Using Science to Guide Hand Hygiene Surveillance and Improvement
Prof. Eli Perencevich, University of Iowa
Broadcast live from the Infection Prevention Society conference

Ayliffe Lecture: Using science to guide hand hygiene surveillance and improvement

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Conflicts of Interest Statement

- No financial conflicts
- Section Editor for Guidelines, Position Papers, and Invited Reviews @ ICHE
- Federal Funding
  - VA HSR&D (COIN and CREATE)
  - CDC Prevention Epicenter
  - AHRQ
This talk will review the science behind monitoring and improving hand hygiene

Hand hygiene basics – opportunities, barriers and effective interventions

System types and effectiveness

Publication Bias, Hawthorne

Hand hygiene is important...

AN INVISIBLE SNEEZE DROPLET CAN CONTAIN 200 MILLION GEMS!
OUR HAND SANITIZER KILLS 99.99% OF GEMS!
200,000,000 x 0.01% =

http://xkcd.com/1161/
Hand hygiene is important...

Sneeze into your elbow!!

Hand Hygiene at Crossroads

- “Hand Hygiene Compliance: are we kidding ourselves?”
- Targets set at >90%, met by most facilities
- 2009-2014 Systematic Review
  - Mean compliance before intervention – 34%
  - After intervention – 57%
- What should be the target? – Fair monitoring
  - Achievable
  - Beneficial

FOR MORE INFO...


A Webber Training Teleclass
www.webbertraining.com
Veterans Health Administration

- VHA is largest integrated health system in US
- 168 VA Medical Centers
  - 132 Community-Living Centers (Nursing Homes)
- 1,053 Outpatient Clinics
- Serves over 9 million enrolled veterans
- Centralized medical records and policies

Hand Hygiene 2015: Complicated

- CDC Guideline for Hand Hygiene in Health-Care Settings (2002) - 56 Pages
- WHO Guideline on Hand Hygiene in Health Care (2009) - 270 pages

- VHA DIRECTIVE 2011-007
  - Effective: March 1, 2011
  - Expired: February 29, 2016
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2012 VHA Hand Hygiene Survey

- VHA Hand Hygiene Workgroup
- 141 VA healthcare systems participated

- Administered through the Office of the Deputy Under Secretary of Healthcare Operation Management (DUSHOM) Office
  - “the staff member responsible for their facility’s hand hygiene program”

51-Item Intranet-Based Survey

- Three areas of focus:
  1. How hospitals measured HCWs hand hygiene
  2. Which intervention strategies should be recommended to improve compliance
  3. Facility threshold/goal for compliance


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How did VHA measure compliance in 2012?

- **Direct Observation**: 98.6%
- **Product Usage**: 22.7%
- **Automated System**: 2.8%

When did they measure compliance?

- **Room Entry**: 68.1%
- **Room Exit**: 70.9%

Which WHO Moments?

WHO Five Moments from “Clean Care is Safer Care” Patient Safety Challenge and Guidelines on HH in Health Care (2009)

- Before contact: 55.3% 56.7%
- After contact: 48.2% 47.5% 45.8%
- Patient Sourcing
- Anticeptic procedure
- Exposure to bodily fluid


Having a (hand hygiene) moment

16 Moments For Hand Hygiene
- entering patient room
- before touching a patient
- before handling medication
- before clean/antiseptic procedure
- before putting on sterile gloves
- after removing gloves
- after exposure to body fluid
- after visibly dirty/soiled
- moving from a contaminated body site to another body site during the care of the same patient (say that one three times while rubbing your belly and head)
- after touching equipment or patient surroundings
- after touching a patient
- exiting a patient room
- before eating
- after using the restroom
- when preparing food
- after delivering food (if worker touches patient, bed linens, or objects in the room)

Which Opportunities?

- Compare compliance using WHO “My 5 Moments” vs “Before & After” or “Before” (2009-201)
- **Before & After** may provide a surrogate marker of overall hand hygiene compliance

### Table 1
Number of opportunities and hygiene compliance according to the three models

<table>
<thead>
<tr>
<th></th>
<th>My 5 Moments</th>
<th>Before &amp; After</th>
<th>Before</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of opportunities</td>
<td>5577</td>
<td>3946</td>
<td>2149</td>
</tr>
<tr>
<td>Compliance</td>
<td>62% (61–64)</td>
<td>61% (60–63)</td>
<td>52% (50–54)</td>
</tr>
</tbody>
</table>

* a 95% confidence interval.

Feasibility of “WHO My 5 Moments” vs Entry/Exit in the US?

- 3 hospital (6 ward, 5 ICU) study comparing ability to monitor WHO M5M vs Entry/Exit compliance
- Question: Could we “see” it?
- **WHO M5M in ICU vs Ward**
  - M5M observed during 39% of episodes of care in ICU
  - Compared to 28% observed on wards, P<0.01


A Webber Training Teleclass
www.webbertraining.com
Entry/Exit captures most WHO M5M Opportunities

Rate of Healthcare Worker–Patient Interaction and Hand Hygiene Opportunities in an Acute Care Setting

Laura Goodiffe, MPH;1,2 Kelsey Ragan, MPH;1,2 Michael Larocque, BSc;1 Emily Berglundvaag;1 Sophia Khan;1 Christine Moore, BSc;1 Liz McCleight, CIC;1 Brenda L. Coleman, PhD;3,4 Allison J. McGeer, MD;1,3 for the Mount Sinai Infection Control Team

- 257 hours
- 1605 opportunities
- Mean 4.2 op/hour
- 77% RN, 8% MDs

ICHE 35:7 (July 2014), pp. 826-832

How much monitoring happens?


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www.webbertraining.com
Barriers to Compliance: Need more than feedback to improve hand hygiene

- Skin dryness and irritation
- No time to wash, nursing workload
- Inconvenient sinks, hand hygiene dispensers
  - Fire codes in US
- Carrying something in your hands when entering
- Compliance not individually tracked*

Recognizing the barriers, what interventions have been proven to increase compliance?

Searching for an Optimal Hand Hygiene Bundle: A Meta-analysis

- Systematic Review 2000 to April 2012
- 8148 articles identified, 65 fully reviewed
- 45 studies included (RCT and Quasi-experimental)


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WHO Multimodal Hand Hygiene Improvement Strategy

- Education
- Access to dispensers/pocket size hand rub
- Reminders
- Institutional Safety Climate (Administrative Support)
- Feedback*
  - 27 studies, only one analyzed alone

There is strong evidence for WHO bundle

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>log(Odds Ratio)</th>
<th>SE</th>
<th>Weight</th>
<th>Odds Ratio</th>
<th>IV, Random, 95% CI Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hugonnet</td>
<td>0.65</td>
<td>0.1</td>
<td>19.4%</td>
<td>1.92</td>
<td>[1.57, 2.33] 2002</td>
</tr>
<tr>
<td>Harbarth</td>
<td>0.64</td>
<td>0.05</td>
<td>38.4%</td>
<td>1.90</td>
<td>[1.72, 2.09] 2002</td>
</tr>
<tr>
<td>Trick</td>
<td>0.53</td>
<td>0.06</td>
<td>33.6%</td>
<td>1.70</td>
<td>[1.51, 1.91] 2007</td>
</tr>
<tr>
<td>Allegranzi</td>
<td>0.92</td>
<td>0.17</td>
<td>8.6%</td>
<td>2.51</td>
<td>[1.80, 3.50] 2010</td>
</tr>
</tbody>
</table>

Total (95% CI) 100.0% 1.88 [1.69, 2.09]

Heterogeneity: Tau^2 = 0.01; Chisq = 5.60, df = 3 (P = 0.13); I^2 = 46%
Test for overall effect: Z = 11.62 (P < 0.00001)


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How much hand hygiene is enough?

- No matter how we measure it, when can we be satisfied that we are preventing infections?

Is there a target threshold for hand hygiene compliance associated with reduced infections?

Most of hospitals have compliance around 40-60%


Hand hygiene compliance threshold?

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Hand hygiene compliance threshold?


But what about automated systems?

Automated and electronically assisted hand hygiene monitoring systems: A systematic review
Melissa A. Ward MS a, Marlin L. Schweizer PhD a,b, Philip M. Polgreen MD, MPH a, Kalpana Gupta MD, MPH c,d, Heather S. Reisinger PhD a,b, Eli N. Perencevich MD, MS a,b, e

- Systematic review: 1 Jan 2000 – 31 March 2013
- 3,463 articles identified, 42 included
  - Enhanced direct observation
  - Video monitoring
  - Electronic dispenser counters
  - Automated monitoring networks

Ward M et al. AJIC 2014

A Webber Training Teleclass
www.webbertraining.com
Enhanced direct observation systems

- 5 studies
- iScrub – free
- Customizable, time-stamped
- Email spreadsheet
- May simplify audit-feedback
- No evidence of benefit

http://compepi.cs.uiowa.edu/index.php/Research/IScrub

Video-monitoring shows potential to improve compliance

- 4 studies
- Generally associated with improved compliance
- Placement important
  - 5 moments
- “Big Brother”
- Costs - $50,000 plus $1000/month in 17 bed unit

Ward M et al. AJIC 2014
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Third-party remote video monitoring effective intervention in MICU and SICU

- 2 year study
- Camera of sinks/ dispensers
- Sensor for Entry/Exit
- Monitors in India
- Pre-feedback 10%
- Post-feedback 81.6%
- At 75 weeks 87.9%

Armellino D et al AJIC 2013

Electronic Dispenser Counters

- 15 studies
- Time-stamped
- Can’t determine appropriateness, lacks denominator
- Associated with improved accuracy vs direct observation*

*Morgan DM AJIC 2012
*Marra AR ICHE 2010

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Counters with feedback not effective

- 6-month intervention vs control step-down units
- Intervention: counts given to individual nurses 2x/week, placed in chart, compared to other nurses

<table>
<thead>
<tr>
<th>Outcome Variable</th>
<th>Intervention Unit</th>
<th>Control Unit</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol Gel</td>
<td>33.6</td>
<td>30.2</td>
<td>.54</td>
</tr>
<tr>
<td>CHG</td>
<td>7.5</td>
<td>5.6</td>
<td>.59</td>
</tr>
<tr>
<td>Total</td>
<td>41.1</td>
<td>35.8</td>
<td>.56</td>
</tr>
</tbody>
</table>

Marra AR ICHE 2008

But when the Positive Deviance model applied, hand hygiene increased

- Same step-down units (SDU) and counters
- 9 month study – 3 x 3-month periods

<table>
<thead>
<tr>
<th></th>
<th>Pre-intervention</th>
<th>PD East SDU</th>
<th>PD Both SDU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol dispense/1000 pt-days</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East</td>
<td>46,890</td>
<td>62,000*</td>
<td>57,930</td>
</tr>
<tr>
<td>West</td>
<td>44,460</td>
<td>33,570</td>
<td>43,980</td>
</tr>
</tbody>
</table>

| Alcohol L / 1000 pt-days |       |       |             |
| East                | 136               | 250*     | 239         |
| West                | 115               | 126      | 205         |

P <0.01

Marra AR ICHE 2010

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Automated hand-hygiene monitoring networks

- 18 studies
- Detect when HCW enters and hand hygiene event, remind HCW, wearable component
- Audible reminder on ward entrance raised hand hygiene from 8% to 50% in HCW and visitors*
- Urgent-care, 13 HCW study with monthly reminders: 37% to 49% compliance p<0.01#

*Fakhry M et al. AJIC 2012
# Sahud AG et al. JHI 2012

Alcohol-sensing badges with audio-visual reminders

- 35-bed orthopaedics ward
- 19 nurses wore credit-card-sized alcohol sensor badge (BioVigil LLC, Santa Rosa, CA, USA) for two weeks
- Door sensor triggered by entry
- If alcohol detected – green+ping
- If alcohol not-detected – red+beep
- 31-day study

Edmond et al. JHI 2010, 76;354-372
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Alcohol sensor badge raised compliance

<table>
<thead>
<tr>
<th>Phase 1: Direct Observation</th>
<th>Compliance=66%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 2: Electronic monitoring</td>
<td>Compliance=93%</td>
</tr>
</tbody>
</table>

Edmond et al. JHI 2010, 76;354-372

Systematic Review Recommendation – Hold off on buying these systems

- Small, uncontrolled, quasi-experimental studies
- “Limited data is currently available to recommend adoption of specific automatic or electronically-assisted hand hygiene surveillance systems...Given the restricted clinical and infection prevention budgets of most facilities, cost-effectiveness analysis of specific systems will be required before these systems are widely adopted”

Ward M et al. AJIC 2014
Caveat emptor - “Let the buyer beware”

- Buyers vs. sellers “information”
- “Publication Bias”: investigators don’t publish small and/or negative studies

Full publication of results initially presented in abstracts

Scherer RW, Langenberg P, von Elm E

DID THEY PUBLISH THEIR ABSTRACTS?

Cochrane Database Syst Rev. 2007 Apr 18;(2):MR000005

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Figure 2. Cumulative full publication; comparison of abstracts describing randomized or controlled clinical trials (RCTs, 9 studies) with abstracts describing other study designs (Non-RCTs, 36 studies)

Which abstracts are likely to be published?

- “Positive” results (RR = 1.30; CI 1.14-1.47)
- Oral vs. poster (RR = 1.28; CI 1.09-1.49)
- Higher quality of abstracts (RR=1.30, CI 1.00-1.71)

Cochrane Database Syst Rev. 2007 Apr 18;(2):MR000005
Real-time location system (RTLS) **abstract**

- Before/After QE Design
  - 10-month study
- RTLS badges
- IR beacons installed in rooms
- Outcome: directly observed entry-exit compliance

Boyce JM IDWeek 2012 #37759

**RTLS electronic monitoring system associated with lower compliance**

- 36% decline in entry compliance (p=0.191)
- 32% decline in the exit compliance (p<0.001)
- The average accuracy of the badge RTLS system was 60%
  - False-negative results led to HCW frustration
- Negative study – not published

Boyce JM IDWeek 2012 #37759
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Reminder: Most use direct observation

- 98.6% Direct Observation
- 22.7% Product Usage
- 2.8% Automated System

FOR MORE INFO...

But if direct-observation is so terrible, shouldn’t we just buy a system anyway?

- Hand hygiene opportunities are too numerous
  - Night and weekend shifts
  - Too much time/money to monitor
  - Do we need to count every one?

- Hawthorne Effect

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Lots of hand hygiene opportunities going on

Estimation of hand hygiene opportunities on an adult medical ward using 24-hour camera surveillance: Validation of the HOW2 Benchmark Study

Thomas Diller MD, MMM, J. William Kelly MD, Dawn Blackhurst DrPH, Connie Steed MSN, RN, CIC, Sue Boeker BSN, RN, CIC, Danielle C. McElveen MA

- 12 beds in gen med ward
- Video – 5 moments
- 72 op/patient/day
- 75% RN, 5% MD
- If 140,000 patient days
  - 10 million/year!!!

Am J Infect Control. 2014 Jun;42(6):602

How many observations needed?

- Prospective cohort, 3 hospitals
  - 7,743 HCW visits
  - 1,989 hours of observation
  - 3.89/hour/room
- Sample power calculations
  - 10% absolute compliance change month-to-month
  - 2-sided test, type I error at 5% significance, 80% power

Yin J. ICHE 2014;35 (9):1163-8

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Use chart to estimate number of opportunities and hours of direct observation

<table>
<thead>
<tr>
<th>Baseline HH</th>
<th>Target HH</th>
<th># opportunities</th>
<th># hours (1 room at time)</th>
<th># hours (2 rooms at time)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>50</td>
<td>191</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td>50</td>
<td>60</td>
<td>194</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td>60</td>
<td>70</td>
<td>182</td>
<td>47</td>
<td>23.5</td>
</tr>
<tr>
<td>70</td>
<td>80</td>
<td>153</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>80</td>
<td>90</td>
<td>108</td>
<td>28</td>
<td>14</td>
</tr>
</tbody>
</table>

Yin J. ICHE 2014;35 (9):1163-8

The Hawthorne Effect is a limitation of direct-observation surveillance

- Improvement of human behavior when a subject knows they are being observed

1932
Hawthorne Works, Cicero IL

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Length of Observation Periods?

![Graph showing the rate of hand hygiene compliance over observation periods.]

Chen LF ICHE 2013; 34(2): 207-10

Evidence of Hawthorne Effect

- Prospective Cohort: March 2011 – May 2013
- 3 VA hospitals
  - 5 ICUs
  - 6 medical/surgical wards
- Research-assistant observers
  - Hallway, did not announce presence
  - Monitored for fixed 1-hour intervals
  - Opportunities Entry/Exit

Yin J. ICHE 2014;35 (9):1163-8
Hypothesis

- If the Hawthorne effect was continuous across all time periods, expect compliance to remain unchanged during entire 1-hour observation period
- Asked whether mean hand hygiene compliance rate changed significantly over the 1-hour period
  - Fitting linear regression to the hand hygiene compliance rate

Results

- **11,444 HH opportunities**
  - 3,432 hours of direct observations
- **Entry Compliance: 41.3%**
  - (4,546/11,018 opportunities)
- **Exit Compliance 59.4%**
  - (6,225/10,488 opportunities)

Yin J. ICHE 2014;35 (9):1163-8
Entry compliance shows increased bias after observer on ward > 38 minutes

- Before 38 minutes: 40.4%
- After 38 minutes: 43.4%
- p=0.005

Yin J. ICHE 2014;35 (9):1163-8

Limiting observer time on ward to less than 14 minutes reduces bias

- Before 14 minutes: 56.2%
- Between 14-50 minutes: 60.5%
- After 50 minutes: 66.0%
- P<0.001

Yin J. ICHE 2014;35 (9):1163-8
Putting it all together

VHA Hand Hygiene Workgroup

- Bradley Bender, MD – Chief of Staff (Gainesville)
- Elizabeth Eckstein, RN – IP (Cleveland)
- Kim Findley, RN – Assoc Clin Research (COHIC)
- Carol Keller – Systems Redesign Manager (West LA)
- Troy Knighton, Ed S – IDPIO (OPH)
- Caryl Lee, RN MSN – National Center Patient Safety
- Michael Martin – NAGE (Martinsburg)
- Richard Martinello, MD Clinical Public Health (OPH)
VHA Hand Hygiene Workgroup

- Daniel Morgan, MD – Hospital Epi (Baltimore)
- Eli Perencevich, MD – Workgroup Chair (Iowa City)
- Lesley Royal, RN – IP (Omaha)
- Heather Reisinger, PhD – Med Anthro (Iowa City)
- Carol VanDeusen Lukas, Ed D – COLMR (Boston)
- Amy Zoll, RN – Clinical Nurse (Kansas City)
- Lewis Radonovich, MD – COHIC, OPH (Gainesville)

DRAFT UNDERSECRETARY FOR HEALTH’S INFORMATION LETTER
ESTABLISHING A STANDARD FOR HAND HYGIENE SURVEILLANCE
IN HEALTH CARE SETTINGS

- (1) Monitor Hand Hygiene:
  - “Before patient interaction” defined as hand hygiene immediately on or before entering the space occupied by a patient.
  - “After patient interaction” defined as hand hygiene immediately on or before exiting the space occupied by a patient.
- (2) Duration of Direct Observation Periods
  - “monitoring by one or more personnel in a single location should persist for no more than 15 minutes at each location”
(3) Number of observations required per quarter

- **Minimum of 200 before and after** (i.e., 200 before entry and 200 after exit)
- Note: approximately 4-5 opportunities are observed per hour
- Would require 40-50 hours of observation per quarter or about 13-17 hours of observation per month

Conclusions: Keep Hand Hygiene Simple!

- Automated systems can monitor but compliance benefits unproven
  - No randomized trials
  - No evidence for lower infections
  - Significant publication bias
- **Don’t give up on direct-observation**
  - Focus on entry/exit monitoring
  - Less than 14 minutes!
Thank you

Fist bumps and weak handshakes only...

Mela et al. AJIC 42 (8): 916-7, August 2014
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Fist bumps and weak handshakes only...

Mela et al. AJIC 42 (8): 916-7, August 2014
Questions and Thank you!

- Automated systems can monitor but compliance benefits unproven
  - No randomized trials
  - No evidence for lower infections
  - Significant publication bias

- Don’t give up on direct-observation
  - Focus on entry/exit monitoring
  - Less than 14 minutes!

QUESTIONS?
@eliowa
eli-perencevich@uiowa.edu
stopinfections.org

Coming Soon

September 29  ADHERENCE ENGINEERING TO REDUCE CENTRAL LINE ASSOCIATED BLOODSTREAM INFECTIONS
Prof. Frank Drews, University of Utah

October 13  UPDATE ON STRATEGIES FOR CLEANING AND DISINFECTION OF ENVIRONMENTAL SURFACES IN HEALTHCARE
Prof. John Boyce, J.M. Boyce Consulting
Sponsored by Sealed Air Diversey Care (www.sealedair.com)

October 19  (South Pacific Teleclass) TECHNOLOGY FOR MONITORING HAND HYGIENE IN THE 21ST CENTURY – WHY ARE WE USING IT?
Prof. Mary-Louise McLaws, University of New South Wales, Australia

October 20  (FREE Teleclass) THE HISTORY OF CBIC AND WHY CERTIFICATION IS STILL IMPORTANT TODAY

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