What's new in Hand Hygiene Literature?

Train the Trainers in Hand Hygiene

Faculty of Medicine, Geneva, Switzerland

Outline

- How has hygiene literature evolved over the years?
- What about the “HOW to handrub”?
- Can we improve hand hygiene monitoring?

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- What about the “HOW to handrub”?
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Growth rates of modern science

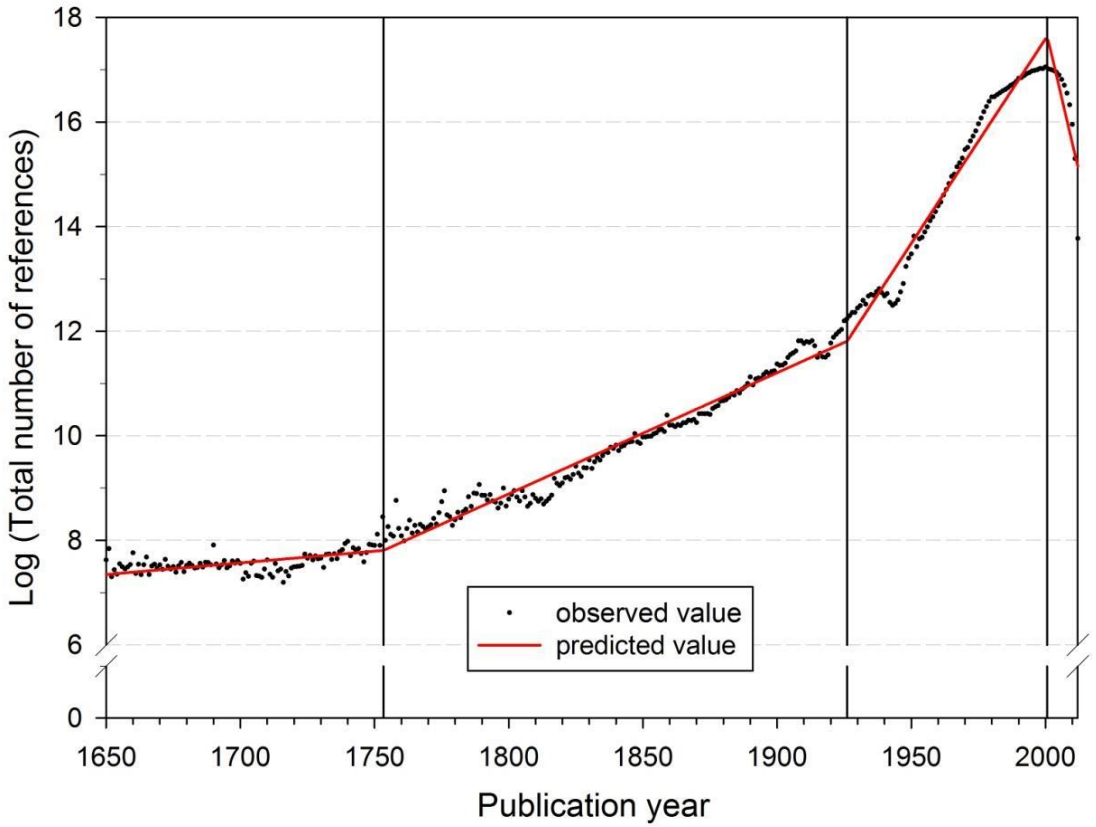


Figure 1. Segmented growth of the annual number of cited references from 1650 to 2012 (citing publications from 1980 to 2012)

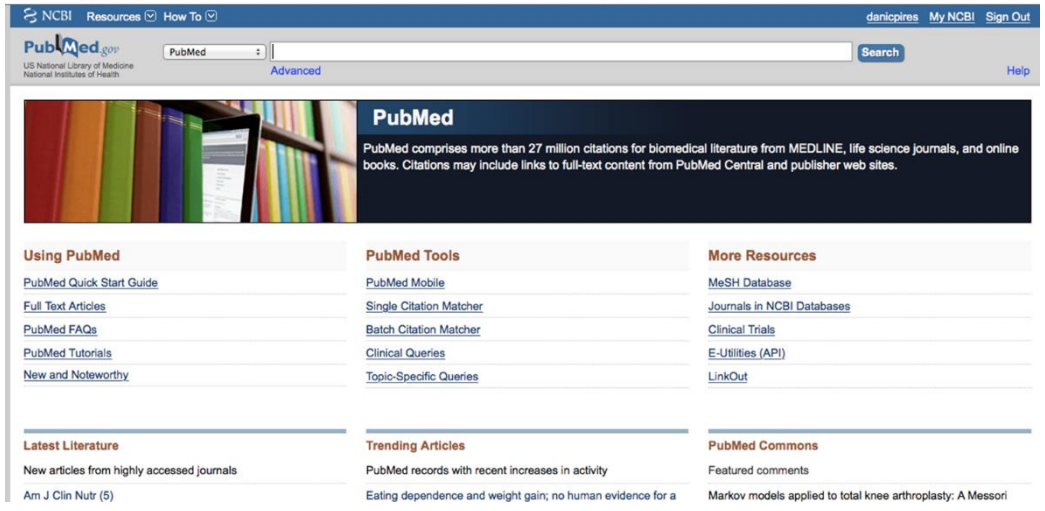
Time-poor clinician suffering from Information Overload

“America's two greatest gifts to the world…”

MEDLINE
U.S. National Library of Medicine

King Oliver's Creole Jazz Band, 1921

National Center for Biotechnology Information
NCBI
PubMed



Most frequently used Mesh terms and keywords related to hand hygiene

MeSH terms

Hand hygiene (2013)

Hand disinfection (1982)

Hand sanitizers (2014)

Keywords

Hand hygiene

Hand disinfection

Hand sanitizers

Handrubbing

Hand washing

Alcohol-based handrubs

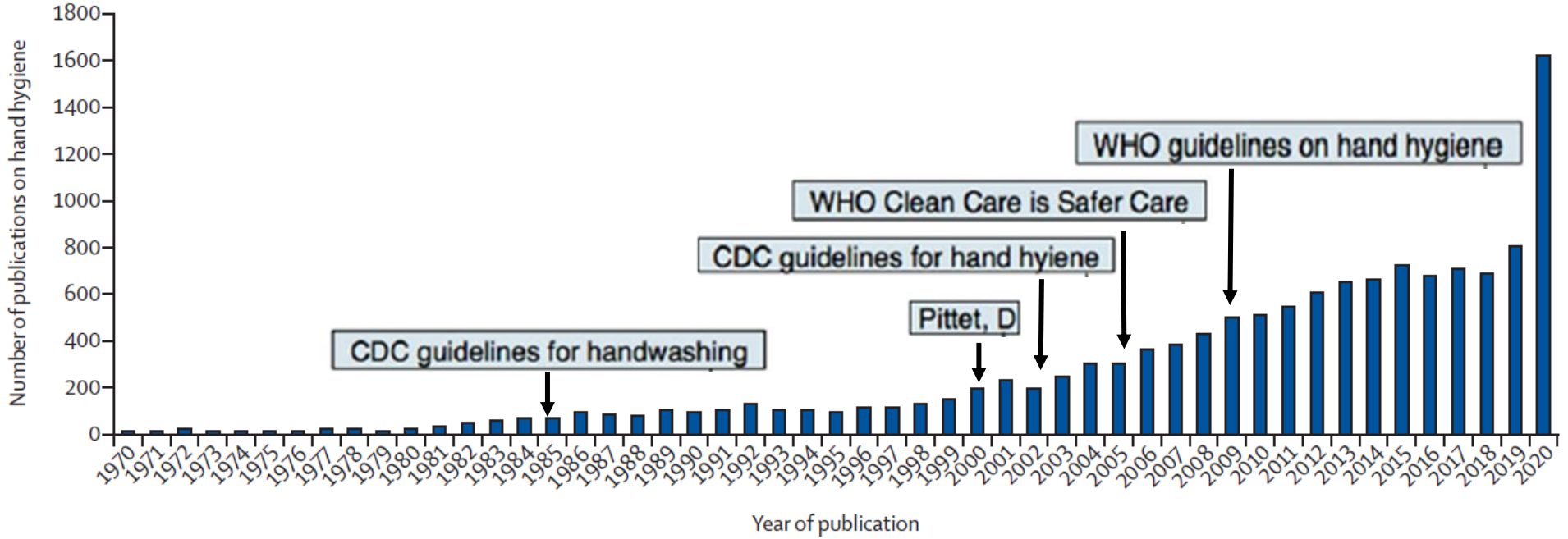
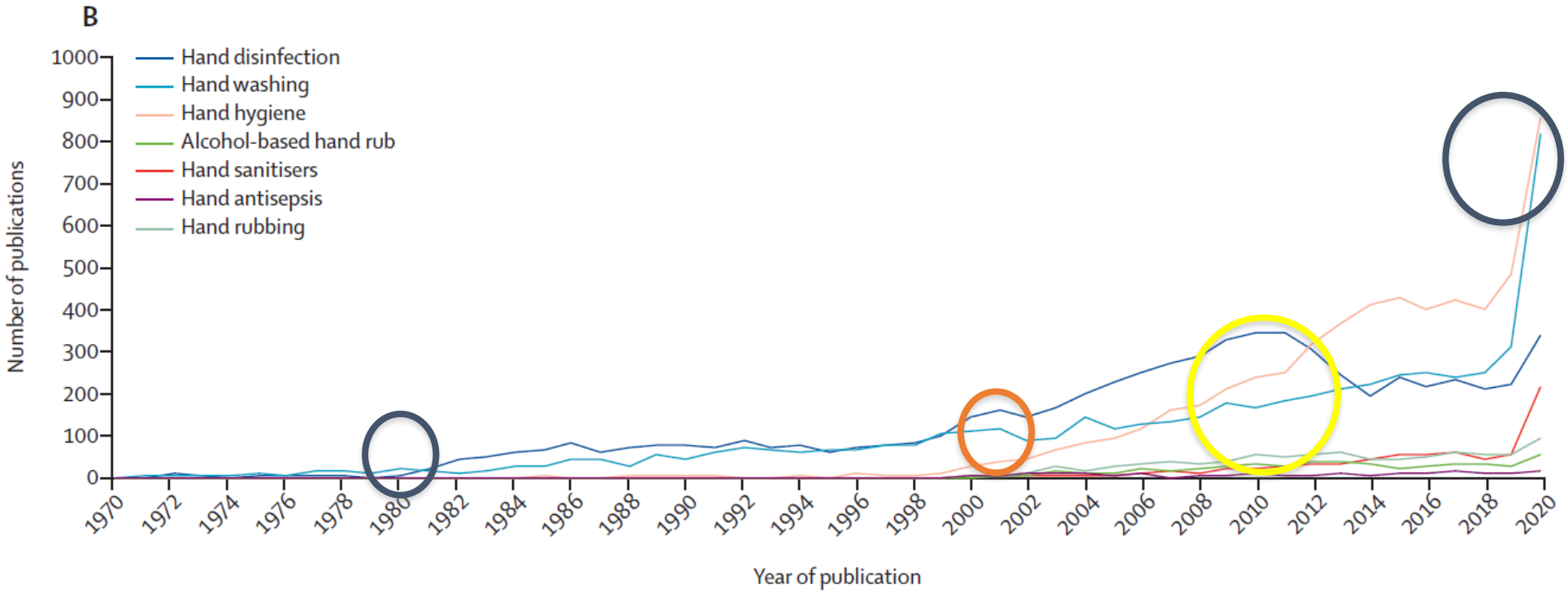


Figure 2: **Number of publications on hand hygiene retrieved from MEDLINE by year, using Medical Subject Headings search terms and keywords from Jan 1, 1920, until Dec 31, 2020** Considering the scarcity of publications from the earlier years, we only presented data from 1970. (A) Number of publications on hand hygiene by year. The search detail retrieved for all keywords was: ("Hand Hygiene"[MeSH] OR "hand hygiene" OR "hand disinfection"[MeSH] OR "hand disinf*" OR "hand sanitizers"[MeSH] OR "hand sanit*" OR "hand washing" OR "handwashing" OR "hand wash" OR "hand rub*" OR "handrubbing" OR "hand cleans*" OR "hand deconta*" OR "hand cleaning" OR "alcohol-based hand rub*" OR "hand-antisep*" OR "surgical scrub*") AND (("1920/01/01"[Date - Publication] : "2020/12/31"[Date - Publication])). (B) Trends in hand hygiene-related keywords used in medical literature. Search terms used were: "hand hygiene"; "hand disinf*"; "hand sanit*"; "hand washing" OR "handwashing" OR "hand wash"; "hand rub*" OR "handrubbing"; "alcohol-based hand rub*"; "hand-antisep*".

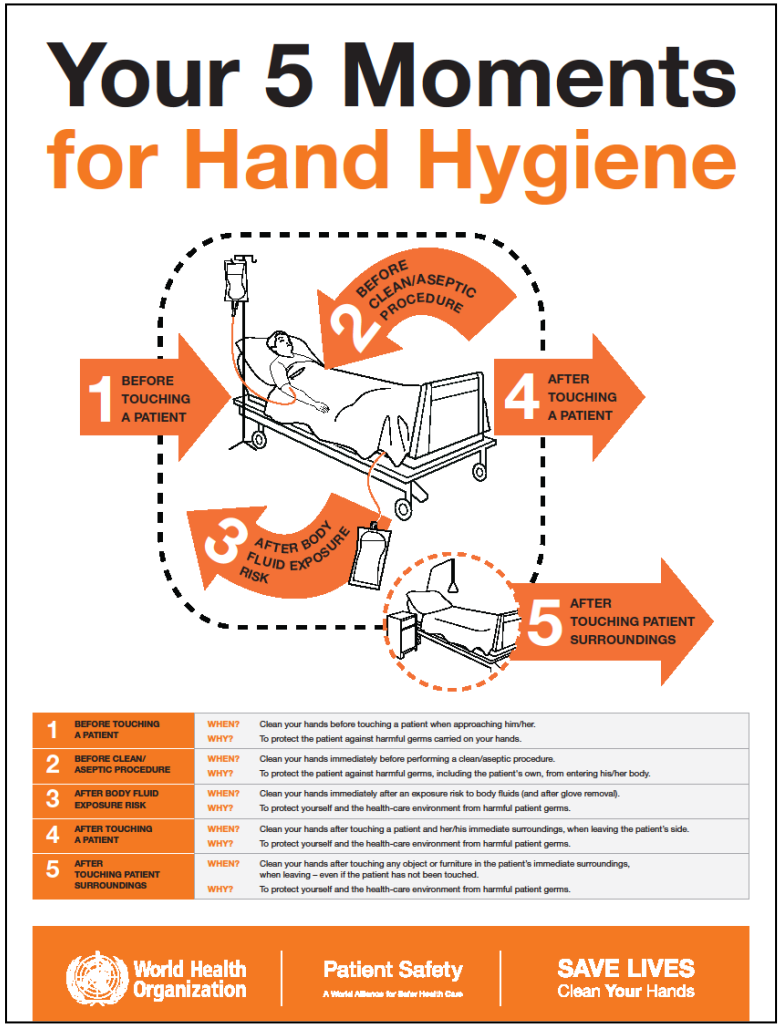

B
Hand disinfection
Hand washing
Hand hygiene
Alcohol-based hand rub
Hand sanitisers
Hand antisepsis
Hand rubbing
Number of publications
1000
900
800
700
600
500
400
300
200
100
0
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
Year of publication

Other available resources

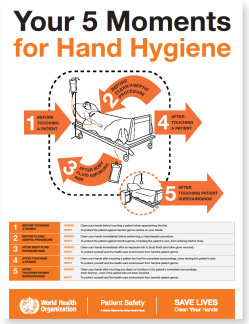
Outline

- How has hygiene literature evolved over the years?
- What about the “HOW to handrub”?
- How can we improve hand hygiene monitoring?

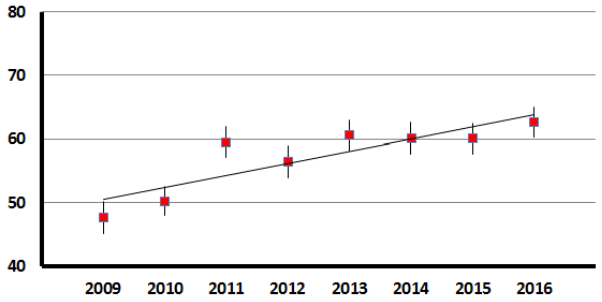
HH, it's all about **WHEN** and **HOW**!



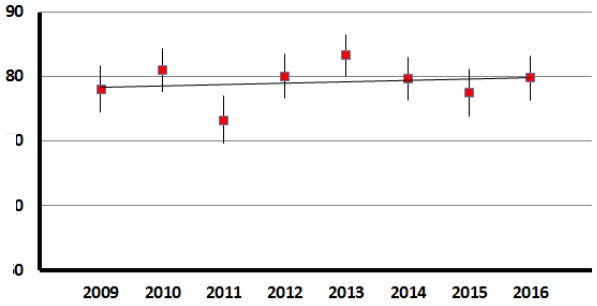
WHEN to handrub – focus on the 5 moments for hand hygiene



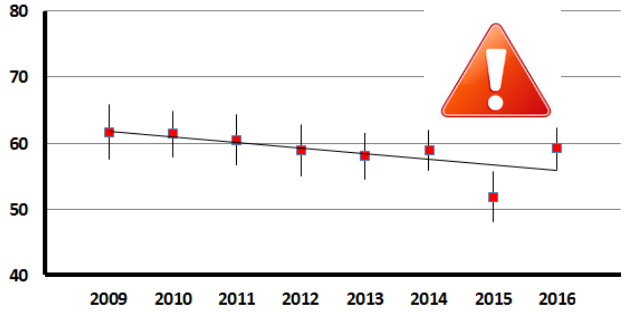
Before contact



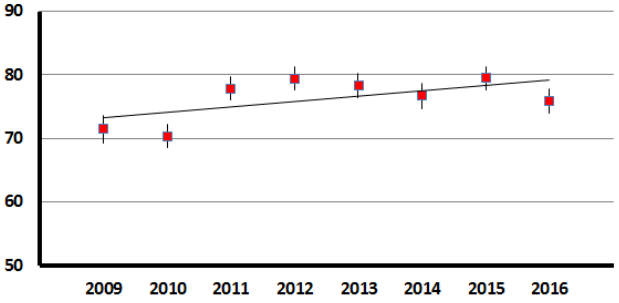
After body fluid



Before aseptic

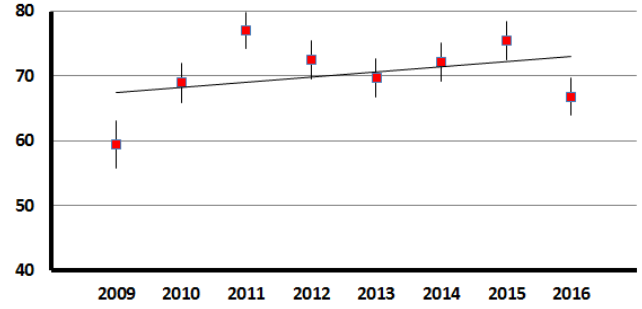


After patient contact

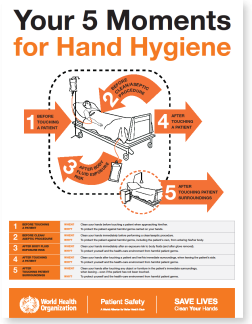


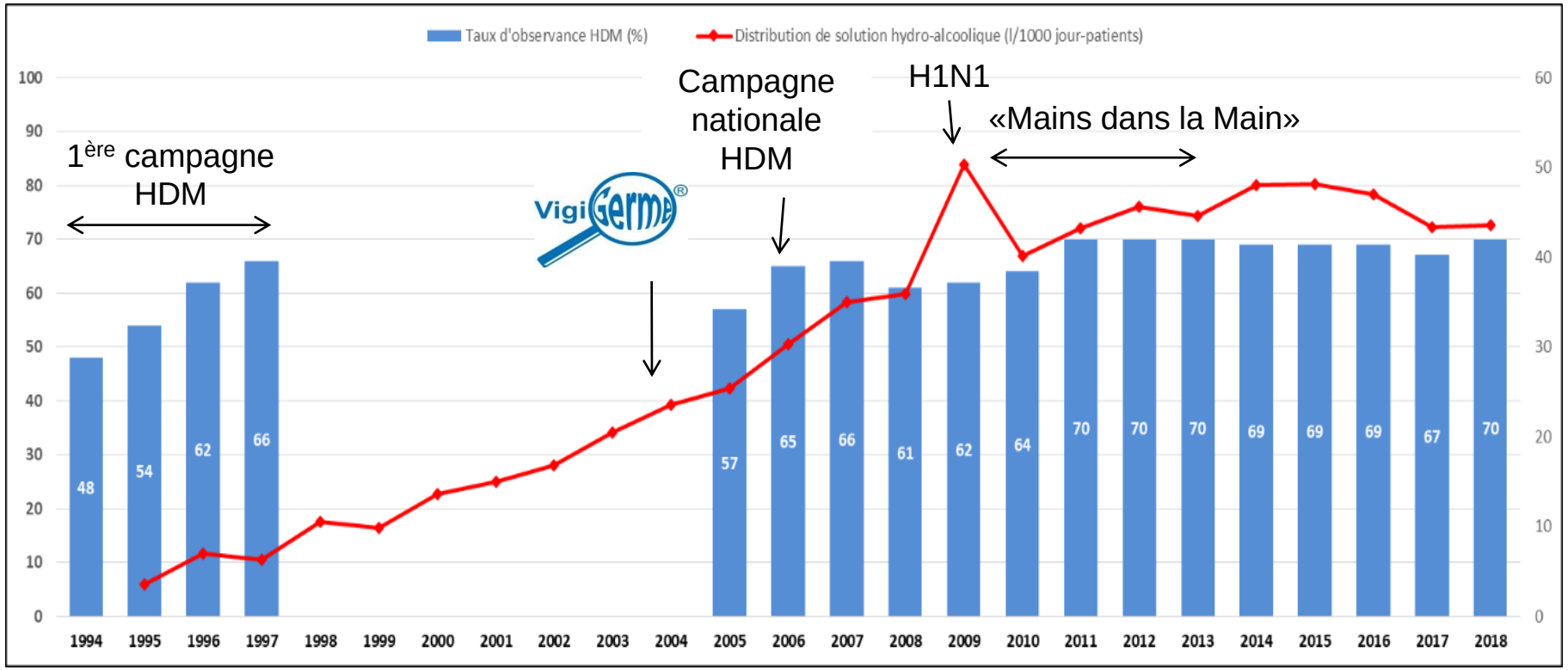
Hôpitaux Universitaires Genève

After contact with the environment



WHEN to handrub ?

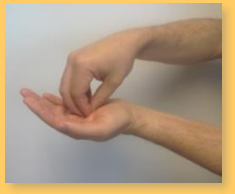
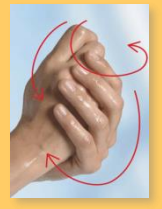




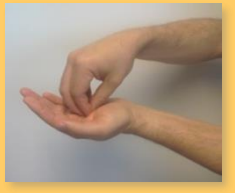
But what about the **quality of the hand hygiene action** (**HOW**)?

- Likely important to prevent HAI
- Imprecise recommendations
- Suboptimal adherence from HCWs
- Few national programs and HCFs have a monitoring tool for the quality of HH

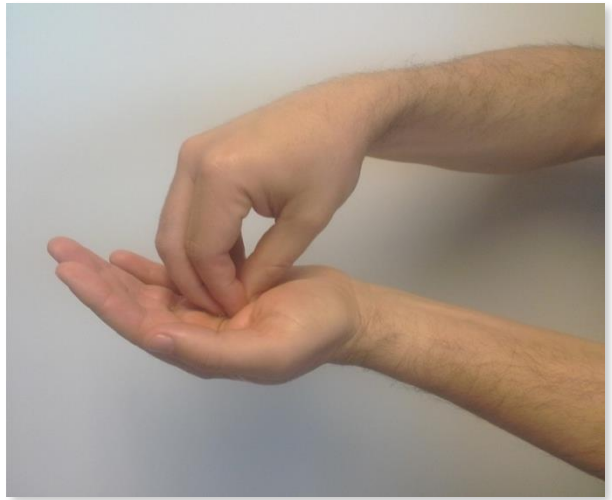
HOW to handrub: Recommendations

	Technique 	Volume 	Duration 
WHO 2009	▪ 6 steps: « how to handrub » (poster) ▪ Palms 1st/ Fingertips 6th	▪ Palmfull	▪ Until dry ▪ 20 - 30 sec
CDC 2002	▪ Cover all surfaces of hands	▪ According to indications by manufacturer	▪ Until dry ▪ If dried before 10 sec, not enough volume
SFHH 2009	▪ 7 steps ▪ Palms 1st/ Fingertips 6th ▪ Wrists 7th ▪ Each step 3 or 4 times	▪ To cover all hand surfaces ▪ Between 1.5 and 3.0 ml	▪ Until dry
EN 1500 1997, 2013	▪ 6 steps ▪ Palms 1st/ Fingertips 6th ▪ Each step 5 times	▪ 3 ml	▪ 30 sec

HOW to handrub: in practice

	Technique 	Volume 	Duration 
Sickbert-Bennett EE *et al.* *AJIC 2005*			12 sec
Widmer AF *et al.* *ICHE 2007*	6 steps technique 31% compliance	3 ml 54% compliance	30 sec 61% compliance
Pittet D *et al.* *ICHE 2009*			5 to 24 sec
Stewardson AJ *et al*. *PLoS One 2014*	6 steps technique 0% compliance		
Tschudin-Sutter S, *et al*. *ICHE 2015*	6 steps technique 8.5% compliance		
Leslie RA *et al.* *ARIC 2015*		1 ml	
Pittet *et al.* *Unpublished data 2016*		1.6 mL (IQR 1.2 – 2.2)	11.5 sec (IQR 7.9 – 15.9)

HOW to handrub: what is the evidence and what are the knowledge gaps?

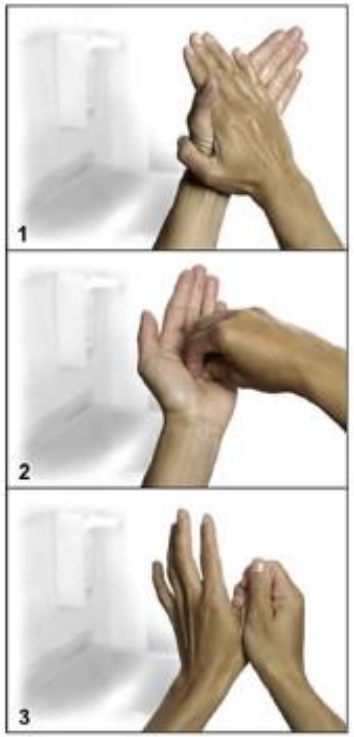


Technique

Volume of ABHR

Duration

HOW to handrub: HH technique, which one to choose?



1. Cover all surfaces of the hands

2. Rotational rubbing of fingertips in the palm of the alternate hand

3. Rotational rubbing of both thumbs

Fig. 1. Three-step hand hygiene technique.

Tschudin-Setter S. et al. Clin Microbiol Infect. 2017;23:409.e1-409.e4

1. Applying ABHR to the palm of one hand and rubbing hands

2. Co s

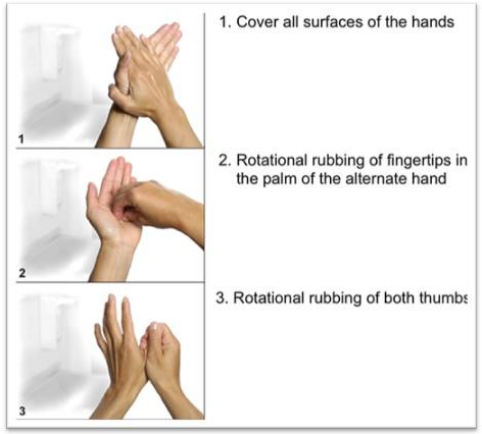
3. Co til hands are dr

Reilly JS. et al. Infect Control Hosp Epidemiol. 2016;37:661-6

HOW to handrub:
HH technique, 3-step vs 6-step

A cluster-randomized clinical trial compared the 3-step technique with the WHO 6-step technique

Proposed three-step hand hygiene method



WHO's six-step hand hygiene method

HH compliance ↑	**75.9%**	65.0%
Adherence to all specified steps ↑	**51.7%**	12.7%
Bacterial load reduction ≈	1.60 $\log_{10}$ CFU [IQR 0.54–2.44]	1.67 $\log_{10}$ CFUs [IQR 0.85–2.53]

HOW to handrub: HH technique

Revisiting the WHO "How to Handrub" Hand Hygiene Technique: Fingertips First?

TABLE 1. Reduction of Bacterial Counts From Mean Baseline Values Depending on the Sequence of the Hand-Rubbing Technique[a]

	Mean Baseline Count (n = 16)	Standard WHO Technique (n = 16)	WHO "Fingertips First" Technique (n = 16)	*P* Value
Globally	6.18 (±0.86, 6.35)	2.68 (±1.48, 2.85)	3.44 (±1.33, 3.20)	<.001[b]
By hand size				
Small	5.30 (±0.85, 5.3)	3.40 (±1.83, 3.40)	3.95 (±1.84, 4.25)	<.001[c]
Medium	6.22 (±0.80, 6.4)	2.57 (±1.62, 3.05)	3.10 (±1.59, 2.70)	<.001
Large	6.73 (±0.42, 6.7)	2.30 (±1.17, 2.05)	3.45 (±0.60, 3.35)	.001

[a]Data are $\log_{10}$ values shown as mean (± SD, median).
[b]From a mixed linear model with a random effect on the intercept.
[c]From a mixed linear model with a random effect on the intercept and an interaction between the sequence and hand size category.

HOW to handrub: what is the evidence and what are the knowledge gaps?

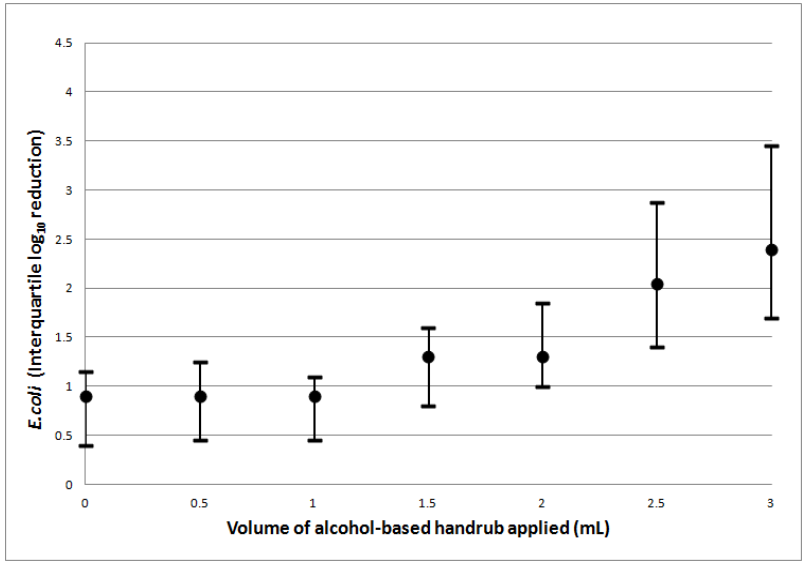
Technique

Volume of ABHR

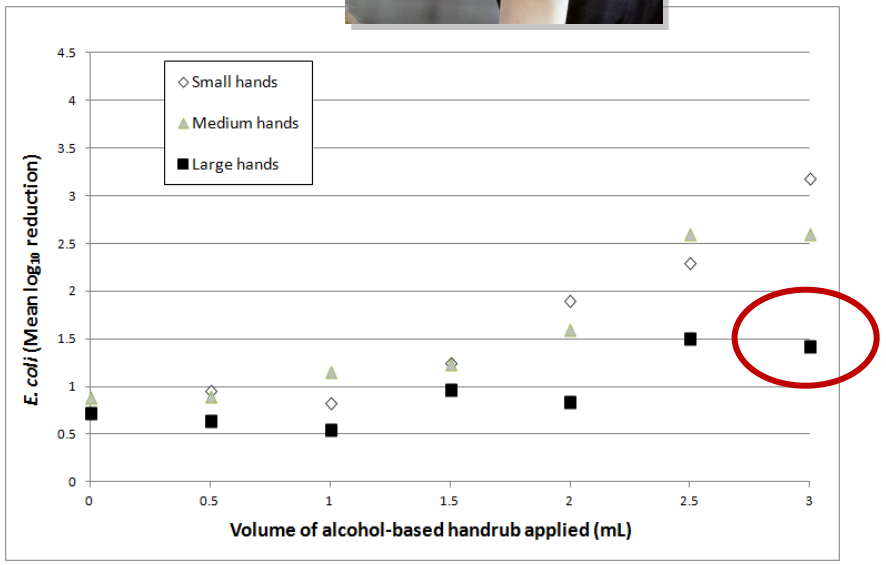
Duration

HOW to handrub: volume of ABHR

Should Alcohol-Based Handrub Use Be Customized to Healthcare Workers' Hand Size?



Bacterial reduction on HCWs hands according to the **volume of ABHR**



Bacterial reduction on HCWs hands according to **hand size categories** and the **volume of ABHR**

HOW to handrub: volume of ABHR

The rate of hand coverage is affected by ABHR volume used and strongly correlated with the hand size

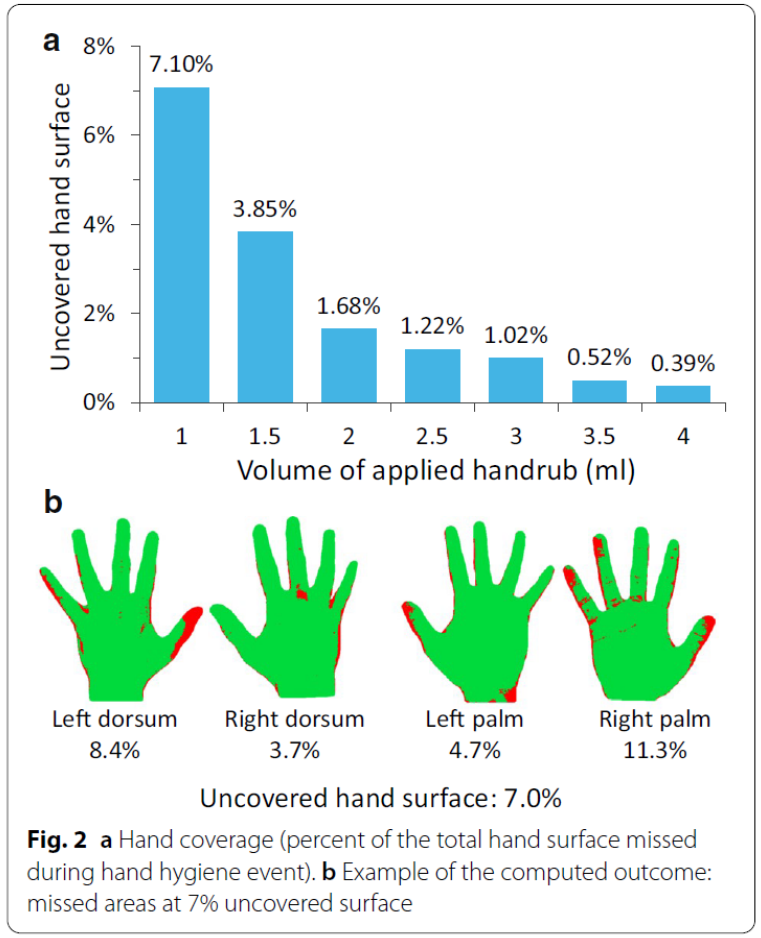


Fig. 2 **a** Hand coverage (percent of the total hand surface missed during hand hygiene event). **b** Example of the computed outcome: missed areas at 7% uncovered surface

In most HH events, a 3 ml ABHR volume is adequate for coverage of different hand sizes

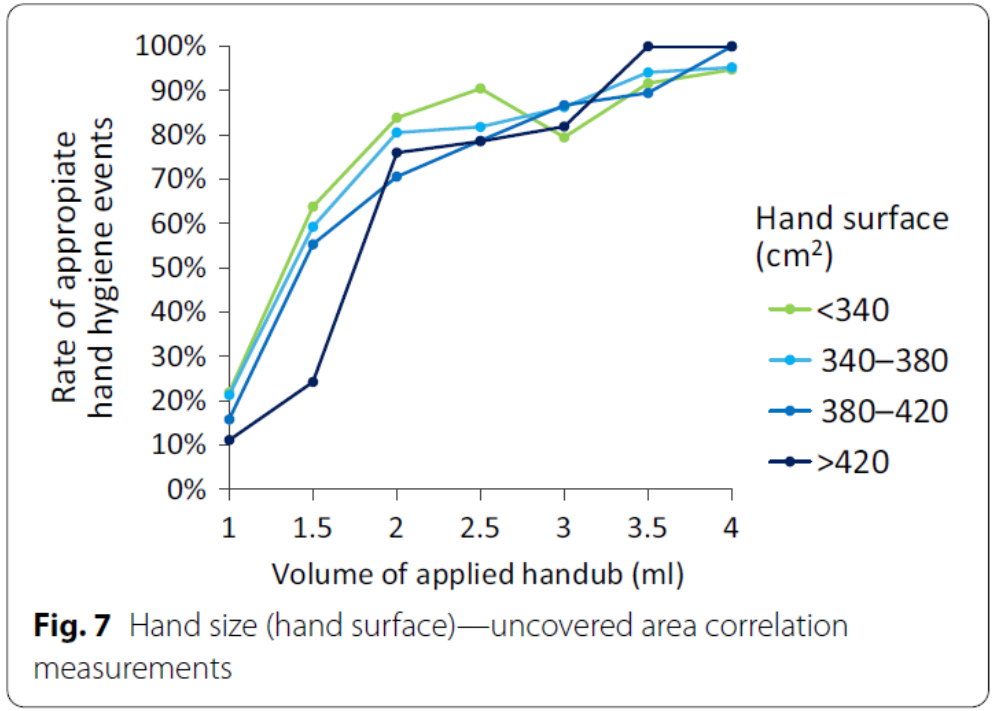


Fig. 7 Hand size (hand surface)—uncovered area correlation measurements

HOW to handrub: volume of ABHR

The rate of hand coverage is affected by ABHR volume used and strongly correlated to the hand size

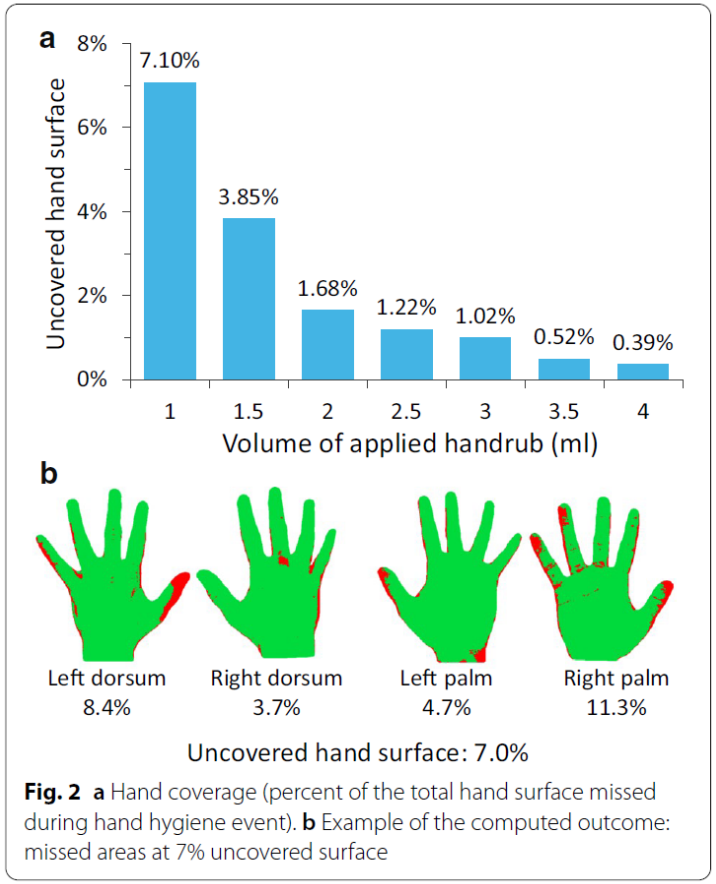


Fig. 2 **a** Hand coverage (percent of the total hand surface missed during hand hygiene event). **b** Example of the computed outcome: missed areas at 7% uncovered surface

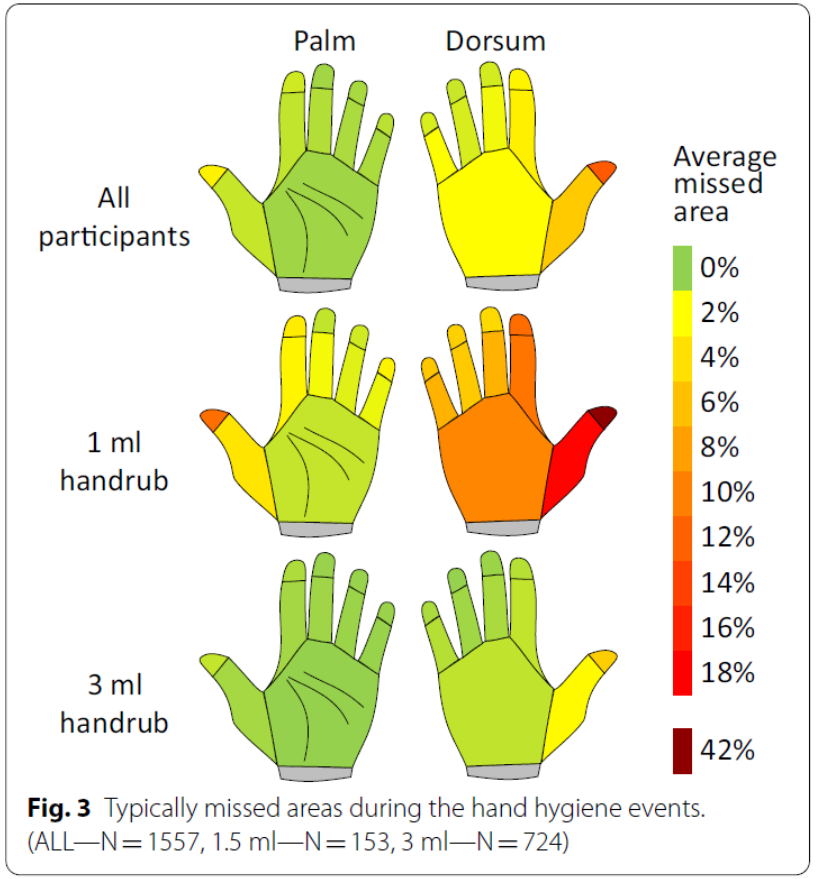


Fig. 3 Typically missed areas during the hand hygiene events. (ALL—N = 1557, 1.5 ml—N = 153, 3 ml—N = 724)

HOW to handrub: what is the evidence and what are the knowledge gaps?

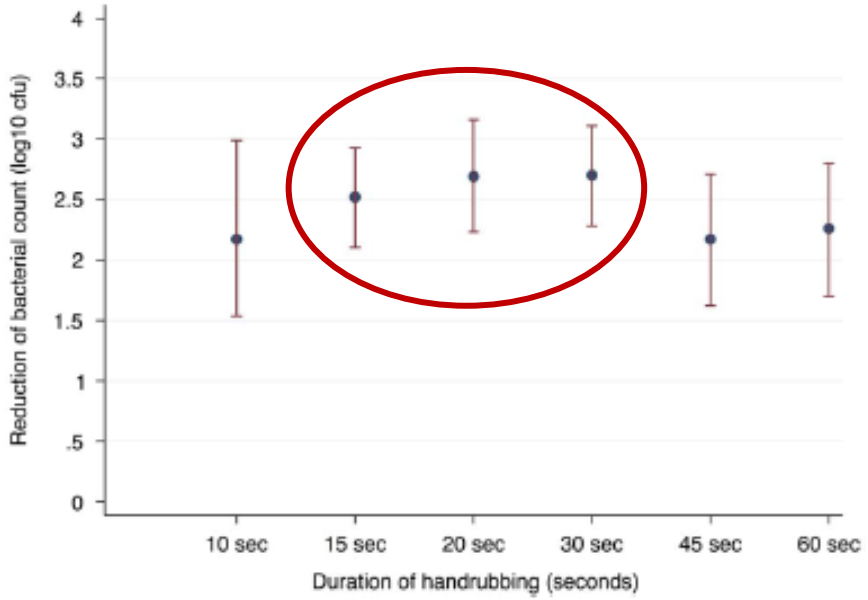
Technique

Volume of ABHR

Duration

HOW to handrub: duration of hand friction

Hand Hygiene With Alcohol-Based Hand Rub: How Long Is Long Enough?



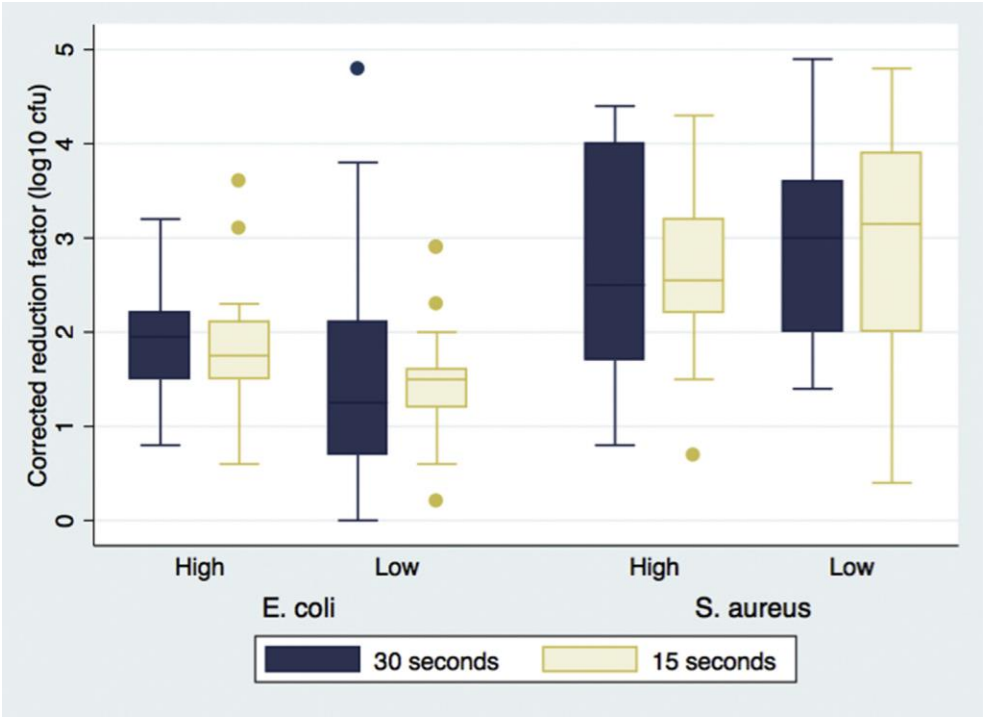
Bacterial $\log_{10}$ reduction (mean and 95% CI) from baseline across the 6 durations of hand friction

If we consider the non-inferiority limit of 0.6 log (EN 1500):

15 sec is non-inferior to 30 sec

HOW to handrub: duration of hand friction

With hand-size customized volumes of ABHR, HH actions have been tested on experienced HCWs (N:18) for different durations (15 secs vs 30 secs), bacteria (*S.aureus* and *E. coli*), and loads (10^8 or 10^6 CFU/mL)



15 sec is non-inferior* to 30 sec for reducing bacterial load regardless of the type of the bacteria or bacterial load

*The non-inferiority limit of 0.6 log (EN 1500)

HOW to handrub: duration of hand friction

TABLE 2. Log Reduction Factors of Commercially Available and WHO-Recommended ABHRs Within 15 Seconds Compared to the EN 1500 Reference Alcohol at 30 Seconds After Artificial Contamination With *Eschericha coli K12*

	Log Reduction Factor ± SD	
Formulation (% w/w)	Test Product	Reference[a]
Ethanol (70.0)	4.4 ± 1.04	4.0 ± 0.53
Ethanol (80.0), H_2O_2 (0.1)[b]	4.1 ± 0.60	4.4 ± 0.57
Ethanol (45.0), propan-1-ol (18.0)	4.5 ± 0.77	4.7 ± 0.94
Ethanol (54.0), propan-1-ol (10.0)	4.8 ± 0.69[c]	4.5 ± 0.77
Ethanol (15.0), propan-1-ol (55.0)	4.4 ± 0.80	4.4 ± 0.75
Ethanol (73.4), propan-2-ol (10.0)	4.7 ± 0.66[c]	3.8 ± 0.77
Propan-2-ol (70.0), H_2O_2 (0.1)[b]	4.9 ± 0.80[c]	4.5 ± 0.70
Propan-1-ol (30.0), propan-2-ol (45.0), mecetroniumetile sulfate (0.2)	5.2 ± 0.62[c]	5.1 ± 0.63
Propan-1-ol (14.3), propan-2-ol (63.14)	4.8 ± 0.55	4.5 ± 0.72

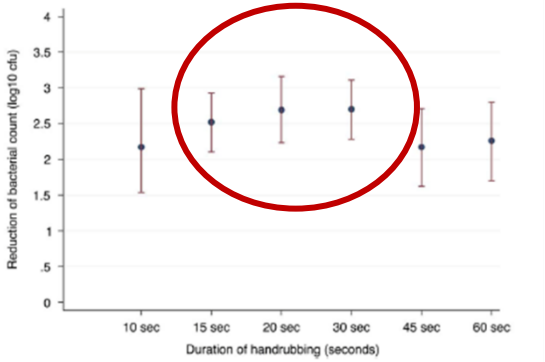
No difference between 15 and 30 sec

HOW to handrub: duration of hand friction

Laboratory and clinical studies have found that:

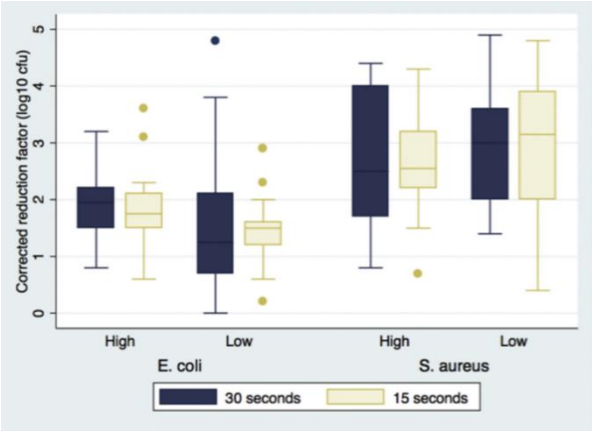
-The 15-second application time of ABHR is not inferior* to 30-second

- It is not affected by different ABHR formulations, the type of bacteria or bacterial load



Bacterial $\log_{10}$ reduction (mean and 95% CI) from baseline across the 6 durations of hand friction

*The non-inferiority limit of 0.6 log (EN 1500)



Pires D, et al. Infect Control Hosp Epidemiol. 2017;38:547-52
Pires D, et al.Clin Microbiol Infect 2019;25:851-6
Kramer A et al. Infect Control Hosp Epidemiol 2017; 38: 1430-34

A clinical trial also showed an increase in HH compliance in the 15-second application time group in addition to its non-inferiority

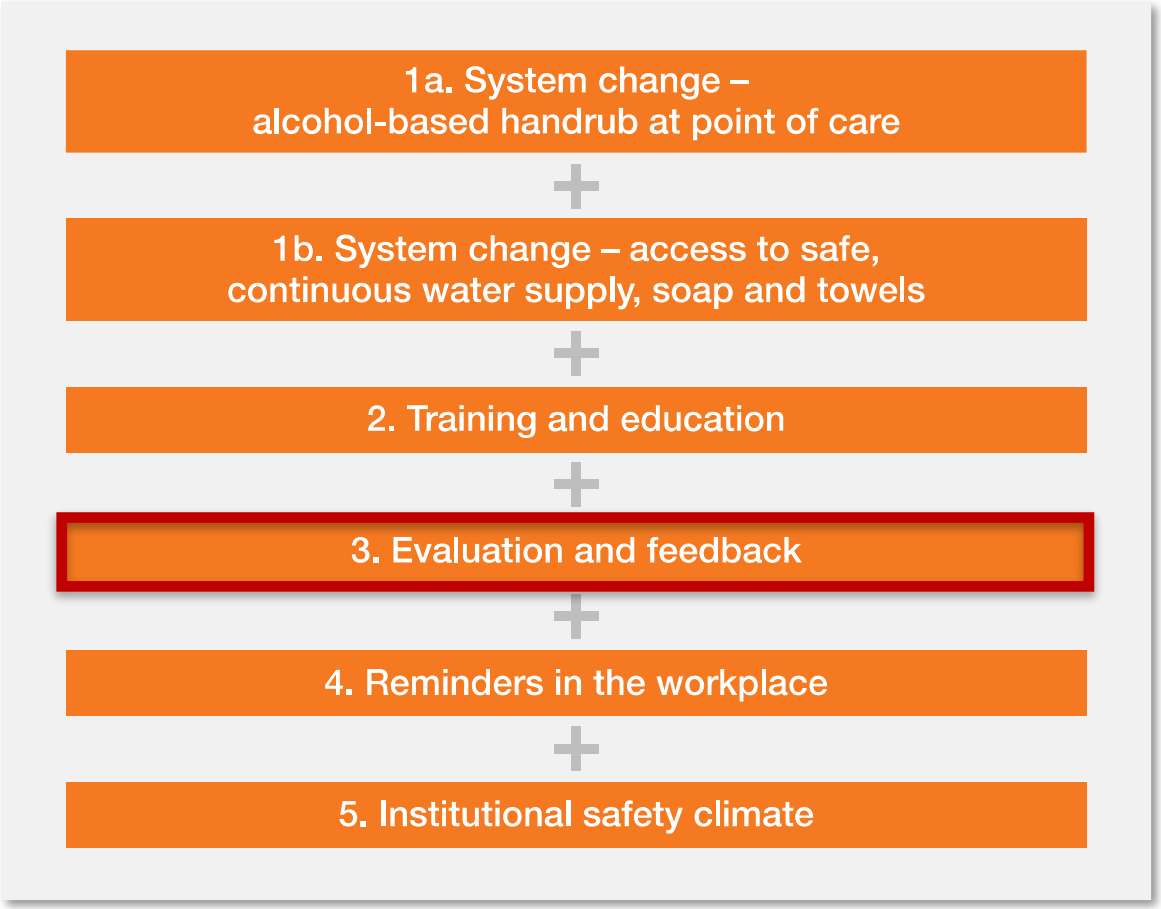
Harnoss JC, et al. J Hosp infect 2020; 104:419-24

Outline

- How has hygiene literature evolved over the years?
- What about the “HOW to handrub”?
- **How can improve hand hygiene monitoring?**
  - **Recent advances and persisting knowledge gaps**

WHO Hand Hygiene improvement

Multimodal Strategy



HH monitoring is part of component 3

HH Monitoring

Direct observation- the gold standard for monitoring HH adherence with some limitations:

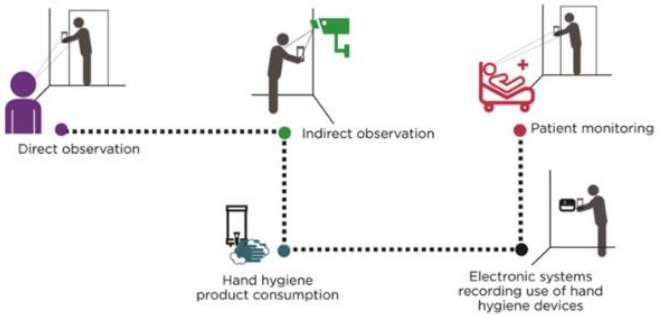
-The Hawthorne effect, insufficient sampling, time-consuming, expensive

- Difficulty benchmarking between HCF

- No standardization

BMJ Qual Saf 2014

Electronic monitoring systems (EMS) have been proposed to overcome these limitation



Hawthorne effect on HH adherence

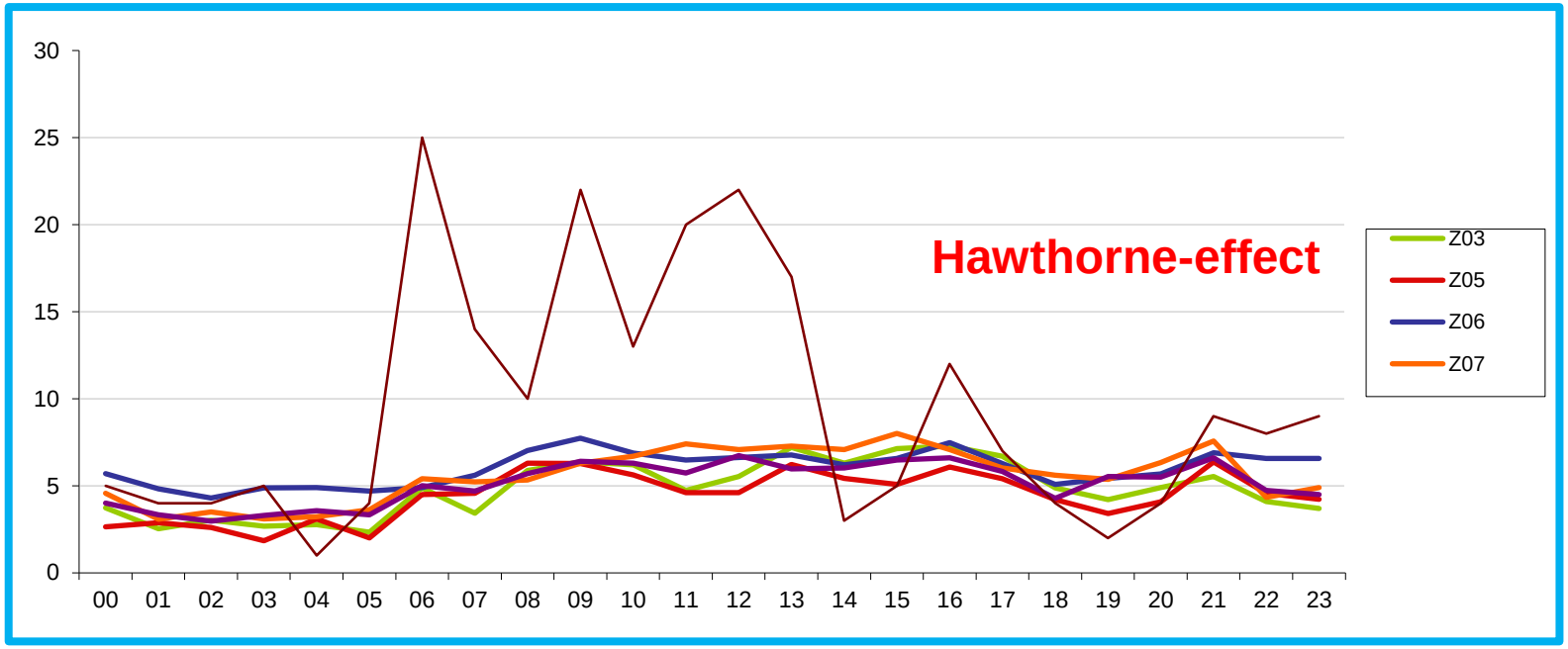


Figure courtesy of Stefan Hagel

A study on ICU comparing HH events (HHE) recorded either electronically (ER) or by direct observation (DO) showed:

- A strong positive correlation between DO compliance and ER HHEs ($p<.0001$)
- A marked influence of the Hawthorne effect on HH performance

Electronically-assisted direct observation

iScrub®

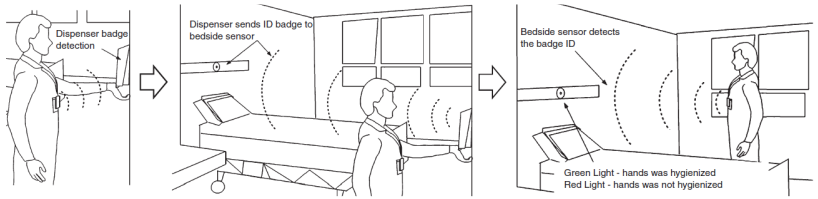
Hand hygiene quality monitoring

Continuous volume and duration measure and feedback

What are other ways to perform HH monitoring?

Video-based surveillance

Monitoring network systems



Electronic ABHR dispenser counters

Wall mounted or individual dispensers

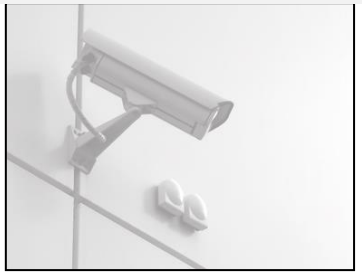
Electronically-assisted direct observation

iScrub®

Hand hygiene quality monitoring

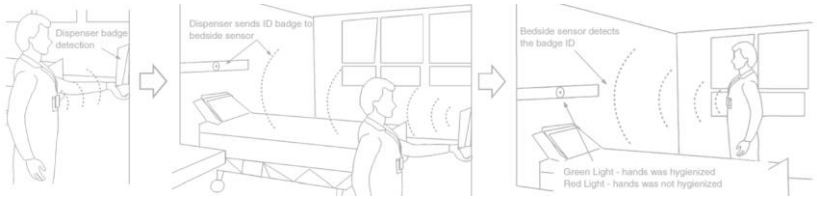
Continuous volume and duration measure and feedback

Video-based surveillance



What are other ways to perform hand hygiene monitoring?

Monitoring network systems



Electronic ABHR dispenser counters

Wall mounted or individual dispensers

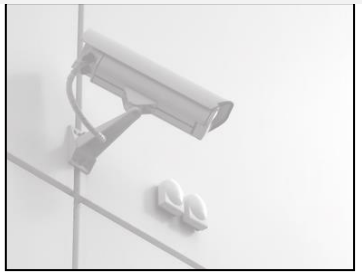
Electronically-assisted direct observation

iScrub®

Hand hygiene quality monitoring

Continuous volume and duration measure and feedback

Video-based surveillance



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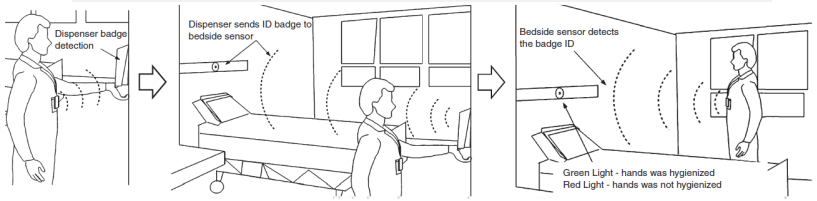
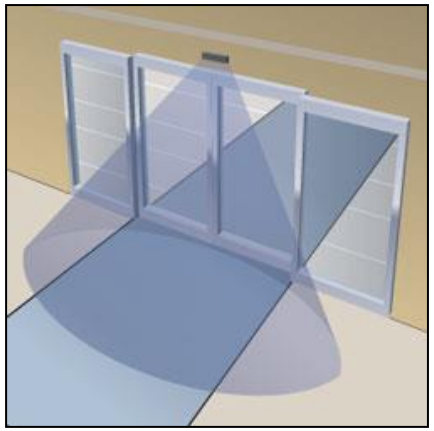


Electronic ABHR dispenser counters

Wall mounted or individual dispensers

Monitoring network systems



Motion detectors and light beams

Crit Care Med (2004) 32:358–363

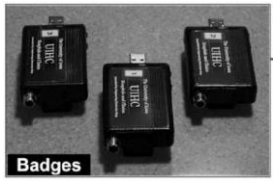
Am J Inf Control (2007)36:199-205

Am J Inf Control (2012);40:320-323

Detectors of alcohol vapor

J Hosp Infect (2010) 76:354–372

J Hosp Infect (2014) 88:84-88



Radio frequency

BMC Infect Dis (2011);11:151

CMI (2014);20(1):22-8

Am J Inf Control 2014;42(6):608-11

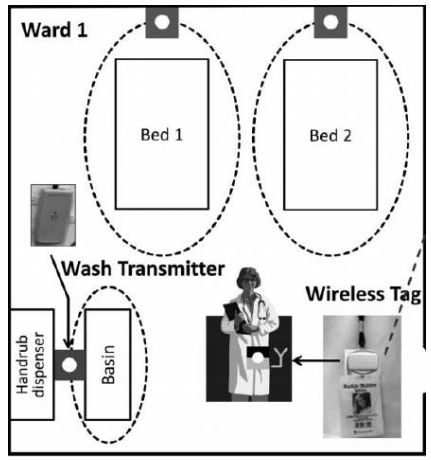
Wireless radio motes

ICHE (2010) 31:1294–1297

ICHE (2012) 33:689-95.

ICHE (2012);33:1259-1261.

J Infect Dis (2012);206:1549-57.

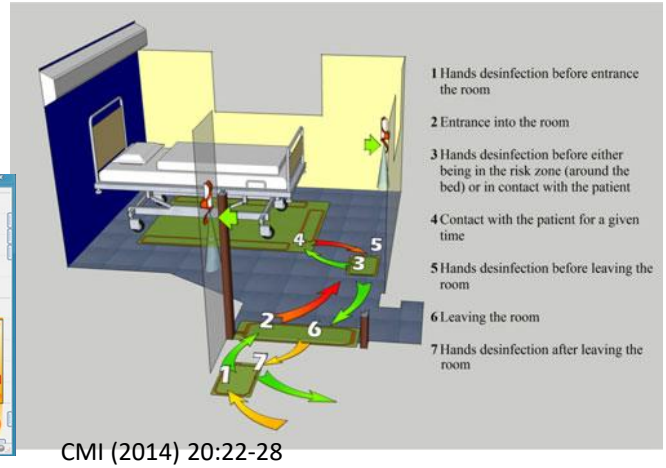


Ultrasound

ICHE (2013);34(9):919-928

ICHE (2014);35(11):1336-41

BMJ Qual Saf 2014;23:974–980



CMI (2014) 20:22-28

Electronically-assisted direct observation

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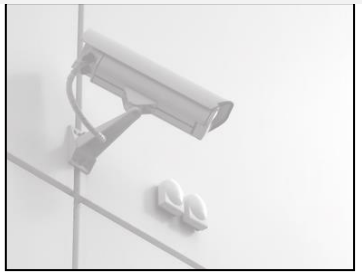
Hand hygiene quality monitoring

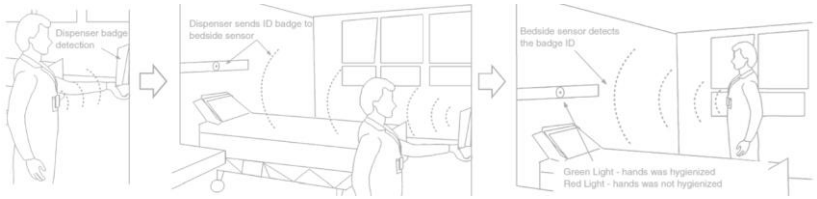
Continuous volume and duration measure and feedback

What are other ways to perform hand hygiene monitoring?

Video-based surveillance



Monitoring network systems



Electronic ABHR dispenser counters

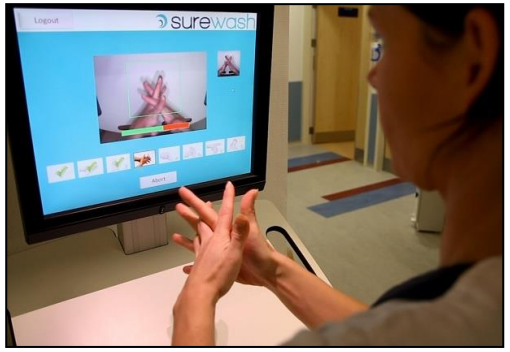
Wall mounted or individual dispensers

Hand hygiene quality monitoring

Volume & duration
monitoring and feedback

Duration
gaz sensor

Hand coverage
Ultraviolet scan



Technique
Video measurement

HH quality monitoring

JAMA Network | Open

RCT: Effect of Wearing a Novel Electronic Wearable Device on Ha[illegible] Healthcare Workers

POPULATION

17 Men, 80 Women

42 y

INTERVENTIO[illegible]

97 [illegible]

[illegible] Feedback
[illegible]th care workers

[illegible]mo Wearable Device Feedback
3 Units, 22 health care workers

2 mo Wearable Device Feedback
3 Units, 25 health care workers

1 mo Wearable Device Feedback
3 Units, 24 health care workers

SETTI[illegible]S / LOCATIONS

Geriatric hospital of Geneva University Hospitals, Geneva, Switzerland

PRIMARY OUTCOME

Hand hygiene compliance was measured by direct observation before and during the intervention using the World Health Organization guidelines

[illegible]groups, overall hand hygiene [illegible]as not different between baseline and [illegible]vention periods

Overall Hand Hygiene Compliance

OR, 1.03; 95% CI, 0.75-1.42; P = 0.85

Nevertheless,
Using the device improved quality of HCWs' HH action;
- The volume of ABHR used, and the duration of hand rubbing increased significantly

What is the evidence that electronic monitoring improves HH and reduces HAI?

- Mostly single-site, non-controlled, before-after studies evaluated the impact of EMS on HAI:

  - A trend toward improvement in HH is shown

    ➡ But supporting evidence for HAI reduction is weak

  - Data is limited to only a few current commercially available systems

- Most studies use non-validated surrogate markers of HH and focus on entry and exit of patient rooms
- To demonstrate the benefit of EMS in reducing HAI, more high-quality studies are needed that use validated, system-independent measures of HH and stronger study designs

What is the evidence that electronic monitoring improves HH and reduces HAI?

For further reading:

- *McCalla S, et al*. Am J Infect Control 2017; 45:492–7
- *McCalla S*, *et al*. Am J Infect Control 2018; 46:1381-86
- *Boyce JM, et al*. Infect Control Hosp Epidemiol 2019; 40:741–7
- *Leis JA, et al.* Clin Infect Dis 2020; 71:e680–5
- *Knepper BC, et al.* Infect Control Hosp Epidemiol 2020; 41:931–7
- *Knudsen AR, et al*. J Hosp Infect 2021; 115:71-4

Strengths and challenges of these systems

Strengths	Challenges
Provide large amounts of data by monitoring continuously HH actions	Use surrogate indicators: room entry-exit or dispenser activation
Less biases measures of HH compliance	Deficit in identification of WHO's 5 Moments
Lower Hawthorne effect	Most of the systems cannot differentiate who access the dispenser (HCWs, patient or visitors)
Some provide automatic analysis of data	Before installation accuracy and validity need to be tested at the HCF
Some can monitor and help to improve the quality of the HH action	Concerns of HCWs: privacy, data accuracy, data processing by the administration (e.g. possible penalties for non-compliance)
Some can provide a continuous real-time feedback and reminder	Costs and infrastructure requirements
Need less human resources	Cost effectiveness

Srigley JA et al, J Hosp Infect 2015;89:51-60
Pires D & Pittet D. Am J Infect Control. 2017;45:464-5
Ward MA et al, Am J Infect Control. 2014;42:472-8
Mckay KJ et al. Infection, Disease and Health 2020;92-100
Boyce JM. Infect Dis N Am. 2021; 553-73

Take home messages

There is a need for:

- More evidence-based guidance on “HOW to handrub”
- A clinically meaningful threshold to evaluate the “HOW to handrub“
- A strategy to monitor and feedback on the quality of handrub

Take home messages

- **Electronic monitoring devices are promising**
- The implementation of these systems has been studied as an intervention to improve HH with some successful results
- Electronic monitoring devices need to be integrated in **a wider HH improvement strategy**
- **Hybrid approaches** might be useful:

- Direct observation promoting positive behavior change and engagement
- The Electronic monitoring systems having the potential to reduce biases associated with data collection by direct observation

So, the future is promising…

WHO Hand Hygiene improvement

Multimodal Strategy

1a. System change –
alcohol-based handrub at point of care

+

1b. System change – access to safe,
continuous water supply, soap and towels

+

2. Training and education

+

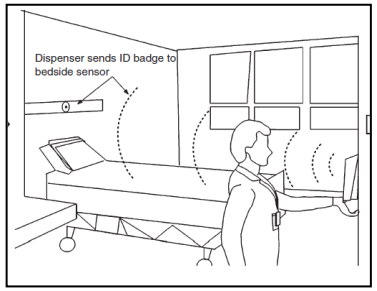
3. Evaluation and feedback

+

4. Reminders in the workplace

+

5. Institutional safety climate



Thank you