The World Health Organization hand hygiene observation method

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Monitoring hand hygiene adherence and providing performance feedback to health care workers is a critical component of multimodal hand hygiene promotion programs, but important variations exist in the way adherence is measured. Within the framework of the World Health Organization's (WHO) First Global Patient Safety Challenge known as ''Clean Care is Safer Care,'' an evidence-based, user-centered concept, ''My five moments for hand hygiene,'' has been developed for measuring, teaching, and reporting hand hygiene adherence. This concept is an integral part of the WHO's hand hygiene improvement strategy conceived to translate the WHO Guidelines on Hand Hygiene in Health Care into practice. It has been tested in numerous health care facilities worldwide to ensure its applicability and adaptability to all settings irrespective of the resources available. Here we describe the WHO hand hygiene observation method in detail—the concept, the profile and the task of the observers, their training and validation, the data collection form, the scope, the selection of the observed staff, and the observation sessions—with the objective of making it accessible for universal use. Sample size estimates, survey analysis and report, and major bias and confounding factors associated with observation are discussed.

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Hand hygiene is the single most important element of strategies to prevent health care–associated infection (HAI).[1-3] Although promotion strategies have been in place for several decades in developing countries, continuous efforts are needed in most hospitals worldwide to maintain an acceptable level of adherence to hand hygiene practice.[2] Monitoring hand hygiene adherence serves multiple functions, including quality of care assessment, incentive for performance improvement, outbreak investigation, and infrastructure design.[4-14]

Direct observation of health care workers (HCWs) during patient care activity by trained and validated observers is recognized as the gold standard for hand hygiene monitoring.[2,15-17] Observation makes it possible to quantify the specific need for hand hygiene and assess the quality of practice. But direct observation is a demanding and resource-intensive activity requiring training, skill, and experience and is fraught with potential biases and confounding factors that can be minimized only by applying a rigorous method. ''My five moments for hand hygiene,'' developed for the Swiss Hand Hygiene Campaign in 2005,[18] is a user-centered concept created according to principles of human factor design[19] that has been adopted and adapted by the World Health Organization (WHO) for inclusion in the implementation strategy proposed in the recent WHO Guidelines on Hand Hygiene in Health Care.[2] Based on an evidence-based model of hand transmission,[20] this concept provides clarity for the observer and the HCW, and accounts for the primary modes of microbiological transmission via the hands.[20] As a standardized tool, the ''My five moments for hand hygiene'' approach allows a comparison of hand hygiene performance across a broad range of health care settings and has been applied successfully by many hospitals worldwide.[2,21] Here we describe the observation method of the ''My five moments for hand hygiene'' concept in detail, using a step-by-step approach that parallels its likely application sequence in any hand hygiene observation project.

PROFILE AND TASK OF OBSERVERS

Observers collect data during routine care activity of HCWs to assess their adherence with the

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recommended indications for hand hygiene. Ideally, these observers should have basic training and experience in patient care as professionals and, importantly, a clear understanding of the logic of the care sequence. The observers must be aware of the potential biases introduced by the observation process and can help minimize these through a complete understanding of the methodology. Stringent adherence to the same methodology over time is required. Limiting the number of observers within a given setting helps further reduce interobserver variation.

UNDERSTANDING THE CONCEPT

The concept of ''My five moments for hand hygiene'' has been described in detail elsewhere.[19] In brief, health care activity is envisioned as a succession of tasks during which HCWs' hands touch an array of surfaces, including patients, objects, and furniture (Fig 1). Each transition between 2 hand-to-surface exposures can result in the hand transmission of microorganisms (Table 1). When patient care is involved, transmission is associated with a risk of colonization or infection. Applying hand hygiene at the proper moment reduces or eliminates this risk.

Based on the nature of the surfaces delimiting the hand-to-surface exposures before and after transition, 5 types of transitions have been identified as risk-prone—the ''five moments'' (Table 2). The concept distinguishes between surfaces inside and outside a ''patient zone'' (Fig 2), which contains the patient and the patient's immediate surroundings that are colonized with the patient's flora. These surfaces typically include the patient's intact skin and all inanimate surfaces that are touched by or in direct physical contact with the patient or the HCW while providing patient care. The transit of microorganisms between the inside and outside of the patient zone or vice versa can be minimized by the application of hand hygiene. The term ''critical sites'' refers to mucous membranes, breaches in skin integrity, access to invasive devices, and body fluid–soiled spots. These represent a particular risk for the transmission of microorganisms by hands inside the patient zone. The performance of hand hygiene immediately before and/or after touching critical sites minimizes these risks.

A crucial point specific to observation sessions is the distinction between hand hygiene indications and opportunities (Table 1). The indication is the reason *why* hand hygiene is needed at a specific time to effectively interrupt microbial transmission (Table 2). It is synonymous with the term ''moment'' used in the WHO promotional material (http://www.who.int/gpsc/5may/background/5moments/en/index.html). Because 2 or more indications may apply simultaneously (eg, after touching patient A and before touching patient B [Fig 2.8]), the term ''opportunity'' was introduced to refer to the period during which any number of hand hygiene indications call for a single hand hygiene action. Importantly, the opportunity constitutes the denominator for calculating adherence, that is, the number of all observed moments when hand hygiene was required. From the observer's standpoint, an opportunity exists whenever it can be observed during the entire time from the departure to the arrival of hand-to-surface exposure (eg, from the trash receptacle/door handle to the patient's hand).

Hand hygiene action is defined synonymously as either rubbing the hands with an alcohol-based handrub or handwashing with soap and water. Neither the duration nor other quality aspects of hand hygiene, such as the quantity of product used, glove use, length of fingernails, or the presence of jewelry, are assessed in the basic WHO observation method. The use of gloves does not preclude the need for hand hygiene action. Thus, when a hand hygiene opportunity arises while the HCW is wearing gloves, then the gloves must be removed and hand hygiene performed; if the HCW fails to remove gloves during the entire opportunity, then the opportunity is recorded as missed (Table 1).

Hand hygiene actions that do not occur within an opportunity, considered ''complementary/facultative,'' should not be taken into account by the observers. Of note, it is essential that local specificities related to the delimitation of the patient zones are established and known by everyone.

TRAINING AND VALIDATION OF OBSERVERS

The first step in the observer's training is to gain an understanding of the ''My five moments for hand hygiene'' concept during patient care.[19] Subsequently, the observer must learn to apply the observation method and use the data collection form. Before conducting observation sessions, an observer must be validated, ideally by parallel observation jointly with a confirmed observer, or by the WHO training film included in the WHO implementation toolkit.[22] In the first case, 2 observers engage in an observation session during a patient care situation, and each completes the observation form separately while observing the same HCW and the same care sequence. Results are then compared and discordant notifications discussed. This process is repeated until concordance is reached in terms of the number and nature of each hand hygiene opportunity that occurred. It is recommended that the same person be in charge of validation for all new observers in a given setting, and that validation be performed in each care setting to be monitored by the future observer. The WHO training film provides

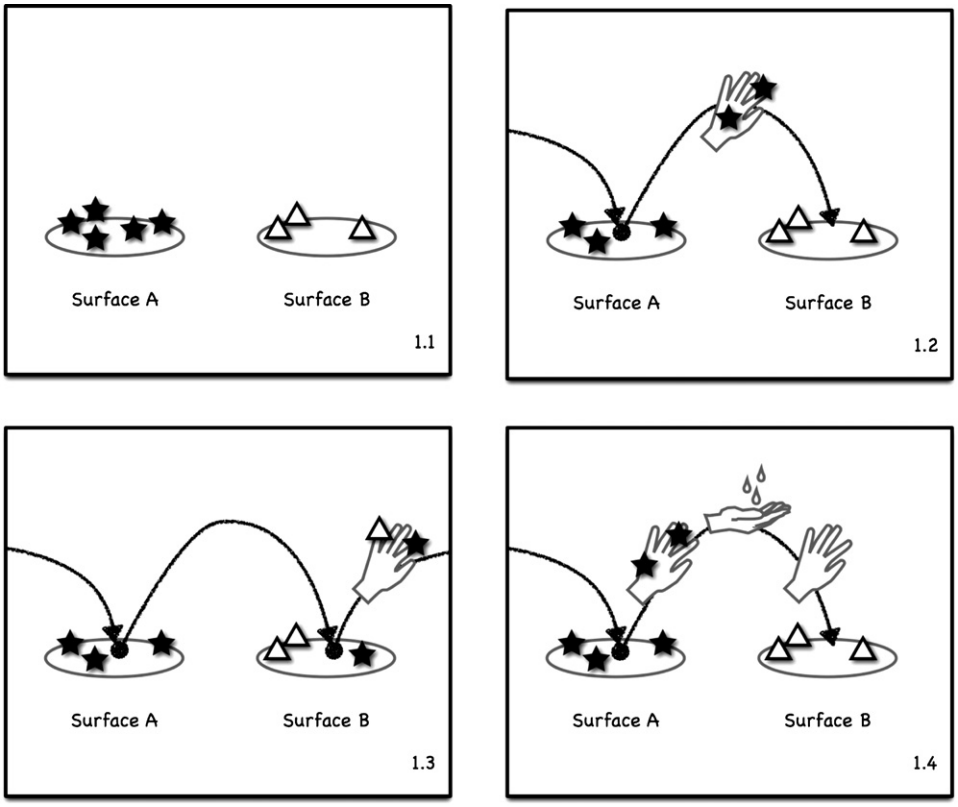

Fig 1. Hand transmission of microorganisms. 1.1, Two surfaces, A and B, contaminated with a distinct flora. 1.2, Contaminated hand after hand-to-surface exposure and in transition between the 2 surfaces. 1.3, The hand has contaminated surface B with flora of surface A. At the same time, the hand became contaminated with flora of surface B and continues transitions to other surfaces. 1.4, If surface B is to be protected against flora of surface A, then applying hand hygiene during the transition can avoid contamination of surface B; in this case, surfaces A and B delimit an opportunity for hand hygiene with the indication of not contaminating surface B with flora of surface A.

visual examples of the ''five moments'' for both HCWs and observers. It was developed to train and test observers, who are asked to complete an observation form while watching the film. The subsequent discussion is usually very valuable for learning purposes. If a time grid of opportunities can be established in a scenario, then kappa statistics can be calculated to quantify the level of concordance between 2 observers.

THE OBSERVATION FORM

Observations are noted on a paper form using a pencil and an eraser for corrections or using a portable electronic device for onsite data entry. Each form represents a separate observation session. The form comprises 2 main sections (http://www.who.int/gpsc/5may/Observation_Form.doc). A header contains institutional-level characteristics and information on the session. The main part consists of 4 columns of 8 blocks representing a sequence of opportunities from top to bottom. Each column is usually dedicated to an individual HCW, whose professional category is indicated in the column header. Alternatively, in situations involving many HCWs but low density of care, each column can be used for more than one HCW of the same professional category; this eliminates the ability to calculate the density of hand hygiene opportunities per HCW and to provide individual feedback after the session, however. During the observation session, the observer notes for each opportunity in the corresponding column block all of the applicable indications and whether hand hygiene was performed by hand rubbing or handwashing or was missed.

DETERMINING THE SCOPE OF AN OBSERVATION PERIOD

Before the start of an observation period, the scope of observations must be determined. If the aim is to build a comparison between 2 or more observation periods, then special attention should be given to controlling for potential confounding factors. This can be done by predefining a target number of opportunities by profession, wards, and/or time of day. To minimize

Table 1. Essential terminology

Hand transmission	HCWs' hands touch a sequence of surfaces; with each hand-to-surface exposure, microorganisms can be transmitted from the donor surface to the receptor surface.
Hand hygiene action	Hand cleansing using alcohol-based handrub or handwashing with soap and water.
Hand hygiene indication	Reason to perform hand hygiene (synonymous with "moment" for promotion and teaching purposes); see Table 2 for more details.
Hand hygiene opportunity	Time span between departure and arrival of hand-to-surface exposure of a risk-prone hand transition that requires a single hand hygiene action motivated by one or more hand hygiene indications; serves as denominator for the calculation of adherence. A missed opportunity corresponds to an opportunity for hand hygiene that was not met by a hand hygiene action.
Observation session	Period of hand hygiene observation in a care setting during 20 minutes ± 10 minutes; each observation form equals one observation session.
Patient zone	Narrow geographical zone around the patient that is exclusively dedicated to that patient and increasingly colonized with patient flora; this zone typically contains the patient's intact skin, bed or chair, bedside table, outside surface of medical devices, monitors, and so on. The patient zone must be agreed upon for each specific health care setting.
Critical sites	Critical sites are mucous membranes, breaches in the patient's skin integrity, invasive device access ports, or body fluid–soiled spots; these are associated with a risk of infection in the patient and/or the exposure of HCWs to patient body fluids; critical sites can be persistent (eg, wounds) or transient (eg, injection).
Endogenous/exogenous infection	HAIs can be caused either by microorganisms contained in the patient flora (endogenous HAIs) or by microorganisms foreign to the patient (exogenous HAIs).

Table 2. The "My five moments for hand hygiene" concept and transmission risks

Indication term for hand hygiene	Departure hand-to-surface exposure	Hand transition and microorganism transmission risk	Arrival hand-to-surface exposure	Major targeted negative infectious outcome	Examples
(1) Before touching a patient	Surface outside the patient zone	Hand transmission of microorganisms from the health care environment to the patient	Patient's intact skin and other surfaces inside the patient zone	Colonization of the patient by hospital pathogens	Touching the door handle and then shaking hands with the patient
(2) Before aseptic/clean procedure	Any surface	Hand transmission of microorganisms from any surface (including the patient skin) to a site that would facilitate invasion and infection	Critical site for infection in the patient	Endogenous or exogenous infection of the patient	Preparing the material and then giving an injection
(3) After body fluid exposure risk	Critical site for body fluid exposure in HCWs	Hand exposure to patient's body fluids potentially containing blood-borne or other pathogens	Any surface	Infection of the HCW by patient bloodborne pathogens	Drawing blood and then adjusting the infusion drop count
(4) After touching a patient	Patient's intact skin and other surfaces inside the patient zone	Hand transmission of microorganisms from the patient flora to other surfaces in the health care setting	Surface outside the patient zone	Dissemination of patient flora to the rest of the health care environment and infection of HCWs	Shaking hands with the patient, arranging the bedside table, and then touching the door handle
(5) After touching patient surroundings (without touching the patient during the same care sequence)	Surface inside the patient zone if the patient was not touched	Hand transmission of microorganisms from the patient flora to other surfaces in the health care setting	Surface outside the patient zone	Dissemination of patient flora to the rest of the health care environment and colonization of HCWs	Touching the bed rail (without touching the patient) and then touching the door handle

interobserver variability, the observer or team of observers should remain the same across the different periods studied.

The best unit for estimating the number of observations is the denominator (ie, opportunities for hand hygiene), because it directly influences the results. If the scope of observation involves the comparison of results, then sample size estimation should be performed. Figure 3 shows exemplary results of sample size estimates according to anticipated baseline and

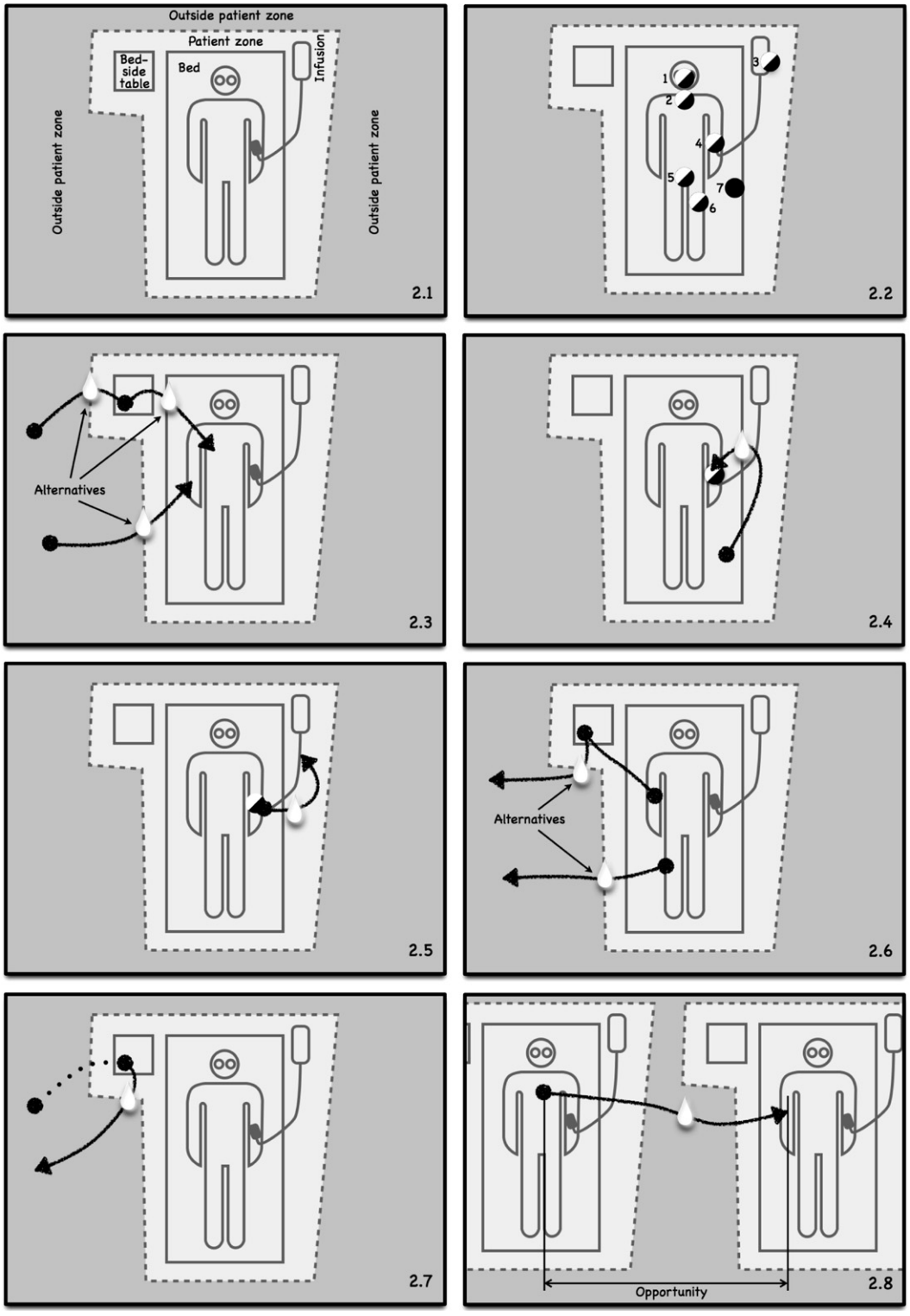

Fig 2. Hand hygiene indications according to "My five moments for hand hygiene." 2.1, Patient with an infusion connected to a peripheral venous access on the left arm in the patient zone containing also a bedside table. 2.2, Examples of critical sites associated with infectious risks for the patient and/or body fluid exposure risks for HCWs: 1, mucous membranes of eyes and mouth; 2, tracheostoma; 3, infusion access port; 4, peripheral venous line access port; 5, urogenital mucosa; 6, wound; 7, bed linen soiled with blood. The white disks represent critical sites of infectious risk for

(*Fig. 2 Continued on next page*)

Fig. 2 (*Continued*)

the patient; the black disks, critical sites with body fluid exposure risk for the HCW; the black-and-white disks, critical sites associated with both risks simultaneously. 2.3, Hand hygiene indication 1: Before touching a patient. Scenario: A HCW touches an object outside the patient zone, then the bedside table, and then the patient. There are 2 valid alternatives for when hand hygiene must be performed. The "drops" represent indications for hand hygiene. 2.4, Hand hygiene indication 2: Before a clean/aseptic procedure. Scenario: A HCW touches the bed inside the patient zone and then the venous access port. 2.5, Hand hygiene indication 3: After body fluid exposure risk. Scenario: A HCW injects a drug into the venous access port and then adjusts the drop rate of the infusion. 2.6, Hand hygiene indication 4: After touching a patient. Scenario: A HCW touches a patient on his or her intact skin, then the bedside table, then an object outside the patient zone. 2.7, Hand hygiene indication 5: After touching (no more than) patient surroundings. Scenario: A HCW ouches some items on the patient's bedside table and then an object outside the patient zone. If there is no hand-to-patient exposure, then hand hygiene is not required before touching a fomite inside the patient zone. 2.8, Two hand hygiene indications falling into the same opportunity: after touching a patient and before touching (a second) patient (without touching any surface outside the patient zones). This observation is noted as a single opportunity requiring a single hand hygiene action.

follow-up adherence levels. These estimates do not take into account clustering of opportunities on the HCW level.

SELECTION OF LOCATION AND TIME

A representative mix of wards and time of day should be obtained. Observers tend to conduct their activity at times and in locations with a high density of care, to allow them to gather a greater number of opportunities more quickly. But observers must be aware that changing the method of time selection and location of observations between observation periods can lead to bias, because there is usually an association between the density of opportunities and adherence.[4] We strongly suggest drawing up a rough location plan and timetable ahead of planned observation sessions, to guarantee longitudinal comparability.

SELECTION OF HEALTH CARE WORKERS

Once location and time are determined, observers must choose the HCWs to be observed during a session. Selection bias should be minimized by selecting the first HCW who becomes involved in care activity on a ward (random convenience sampling). In the case of repeated observation periods in particular, observers may be aware of the intrinsic performance of individual HCWs. Selecting HCWs with extreme hand hygiene behavior (eg, unusually high or low performers) could easily influence the overall results.

CONDUCTING AN OBSERVATION SESSION

The observer should introduce himself or herself to the observed HCW(s) and patient(s) by indicating unobtrusively the reason for his or her presence, and maintain a discreet presence to avoid interference. How this introduction is handled depends on the local social and medical culture. The observer should aim to avoid excessive observation bias by not being too obvious, while not deceiving the observed HCW about the purpose of observation. The session should be concluded after 20 minutes $\pm$ 10 minutes, depending on the duration of the care activity.

ANALYSIS

Hand hygiene opportunities represent the level of analysis. Overall adherence is calculated by dividing the number of hand hygiene actions by the total number of opportunities. It is useful to stratify adherence by institutional sector, professional category, and indication (moment) for hand hygiene using the "My five moments for hand hygiene" as strata.[19] For the rare instances in which opportunities involve more than one indication, we suggest retaining only a single indication for simplicity of analysis, by applying the following priority rules: before aseptic/clean procedure $>$ after body fluid exposure risk $>$ after touching a patient $>$ before touching a patient $>$ after touching the patient's surroundings. An in-depth analysis might be warranted for specific combinations and situations. Of note, this method also makes it possible to observe and report only a selection of all 5 moments for hand hygiene (eg, the moment before touching a patient) in case of limited resources or as a starting point in a basic campaign.

Portable electronic data entry devices might be programmed to do calculations in real time, which might increase data quality by avoiding data entry errors.

REPORTING OF RESULTS

Providing feedback on results to the HCWs is a very powerful promotional tool and should first address

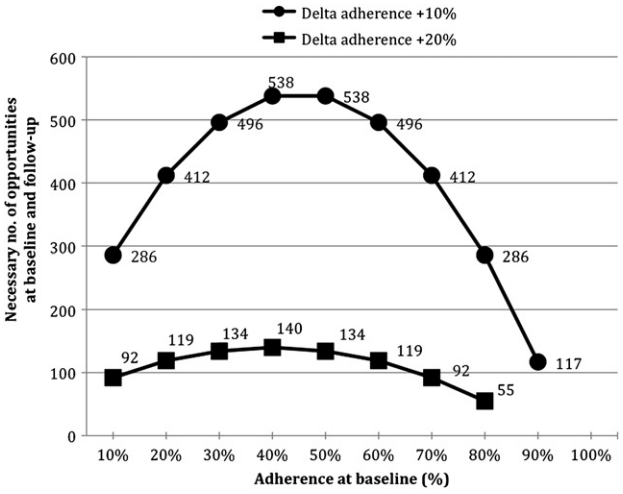

Fig 3. Sample size required to identify a 10% (•) or 20% (■) difference between rates of hand hygiene adherence at two time periods (ie, baseline and follow-up). Note: the required number of opportunities to be observed is at both time periods, ie, the total number of observations is double the number shown on the graph.[30]

groups with a strong sense of group identity, eg, physicians and nurses. Avoiding a delay between observation activity and reporting of results may increase the impact of feedback. However, feedback of suboptimal results not accompanied by an intervention to facilitate improvement should be avoided, as it could discourage HCWs and possibly jeopardize the adoption of future promotional messages.

Special attention should be given to the potentially low number of observed opportunities when using percentages to report adherence. Low numbers are especially prevalent with stratified results. It is good practice to calculate 95% confidence intervals. For instance, for 30 opportunities with an adherence of 50%, the exact binominal confidence interval would be 31% to 69%, whereas for 200 opportunities it would be 43% to 57%. Results also can be reported to each observed HCW individually immediately after an observation session, which produces an immediate training effect.

DISCUSSION

An ideal indicator of hand hygiene performance would produce an unbiased and exact measure of how appropriately HCWs practice hand hygiene. Ideally, this would require a technology that does not interfere with the behavior of those being observed, assesses the microbiological outcome of each hand hygiene action in real time, and reliably captures each moment requiring hand hygiene even during complex care activities. Furthermore, the method used should not require excessive staffing time and costs to provide sufficient data. Bias and insufficient sample size represent the 2 major threats to meaningful monitoring outputs.

Today, such an ideal method does not exist.[16,17,23] All current measurement approaches produce approximate information on hand hygiene performance, each with its own advantages and disadvantages,[24,25] and the method adopted by WHO and described herein is no exception. Nevertheless, the proposed method has numerous advantages. It is rooted in evidence-based guidelines for hand hygiene indications.[2] It was intentionally built to bridge the knowledge gap between observers and those being observed and to provide a user-friendly and robust tool for education, monitoring, feedback, and promotion in a wide range of health care settings.[19] This application range is further widened by the possibility of modulating the sophistication of the data collection and analysis, ranging from capturing only 1 of the 5 moments to detailed causal analysis by applying multivariate models with clustering corrections on the individual HCW level. It also allows the addition of such issues as glove use, specific indications for hand rubbing versus handwashing, and other hand hygiene quality issues with only minor adaptations to the observation form. Therefore, it represents a means of standardizing hand hygiene compliance monitoring and promotion. It allows interfacility comparison at local, national, and international levels, a major achievement in a field in which many different methods are currently used.

Observation bias, also referred to as the Hawthorne effect, is probably the most important bias in hand hygiene observations.[26,27] Covert observations do not represent a valid alternative, however, because of the risk of inducing mistrust in HCWs. Furthermore, covert observations are difficult to maintain in repeated observations. Even if this bias cannot be avoided entirely, desensitizing HCWs through repeated exposure and unobtrusive conduct of observers can attenuate it. The Hawthorne effect also can be used as a promotional tool in the case of ongoing and frequent observations.

To the best of our knowledge, there are only 2 reports in the literature focusing specifically on hand hygiene observation techniques.[28,29] In general, the methods used to monitor hand hygiene in other studies leave much room for interpretation, and those studies would be difficult to repeat from the described methods.[2,23] Even if direct observation is currently the gold standard for hand hygiene monitoring, research is needed to investigate questions about the impact of bias and confounding factors, as well as the potential effectiveness of less resource-demanding observation methods. Thus, we urge researchers and clinicians to use standard observational methods and consider adopting the methods described in this article.

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References

1. Pittet D, Boyce J.M. Hand hygiene and patient care: pursuing the Semmelweis legacy. Lancet Infect Dis 2001;April:9-20.
2. World Health Organization. WHO guidelines for hand hygiene in health care. Geneva, Switzerland: World Health Organization; 2009.
3. Allegranzi B, Pittet D. The role of hand hygiene in healthcare-associated infection prevention. J Hosp Infect 2009; Aug 29. [Epub ahead of print].
4. Pittet D, Hugonnet S, Harbarth S, Mourouga P, Sauvan V, Touveneau S, et al. Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. Lancet 2000;356:1307-12.
5. Larson EL, Early E, Cloonan P, Sugrue S, Parides M. An organizational climate intervention associated with increased handwashing and decreased nosocomial infections. Behav Med 2000;26:14-22.
6. Conly JM, Hill S, Ross J, Lertzman J, Louie TJ. Handwashing practices in an intensive care unit: the effects of an educational program and its relationship to infection rates. Am J Infect Control 1989;17:330-9.
7. Dubbert PM, Dolce J, Richter W, Miller M, Chapman SW. Increasing ICU staff handwashing: effects of education and group feedback. Infect Control Hosp Epidemiol 1990;11:191-3.
8. Raju TN, Kobler C. Improving handwashing habits in the newborn nurseries. Am J Med Sci 1991;302:355-8.
9. Tibballs J. Teaching hospital medical staff to handwash. Med J Aust 1996;164:395-8.
10. Harbarth S, Pittet D, Grady L, Zawack A, Potter-Bynoe G, Samore MH, et al. Interventional study to evaluate the impact of an alcohol-based hand gel in improving hand hygiene compliance. Pediatr Infect Dis J 2002;21:489-95.
11. Lam BC, Lee J, Lau YL. Hand hygiene practices in a neonatal intensive care unit: a multimodal intervention and impact on nosocomial infection. Pediatrics 2004;114:e565-71.
12. Larson EL, Bryan JL, Adler LM, Blane C. A multifaceted approach to changing handwashing behavior. Am J Infect Control 1997;25:3-10.
13. Rosenthal VD, McCormick RD, Guzman S, Villamayor C, Orellano PW. Effect of education and performance feedback on handwashing: the benefit of administrative support in Argentinean hospitals. Am J Infect Control 2003;31:85-92.
14. Won SP, Chou HC, Hsieh WS, Chen CY, Huang SM, Tsou KI, et al. Handwashing program for the prevention of nosocomial infections in a neonatal intensive care unit. Infect Control Hosp Epidemiol 2004;25:742-6.
15. Boyce JM, Pittet D. Guideline for hand hygiene in health-care settings. Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Society for Healthcare Epidemiology of America/Association for Professionals in Infection Control/Infectious Diseases Society of America. MMWR Morb Mortal Wkly Rep 2002;51:1-45.
16. Boyce JM. Hand hygiene compliance monitoring: current perspectives from the USA. J Hosp Infect 2008;70(Suppl 1):2-7.
17. Braun BI, Kusek L, Larson E. Measuring adherence to hand hygiene guidelines: a field survey for examples of effective practices. Am J Infect Control 2009;37:282-8.
18. Sax H, Uckay I, Pittet D, and the SwissNOSO Network. A nationwide joint success: the Swiss National Hand Hygiene Campaign. Presented at the 47th Interscience Conference on Antimicrobial Agents and Chemotherapy. Chicago, IL, September 17-20, 2007.
19. Sax H, Allegranzi B, Uckay I, Larson E, Boyce J, Pittet D. "My five moments for hand hygiene": a user-centred design approach to understand, train, monitor and report hand hygiene. J Hosp Infect 2007;67:9-21.
20. Pittet D, Allegranzi B, Sax H, Dharan S, Pessoa-Silva CL, Donaldson L, et al. Evidence-based model for hand transmission during patient care and the role of improved practices. Lancet Infect Dis 2006;6:641-52.
21. Pittet D, Allegranzi B, Storr IJ. The WHO Clean Care is Safer Care programme: field-testing to enhance sustainability and spread of hand hygiene improvements. J Infect Public Health 2008;1:4-10.
22. World Health Organization. Implementation toolkit for the WHO hand hygiene improvement strategy. Geneva: World Health Organization; 2009. Available fromhttp://www.who.int/gpsc/tools/faqs/implementation/en/index.html Accessed April 27, 2009.
23. Gould DJ, Chudleigh J, Drey NS, Moralejo D. Measuring handwashing performance in health service audits and research studies. J Hosp Infect 2007;66:109-15.
24. Haas JP, Larson EL. Measurement of compliance with hand hygiene. J Hosp Infect 2007;66:6-14.
25. The Joint Commission Division of Quality Measurement and Research. Measuring hand hygiene adherence: overcoming the challenges. Oakbrook Terrace, IL: The Joint Commission; 2009.
26. Landsberger H. Hawthorne revisited. Ithaca (NY): Cornell Social Science Research Center. Cornell University; 1958.
27. Eckmanns T, Bessert J, Behnke M, Gastmeier P, Ruden H. Compliance with antiseptic hand rub use in intensive care units: the Hawthorne effect. Infect Control Hosp Epidemiol 2006;27:931-4.
28. Brown TL, Burrell LJ, Edmonds D, Martin R, O'Keeffe J, Johnson P, et al. Hand hygiene: a standardised tool for assessing compliance. Aust Infect Control 2005;10:2-6.
29. McAteer J, Stone S, Fuller C, Charlett A, Cookson B, Slade R, et al. Development of an observational measure of healthcare worker hand-hygiene behaviour: the hand-hygiene observation tool (HHOT). J Hosp Infect 2008;68:222-9.
30. Chow S, Shao J, Wang H. Sample size calculations in clinical research. 2nd ed. Boca Raton (FL): Chapman & Hall; 2007.