Hospital hand hygiene opportunities: Where and when (HOW2)? The HOW2 Benchmark Study

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Background: Measurement and monitoring of health care workers' hand hygiene compliance (ie, actions/opportunities) is a key component of strategies to eliminate hospital-acquired infections. Little data exist on the expected number of hand hygiene opportunities (HHOs) in various hospital settings, however. The purpose of this study was to estimate HHOs in 2 types of hospitals—large teaching and small community—and 3 different clinical areas—medical-surgical intensive care units, general medical wards, and emergency departments.
Methods: HHO data were collected through direct observations using the World Health Organization's monitoring methodology. Estimates of HHOs were developed for 12-hour AM/PM shifts and 24-hour time frames.
Results: During 436.7 hours of observation, 6,640 HHOs were identified. Estimates of HHOs ranged from 30 to 179 per patient-day on inpatient wards and from 1.84 to 5.03 per bed-hour in emergency departments. Significant differences in HHOs were found between the 2 hospital types and among the 3 clinical areas.
Conclusion: This study is the first to use the World Health Organization's data collection methodology to estimate HHOs in general medical wards and emergency departments. These data can be used as denominator estimates to calculate hand hygiene compliance rates when product utilization data are available.
Key Words: Handwashing compliance.

The elimination of health care-associated infections has become a priority of hospital quality and patient safety programs.[1,2] Professional and regulatory agencies expect infection prevention and control programs to include an ongoing emphasis on improving health care worker (HCW) adherence to hand hygiene (HH) practices as an integral risk reduction strategy.[3-5] Although measurement of HH adherence is imperative, many find the task challenging. HH adherence is measured in a variety of ways, including direct observation, product utilization, and survey methods.[6-8] Advantages and disadvantages of these approaches to measuring HCW HH compliance are discussed in the literature, but to date there has been no consensus on a standardized methodology.[6,9]

The optimal measure of HH adherence would be the number of times that the HCW actually cleaned his or her hands (ie, HH actions) divided by the number of times that the HCW should have cleaned his or her hands (ie, HH opportunities [HHOs]). The World Health Organization (WHO) has defined these opportunities as the following "five moments for hand hygiene":

1. Before touching a patient (eg, touching a door handle and then shaking the patient's hand)
2. Before an aseptic/clean procedure (eg, preparing a syringe and then giving an injection)
3. After a body fluid exposure risk (eg, drawing blood and then adjusting the infusion drop count)
4. After touching the patient (eg, shaking hands with the patient, arranging a bedside table, and then touching the door handle)
5. After touching patient surroundings without touching the patient during the same care episode (eg, touching the bed rail but not the patient, and then touching the door handle).[10]

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The WHO has also developed a standardized and validated tool for measuring HHOs through direct observation of HCWs.[11,12] To date, however, little data have been generated using this tool in hospitals, and no published benchmarking data on HHOs per patient-day are available to hospitals for measuring HH adherence in various patient care locations. The purpose of the present study was to develop estimates of the expected number of HHOs per patient-day and/or bed-hour in several different hospital settings using the WHO methodology. The resulting estimates will have utility as the denominator in calculating compliance rates when only the numerator, or number of HH actions, is known.

METHODS

Sample and setting

This study was conducted in 2 different hospitals and 3 different types of nursing units within the Greenville Hospital System University Medical Center in Greenville, SC. The hospitals were Greenville Memorial Medical Center, a 746-bed teaching hospital and tertiary referral center, and Greer Memorial Hospital, an 82-bed community acute care hospital. The 3 different types of nursing units in these 2 hospitals were an adult medical-surgical intensive care unit (ICU), an adult medical inpatient ward, and an emergency department (ED). The hospitals and nursing units were chosen to maximize generalizability to other health care institutions; unit types were defined using the location definitions of the Centers for Disease Control and Prevention, National Healthcare Safety Network's infection surveillance system.[13,14] The Greenville Hospital System's Institutional Review Board approved this study.

Observer training

Three registered nurse observers (1 lead observer and 2 full-time observers) were trained by one of the authors (E.L.) to conduct direct observations of HHOs using the WHO's HH monitoring method. Initial training was conducted onsite at Greenville Memorial Medical Center over a 2-day period and consisted of a review of the WHO training manual for observers,[12] a discussion of the WHO's 5 moments for HH, and a review of HHO examples on the WHO training video. Observers then practiced using the WHO data collection forms on the clinical units, to ensure complete understanding of the HH monitoring process and establish interrater reliability. The WHO data collection form was modified to include additional health care provider types that typically work in US hospitals (Fig 1). Interrater assessment was conducted biweekly throughout the study period using two different methods. Primarily, the lead observer would accompany each observer to reinforce consistency in data collection; in addition, observers conducted direct observations together and compared results. The 2 full-time observers collected all of the study data, with the lead observer providing interrater assessment and ongoing training.

Data collection

The WHO method of HH monitoring was followed. The observer selected HCWs on a unit who were involved in patient care activities (ie, random convenience sampling). After introducing herself to the HCW and patient by indicating the reason for her presence, the observer watched the activity while maintaining a discreet presence. Data collected included HCW type, hospital department, nursing unit, indications, opportunities, and compliance activity. No personal identifying data on the HCW or the patient were collected.

Study data were collected based on the WHO methodology and unit-specific sampling coverage of all 7 days of the week and 24 hours per day from January through March 2010. This allowed for estimation of HHOs by unit, weekday/weekend, and AM versus PM 12-hour shifts.

Estimation of HHOs

The WHO methodology for capturing HH compliance data is geared toward HCWs' patient-centered activity; in addition, there is an intrinsic observer bias to seek out and capture ''activity'' versus ''nonactivity.'' These phenomena can lead to overestimation of the number of HHOs in a given unit during a specific time frame. Based on multiple statistical analyses and detailed interviews of the observers, we determined that this overestimation factor was approximately 2.0. The rationale for making this adjustment is that the observers were actually capturing twice the amount of activity, or two nursing staffs' worth of activity, in a given time frame.

We conducted a substudy of ''systematic 100% data collection'' versus ''random activity-based'' sampling in which both observers collected 100% of the activity within a prescribed block of the medical-surgical ICU. Comparing the two sampling methods revealed that systematic data collection captured 20% more HHOs compared with random collection (ie, the sampling factor).

Based on the foregoing findings, we calculated estimated HHOs using the sample estimate of HHOs per minute, the unit's census, the unit's patient-to-nurse ratio, the adjustment factors overestimation and sampling, and extrapolation to the 12-hour or 24-hour

Observation Form

Facility:		**Date:** (dd/mm/yy)	/ /	**Session Number*:**	
Ward:		**Start/End time:** (hh:mm)	: / :	**Observer:** (initials)	
Department:		**Session duration:** (mm)		**Page N°:**	

Prof.cat			Prof.cat			Prof.cat			Prof.cat		
Opp.	**Indication**	**HH Action**	**Opp.**	**Indication**	**HH Action**	**Opp.**	**Indication**	**HH Action**	**Opp.**	**Indication**	**HH Action**
1	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**1**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**1**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**1**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves
2	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**2**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**2**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**2**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves
3	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**3**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**3**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**3**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves
4	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**4**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**4**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**4**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves

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5	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**5**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**5**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**5**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves
6	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**6**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**6**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**6**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves
7	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**7**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**7**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**7**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves
8	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**8**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**8**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves	**8**	☐ bef-pat. ☐ bef-asept. ☐ aft-b.f. ☐ aft-pat. ☐ aft.p.surr.	☐ HR ☐ HW ○ missed ○ gloves

* To be completed by the data manager.
** **Optional**, to be used if appropriate, according to the local needs and regulations.

web 4C/FPO

Fig 1. Modified WHO HHO form.

General Recommendations

1. A session consists of one observation period on a defined department.
2. One HCW should ONLY be observed for a maximum of four hand hygiene opportunities.
3. In the context of open and direct observations, the observer introduces him/herself to the health-care worker and to the patient when appropriate, explains his/her task and proposes immediate informal feed back.
4. The top of the form (header) is completed before starting data collection (except end time and session duration).
5. The session should last no more than 20 minutes (± 10 minutes according to the observed activity); the end time and the session duration are to be completed at the end of the observation session.
6. The observer may observe up to three health-care workers simultaneously, if the density of hand hygiene opportunities permits.
7. Each column of the grid to record hand hygiene practices is intended be used for observation of a single HCW.
8. As soon as you detect an indication for hand hygiene, count an opportunity in the appropriate column and cross the square corresponding to the indication(s) you detected. Then complete all the indications that apply and the related hand hygiene actions observed or missed.
9. When several indications fall in one opportunity, each one must be recorded by crossing the squares.
10. Performed or missed actions must always be registered within the context of an opportunity.
11. Glove use may be recorded **only** when the hand hygiene action is missed while the health-care worker is wearing gloves.

Short description of items

Facility:	GHS campus where observations are conducted (GMH, GrMH, HMH, etc)	
Ward:	CDC ward description (inpatient medical ward, inpatient surgical ward, etc)	
Department:	Name and cost center of the department (3B-6350)	
Date:	day (dd) / month (mm) / year (yy)	
Start/end time:	hour (hh) / minute (mm)	
Session duration:	difference between start and end time, resulting in minutes of observation.	
Session N°:	attributed at the moment of data entry for analysis.	
Observer:	observer's initials (the observer is responsible for the data collection and for checking their accuracy before submitting the form for analysis)	
Page N°:	to write only when more than one form is used for one session.	
Prof.cat:	according to the following classification:	
	1. nurse	1.1 nurse, 1.2 PCT/NST, 1.3 student
	2. auxiliary	2.1 EVS, 2.2 dietary aides, 2.3 volunteers
	3. physician	3.1 physician, 3.2 resident, 3.3 medical student, 3.4 physician assistant
	4. other HCW	4.1 therapist (physical therapist, occupational therapist, audiologist, speech therapist), 4.2 technician (radiologist, cardiology technician, OR technician, laboratory technician, etc), 4.3 other (dietician, dentist, social worker, transporter, and any other healthcare professional involved in patient care), 4.4 student, 4.5 unit secretary, 4.6 EMS, 4.7 Security
Opp (Opportunity):	defined by one indication at least	
Indication:	reason(s) that motivate(s) hand hygiene action; all indications that apply at one moment must be recorded	
	bef.pat: before touching a patient	aft.b.f: after body fluid exposure risk
	bef.asept: before clean/aseptic procedure	aft.pat: after touching a patient
		aft.p.surr: after touching patient surroundings
HH action:	response to the hand hygiene indication(s); it can be either a positive action by performing handrub or handwash, or a negative action by missing handrub or handwash	
	HR: hand hygiene action by handrubbing with an alcohol-based formula HW: hand hygiene action by handwashing with soap and water	Missed: no hand hygiene action performed If the action is Missed, then the observer should indicate if the HCW was wearing gloves at the time of the missed opportunity.

Fig 1. Continued.

Sample data: 19 opportunities over a 68-minute observation session = 0.279 HHO/Min.
Census=14; Patient-to-nurse ratio=1.7; Nurses on unit=8.2
Activity measured = 8.2/2 = 4.1 (Correction for over-estimation)
Systematic difference = Activity*0.20 = 0.82 (Correction for systematic vs. random)
Adjustment factor = Activity + Systematic = 4.92
Opportunities per patient day over a 24-hour period =
(Sample opportunities/min * 1440 min. * Adjustment factor) / Census =
(0.279*1440*4.92) / 14 = 141.2 opportunities per patient day

Fig 2. Example calculation for HHO estimation.

clock. Patient-to-nurse ratios ranged from 1:1.7 in the medical-surgical ICUs to 1:5 in the medical wards and EDs. An example calculation based on one observation session in the medical-surgical ICU is provided in Figure 2.

Statistical analysis

Opportunities per patient-day were estimated for the medical-surgical ICUs and medical wards; patient-day information was obtained from the electronic hospital census. Opportunities per bed-hour were estimated for the EDs; bed-hours were calculated by summing each patient's time in an ED bed (admission to discharge). Shifts were defined in 12-hour increments; shift 1 was 7:00 AM to 6:59 PM, and shift 2 was 7:00 PM to 6:59 AM.

Parametric 95% confidence intervals (CIs) were computed for each opportunity estimate using the sample mean and standard error. Interrater reliability of opportunity estimates between the 2 observers was assessed using Wilcoxon's signed-rank test and Pearson's correlation coefficient. SAS version 9.2 (SAS Institute, Cary, NC) was used for all data analyses.

RESULTS

A total of 6,640 HHOs were identified during 436.7 hours of observation over the 12-week data collection period. The majority of opportunities (78%) were identified at the large teaching hospital. Further descriptive detail of opportunities, hours of observation, and average daily census by facility and clinical area are provided in Table 1.

Table 2 presents the frequency of HH indications (ie, the 5 moments for HH) by clinical area. In all 3 clinical areas, indications 4 and 5 (after contact with a patient and after contact with a patient's surroundings) composed the majority of indications (~62%). Indication 3 (after body fluid exposure) was more common in the medical-surgical ICU (12%), and indication 2 (before aseptic technique) was more common in the general medical ward (7%). Indication 1 (before patient contact) was roughly equivalent across the 3 areas (~21%).

Table 3 presents estimates of average HHOs and corresponding 95% CIs by hospital, clinical area, and shift. Estimated HHOs per patient-day ranged from a high of 179 in the large teaching hospital medical-surgical ICU to a low of 30 in the small community hospital medical ward. Estimated HHOs per bed-hour were 5.03 in the critical/intermediate ED and 1.84 in the general ED. Significant differences between estimates were found for the following comparisons: large versus small hospital, medical-surgical ICU versus medical ward, and critical/intermediate care ED versus general care ED (all $P < .05$). Consistently, across all 3 clinical areas, estimates were higher for the PM shift in the large teaching hospital and higher for the AM shift in the small community hospital; these differences were not statistically significant, however (all $P > .05$).

We assessed interrater reliability between the 2 observers on 20 different occasions throughout the study period and in each of the 3 clinical areas. The average mean difference (standard deviation) of estimated HHOs per minute for observer 1 versus observer 2 was -0.003 (0.016); this difference was not significantly different from 0 ($P = .63$). The Pearson correlation of estimated HHOs per minute for observer 1 versus observer 2 was 0.97 ($P < .001$).

DISCUSSION

Although the WHO's HH observation tool has been used globally, we believe that this is the first reported attempt to apply this standardized method to a broad range of hospital settings in the United States for the purpose of establishing benchmarks for expected HHOs, the denominator for calculating HH rates. This study assessed HHOs in medical-surgical ICUs, general medical wards, and EDs of a large university teaching hospital and a small suburban community hospital.

Only 3 previous studies have reported direct attempts to quantify HHOs, and HH was the primary focus of the investigation in none of them. Kim et al[15] measured HHOs in a study of ICU compliance rates as a function of glove use, isolation status, and body site exposure and found 589 HHOs over 40 hours of observation, or about 15 opportunities per hour. The authors made no attempt to express the HHOs per patient per unit of time or to control the number of HCWs observed simultaneously. They also did not conduct an assessment by time of day.

McArdle et al[16] measured HHOs in HCWs providing care for patients in a single 12-bed ICU. They conducted 124 hours of structured observations around the clock and reported their results on a per patient per day basis. The purpose of that study was to determine how much time was required for HCWs to practice adequate HH. The authors developed criteria to categorize patient contacts as either direct or indirect and reported 350 direct and indirect patient care

Table 1. Hospitals, study units, and data collection

Hospital type/unit type	Average daily census	Total hours of observation	Total opportunities
Large teaching (746 beds)			
Adult medical-surgical ICU	17.7	105.2	1989
Adult medical ward	29.3	81.3	1740
ED intermediate/critical care	105 visits	65.7	1463
Total	—	252.2	5192
Small community (82 beds)			
Adult medical-surgical ICU	4.2	82.1	610
Adult medical-surgical ward	20.0	63.9	545
ED	81 visits	38.5	293
Total	—	184.5	1448
Total	—	436.7	6640

Table 2. Indications for HHOs and distribution of HCWs by study unit

	Adult medical- surgical ICU	Adult medical ward	ED
Indications, n (%)			
Before patient contact	944 (20.5)	836 (20.9)	605 (21.4)
Before aseptic technique	237 (5.1)	273 (6.8)	139 (4.9)
After body fluid exposure	556 (12.1)	388 (9.7)	255 (9.0)
After patient contact	1308 (28.4)	1056 (26.5)	829 (29.3)
After contact with patient surroundings	1564 (33.9)	1437 (36.0)	997 (35.3)
HCW HHOs, n (%)			
Nurses*	1938 (74.6)	1828 (80.0)	1240 (70.6)
Physicians†	192 (7.4)	80 (3.5)	266 (15.2)
Auxiliary personnel‡	22 (0.9)	55 (2.4)	18 (1.0)
Others§	447 (17.2)	322 (14.1)	232 (13.2)

*Nurses, patient care technicians/nursing assistants, and nursing students.
†Physicians, residents, medical students, and physician assistants.
‡Environmental Services/housekeeping personnel, dietary aides, and volunteers.
§Therapists (eg, physical therapists, occupational therapists, audiologists), technicians (eg, radiology technicians, cardiology technicians, surgical technicians, laboratory technicians), dieticians, unit secretaries, transporters, social workers, and any other HCWs.

Table 3. Average estimated HHOs (95% CI) by hospital, unit, shift, and 24-hour period

	Large teaching hospital		Small community hospital	
HHOs per patient-day	**Adult medical-surgical ICU**	**Adult medical ward**	**Adult medical-surgical ICU**	**Adult medical ward**
Shift 1 total (7:00 AM-6:59 PM)	87.1 (79.8-94.4)	33.3 (30.3-36.3)	39.1 (32.4-45.7)	16.6 (12.7-20.6)
Shift 2 total (7:00 PM-6:59 AM)	93.5 (81.4-105.5)	40.7 (32.9-48.5)	29.2 (20.1-38.3)	12.7 (9.1-16.2)
24-hour period total	178.8 (168-189)	71.6 (64.9-78.3)	70.9 (61.0-80.7)	30.3 (24.6-35.9)
HHOs per bed-hour		**Critical/intermediate ED**		**General ED**
Shift 1 average (7:00 AM-6:59 PM)		4.83 (4.2-5.5)		1.90 (1.4-2.4)
Shift 2 average (7:00 PM-6:59 AM)		5.39 (4.8-5.9)		1.76 (1.3-2.2)
24-hour period average per bed-hour		5.03 (4.6-5.5)		1.84 (1.5-2.2)

contacts per patient per day. It is unclear whether each of these contacts represented a discrete HHO or whether many of them occurred simultaneously within the context of patient care. (There can be multiple contacts, or moments, within a single HHO.).

Scheithauer et al[17] used the WHO methodology to assess HHOs in 3 different types of ICUs and compared compliance rates based on direct observation with rates based on product usage. They documented 1,897 HHOs over 288 hours of observation, representing 187 HHOs per patient-day in the surgical ICU, 162 HHOs per patient-day in the medical ICU, and 124 HHOs per patient-day in the neurologic ICU. Patients on isolation precautions were excluded from that

study, and indications (ie, moments for HH) were prioritized to avoid counting multiple indications for a single HHO. Our ICU HHO estimates are similar to those of the study of Scheithauer et al[17] and fall within the ranges reported by the other previously mentioned studies.

Previous studies were focused mainly on ICU settings and typically concentrated on determining the level of adherence to various HH standards. As such, there was little emphasis on estimating the number of HHOs over a prespecified time period. Only a few studies have made an effort to study the fluctuations of HHO over the course of a day or a week. Most studies have involved short periods of intense observation, with observations usually focused on the ''busy'' times of the week.

Our study is unique in that we are the first to report estimates of HHOs in general medical wards and EDs. In addition, our work focuses on measuring the number of HHOs (rather than compliance rates) and is the first to report HHO estimates based on the WHO's data collection methodology. As stated earlier, the WHO's methodology focuses on the HCW as the unit of observation, with data collection geared toward activity versus nonactivity. We have adjusted our HHO estimates for this intrinsic overestimation; however, our adjustment methodology requires further verification.

Of note, the majority of HHOs identified in the present study occurred after patient contact or after contact with patient surroundings. This might be a direct result of our use of the WHO methodology, which directs observers to patient care activity, with observers often finding patient care encounters already in progress. That pattern has been reported in other studies as well.[17,18]

The present study has several limitations. Although we had more than 400 hours of direct observation and 6,640 HHOs, our data were collected over a relatively short time frame (3 months). Although this provides more than sufficient numbers to meet the study objectives, it is possible that conducting observations over a longer period can result in changes in behavior (eg, either more or less HH). Second, even though the two study sites were representative of a large teaching hospital and small community hospital, additional study sites will be needed in future studies to expand the representativeness of the findings. Finally, most of the data were collected at a single site. This occurred because our pilot data revealed greater variation in the estimated HHOs at the large teaching hospital, and thus a larger sample size from this hospital was needed to ensure adequate power. In addition, there were a greater number of HHOs at the teaching hospital due to the hospital's higher patient acuity.

Given the heavy manpower burden of direct observation for monitoring HH compliance, health care organizations are eager to find more cost-effective methods. But although product utilization measurements and/or dispenser activations have been shown to provide valuable information related to the volume of HH actions (ie, the numerator), the number of HHOs (ie, the denominator) is also needed to calculate compliance rates. Our study provides these denominator estimates for 3 clinical areas (medical-surgical ICUs, general medical wards, and adult EDs) in 2 different hospital settings. We recommend the use of these denominator estimates as initial parameters for observational monitoring of HH practices. Additional data for specialized care areas and medium-sized hospitals are needed to assess the consistency of HHOs across various health care settings.

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