MAN VS. MACHINE: A NEW APPROACH TO HAND HYGIENE AUDITING

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Objectives

- To review methods of hand hygiene compliance monitoring
- To present new evidence supporting the existence of the Hawthorne effect in hand hygiene compliance monitoring
- To review the evidence for the efficacy of hand hygiene monitoring technology (HHMT)
- To discuss the implications of these findings, including public reporting of hand hygiene rates and the use of HHMT
Hand Hygiene Compliance Monitoring
Measuring Hand Hygiene Compliance

• Improving healthcare worker (HCW) hand hygiene compliance is an important way to reduce healthcare-associated infections (HAIs)
• A multifaceted approach, including measurement of compliance, is recommended
• Measurement options include:
  – Direct observation
  – Self-report
  – Product consumption
  – Hand hygiene monitoring technology

Direct Observation

• “Gold standard”

• Advantages
  – Only method that can assess all indications for hand hygiene
  – One of the few methods that can assess technique
  – Provides opportunity for education

• Disadvantages
  – Labour intensive
  – Can only assess small samples of hand hygiene opportunities
  – Questionable inter-rater reliability
  – Potential for errors in measurement

²Boyce, 2011. ³Haas et al., 2007.
Sources of Measurement Error

• Gaming
• Bias
  – Observer bias
    • Unit-based observers report higher compliance rates than non-unit-based observers\(^4\)
  – Selection bias
  – Hawthorne effect

\(^4\)Dhar et al., 2010.
A New Solution?

- Hand hygiene monitoring technology
  - Counters
  - Electronic monitoring systems – e.g. real-time locating systems (RTLS), radiofrequency identification (RFID)
  - Video monitoring
The Hawthorne Effect
The Hawthorne Effect

- Tendency of people to change their behavior when they are aware of an observer\(^3\)
- Original Hawthorne studies 1924-1932\(^5,6\)
  - Concept was not mentioned until 1950\(^7\)
- Many authors have since questioned whether the original Hawthorne studies actually showed a Hawthorne effect\(^8\)
- However, the Hawthorne effect is widely assumed to play a role in hand hygiene behavior

\(^3\)Haas et al., 2007. \(^5\)Mayo, 1933. \(^6\)Roethlisberger et al., 1939. \(^7\)Adair, 1984. \(^8\)Jones, 1992.
Does the Hawthorne Effect Exist?

- 17 studies of the Hawthorne effect and hand hygiene
- 6 in public washrooms:
  - 90% vs. 16%\(^9\)
  - 77% vs. 39%\(^{10}\)
  - 90% vs. 70%\(^{11}\)
  - 91% vs. 55%\(^{12}\)
  - 90% vs. 44%\(^{13}\)
  - 79% vs. 73%\(^{14}\)
- 2 in other non-health care settings
  - Petting zoos,\(^{15}\) homes\(^{16}\)
- 9 related to hospital hand hygiene compliance monitoring\(^{17-25}\)

\(^9\)Pedersen et al., 1986. \(^{10}\)Munger et al., 1989. \(^{11}\)Edwards et al., 2002. 
\(^{12}\)Drankiewicz et al., 2003. \(^{13}\)Nalbone et al., 2005. \(^{14}\)Monk-Turner, et al., 2005. 
\(^{15}\)Erdozain et al., 2013. \(^{16}\)Ram et al., 2010.
Hand hygiene compliance increased when audits were announced to units in advance compared to when they were unannounced:

- 9.1% to 29.5%\textsuperscript{20}
- 29% to 45%\textsuperscript{21}
- 47.4% to 55.7%\textsuperscript{22}

Increased hand hygiene compliance on high-performing units when an overt auditor (known to the units) was compared to a covert auditor, but not on low-performing units\textsuperscript{23}

Compliance rate as measured by medical students (44.1%) was significantly lower than those measured by infection control nurses (74.4%) and unit HH ambassadors (94.1%)\textsuperscript{24}

\textsuperscript{20}Tibballs, 1996. \textsuperscript{21}Eckmanns et al., 2006. \textsuperscript{22}Maury et al., 2006. \textsuperscript{23}Kohli et al., 2009. \textsuperscript{24}Pan et al., 2013.
Use of Electronic Monitoring to Measure the Hawthorne Effect

- Pilot study of an RTLS
- Hand hygiene compliance was 88.9% during audits, compared to an overall compliance of 31.5% for the days when the audits took place
- Limited by small sample size and lack of controlling for potential confounders

Cheng et al., 2011.
Summary of Literature

• Some evidence to support the existence of a Hawthorne effect in hand hygiene compliance, but existing studies have significant limitations

• Little is known about temporal and spatial boundaries of the Hawthorne effect or modifying factors that may play a role
Study Objective

• To determine the magnitude of the Hawthorne effect in hand hygiene compliance monitoring using an electronic monitoring system
Electronic Monitoring System

- RTLS was installed on two multi-organ transplant units from July 2012 to March 2013
- Generated continuous real-time location data via ultrasound tags worn by staff and patients
- Measured every use of alcohol-based hand rub (ABHR) and soap dispensers
Patients, staff and equipment wear **active tags**.
Active tags send location information every few seconds over a **wireless network**.
Unit Floor Plan
Study Design

- Retrospective cohort study
- Cohort = dispensers on the two units
- Exposure = presence of auditor
- Outcome = hand hygiene event rate (# dispenses per dispenser per hour)
Data Collection

• Auditors wore system tags to track the exact time of auditing and their location on the units
  ▪ Auditors were blinded to study hypothesis and conducted audits as per usual practice in accordance with the Just Clean Your Hands program
• Audits were performed 1-2 times monthly on each unit from November 2012 to March 2013
• Number of dispenses was determined for areas within eyesight of the auditor when he/she was in a defined location for at least 5 minutes
  ▪ Separate counts for dispensers in rooms and hallways
• Count was converted into an event rate per dispenser per hour
Comparisons

- Area of the unit not visible to the auditor at the same time period during the audit
  - Control for confounding related to time
- Same area where the auditor was located at 1, 2, and 3 weeks prior to the audit
  - Control for confounding related to location
- Same area where the auditor was located 5 minutes prior to auditor’s arrival
  - Reverse causality bias
Results: Location Comparison

Events per dispenser per hour

- Out*: Auditor 3.5, Other Area 1.5
- In: Auditor 0.0, Other Area 0.0
- Total**: Auditor 3.7, Other Area 1.5

*p=0.001 **p=0.008
Results: Time Comparison

Events per dispenser per hour

Out*  In  Total*

Auditor

1 Week Prior

*p<0.001
Results: Prior to Auditors’ Arrival

Events per dispenser per hour

Out*: 3.5
In: 0.5
Total**: 2

* $p=0.009$ ** $p=0.003$
Summary of Results

• Hand hygiene event rate is ~3 times higher within eyesight of the auditor compared to other locations at the same time and the same location in previous weeks
  – The effect is seen only in hallway dispensers, where the auditor can be seen, and not inside patient rooms
  – The increase in event rate happens after the auditor’s arrival, not before
Observational study, therefore cannot attribute causality

Measuring hand hygiene events, not HCW compliance
  – To get a denominator, all HCWs would have to be wearing system tags

Some hand hygiene events may have been performed by untagged HCWs or visitors

System itself may have caused a Hawthorne effect

Study conducted with a relatively small number of observations on multi-organ transplant units
Efficacy of Hand Hygiene Monitoring Technology
Is Technology the Answer?

- **Validity**
  - How accurately do electronic/video monitoring systems (EMS/VMS) measure hand hygiene compliance?
  - Limited data

- **Efficacy**
  - Do EMS/VMS lead to improvements in hand hygiene compliance?
  - Potential mechanisms
    - Feedback
    - Real-time reminders
    - Enhanced Hawthorne effect
Study Objectives

• To determine whether HHMT increases directly observed hand hygiene compliance among HCWs compared to usual care

• To determine whether HHMT reduces HAI incidence or improves other measures of hand hygiene compliance, including:
  – Hand hygiene frequency
  – Volume of soap and ABHR use
  – Compliance as defined by the individual HHMT [i.e. system-defined compliance (SDC)]
Methods

- Systematic review following PRISMA guidelines\textsuperscript{26}
- Searched multiple databases from inception until Dec 31, 2013
- Eligibility criteria
  - Experimental and quasi-experimental studies of HHMT conducted in acute or long-term care that measured hand hygiene and/or HAI incidence
  - Excluded if HHMT was installed solely to evaluate another intervention or if study focused on hand hygiene at ward/hospital entrances or in OR
  - Peer-reviewed, English language publications
- All steps in selection, data extraction and risk of bias assessment\textsuperscript{27,28,29} performed independently by 2 authors

\textsuperscript{26}Moher et al., 2009. \textsuperscript{27}Higgins et al., 2011. \textsuperscript{28}Harris et al., 2004. \textsuperscript{29}Schweizer et al., 2014.
Search Results

1935 citations identified from literature search

1443 non-duplicate, English publications

492 duplicate or non-English articles excluded

1295 articles excluded

148 full text articles reviewed

141 articles excluded due to:
- No HHMT studied \((N = 56)\)
- Not peer-reviewed \((N = 35)\)
- Not an experimental or quasi-experimental study \((N = 39)\)
- HHMT used to evaluate another intervention \((N = 1)\)

7 articles included
<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design</th>
<th>Study Setting</th>
<th>Population</th>
<th>HHMT type</th>
<th>Events tracked</th>
<th>Movement tracking</th>
<th>Feedback</th>
<th>Real-Time Reminders</th>
<th>Outcomes</th>
<th>Compliance definition</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swoboda, 2004&lt;sup&gt;30&lt;/sup&gt;</td>
<td>Pretest-posttest study</td>
<td>Intermediate care unit</td>
<td>All HCW and visitors</td>
<td>EMS</td>
<td>ABHR + soap</td>
<td>Room exit</td>
<td>No</td>
<td>Voice prompt</td>
<td>SDC, nosocomial infection rate</td>
<td>Proportion of room exits with a hand hygiene event prior to or within 10s of exit</td>
<td>P1 (monitoring): 19.1% P2 (monitoring + reminders): 27.3% P3 (monitoring): 24.1% P2 vs. P1: +8.2%* P3 vs. P1: +5%</td>
</tr>
<tr>
<td>Ventkatesh, 2008&lt;sup&gt;31&lt;/sup&gt;</td>
<td>Pretest-posttest study</td>
<td>Haematology ward</td>
<td>All HCW and visitors</td>
<td>EMS</td>
<td>ABHR</td>
<td>Room entry/exit</td>
<td>No</td>
<td>Voice and sound prompt</td>
<td>SDC, VRE transmission</td>
<td>Proportion of room entries/exits with a hand hygiene event</td>
<td>P1 (monitoring): 36.3% P2 (monitoring + reminders): 70.1% P2 vs. P1: +33.8%*</td>
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# Feedback without Reminders

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<tbody>
<tr>
<td>Armellino, 2012³²</td>
<td>Interrupted time series</td>
<td>Medical ICU</td>
<td>All HCW</td>
<td>VMS</td>
<td>ABHR + soap</td>
<td>Room entry/exit</td>
<td>Aggregate, continuous</td>
<td>No</td>
<td>SDC</td>
<td>Proportion of room entries/exits with a hand hygiene event prior to or within 10s of entry/exit where time in room &gt; 60 seconds</td>
<td>P1(monitoring): 6.5% P2(monitoring + feedback): 81.6% P3(monitoring + feedback): 87.9% P2 vs. P1: +75.1%* P3 vs. P1: +81.4%*</td>
</tr>
<tr>
<td>Armellino, 2013³³</td>
<td>Interrupted time series</td>
<td>Surgical ICU</td>
<td>All HCW</td>
<td>VMS</td>
<td>ABHR + soap</td>
<td>Room entry/exit</td>
<td>Aggregate, continuous</td>
<td>No</td>
<td>SDC</td>
<td>As above</td>
<td>P1(monitoring): 30.4% P2(monitoring + feedback): 82.3% P2 vs. P1: +51.9%*</td>
</tr>
<tr>
<td>Marra, 2010³⁴</td>
<td>Non-randomised, controlled trial</td>
<td>Step down unit (2)</td>
<td>All HCW and visitors</td>
<td>EMS</td>
<td>ABHR</td>
<td>Not tracked</td>
<td>Aggregate, 2/wk</td>
<td>No</td>
<td>Hand hygiene frequency, nosocomial infection rate</td>
<td>N/A</td>
<td>Control (monitoring): 110718 Intervention (monitoring + feedback): 117579 Intervention vs. control: +6861</td>
</tr>
</tbody>
</table>
## Feedback and Reminders

<table>
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</table>
| Levchenko, 201335 | Pretest-posttest study | Chronic care ward       | 14 nurses  | EMS       | ABHR + soap    | Room entry/exit    | Individual, 2/wk | Vibration       | SDC, hand hygiene event rate | Proportion of room entries/exits with a hand hygiene event within 60s prior to entry or 20s prior to exit (‘clean’) or within 20s of vibratory reminder (‘performed after prompt’) | P1(monitoring): 2.97  
 P2(monitoring + feedback): 2.84  
 P3(monitoring + feedback + reminders): 6.61  
 P2 vs. P1: -0.13  
 P3 vs. P1: +3.64 |
| Fisher, 201336    | RCT          | 2 wards + surgical ICU | 231 nurses | EMS       | ABHR           | Zone entry/exit    | Individual, 1/wk | Vibration       | SDC                    | Proportion of zone entries/exits with a hand hygiene event within 6s of entry or 60s of exit | Intervention (monitoring + feedback + reminders) vs. Control (monitoring): +6.8%* |
Summary of Results

• No studies met primary objective (directly observed compliance)
• Study at lowest risk of bias showed no clinically significant effect of an RTLS
• VMS appear promising but studies at moderate risk of bias
• Insufficient evidence to recommend adoption of HHMT as an improvement strategy
• Future trials must include stronger designs, control groups, and system independent measures of hand hygiene
Implications
Public Reporting

• BC, Ontario, and other provinces have made hospital hand hygiene compliance rates publicly reportable.
• Public reporting may increase the potential for gaming and bias\(^\text{37}\).
• Indicator-based improvement vs. evidence-based improvement.

\(^\text{37}\)Muller et al., 2011.
Reported Rates

- BC provincial average (FY2013-14)
  - 72% for moment 1 and 81% for moment 4\(^{38}\)
- Ontario provincial average (FY2013-14)
  - 86% for moment 1 and 91% for moment 4\(^{39}\)
- A systematic review found a median HH compliance rate of 40%\(^{40}\)
- Despite the significant increase in compliance since public reporting began in Ontario, there has been no change in HAI rates\(^{41}\)

\(^{38}\)PICNet, 2015. \(^{39}\)Health Quality Ontario, 2015. \(^{40}\)Erasmus et al., 2010. \(^{41}\)Didiodato, 2013.
Reality Check

• Actual HCW hand hygiene compliance rates are not as high as reported
  – May be up to 3x lower

• Potential solutions
  – Stop public reporting
  – Change from direct observation to another method of hand hygiene compliance measurement
## Comparison of Methods

<table>
<thead>
<tr>
<th>Direct Observation</th>
<th>Hand Hygiene Monitoring Technology</th>
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<tbody>
<tr>
<td>Subject to observer and selection biases</td>
<td>Lower likelihood of bias</td>
</tr>
<tr>
<td>Hawthorne effect</td>
<td>May be less subject to Hawthorne effect</td>
</tr>
<tr>
<td>Questionable inter-rater reliability</td>
<td>Consistent, algorithm-based data collection</td>
</tr>
<tr>
<td>Few observations, usually during peak hours of patient care activity</td>
<td>Constant, real-time assessment of all hand hygiene behaviour</td>
</tr>
<tr>
<td>Measures all 4 moments of hand hygiene</td>
<td>Often uses room entry/exit as denominator</td>
</tr>
<tr>
<td>Ability to assess technique</td>
<td>Most systems unable to assess technique</td>
</tr>
<tr>
<td>Can provide feedback/education to HCWs</td>
<td>May or may not provide feedback</td>
</tr>
<tr>
<td>Generally accepted by HCWs</td>
<td>May be less acceptable to HCWs</td>
</tr>
<tr>
<td>Labour intensive</td>
<td>Can be expensive to install and maintain</td>
</tr>
<tr>
<td>Can compare across facilities</td>
<td>Unable to compare compliance rates between systems</td>
</tr>
</tbody>
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Conclusions

• HHMT has advantages but it is not a panacea
  – Institutions need to weigh costs and benefits in their particular setting
  – Ideally HHMT should be installed with the goal of conducting evaluation/research

• Ongoing efforts are necessary to truly improve hand hygiene compliance and reduce HAIs
  – Focus on changing individual behaviour and organizational culture
  – Frontline ownership (FLO)
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- Dr. Gerald Evans
Questions?

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References


References

References


#CLEANSHOTS
Subtitle Goes Here
#CLEANSHOTS

- 336 Clean Shots
- More than 11,700 gallery visits
- More than 5,700 votes
EXTRA EDITION
East End News
16 April 1885

This morning at 0900 hours at the local hospital, Sherlock Holmes arrested his brother Mycroft for having dirty hands. The city currently has a Clean Hands campaign and Scotland Yard has been commissioned to oversee it. Everyone found with dirty hands will immediately be imprisoned and forced to clean their hands. No word as to how clean Mycroft’s hands are now. East Enders need to be aware this is a serious enough crime to make Sherlock Holmes arrest his own brother.

Keep posted for more news about Sherlock Holmes and the Case of the Missing Microbes.
Did you wash your hands?
Thank you to everyone who took part and made this campaign a success!