Accessing the Clinical Accuracy of a Hand Hygiene System

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Hosted by Martin Kiernan

Background

- Medical doctor and PhD from Copenhagen University
- Worked with hand hygiene compliance for the last 7 years
- Senior Medical Director in Sani Nudge
- Podcast: The Hygiene & Infection Prevention Network

The importance of hand hygiene is widely acknowledged

- Spread of infections and antimicrobial resistance present a major threat to human health comparable in scale to climate change.
- **CDC**: Practicing hand hygiene (HH) is a simple yet effective way to prevent healthcare-associated infections (HAI).
- **WHO**: Performing HH at the right moments is the most effective way to prevent HAI.

The Lancet Respiratory Medicine, Editorial. Antimicrobial resistance-what can we learn from climate change? Lancet Respir Med. 2016 Nov;4(11):845.
Centers for Disease Prevention and Control. Hand Hygiene in Healthcare Settings. https://www.cdc.gov/handhygiene/
World Health Organization, WHO Patient Safety. WHO guidelines on hand hygiene in health care : a summary. 2009. https://apps.who.int/iris/handle/10665/70126

The effects of hand hygiene

- **Patient safety**: Fewer infections
  - Length-of-stay
  - Medication
  - Re-operation
  - Isolation regimen
  - Readmission
- **Staff safety**: Fewer infections
  - Safer working environment
  - Decreased absenteeism
  - Less family members infected (influenza, norovirus, etc.)
- **Costs**: Three times higher for patients who acquire a HAI

The Kings Fund. Healthcare-Associated infections: Stemming the rise of superbug, 2008.
World Health Organization. Health care associated infections fact sheet. Available: http://www.who.int/gpsc/country_work/gpsc_ccisc_fact_sheet_en.pdf
World Health Organization. WHO Guidelines on Hand Hygiene in Health Care: First Global Patient Safety Challenge Clean Care Is Safer Care. Available: https://www.ncbi.nlm.nih.gov/books/NBK144012/
Knudsen AR, et al. Effectiveness of an electronic hand hygiene monitoring system in increasing compliance and reducing healthcare-associated infections. J Hosp Infect. 2021 Sep;115:71-74.
Guest JF, et al. Modelling the annual NHS costs and outcomes attributable to healthcare-associated infections in England. BMJ Open. 2020 Jan 22;10(1):e033367.
Rahmqvist M et al. Direct health care costs and length of hospital stay related to health care-acquired infections in adult patients based on point prevalence measurements. Am J Infect Control. 2016 May 1;44(5):500–6.

The science in compliance

HH compliance (HHC) is already a part of healthcare workers' daily practices, but there is a tremendous opportunity to elevate patient care through improved HHC:

- The average HHC of HCWs is **40%**.
- Improvements in HHC is difficult to sustain.

Centers for Disease Prevention and Control. Hand Hygiene in Healthcare Settings. https://www.cdc.gov/handhygiene/
Erasmus V, et al. Systematic review of studies on compliance with hand hygiene guidelines in hospital care. Infect Control Hosp Epidemiol 2010;31:283-94.
Gould D, et al. Measuring handwashing performance in health service audits and research studies. Journal of Hospital Infection 2007;66(2): 109–115.
Gould D, et al. Interventions to improve hand hygiene compliance in patient care. Cochrane Database Syst Rev. 2017 Sep 1;9(9):CD005186.

Influential factors associated with HHC

1. Time constraints and busyness (stress factor, cognitive load)
2. Hand hygiene as self-protection (gloves and perception)
3. Awareness of being watched (Hawthorne effect)
4. Converting knowledge into action and changing intention into behavior (system 1 and 2)
5. Availability and placement
6. Social pressure and role modelling (culture, management support)
7. Skin irritation
8. Knowledge

Sands M, et al. Determinants of hand hygiene compliance among nurses in US hospitals: A formative research study. PLoS One. 2020; 15(4): e0230573.
Squires JE, et al. Understanding Practice: Factors That Influence Physician Hand Hygiene Compliance. Infect Control Hosp Epidemiol. 2014 Dec;35(12):1511-20.

HHC in healthcare during the pandemic

What have we learned?

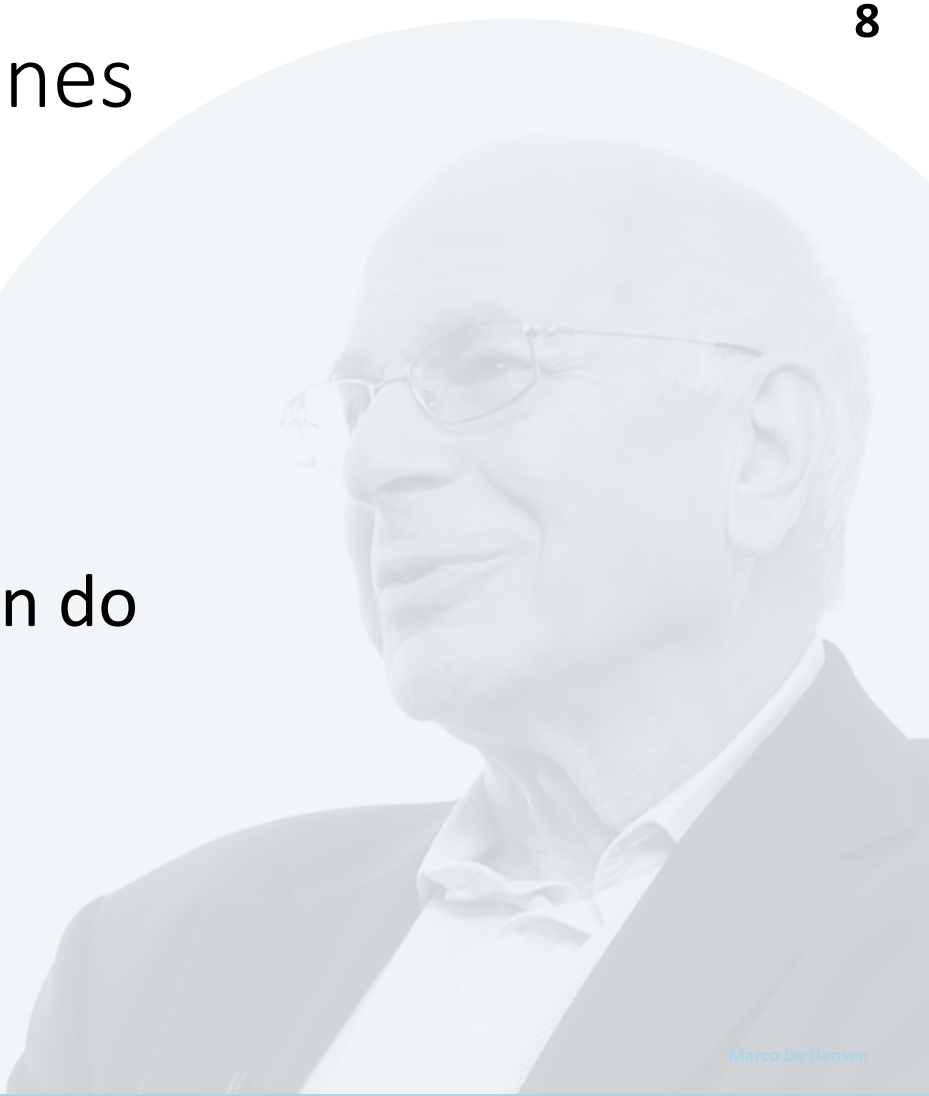
- Some studies have documented an increase in compliance while others have reported a decline.
- The organizations had different starting points before the pandemic, and they responded differently.
- Time constrains, business, self-protection, leadership played a role.
- HHC is not given! Behavior and culture are dynamic variables and differs from organization, ward, person.

Huang F, et al. Covid-19 outbreak and health care worker behavioral change toward hand hygiene practices. J Hosp Infect. 2021:27–34.
Stangerup M, et al. Hand hygiene compliance of healthcare workers before and during the COVID-19 pandemic: A long-term follow-up study. Am J Infect Control. 2021 Sep;49(9):1118-1122.
Williams V, et al. Impact of COVID-19 on hospital hand hygiene performance: a multicentre observational study using group electronic monitoring. CMAJ Open. 2021 Dec 14;9(4):E1175-E1180.
Wang Y, et al. Compared hand hygiene compliance among healthcare providers before and after the COVID-19 pandemic: A rapid review and meta-analysis. Am J Infect Control. 2021 Dec 7;S0196-6553(21)00792-6.

We fall back into old routines and habits

> Thinking is to humans as swimming is to cats; they can do it but they'd prefer not to

Nobel prize winner – Daniel Kahneman



Time to rethink hand hygiene

Hand hygiene culture is like an ecosystem that needs to be nurtured.

The culture requires a movement, not a mandate.

A sustainable hand hygiene culture can't be achieved through top-down mandate.

It lives in the collective hearts and habits of people and their shared perception of "how things are done around here."

Walker B, Soule SA. Harvard Business Review. Available: https://hbr.org/2017/06/changing-company-culture-requires-a-movement-not-a-mandate

Evolution of hand hygiene monitoring

Innovation and digitalization is driving the trend

DIRECT OBSERVATION

Hand hygiene moments are recorded by different observers

Observations are tabulated manually and only captures 1-4% of all events[1]

The Hawthorne Effect: people act differently when watched

PRODUCT USAGE MEASUREMENT

Dispenser activity is tracked to measure product consumption

Results are compared to a theoretical number of hand hygiene opportunities

The ability to impact individual behavior is low

ELECTRONIC MONITORING

Comprised of an integrated system that may include badges, dispensers, sensors

Gives hospitals the ability to collect, analyze and report real-time, actionable data

Provides healthcare workers with real-time reminders of when to perform hand hygiene

www.jointcommission.org/assets/1/18/hh_monograph.pdg

Direct observation

Description	• Direct observation of hand hygiene practices. • May be manual (pen and paper) or technology-assisted using an app
Advantages	• The only method that can evaluate the "Five Moments for HH“ and technique
Disadvantages	• Hawthorne Effect (up to 300%) • Inter-observer variation requiring effort in training data collectors • Time intensive to observe and manually create reports • Short observation periods • Captures a fraction of HH opportunities • Limited opportunity to observe hand hygiene in patient rooms, toilets, etc. due to privacy • Can be difficult to observe a colleague

www.jointcommission.org/assets/1/18/hh_monograph.pdg

Measuring product use 

Description	• Indirect way to measure hand hygiene compliance by measuring number of sanitizations and/or soap/ABHR consumption
Advantages	• Less resource intensive than direct observation • Possible to do it manually or electronically • Can be done in different hospital settings
Disadvantages	• Does not monitor compliance of individual HCWs, role or shift • Does not measure specific moments from "Five Moments" (i.e., show used when/where appropriate) • Does not omit visitor or patient use of product

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ECOLAB

Electronic monitoring

Description	• Several different types of electronic sensors using different technologies • Real time locating systems • **Group or individual monitoring**
Advantages	• Require fewer human resources • Provide larger data sets • Less subject to observation bias • May provide real-time feedback to HCWs • When integrated with a database, allow for automated reports
Disadvantages	• Some technologies can be expensive with high maintenance costs • Some technologies make it necessary to work closely with engineering to assess possible interference with existing equipment • Some technologies connect to hospital network and may tax the network and/or IT resources

www.jointcommission.org/assets/1/18/hh_monograph.pdg

What is the standard of HH measures and public reporting?

Denmark 🇩🇰

- No requirements of reporting = no standardization.
- Each hospital do something different. Automated HAI surveillance database (HAIBA).

Germany 🇩🇪

- Alcohol-based hand rub consumption surveillance (HAND-KISS)

France 🇫🇷

- Product consumption
- HAI (THA, TKA)

US 🇺🇸

- Transparency and standardization approach ✅
- Leapfrog Hospital Survey: Collecting HHC data on at least 200 HH opportunities (or a minimum percentage of hand hygiene opportunities), each month, in each patient care unit.
- Using an electronic compliance monitoring system and/or direct observation methods that meet Leapfrog's criteria for collecting hand

Increasing interest for electronic hand hygiene monitoring systems (EMS)

- Healthcare systems acknowledge the value of EMS
- COVID-19 has emphasized the need and showed the way
- Part of the automation and digitalization agenda
- Hospitals need tools that automate the data collection for them and provide easy-to-read and actionable compliance information
- Healthcare systems are facing an increasing pressure from accreditation bodies to measure and document hand hygiene compliance as part of quality assurance
- Healthcare organizations are starting to use EMS as part of the WHO's multimodal strategy for HH improvement

National Patient Safety Goal: Monitoring of Hand Hygiene. Goal 7- 07.01.01. Comprehensive AccreditationManual for Hospitals Standards FAQs. Joint Commission website. http://www.jointcommission.org/

Increased focus on EMS by WHO

*"WHO is particularly attentive to **encourage innovations**, such as non-touch dispensers, **automatic monitoring systems** and other technologies taking human factors and ergonomics into account, and more sophisticated adult learning educational approaches to facilitate uptake, such as gaming and augmented reality applications."*

*"WHO strongly recommends hand hygiene as a **key performance indicator** and a minimum requirement for IPC programs in all countries."*

EDITORIAL

'My Five Moments': understanding a user-centred approach to hand hygiene improvement within a broader implementation strategy

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Between 2006 and 2009, WHO elaborated and issued the concept of 'My Five Moments for Hand Hygiene' in healthcare[1–4] in collaboration with the pioneering infection prevention and control (IPC) research group at the University of Geneva. The primary objective of this approach is to facilitate behavioural change and prioritise hand hygiene action at the exact times needed to prevent the transmission of pathogens and avoid harm to patients and health workers during care delivery. Importantly, the Five Moments approach overcomes some relevant barriers to hand hygiene practices identified before its launch, such as long lists for hand hygiene action without any consideration of the dynamics of patient, health worker and environmental interactions.[5] The originality of the concept was to take both microbial transmission risk and human factors into account, and present an effective way to clean hands at the point of care within busy health workers' schedules and empower them to understand where hand hygiene opportunities occur within their workflow.

In addition to providing a scientific background to the Five Moments,[2 4] WHO included recommendations ranked according to the United States Centers for Disease Control and Prevention/Healthcare Infection Control Practices Advisory Committee system on indications for hand hygiene within the WHO guidelines on hand hygiene in healthcare.[3] Based on evidence evaluation and consensus by experts representing key stakeholders (including those in the field of IPC and practising clinicians), these recommendations were reflected in the Five Moments. Importantly, the Five Moments approach was pilot tested before publication in a wide range of countries and settings with different resources and cultures, as part of the WHO multimodal hand hygiene implementation strategy and toolkit.[6] This strategy has been shown to contribute to significant hand hygiene compliance and knowledge improvement across different professional categories, as well as a reduction in healthcare-associated infections and the spread of antimicrobial resistance.[2 7]

Since then, the Five Moments have been included in numerous hand hygiene implementation and monitoring resources by WHO[8] and others,[9] and adopted worldwide with adaptations to different settings and interpretations of the concept.[10] However, in this issue, Gould *et al*[11] highlight concerns around the Five Moments, questioning its inclusiveness of stakeholders' views, easiness of implementation and adaptation and other limitations. Furthermore, feedback to WHO has suggested that it would be of added value to develop an approach to understanding where to start with the use of the WHO implementation tools, including those associated with the Five Moments, and how to adapt them to local conditions. Implementation initiatives to date have embraced the following five aspects, which are potentially key elements to help drive forward such an approach[12] and may help overcome some of the concerns expressed by Gould *et al*.[11]

ADAPTATIONS

Adaptations to local contextual factors and a range of situations are known to contribute significantly to successful

National Patient Safety Goal: Monitoring of Hand Hygiene. Goal 7- 07.01.01. Comprehensive AccreditationManual for Hospitals Standards FAQs. Joint Commission website. http://www.jointcommission.org/

Use of an EMS affords the NHS a cost-effective intervention

Open access Original research

BMJ Open

Modelling the costs and consequences of reducing healthcare-associated infections by improving hand hygiene in an average hospital in England

Julian F Guest ,[1,2] Tomas Keating,[1] Dinah Gould ,[3,4] Neil Wigglesworth[5]

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ABSTRACT

Objective To assess the potential clinical and economic impact of introducing an electronic audit and feedback system into current practice to improve hand hygiene compliance in a hypothetical general hospital in England, to reduce the incidence of healthcare-associated infections (HCAIs).

Methods Decision analysis estimated the impact of introducing an electronic audit and feedback system into current practice to improve hand hygiene compliance among front-line healthcare practitioners (HCPs).

Results The model assumed 4.7% of adult inpatients (ie, ≥18 years of age) and 1.72% of front-line HCPs acquire a HCAI in current practice. The model estimated that if use of the electronic audit and feedback system could lead to a reduction in the incidence of HCAIs of between 5% and 25%, then the annual number of HCAIs avoided could range between 184 and 921 infections per hospital and HCAI-related mortality could range between 6 and 31 deaths per annum per hospital. Additionally, up to 96 days of absence among front-line HCPs could be avoided and up to 7794 hospital bed days could be released for alternative use. Accordingly, the total annual hospital cost attributable to HCAIs could be reduced by between 3% and 23%, depending on the effectiveness of the electronic audit and feedback system. If introduction of the electronic audit and feedback system into current practice could lead to a reduction in the incidence of HCAIs by at least 15%, it would have a ≥0.75 probability of affording the National Health Service (NHS) a cost-effective intervention.

Conclusion If the introduction of the electronic audit and feedback system into current practice in a hypothetical general hospital in England can improve hand hygiene compliance among front-line HCPs leading to a reduction in the incidence of HCAIs by ≥15%, it would potentially afford the NHS a cost-effective intervention.

Strengths and limitations of this study

- ► This is the first published study to evaluate the potential clinical and economic impact of reducing the incidence of healthcare-associated infections (HCAIs) in a hypothetical general hospital in England.
- ► This was a modelling study based on disparate sources of published evidence.
- ► The costs and consequences of introducing an electronic audit and feedback system into current practice to improve hand hygiene compliance among front-line healthcare professionals (HCPs) in an average general hospital in England were estimated from a model depicting the pathways and associated management of adult inpatients and front-line HCPs who acquire a HCAI in the hospital environment over a period of 1 year.
- ► The relationship between HCPs improving compliance with hand hygiene and reducing the background incidence of HCAIs is uncertain.
- ► The model does not consider HCPs' adaptation to the electronic audit and feedback system and subsequent decline in compliance nor does it distinguish between different types of pathogens causing HCAIs and the definition of HCAI would appear to vary between clinicians.

INTRODUCTION

Healthcare-associated infections (HCAIs) are those occurring in a healthcare setting that were not present prior to a patient entering that care setting.[1] HCAIs can develop either as a direct result of healthcare interventions or from being in contact with a healthcare setting.[2] The epidemiological evidence indi-

major contributing factor in the acquisition and spread of infection in hospitals, and such transmission can occur directly via hands, or indirectly via an environmental source (eg, commodes, wash bowls, blood pressure monitors, mobile phones).[3 4] HCAIs can be caused by a range of pathogens including meticillin-resistant *Staphylococcus aureus* (MRSA), meticillin-sensitive *Staphylococcus aureus*, *Clostridium difficile* (*C. difficile*) and *Escherichia coli* (*E. coli*).[5] Antibiotics are the mainstay of HCAI management,[6] although their use can increase the likelihood of infection from drug-resistant organisms and *C. difficile*.[6 7]

HCAIs pose a serious risk to patients, healthcare practitioners (HCPs) and visi-

Cost-Benefit

- Net benefit of introducing the EMS varies between £33,800-2.4 million, depending on the percentage reduction in HAIs.
- If the reduction in HAIs is ≥3%, the cost of the EMS would be offset by the ensuing cost-reductions.
- If at least a 15% reduction in HAIs occurs, the probability of cost-effectiveness is very high.
- For every £1 spent by the hospital on the EMS, they save ≥£1.10

Assumptions

- Probability of adult inpatients acquiring a HAI: 4.7%
- HAI prevalence of front-line HCPs : 1.72%
- Hand hygiene improvement: 20%
- HAI reduction using EMS: 5-25%
- EMS cost: £1.5

Guest JF et al. Modelling the costs and consequences of reducing healthcare-associated infections by improving hand hygiene in an average hospital in England. BMJ Open. 2019 Oct 1;9(10):e029971.

Here are 5 Things to Consider When Evaluating an EHHCM Solution

1. WHAT IS BEING MONITORED? ✅
2. HOW ACCURATE IS THE MONITORING DATA? ✅
3. HOW IS MONITORING DATA REPORTED?
4. WHAT IS THE INSTALLATION PROCESS?
5. WHAT TRAINING AND SERVICE ARE INCLUDED?

WHAT IS BEING MONITORED?

- Several EMS are commercially available
- No system is the same
- Simple classification:
  - Group monitoring
  - Room monitoring
  - Patient-centered monitoring

Evolution of the EMS

Advanced classification:

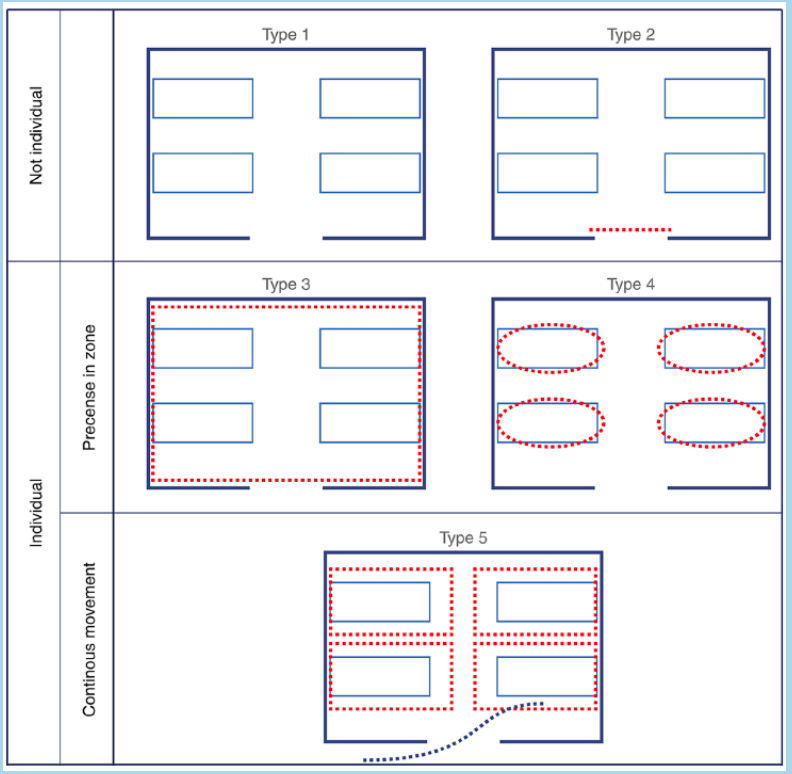
Type 1: Measure consumption as a proxy for adherence. Opportunities are not measured

Type 2: Passage-counter measuring the number of people passing certain strategic points as a proxy for opportunities

Type 3: Entry/Exit. Use badges to distinguish between HCWs, patients and visitors

Type 4: Zones to detect movement between beds

Type 5: Continuous detection, flexible zones, also in other areas than patient rooms



Gould D, et al. Electronic hand hygiene monitoring: accuracy, impact on the Hawthorne effect and efficiency. J Infect Prev. 2020 Jul;21(4):136-143.

HOW ACCURATE IS THE MONITORING DATA?

The importance of validation

- Accuracy is a focus area for healthcare workers
- How do I assess the quality of a third-party compliance monitoring system to ensure I'm setting my hospital up for long-term success?
- Without validation data IPC teams can be reluctant to procure EMS

Kelley, et al. Electronic hand hygiene monitoring systems can be well-tolerated by health workers: Findings of a qualitative study. J Infect Prev. 2021 Nov; 22(6): 246–251.
Hansen MB, et al. Assessing the clinical accuracy of a hand hygiene system: Learnings from a validation study. Am J Infect Control. 2021 Jul;49(7):963-965.

We need an updated overview

- A systematic review of 42 articles mentioning automated measurement systems found that fewer than 20% of the studies included calculations for accuracy (2014)
- Long time ago! Always a step behind? Technology evolution speeds up exponentially and our knowledge should be able to follow that speed.
- Cochrane reviews need to be updated every second year. The same should be the case for the EHM validation reviews.

Ward MA, et al. Automated and electronically assisted hand hygiene monitoring systems: a systematic review. Am J Infect Control. 2014 May;42(5):472–8.

3-phase validation approach by limper et al.

Independent event-approach

Phase 1: Test environment

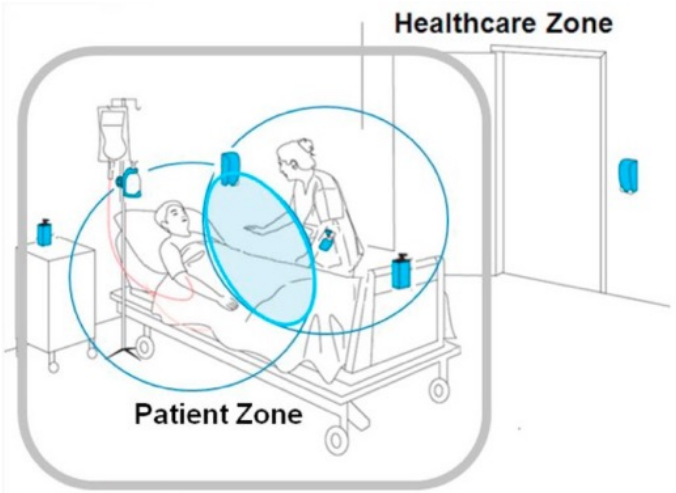
Evaluate the accuracy under controlled laboratory conditions with trained people who perform pre-determined actions

Phase 2: Planned path

Follow a planned path in a ward and activate all sensors

Phase 3: Behavioral validation

Using trained observers to perform direct observation to document room activity and compare to the raw data collected by the EMS



Limper HM, et al. Assessment of an aggregate-level hand hygiene monitoring technology for measuring hand hygiene performance among healthcare personnel. Infect Control Hosp Epidemiol. 2017;38(3):348–52.

Technical needs that are not currently addressed

- Two observers: Inter-observer variability
- Check-list: Badges worn correctly, sensors on used dispensers, exact time registration that is aligned with the EMS to identify the same events.
- Definition of true and false HH actions
- Accuracy measures to be used: Sensitivity, specificity, PPV, NPV? How to identify true negative event?
- Finding the same events again… the act of precision. If you are having an anonymized system, it can be difficult to identify the events. Use of test badges?

Advice
Look at it as a research study

- Make a good study protocol
  - Include a sample size calculation
- Incorporate user feedback
  - Lack of qualitative components when assessing EMS
  - Important to better understand HCWs' perception of EMS

What needs to be done

The IPC community must agree on:

1. The method to be used within each group of EMS
2. What to be measured?
   - Independent event-approach or
   - Separating HH events and HH opportunities to be able to compare between different groups?
   - Should HH opportunities in relation to patient contact be combined HH opportunities in, e.g., medication room and rinsing rooms – or reported separately?
3. Statistics to be used and how it should be reported
   - Limper et al. recommends sensitivity and positive predictive value
   - Clear definition of true and false HH actions
   - Guidance on appropriate sample size or guidance for calculations
4. The qualitative measures needed to evaluate an EMS

Limper HM, et al. A Validation Protocol: Assessing the Accuracy of Hand Hygiene Monitoring Technology. Infection Control & Hospital Epidemiology 37(8): 1002–1004.

Change in mindset is needed 🧠

Alignment of expectations

- 100% HHC is not possible – and that is ok
- HHC will not be as high with EMS compared with direct observations
- HHC will not be as high with EMS type 5 and 4 as compared to Type 3

There will be situations where HH is not performed

- Example: Emergency situations

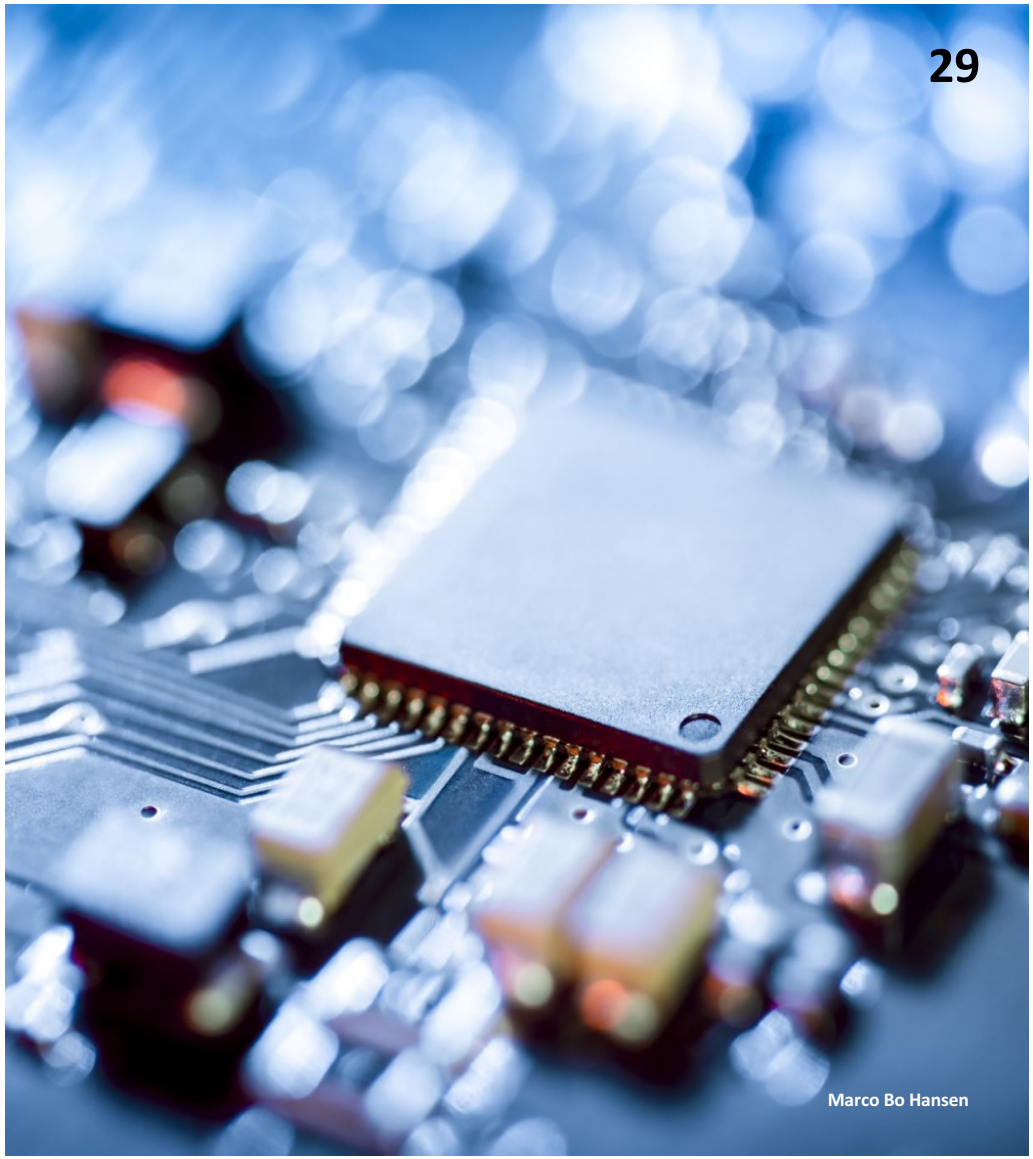
Focus on changes from baseline and not so much on specific numbers

Should all healthcare organizations perform EMS validation?

- Is one published validation study sufficient? How many?
- A good validation setup requires time and resources. Time that most healthcare organizations don’t have
- It is not scalable way of implementing technology
- Look in the literature to see what has been published
- Create a pragmatic setup that can be adapted to the requirements of the organization in alignment with their resources

Digitalization is the future

- We should work with the technological development and not against it
- Good validation of EMS is a step in the right direction
- Clear guidance and best practices need to be communicated uniformly by the IPC community across on a global level (not country level)



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