

## Hand-cleansing during Postanesthesia Care

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**Background:** Transmission of microorganisms from the hands of healthcare workers is the main source of cross-infection and can be prevented by hand-cleansing. The authors assessed the compliance rate with hand-cleansing practices in the postanesthesia care unit and investigated factors associated with noncompliance.

**Methods:** Patient care activities, indications for and compliance of postanesthesia care unit staff with hand-cleansing, defined as either washing hands with soap and water or rubbing hands with alcohol, were monitored at the time of patient admission and during their stay. Multivariate analysis identified predictors of noncompliance with hand-cleansing on admission after adjustment for confounders.

**Results:** A total of 3,143 patient care activities, including 1,091 opportunities for hand-cleansing at high or medium risk for cross-transmission, were recorded among 187 patients. The higher the workload, the higher the number of indications for hand-cleansing and the lower the compliance. Average compliance with hand-cleansing at postanesthesia care unit admission was 19.6%. Independent predictors for noncompliance included caring for patients older than 65 yr (odds ratio, 2.23; 95% confidence interval, 1.40-3.57) and those recovering from clean/clean-contaminated surgery (odds ratio, 2.27; 95% confidence interval, 1.11-4.76), as well as high intensity of patient care (odds ratio, 1.01 per patient care activity; 95% confidence interval, 1.0-1.02). Compliance with hand-cleansing for patients already admitted to the postanesthesia care unit was 12.5%.

**Conclusions:** Failure to cleanse hands during patient care is common in the postanesthesia care unit and is associated with identifiable factors. The close relation between the intensity of patient care and noncompliance argues that hand-cleansing should not be viewed as a problematic individual behavior only, and system change must be considered in prevention strategies.

PATIENTS are routinely admitted to the postanesthesia care unit (PACU) after surgery. Although adverse postoperative events occur in up to 40% of patients admitted to PACUs,<sup>1</sup> few studies have been performed on the

infectious hazards. Only one study has suggested that nosocomial infections are a real problem in the practice of anesthesia and highlighted the need to implement preventive measures.<sup>2</sup> However, PACUs have many similarities with intensive care units (ICUs). It is well known that in ICUs, most endemic infections are caused by the carriage of microorganisms on the hands of healthcare workers (HCWs),<sup>3,4</sup> and outbreaks of infections resulting from cross-transmission are frequent.<sup>5</sup>

Hand-cleansing is the simplest and most effective measure to prevent hospital-acquired infections.<sup>6</sup> Several studies have focused attention on compliance with hand-cleansing in the ICU or medical/surgical wards and have emphasized the importance of alcohol-based handrub solution.<sup>7-11</sup> A paucity of data exists for the PACU, where intensity of patient care and the number of contacts between HCWs and patients are high<sup>1</sup> and procedures at high risk for cross-contamination are common. The aim of this study was to assess HCWs' compliance with hand-cleansing and factors associated with poor compliance in the PACU.

### Material and Methods

#### Study Design

Between June 19 and July 8, 2000, we conducted an observational study at the PACU of the University of Geneva Hospitals, a 2,300-bed healthcare center providing primary and tertiary care to Geneva and the surrounding area. The PACU is a 12-bed open unit with 25-35 daily admissions. Patients are admitted only after extubation. The nurse-to-patient ratio is 1:3. Three sinks with medicated soap and paper towels and individual bottles of handrub solution (alcohol-based preparation with 0.5% chlorhexidine gluconate and skin emollients) for hand-cleansing are available.<sup>10</sup>

Seven trained observers recorded potential opportunities for and actual performance of hand-cleansing during a care session. At least two observers worked simultaneously. Observations were not conducted during nights or weekends. Observers were visible but as unobtrusive as possible.<sup>8-10</sup> PACU staff were aware of being monitored about infection control practices but did not have information on which aspect. Data were recorded on a specially designed report form that had been pretested and adjusted in previous studies.<sup>8,10</sup> Two periods are reported: period I, immediately at PACU admission, and period II, starting at least 30 min after patient admission. Concordance among observers and sensitivity to detect

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opportunities for hand-cleansing were excellent when previously evaluated.<sup>8,10</sup>

The current study was approved by the hospital's ethical committee. Because data were recorded without any intervention and according to a protocol already used within the institution,<sup>8</sup> including ICUs,<sup>10,11</sup> authorization was given to waive informed consent. We informed department chairs about the upcoming study in May 2000. Personnel were not informed of which aspects of infection control practices would be evaluated, and during the study, they were not given feedback on their performance. In accordance with the requirements of the institutional review board,<sup>8,10</sup> we did not identify staff members by unique identifier.

### Study Variables

Patient care activities and indications for hand-cleansing were coded according to standard definitions<sup>8,10,12</sup> and included direct patient contact, wound care, blood sampling, intravenous or arterial catheter care, respiratory tract care, handling of body fluids or secretions, and breaks in the sequence of patient care (*i.e.*, the HCW left the bedside to answer a telephone or to prepare materials or a drug for patient care).<sup>13</sup> Compliance with hand-cleansing was defined as either washing hands with soap and water or rubbing hands with an alcohol-based solution.<sup>10,12</sup> We focused the study on the type of care that generated indications for HCWs to perform hand-cleansing while directly caring for patients. Indications for hand-cleansing were categorized<sup>8,10,11</sup> into those presenting a medium risk of cross-contamination (*e.g.*, after direct patient contact, intravenous/arterial care, urinary care, respiratory care, wound care, contact with biologic body fluid), and a high risk of cross-transmission (between care of a dirty and a clean body site, before intravenous/arterial care, urinary care, respiratory care, and wound care). It should be noted that both hand-cleansing after patient contact to prevent hand contamination between separate patients and hand-cleansing between a dirty and clean body site in the same patient to prevent cross-transmission within the same patient were considered as indications for hand-cleansing.<sup>8,10,12</sup> Low-risk indications comprised indirect patient contact and hospital maintenance. Hand-cleansing was required regardless of whether gloves were used or changed.<sup>12</sup> Failure to remove gloves after patient contact or contact between a dirty and a clean body site on the same patient was considered as noncompliance.<sup>8,10,12</sup>

Intensity of patient care was estimated by the number of patient care activities per hour for each HCW observed. The activity index<sup>8,10,11</sup> was estimated by the number of observed indications at high or medium risk for hand-cleansing per hour for each HCW observation.

Potential confounders of hand-cleansing compliance at admission included HCW professional category, type of surgery, scheduled or unscheduled surgery, Altemeier

class,<sup>14</sup> American Society of Anesthesiologists physical status, anesthetic technique, level of risk for cross-contamination (high or medium risks), and intensity of patient care.

### Statistical Analysis

We compared categorical variables by use of the chi-square test or Fisher exact test when expected values in either cell were less than 5, and we compared continuous variables by use of the Student *t* test. Nonparametric methods (rank-sum test) were used when departure from normality was observed (activity index). Continuous variables were expressed as the mean ( $\pm$  SD) or as the median (25th-75th percentiles). Association between continuous variables was graphically explored using nonparametric regression<sup>15</sup> and summarized by linear regression if appropriate. This method was used to investigate the association between compliance and workload.<sup>8,11</sup> The dependent variable was compliance with hand-cleansing. All variables from the patient's admission were first examined by univariate analysis using the Mantel-Haenszel method and logistic regression. Variables associated with the dependent variable with a probability equal to or less than 0.1 were further investigated in a multivariate logistic regression model. Measures of association are summarized by odds ratios, displayed with their 95% confidence intervals. We used robust estimates of variance (generalized estimating equation) by including HCW as a cluster.<sup>8,10</sup> All tests were two-tailed, and *P* values less than 0.05 were considered as statistically significant. We used Stata version 6 (Stata Corp., College Station, TX) for all analyses.

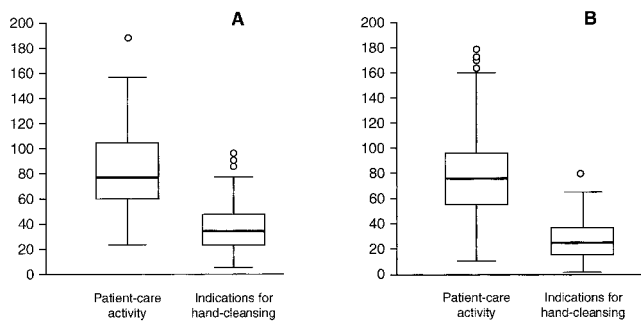
## Results

Data were collected from 240 periods, totaling 39 h of HCW observation (table 1). Eighty-seven HCW observations concerned 57 patients immediately at PACU admission (period I), and 153 concerned 130 patients already admitted in the PACU for at least 30 min (period II). Of 3,143 patient care activities recorded, 1,091 (35%) carried a medium or high risk for cross-transmission. Overall, hand-cleansing was performed 152 times during period I and 299 times during period II. Individual bottles

**Table 1. Intensity of Patient Care and Hand-cleansing Actions in the PACU, University of Geneva Hospitals, 2000**

	On Admission to PACU (Period I)	During PACU Stay (Period II)
Patients observed, No.	57	130
Duration of observation, h	14	25
Patient care activities		
Total number	1,212	1,931
Average per hour ( $\pm$ SD)	82.1 $\pm$ 32.1	79.2 $\pm$ 34.1

PACU = postanesthesia care unit.

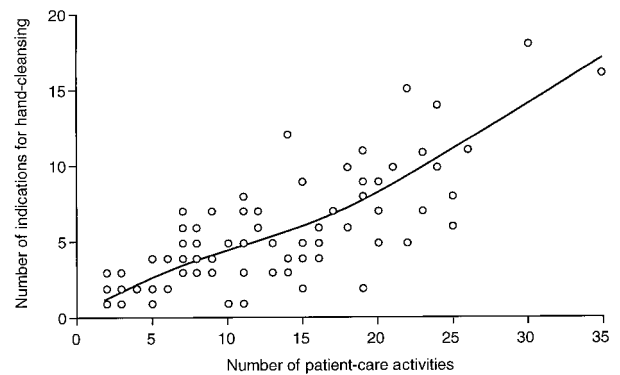


**Fig. 1. Intensity of patient care activities and indications for hand-cleansing at different times during postanesthesia care. (A) At the time of postanesthesia care unit (PACU) admission; (B) during PACU stay. The line in the middle of the box represents the median or 50th percentile of the data. The box extends from the 25th percentile to the 75th percentile. The lines emerging from the box are the whiskers. Observed points outside the whiskers are individually plotted.**

of handrub solution were available at the bedside in 97% of observations.

#### *Compliance with Hand-cleansing at PACU Admission (Period I)*

Fifty-seven patients were admitted for a median length of stay in the PACU of 160 min (120–240 min) after orthopedic (40%), abdominal (30%), urogenital (21%), and thoracic (9%) surgical procedures. Observers recorded 1,212 patient care activities (median, 77 per hour; range, 60–104 per hour) among 61 nurses, 13 physicians, and 13 nurse assistants. Figure 1 illustrates the intensity of patient care activities and indications for



**Fig. 2. Relation between workload and demand for hand-cleansing on admission to postanesthesia care unit. Patient care activities are plotted against the number of indications for hand-cleansing at medium and high risk for cross-transmission per hour of care for 87 observation periods. The line represents the nonparametric regression function.**

hand-cleansing at different times during postanesthesia care. Figure 1, A illustrates the intensity of patient care activities and hand-cleansing indications on admission to the PACU. Among patient care activities, 485 (40%) carried a medium or high risk of cross-transmission and were thus considered as indications for hand-cleansing (table 2). A close relation between workload and the number of indications for hand-cleansing was observed (fig. 2).

Average compliance with hand-cleansing was 19.6% (table 2). Handwashing with soap and water was chosen in 21% of instances; handrubbing with the alcohol-based product was chosen in 79%. Compliance before initiat-

**Table 2. Patient Care Activities and Compliance with Hand-cleansing in the PACU, University of Geneva Hospitals, 2000**

Patient Care Activities	Period I		Period II	
	No. (%)	Compliance, %	No. (%)	Compliance, %
Indications for hand cleansing*	485 (100)	19.6	606 (100)	12.5
Respiratory care (tracheostomy care, noninvasive ventilation)	10 (2)	0	32 (5)	19
Handling intravascular lines (intravenous medication, arterial blood gases, biochemistry studies)	50 (10)	18	120 (20)	6
Direct contact with eyes or mouth	6 (1)	0	5 (1)	40
Direct contact with the patient (routine dressing, pulse and arterial pressure measurements)	254 (52)	9.5	280 (46)	11
Extensive wound treatment	1 (0.2)	0	4 (1)	25
Dressing sterile equipment	32 (7)	22	70 (11)	13
Glove wearing/removal of gloves	68 (14)	28	95 (16)	21
Before initiating care of a new patient	64 (13)	56	—	—
Other patient care activities†	727 (100)		1,325 (100)	
Contact with standard monitoring	104 (14)		98 (8)	
Dressing nonsterile equipment	41 (6)		137 (12)	
Breaks in the sequence of patient care	251 (34)		499 (43)	
Answering telephone	13 (2)		35 (3)	
Care of drains	92 (13)		89 (8)	
Contact with body fluid or secretions	22 (3)		35 (3)	
Contact with environmental surface	187 (26)		241 (21)	
Leaving the patient	17 (2)		31 (2)	
Total	1,212		1,931	

\* Only indications associated with medium- and high-risk for cross-transmission are indicated. † Compliance with hand-cleansing was not determined for low-risk indications.

PACU = postanesthesia care unit.

**Table 3. Factors Associated with Noncompliance with Hand Cleansing at PACU Admission, Univariate Analysis**

Variable	Indications for Hand Cleansing, No. (%)	Compliance, %	Odds Ratio (95% Confidence Interval)
Type of healthcare worker			
Nurse	365 (75)	19.5	1.0
Physician	64 (13)	9.4	2.27 (0.92–5.88)
Nurse assistant	56 (12)	32.1	0.51 (0.27–0.98)
Level of risk for cross-transmission			
Medium-risk procedure	386 (80)	20.5	1.0
High-risk procedure	99 (20)	16.0	1.28 (0.71–2.27)
Isolation procedures			
No	413 (85)	20.3	1.0
Yes	72 (15)	15.3	1.43 (0.37–1.45)
Patient age, yr			
≤65	251 (52)	25.9	1.0
>65	234 (48)	12.8	2.38 (1.45–3.85)
ASA physical status			
≤2	318 (66)	22.0	1.0
>2	167 (34)	15.0	1.66 (0.96–2.86)
Central venous catheter			
Absent	428 (88)	20.3	1.0
Present	57 (12)	14.0	1.56 (0.66–3.70)
Arterial catheter			
Absent	413 (85)	21.6	1.0
Present	72 (15)	8.3	3.03 (1.21–7.69)
Type of surgery			
Abdominal	134 (28)	20.9	1.0
Orthopedic	286 (59)	17.8	1.05 (0.60–1.82)
Urogenital	37 (7)	24.3	1.11 (0.47–2.63)
Thoracic and vascular	28 (6)	25.0	1.61 (0.48–5.26)
Anesthetic technique			
General	313 (64)	19.5	1.0
Locoregional	88 (18)	18.2	1.09 (0.56–2.12)
Combined	84 (18)	21.4	0.87 (0.45–1.66)
Surgery			
Scheduled	377 (78)	18.8	1.0
Unscheduled	108 (22)	21.3	1.20 (0.67–2.17)
Altemeier class*			
Clean/clean-contaminated	448 (92)	18.3	1.0
Contaminated/dirty-infected	37 (8)	35.1	0.41 (0.19–0.88)
Activity index (hand-cleansing indications for high and medium risk per hour)			
<30	133 (28)	24.8	1.0
30–60	253 (52)	19.4	1.36 (0.81–2.08)
>60	99 (20)	13.1	2.13 (1.02–4.4)

*Clean sites (wounds):* Surgical sites in which no inflammation is encountered and the respiratory, alimentary, genital, and urinary tracts are not entered. In addition, clean wounds are primarily closed and, if necessary, drained with closed drainage. Surgical sites for operations that follow nonpenetrating (blunt) trauma should be included in this category if they meet these criteria. *Clean-contaminated sites (wounds):* Operative sites in which the respiratory, alimentary, genital, or urinary tract is entered under controlled conditions and without unusual contamination. Specifically, operations involving the biliary tract, appendix, vagina, and oropharynx are included in this category, provided no evidence of infection or major break in technique is encountered. *Contaminated sites (wounds):* Including open, fresh accidental wounds or operations with major breaks in sterile technique or gross spillage from the gastrointestinal tract. Surgical sites through which there is entry into the genitourinary tract with infected urine or biliary tract with infected bile, and surgical sites in which acute, nonpurulent inflammation is encountered, fall into this category. *Dirty-infected sites (wounds):* Including old traumatic wounds with retained devitalized tissue, foreign bodies, or fecal contamination. Surgical sites where a perforated viscus or pus is encountered during the operation are in this category.

\* Altemeier class refers to the system to classify surgical operative sites by the degree of contamination as follows:

ASA = American Society of Anesthesiology; PACU = postanesthesia care unit.

ing care of a new patient was 56%; it ranged from 0 to 22% during direct patient care activities in the same patient (table 2). There was no difference in hand-cleansing compliance according to the presence or absence of urinary bladder catheter, nasogastric tube, and abdominal or chest tubes. Similarly, no difference was observed according to American Society of Anesthesiologists physical status, type of surgery, or anesthetic technique (table 3). Among HCWs, physicians tended to be less com-

pliant. In multivariate analysis (table 4), patient age less than 65 yr, recovery from clean/clean-contaminated surgery, and high workload were independently associated with noncompliance.

#### *Compliance with Hand-cleansing for Patients during Period II*

Observers recorded 1,931 patient care activities (median, 77 per hour; range, 55–96 per hour) among 120



**Table 4. Predictors of Noncompliance with Hand Cleansing at PACU Admission, Multivariate Analysis**

Factor	Odds Ratio (95% CI)
Patient age >65 yr	2.23 (1.40–3.57)
Increase of patient care activity (by point)	1.01 (1.0–1.02)
Patient recovery for clean/clean-contaminated surgical procedure*	2.27 (1.11–4.76)

\* See footnotes to table 3.

PACU = postanesthesia care unit.

nurses, 17 physicians, and 16 nurse assistants (table 1). A total of 606 activities were indications for hand-cleansing associated with medium or high risk of cross-transmission (table 2). Figure 1, B illustrates the intensity of patient workload and hand-cleansing indications during PACU stay. On average, one third (31.1%) of patient care activities recorded were indications for hand-cleansing and average compliance, while caring for patients admitted in the PACU for at least 30 min was 12.5%. HCWs washed hands with soap and water in 17% of instances and used handrub with the alcohol-based product in 83%.

## Discussion

Our results showed a particularly low compliance with hand-cleansing in the PACU both at time of patient admission (19.6%) and during stay (12.5%). Overall, based on direct observation, indications for HCWs to cleanse their hands ranged between 31% of patient care activities during patient stays in the PACU and 40% of these activities at time of patient admission to the PACU.

Intensity of patient care in the PACU was extremely high, both on admission and during stay. Unsurprisingly, this has been repeatedly identified as a very, if not the most, important risk factor for low compliance both in the hospital ward and in the ICU.<sup>8,10,11,16,17</sup> Within a short time period, PACU nurses must care for several acute medical events. For example, patients with excessive pain require substantial nursing care, especially when combined with agitation.<sup>1</sup> Furthermore, unpredictable events such as critical respiratory or cardiac events add disproportionately to workload. In this study, there is a close relation between the intensity of patient care activities and the number of indications for hand-cleansing: The higher the workload, the higher the number of indications for hand-cleansing associated with a significant cross-transmission risk.

Other risk factors identified with noncompliance were older patient age and clean/clean-contaminated surgical procedures. Surprisingly, it has been reported that therapeutic effort decreases with increasing age in the ICU,<sup>18,19</sup> and nursing workload also increases with patient age.<sup>1</sup>

Several investigators<sup>6,8,10,20,21</sup> have previously observed that HCWs are more likely to comply better with infection control measures when they perceive a potential danger for themselves, e.g., caring for patients recovering from contaminated or dirty surgical procedures.

A confluence of risk factors unique to the PACU renders improvement of compliance with hand-cleansing particularly challenging. First, HCWs may not be sufficiently aware of cross-transmission risks and may be inadequately trained in infection control. Second, admissions to the PACU are not distributed equally throughout the day. Workload increases rapidly when several patients are admitted at the same time. Third, although an open ward is optimal for patient observation, it is easier for HCWs to transmit organisms from patient to patient.

However, we acknowledge that we really do not know the impact of “contaminated” hands in the PACU. Indeed, we were unable to estimate cross-transmission and nosocomial infection rates and their possible relation with poor compliance because such a task would be too time and resource demanding. Although there are no reports to our knowledge of an outbreak in a PACU, the risk seems real. First, the risk of bacterial transfer on the hands of HCWs is proportional to the frequency with which a patient is touched,<sup>13,22</sup> which is very high in the current study. Second, a large proportion of patient care activities were among those encountered in the ICU, a setting where outbreaks of infections related to pathogen cross-transmission from patient to patient or from contaminated device to patient are well documented.<sup>4,5,23</sup> Third, a sustained improvement in compliance with hand-cleansing has been reported to coincide with a dramatic reduction of nosocomial infections and methicillin-resistant *Staphylococcus aureus* transmission in a teaching hospital.<sup>10</sup> Lastly, understaffing, overcrowding, high workload, and poor hygiene practices appear to play an important role in outbreak situations.<sup>5,23–26</sup>

A number of interventions aimed at increasing compliance with hand hygiene have been implemented, with varying degrees of success.<sup>6,27–31</sup> Multifaceted approaches that combine education, continued feedback, reminders, and policy changes can have an important effect on hand-cleansing compliance.<sup>6,10,11,30–32</sup> As shown by the relatively high number of hand-cleansing actions, HCWs in the PACU were not reluctant to clean their hands, and when correctly applied to high- and medium-risk indications, hand-cleansing compliance could have approached 50% in our PACU. Besides these fundamental aspects, education oriented on specific aspects of hand-cleansing during postanesthesia care and placement of equipment and furniture might contribute to help HCWs work more efficiently and comfortably. Recent experiences in hospitals,<sup>6,8,10,12</sup> in particular in ICUs,<sup>7,9,11,29</sup> suggest that appropriate location and easy access to alcohol-based handrub is associated with improved hand-cleansing practices. We propose to test this

strategy in the PACU, supplemented by specific staff education to integrate such a system change in daily practice.

In conclusion, compliance with hand-cleansing is low in the PACU and is associated with factors identifiable at time of patient admission. The strong relation between the intensity of patient care and noncompliance argues that hand-cleansing should be viewed not only as problematic individual behavior, and it is essential that effective strategies be multimodal and consider system changes and new engineering solutions. Promotion should include educating PACU HCWs to recognize indications for hand-cleansing. Long-term change in behavior requires that all staff take responsibility for ensuring that hand-cleansing becomes an everyday part of clinical culture.

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