Measurement of compliance with hand hygiene

J.P. Haas*, E.L. Larson

Columbia University, New York, NY, USA

Available online 5 February 2007

Summary  Compliance with hand hygiene is widely recognized as the most important factor in preventing transmission of infection to patients in health care settings. However, there is no standardized method for measuring compliance. The three major methods used are direct observation, self-report and indirect measurement of hand hygiene product usage. This review discusses the methods of compliance monitoring and the advantages and drawbacks of each.

© 2007 The Hospital Infection Society. Published by Elsevier Ltd. All rights reserved.

Introduction

Hand hygiene (HH) has been known to reduce healthcare associated infections (HAIs) since Ignaz Semmelweis demonstrated dramatic reductions in puerperal sepsis after instituting a hand washing regimen in the Vienna Lying-in Hospital in 1847.1 In 1843, Oliver Wendell Holmes concluded independently that puerperal sepsis was spread by the clinicians’ hands but he was unable to change the practices of obstetricians of that time.2 Although Florence Nightingale did not subscribe to the germ theory of disease, she did recognize cleanliness as an aid to healing.3

Over the past century, HH has come to be recognized as the most effective mechanism to prevent the spread of infection in health care settings, with the role of alcohol-based solutions in improving compliance currently being explored.4,5 The effectiveness of HH has been demonstrated in a number of studies, in which decreased transmission of infection has occurred as HH compliance increases.6–16

The Centers for Disease Control and Prevention Guideline published in 2002 recommends alcohol-based hand sanitizers as the preferred method of hand decontamination in most patient care situations and calls for healthcare institutions to put systems in place to monitor and improve HH compliance.4 There is no standard for measuring compliance with HH practices, however, and each method has advantages and disadvantages. The purpose of this paper is to review, compare and contrast the most frequently reported methods of measuring HH compliance in the literature.

Methods

The literature on HH was searched using the MEDLINE and CINAHL, and EMBASE databases. Key
words ‘hand hygiene’, ‘hand washing’ and ‘compliance’ or ‘adherence’, ‘monitoring’ and ‘measurement’, were used to locate articles that described measurement of hand hygiene adherence. Reference lists from selected articles and from major guidelines were also searched. Articles were included if there was a full description of how HH compliance was monitored. Studies in which more than one monitoring method was used and the results compared were also included. In all, 662 articles were screened for relevance and 31 are included in this review.

Results

The three most frequently reported methods of measuring compliance are direct observation of practice, self-report of healthcare workers and indirect calculation based on HH product usage or electronic monitoring devices.

Direct observation of practices

Direct observation is noted by the World Health Organization (www.who.int/patientsafety, accessed 6 June 2006) to be the ‘gold standard’ and most reliable method for measuring adherence rates of hand hygiene. The generally accepted metric is the number of HH episodes/number of HH opportunities. Based on the CDC Guideline an ‘opportunity’ includes before and after patient care, before an invasive procedure, when hands are visibly soiled with blood, body fluids or other proteinaceous materials, after touching objects in the patient’s environment, and after removing gloves. An advantage of the direct observational method is that it can pinpoint areas of strength or weaknesses in HH behaviour. For example, studies have reported better compliance with HH after patient care compared to HH before care, and many have reported different compliance rates among physicians, nurses and nursing attendants. Such information is important to institutions that are attempting to improve HH compliance. Knowing more specifically where an intervention is needed can allow institutions to target resources to their own particular problems.

Another advantage of direct observation is that it is the only method that can assess HH technique. While many studies have concentrated on frequency, relatively few have measured HH technique as their outcome. Those investigators who have concentrated on technique have found differences in practice that may also impact upon rates of HAI. In a study in which a multi-modal approach towards improving HH was used, handwashing technique was a major component of the observation form, and the use of alcohol gel was captured on a separate form. The focus of other HH studies has been to assess adequate coverage of hand surfaces during a single HH episode rather than the frequency with which HH occurred. There are drawbacks to direct observation. The first is that it is labour intensive and therefore costly. In addition, authors report the use of physicians, infection control professionals, intensive care unit staff, medical students and other trained observers to observe HH among staff members. This raises concerns over how observers are trained, and whether inter-rate reliability is assessed; for most studies, the specifics of how observers were trained is not reported.4

Another problem with direct observation is the possibility that staff members change behaviour when they know that they are being observed. The ‘Hawthorne effect’, as this is called, can result in falsely elevated compliance rates. In some studies, this has had a significant impact on HH compliance rates. To make observations as unobtrusive as possible, guidelines recommend using an observer who has responsibilities in the unit under study, but who is not a part of the care team (www.ihi.org, accessed 17 July 2006). Having members of the patient care team act as observers, however, has the effect of introducing bias into the observations. While this is difficult to assess, and not often reported in the literature, infection control professionals working in healthcare settings report rates on the same units that are dramatically different, depending upon the role and training of the observer (S. Hyman personal communications).

A variation on direct observation is the use of video cameras to monitor worker behaviour. This method has been used in some studies of food preparers in Australia and has some advantages. The cameras can operate during any shift to prevent selection bias in terms of time of observation, or could be operating at random intervals or continuously. The camera is less obtrusive and could minimize the Hawthorne effect. The drawbacks are that someone must review the tapes, so that the process remains resource intensive, and it is costly to install such equipment in patient care units. Selection bias is not eliminated because the camera will only capture selected areas within a unit. The use of alcohol products for HH compounds this problem since they may be used in halls or carried in the pockets of staff members, and therefore be out of range of a video camera. An additional
consideration is privacy of patients and healthcare staff. Technically, video cameras are best suited to open plan units where many patient care areas can be viewed on camera.

In addition to the issues associated with observers of HH practices, definitions of what is observed may also vary. The Institute for Healthcare Improvement (IHI) (www.ihi.org, accessed July 17, 2006) has recently made recommendations for improving HH. These recommendations depart from the previously accepted measure of compliance, which is based on the CDC Guideline, since IHI stresses the need for compliance during a complete patient encounter. This requires monitoring HH before and after patient care, before invasive procedures, contact with blood and body fluid, and contact with the environment along with monitoring the proper use of gloves. The rationale behind the IHI recommendations is that patients don’t benefit from partial compliance with HH procedures. For example, if healthcare workers clean their hands only after completing an entire care episode, they have not adequately protected that patient from the organisms on their hands during the course of providing care. This is a commendable framework for improving compliance but information on the feasibility of monitoring compliance during complete care episodes rather than after each individual indication for HH is lacking. Presumably, encounters that were not observed from start to finish would not be included in the monitoring, and balancing patient privacy may make unobtrusive observations of the complete encounter difficult in many situations. More information on implementation of this new adherence framework is needed.

Some studies focus on performance of HH only before or after selected procedures. Some define compliance as only performance when indicated but also include the technique employed. For example, even if HH was performed, if the clinician didn’t rub or wash hands for at least 15 s, it would not be counted as being compliant. Without a standard definition of HH compliance, and/or lack of standardized methods of training observers, or defining who should be observers, it is easy to see why reported compliance rates vary considerably across studies.

In addition to definitional difficulties, observational studies represent only a sample of the total universe of HH opportunities. Therefore sampling strategies are important to the outcome of HH observational studies. In a study conducted by Pittet and colleagues, the day of the week was an independent predictor of HH compliance. The role of the staff member has also been correlated with HH compliance, as has the task being performed and the acuity of patients.

There is a lack of discussion in many studies regarding sample selection. Those that do report their sampling scheme most often use a sample of convenience such as day shift only. It is possible that HH compliance on shifts such as nights or weekends is not observed as often as it should be, in order to adequately represent the range of HH practices. A study conducted in Australia compared direct observations of the HH practices of radiology professionals to the volume of alcohol gel used per patient day. The authors reported that while direct observations showed no improvement in HH practices, the observations represented only 3% of the radiology patient care encounters. At the same time, consumption of alcohol gel increased significantly. The authors concluded that direct observation did not give an adequate representation of HH practices. A limitation to this study was that any staff could have used the products and observations were limited to radiology staff. Similarly, Aragon and Sole reported a modest, though statistically significant increase in observed HH compliance, with product use almost doubling. It is possible that the HH observations inaccurately represented total HH behaviour due to the selection of an unrepresentative sample for observation.

Finally, the roles of personal accountability and individual differences in HH practice have not been discussed in many HH studies. Although it is generally accepted that there are differences among sub-groups, observing specifically identified individuals is rarely reported. Muto et al. found differential compliance among individuals and reported that, ‘although some subjects reliably washed their hands 100% of the time after patient contact, seven healthcare workers never washed their hands during 24 observed opportunities.’ Furthermore, they reported that one individual was observed to avoid handwashing as many as nine times in a row. Won et al. reported increased HH compliance and decreased HAIs in a neonatal intensive care unit in which personal financial incentives or penalties for staff were part of the intervention.

In most studies, compliance is reported either overall or role- or task-based. This may be misleading if the majority of healthcare workers in a given sub-group have acceptable rates of compliance but there are outliers. Individualized observations of healthcare workers would require additional resource commitment and this would add another level of complexity to studies. In addition, staff privacy is a consideration and often a signed
informed consent is required from staff members whose behaviour is going to be observed. If available, individual level information would be valuable for targeting HH interventions to specific groups or individuals. The interventions needed to improve inadequate HH compliance among healthcare workers as a group would be different than those needed for individuals who are refractory to HH education and motivational efforts.

Self-report of practice

Self report of practice has been used to assess HH in some studies. The advantage of this method over observation of HH is a significant savings of resources but the validity of self-report data must be assessed. Moret et al. compared self-assessment to direct observation in 25 units of a university hospital in France. The authors selected eight specific procedures that they considered to be representative of patient care activities in general and had observers monitor HH practices around these activities. Later the same day, all patient care providers on the unit under observation were asked to anonymously complete a self-assessment of their HH practices using a survey which ranked frequencies of HH behaviour into four categories (never, sometimes, often, always). These investigators reported that physicians and nursing attendants systematically overestimated their compliance with HH, while nurses underestimated compliance, although the difference in estimates between self-report and direction observation was statistically significant only for nurses in the activity of changing an infusion bag ($P = 0.01$) and nursing attendants providing general patient care ($P = 0.05$). The differences in self-reported compliance were not significant for most HH opportunities. The exception to this was that nursing assistants significantly overestimated their HH compliance after nursing care compared to the direct observations.

Larson et al. compared self-reported and directly observed HH compliance in a study in two neonatal intensive care units. This study was limited to HH behaviour of 106 nurses who completed a total of 1071 monthly diary cards over a 2 year period. The diary cards were to be completed during the shift once a month, and a tick made for each time certain HH activities (handwashing with soap and water, use of alcohol gel, use of lotion, donning of gloves) were performed. Nurses were also asked to estimate the time per hour spent wearing gloves. During the study a member of the research team observed HH performance for 206 h. The observations were made at random intervals. The rationale for using the diary cards was to minimize recall bias on the part of the nurses. Self-reported and observed overall HH compliance did not differ significantly, though several individual HH activities were significantly different between the two methods of measurement. Because there were no individual identifiers from the observations, it was not possible to match observed behaviour with self-report. The investigators concluded that it was not possible to tell which methodology of measuring compliance was more valid because the random observation periods did not adequately represent all times of day and night and thus did not reflect usual practices as reported on the diary cards from participating nurses. It was also possible that the self-reported HH practices were not as accurate as the direct observations. It is interesting that the nurses’ self-reports of alcohol gel and lotion use were significantly higher than observed whilst hand washing was significantly lower in self-report than observed.

Mody et al. did not describe how the accuracy of the self-reported HH practices was validated and after the educational intervention, and that there was no difference within the groups except after the alcohol gel intervention. Thus it was possible to infer that the self-report reflected some change associated with the alcohol intervention.

O’Boyle et al. studied self-report versus observed practices in a study in which nurse volunteers were identified individually. In this study, the correlation between self-reported and observed HH behaviour was low, and the authors posited that unit activity might have had more impact on HH than behavioural intention. This study was important because the design allowed for individual correlations between behavioural intention to perform HH, self-reported proportion of HH compliance and direct observation of the same individuals. The limitations to this study were that it included only nurses, so it was not possible to generalize to other professions. In addition, the behaviour of volunteers in this study might not have been representative of all nurses; those who did not volunteer may have had different HH practices. Elridge et al. compared direct observation with self-report in a study of interventions to improve HH in four ICUs. There was an increase in observed HH from 47 to 80% but self-reported compliance, which was 87.8% at the beginning of the study, did not change over the study period. Studies in community settings have also noted inaccurate self-reporting. People reported better compliance with HH procedures and disposal of infant faeces than was directly observed, and better practices
with safe food preparation practices, including HH, than was observed on videotapes.27,38

**Indirect measurement**

The third method for measuring HH performance is an indirect method, by calculating product usage, or by electronic monitoring of sink or alcohol gel dispenser use. This method has the advantage of capturing total use, so is not subject to selection or recall bias. It is also less time consuming than direct observation. However, systems must be in place to ensure accuracy of measuring product usage on an individual unit.39

Bittner et al. developed a method for correlating soap and paper towel usage with HH episodes in a medical intensive care unit. This involved comparing the weight of soap and paper towels and the height of paper towel stacks at each sink at the beginning and end of the observation period; product usage was then compared with observed HH behaviour, accounting for patient census. The authors reported a high correlation between product usage and observed HH. McGuckin developed a HH compliance programme in which soap and alcohol gel usage per patient day were used to measure compliance rates.40 The amount of product used was divided by 1.7 mL per HH episode and further divided by the number of patient days to provide a rate of HH episodes per patient day. During this study HH episodes per patient day increased significantly but no other correlations to direct observation of HH or infection rates were assessed.

In two studies, Larson et al. used counters installed in soap and alcohol-based sanitizer dispensers to calculate the number of HH episodes. In the first study, HH episodes per patient day were calculated by dividing the number of ‘hits’ on the soap dispensers by the patient days during the study period.8 The authors reported a doubling of product use and a concomitant decrease in infections caused by meticillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant enterococcus (VRE).

The study of alcohol product usage was designed to assess whether staff had a preference for a touch-free dispenser compared with a traditional wall-mounted dispenser.32 The study took place in two units of an urban paediatric hospital. Here too, counters were used in all dispensers and each ‘hit’ was considered a HH episode. In this study there was a significant increase in HH episodes during the touch-free dispenser phase in both study units. Direct observation was also used in this study but the authors did not assess the correlation between the two methods.

A study of electronic monitoring of entry and exit from patient rooms along with voice prompts to wash hands was reported in 2004.41 In this study, electronic motion detectors were installed in a surgical intermediate care unit to detect entrance or exit from rooms, electronic and computer systems monitored the use of toilets, sinks, soap and alcohol gel dispensers, and HH was monitored with these systems at baseline. In the intervention phase, an automated voice prompt reminded individuals to perform HH when an exit from the patient room was detected without a HH episode being recorded. The voice messages were directed to specific rooms but the system was not designed to identify who entered or exited the rooms. Following the intervention phase, electronic monitoring continued without the voice prompt reminders. During the initial phase, the rate of HH compliance was 44% by direct observation as compared with 21.6% using electronic monitoring. There was a follow-up comparison that confirmed a 20% absolute difference in compliance between the two methods. The authors clarified that the direct observations were targeted at healthcare workers interacting with patients, while the electronic system recorded all entries and exits without discrimination of the role of the person involved. The increases in compliance during both the voice prompt and follow up periods were statistically significant. The intervention portion of the study lasted for six months and the authors did not describe staff response to the automated voice prompts. It is not clear whether staff response to audible reminders would remain positive over an extended period of time.

The studies described above illustrate some of the advantages and disadvantages of indirect measurement of HH. Product usage can be an efficient way to monitor HH per patient day over time in a given unit. Indirect measurement is not subject to the same potential for sampling bias as direct observation, since product use across all shifts is measured. However, product usage does not capture the appropriate denominator (i.e. when HH is indicated). There is no way to account for changes in patient acuity in a measurement based on HH episodes per patient day. Similarly, some staff may use two ‘hits’ of product per HH episode (as recommended by some experts, and appropriately for staff with large hands), which cannot be captured by product use information. Furthermore, product usage by patients and families cannot be separated from that used by staff, so healthcare worker compliance is likely overestimated in units where patient and family participation in HH is a part of the culture.
Product use monitoring saves the expensive cost of labour involved in direct observation of HH practices. There is a cost involved, however, in either purchasing counters for dispensers or installation of more complicated monitoring devices. Computerized or videotaped monitoring systems require a large initial investment and costly ongoing maintenance and technical support. Thus elaborate electronic monitoring systems are not likely to be used widely in healthcare settings. Perhaps the biggest disadvantage of product usage as a measure of HH compliance is that it does not give any direct information about when or why failures in HH occur. It is not possible to determine if one group or specific task is problematic, so specific information to target interventions would have to be collected separately.

Finally, some authors use infection rates or transmission rates as measures of HH compliance. Since the goal of improving HH compliance is to decrease rates of HAI, measuring the impact on HAI rates appears to be a logical approach. In terms of feasibility, the advantage of this method is that it uses data that may already be collected by the institution. Many studies have used HAI rates as an outcome measure. In some studies, improved HH is associated with reductions in rates of HAI. Others have not found a decrease in HAI or a decrease in HAI with implementation of HH programmes.

Eckmanns et al. studied pathogen transmission by molecular analysis of 10 'indicator' bacteria commonly cultured from patients in five study intensive care units. Transmission was defined as identification of genetically indistinguishable isolates in two or more patients who had been treated either in overlapping intervals or within a nine-day period in the same critical care unit. There were five transmission episodes per 1000 patient days, of which 29% resulted in clinical infection. The authors found that observed HH compliance and product use were correlated but that these measures were not correlated with pathogen transmission or infection. A limitation of this study was that the HH observations and molecular analyses were performed during different time periods. It is possible that other factors may have differed during those time periods, although the authors reported that the product use during the culturing phase of the study and the HH observations were correlated, and that the case mix did not change between the study periods. Two other limitations were that HH compliance was between 30 and 47%, so compliance may not have reached the threshold needed to have a discernible impact on infection or transmission rates. Furthermore, since only clinical cultures were obtained, the transmission rates may have been underestimated.

Though decreased HAI rates are the goal of any HH compliance programme, care must be taken to control for confounding factors and to recognize which HAI are likely to be associated with HH compliance versus other factors. In a recent study of transmission of VRE, the authors reported decreased transmission when adherence to environmental cleaning procedures was increased. Depending upon the organism, other interventions may also play a role in decreasing infection. Similarly, interventions which involve aseptic technique for the insertion of invasive devices should have an impact on HAI, without necessarily being the result of a HH intervention.

Summary and recommendations

Compliance with HH is measured in many ways; advantages and disadvantages of several commonly used methods are summarized in Table I. The 'gold standard' of direct observation provides the most detailed information, but has many variations and a number of disadvantages, and including being subject to bias and the Hawthorne effect. So far no consistent way of measuring compliance has emerged. The most commonly reported measure is the number of HH episodes/number of HH opportunities. Other studies have chosen selected tasks or opportunities as their focus of attention. A new standard being developed by the IHI calls for monitoring complete episodes of patient care for 'all or nothing' compliance measurement. The rationale is that compliance with each opportunity does not increase overall safety for patients. However, it is very difficult to observe complete patient contacts from beginning to end. Observations of HH behaviour are made more difficult by staff actions aimed at preserving patient privacy. Feasibility testing for monitoring HH by the IHI method has not been reported. Self-report is another way in which HH compliance is monitored but studies have not demonstrated adequate validity for this methodology. Finally, measurement of product usage is an efficient method for collecting HH episode data but product usage data do not offer the level of detail that direct observation provides. Institutions or individual nursing units must develop meaningful denominators such as patient days or visits, or perhaps an estimation of the average HH opportunities per hour on the individual unit.

Very few studies have focused on individual healthcare worker behaviour. New calls for
personal accountability for HH and developing technology may lead to methods of monitoring individual HH behaviour.\textsuperscript{44,45} These methods must also allow for the measurement or calculation of meaningful denominators in order to be used as a replacement rather than an adjunct to direct observation.

In order to assess the relevance of studies of HH behaviour, the methods must specify in detail the way in which HH was measured. This includes a full description of how observed samples were selected, how observers were selected and trained and how inter-rate reliability was assessed. For studies that use indirect monitoring, an estimation of the appropriate denominator of product use is needed.

Ultimately, a standardized approach to HH compliance monitoring methodology would be the best way to assure that the results of different studies are comparable. This may not be possible, however, because the costs of different monitoring methods are disparate, and institutions may prioritize the needs for this monitoring differentially. Unless a single methodology emerges as a best practice, and is specified in HH monitoring guidelines, a unified approach is unlikely to emerge. In September 2006, The Joint Commission for the Accreditation of Healthcare Organizations announced a project to be conducted in partnership with leading infection control organizations and leaders to identify best approaches for measuring

\textbf{Table I} \hspace{1cm} \textbf{Methods of measuring compliance with hand hygiene with advantages and disadvantages}

<table>
<thead>
<tr>
<th>Method</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct observation</td>
<td>‘Gold standard’. The only method that can give specific information on who is performing hand hygiene, or what indications for hand hygiene have good or poor compliance rates. The only method that can assess technique. Highest granularity of observations</td>
<td>Labour and resource intensive. Subject to Hawthorne effect. Small samples of all hand hygiene opportunities are usually observed. Can be subject to bias due to oversampling selected shifts (days) or units (e.g. ICUs) and inadequate sampling of others (nights/weekends). No standardized way to observe; some studies focus on frequency of hand hygiene and others on technique</td>
</tr>
<tr>
<td>Remote observations</td>
<td>Videotaped observations less subject to selection bias, as they can operate at any time</td>
<td>Expensive to install and maintain equipment. Labour costs to review tapes. Can be subject to bias based on where camera is pointing</td>
</tr>
<tr>
<td>Self-report</td>
<td>Low cost. Involves healthcare workers in thinking about their hand hygiene behaviour</td>
<td>Poor validity in several studies</td>
</tr>
<tr>
<td>Product volume use per patient day</td>
<td>Less costly to monitor. Overall measure of use, not subject to selection bias</td>
<td>Cannot provide information about which indications for hand hygiene are being followed, or which types of staff members are in best/worst compliance. Not able to assess technique</td>
</tr>
<tr>
<td>Electronic monitoring</td>
<td>Not subject to observer bias. Less subject to Hawthorne effect</td>
<td>Expensive to install and maintain. Unable to discern role of person entering or leaving the room</td>
</tr>
<tr>
<td>Individual staff member product use</td>
<td>New technology that can keep track of individual staff members’ product use patterns. Promotes individual accountability</td>
<td>Not able to provide a useful denominator at this time. Need context to evaluate the individuals’ use patterns</td>
</tr>
<tr>
<td>HAI rates</td>
<td>Important as the ultimate goal of hand hygiene compliance. Often already collected by the institution</td>
<td>Relationship between hand hygiene and HAI may be confounded by other interventions (e.g. cleaning the environment)</td>
</tr>
</tbody>
</table>

ICU, intensive care unit; HAI, healthcare associated infection.
compliance with HH guidelines in healthcare organizations. The results of this project will provide sorely needed guidance for how to approach this important problem.

References


