, and feedback to staff are often used as an effective strategy to help influence behaviors and improve hand hygiene compliance. Electronic compliance monitoring solutions often provide an unbiased and comprehensive measure of hand hygiene activity within a facility.

Studies where interventions resulted in significant improvement in compliance to hand hygiene guidelines also demonstrated a substantial decrease in infections\textsuperscript{12}. Electronic hand hygiene compliance monitoring systems, in combination with staff education and availability of alcohol hand sanitizers, can be very effective in reducing infections and have demonstrated significant cost savings and reduction in patient length-of-stay across a number of case studies in a variety of acute care environments.
REFERENCES


12. "Evidence of hand hygiene to reduce transmission and infections by multidrug resistant organisms in HC settings" WHO 2014 http://www.who.int/gpsc/5may/MDRO_literature-review.pdf.


27. Wodford et al, "Success with technology to increase Hand Hygiene Compliance" APIC Conference 2013.


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