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Hand Hygiene Knowledge, Hand Contamination and Practice of Italian Nursing and Medical Students

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ABSTRACT

BACKGROUND: Our objective was to measure hand bacterial contamination in a group of Italian nursing and medical students attending clinical wards for practical training, in order to verify the reliability of the information on hand hygiene (HH) adherence obtained by a self-reporting questionnaire. This questionnaire was administered with the aim of exploring the effectiveness of basic education.

METHODS: In this cross-sectional study, an anonymous questionnaire designed to investigate HH knowledge and practices was administered to a convenience sample of 100 nursing and 100 medical students. Data collected was combined with hand bacterial contamination measured both at the point of entry and exit from the ward.

RESULTS: HH practices and knowledge were significantly higher in nursing compared to medical students. The most effective procedure in reducing bacterial contamination was the alternate use of hand washing and hand rubbing compared to only one practice and the absence of hand hygiene (geom. mean: 180.3, 410.2 and 907.4 CFU/hand respectively, p<0.001).

Hand contamination was significantly higher in students who declared to have hardly ever/never implemented HH teaching during clinical practice compared to those who stated to have done it frequently/always (geom. mean: 716 vs 277.1 CFU/hand, p<0.02).

CONCLUSIONS: Our investigation adds something new to the topic of HH that is the measure of bacterial hand contamination to verify the reliability of the information obtained by questionnaire. The findings, pointing out some critical aspects in HH teaching among healthcare students, highlight that solid knowledge results in correct behaviour, and consequently in a reduction of hand contamination.

Key words: hand hygiene, hand bacterial contamination, medical students, nursing students, education

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BACKGROUND

Health care-associated infections (HCAIs) are a major public health problem, having an impact on patients morbidity and mortality, length of hospital stay, and costs for both antimicrobial treatments and hospitalization [1,2]. Recent prevalence studies conducted in Italy estimated that every year about 450-700,000 patients (5-8% of those hospitalized) acquired an infection during hospitalization [3-5]. About 30% of HCAIs can be prevented by simple control measures, and hand hygiene (HH) is the most effective single behavior that can stop the spread of infection [6,7]. Despite the availability of extensive guidelines, compliance with HH among healthcare workers is still low, rarely exceeding 50%, thus representing a critical issue in all healthcare settings [8,9]. Differences in compliance were observed among healthcare professionals, with lower rates in physicians than in nurses [10]. Lack of time, heavy workload, understaffing, lack of equipment/supplies and skin damage were stated as barriers to HH compliance. Additionally, cultural barriers, lack of education and/or poor awareness of the risk of pathogens cross-transmission may contribute to a poor HH compliance [8]. Interventions designed to improve HH adherence within healthcare operators have a limited long-term success: most of the campaigns promoting compliance seem to be associated with a transient effect, stressing the difficulty in changing workers' deep-rooted behaviour [11,12]. In this context, a key point in improving the compliance with HH protocols can proceed from establishing the effectiveness of the educational process of healthcare students since the beginning of their clinical training.

Several studies have examined undergraduate's HH knowledge and practices via a self-administered questionnaire, but this instrument has been reported to overestimate adherence [13]. Therefore, the main purpose of this study was to measure hand bacterial contamination in a group of Italian nursing and medical students attending clinical wards for practical training, in order to verify the reliability of the information on HH knowledge and practices obtained by a questionnaire. This questionnaire was administered with the aim of exploring the effectiveness of basic education. Information from this study may be useful to assess critical points and therefore to plan the application of targeted measures in the educational process of healthcare students, in order to assure the adoption of proper behaviour from the beginning of their future jobs.

METHODS

Study Design

This cross-sectional study was conducted in two training periods: March-June 2011 and November 2011-February 2012. A convenience sample of 100 medical and 100 nursing students attending practical training at the University Hospital of Modena was recruited. The courses were of 6 and 3 years duration respectively. The internship of the Medicine course started at the third year and that of Nursing Sciences at the first, thus involving 440 (110 students/year) and 450 (150 students/year) total students, respectively. The recruitment was carried out weekly, involving the first 10 students reaching the changing room in the early morning. A single student could not be observed more than once. To assess bacterial contamination, an initial hand swab was collected from all participants before entering the ward, and a second one at the end of the training shift, when an anonymous questionnaire was administered and returned in a sealed envelope numbered according to the hand swabs.

The study was performed in accordance with the principles of the Declaration of Helsinki. All participants signed a written informed consent. The study was approved by the Medical School Board and by the authorities at the University Department where the authors work.

Microbiological procedures

Samples from the dominant hand of participants were obtained by swabbing fingers and palms. Swabs were collected by a unique trained researcher with the help of sterile cotton buds, soaked in 0.85% saline solution [14]. Samples were immediately transported to the laboratory for the determination of Heterotrophic Plate Count (HPC) at 37 °C by the pour plate method using standard Plate Count Agar (PCA, Oxoid). Potentially

pathogenic organisms such as coagulase-negative staphylococci (CNS), micrococci, *Staphylococcus aureus, Pseudomonas aeruginosa,* enterococci and coliforms, were also tested by standard cultural methods and confirmed with appropriate biochemical tests. Colonies were counted at 24h and 48h. Results were expressed as the number of colony-forming units (CFU)/hand.

Questionnaire

The questionnaire was designed specifically for the purpose of the study. It comprised 34 semi-structured questions, and it was organized in three parts. The first intended to gather information about the morning shift just concluded: department attended, activities carried out, tools employed, HH procedures applied (hand washing and/or hand rubbing) and other protective devices adopted, such as gloves, goggles and masks. The second part concerned the knowledge of HH acquired during the course, and consisted of six questions addressed to the following topics: when to perform HH, who is protected by proper HH, technique and duration of the procedures, usefulness of proper hand hygiene in hospital and relationship between HH and nosocomial infections. In the final part, general information on age, gender and year of the course were collected.

Statistical analysis

Statistical analysis was performed using SPSS software 20.0 (SPSS Inc, Chicago, Il). For knowledge items, a score of one was given for each correct answer, and a total score was calculated ranging from 0 to 6 with increasing knowledge. Logarithmic transformation was used in statistical analysis to normalize the non normal distribution of the microbiological data, and the results are presented as geometric mean values. Differences between nursing and medical students HH practices and knowledge were tested by Chi-squared-test (X^2) for categorical parameters, and with Student's t-test and one-way analysis of variance (ANOVA) F-test for continuous variables. Student's t-test and ANOVA were also applied to analyze the effects of HH compliance and HH procedures on hand

contamination. Paired t-test was applied to test differences between bacterial contamination before-after the morning training.

RESULTS

Questionnaire

Seventy-six percent of nursing students and 56% of medical students were female (p = 0.003). The mean age (+SD) was 24.2 ± 5.4 years and 23.7 ± 1.9 years, respectively. Twenty-six nursing students were in the first year of their course, 33 in the second and 41 in the last year. Distribution of medical students was the following: 15 in the third year, 38 in the fourth, 10 in the fifth and 37 in the sixth year. Morning training shift duration differed: all nursing students attended hospital wards for 6 hours, whereas medical students had a 2 or 3 hour (58% and 39%, respectively) training shift, according to the ward organization. Table 1 summarizes the hand hygiene practices declared by the examined students. All nursing students performed at least one HH practice compared to 61% of future physicians (p < 0.001). Moreover, the frequency of traditional hand washing, hand rubbing and use of gloves was significantly higher in nursing than in medical students. Significant differences by discipline were also observed in HH adherence at the ward entry and exit.

Among nursing students, a wide spectrum of patient care was declared: the patient's personal hygiene, wound treatment, distribution of medicines, instrument contact, collection of specimens, contact with biological fluids, consultation of case history and the use of invasive instruments. As a result, 58% of nursing students performed three or more different types of activity. On the contrary, 74% of medical students declared only a single type, mainly "observation during ward round" (56.1%).

Concerning HH knowledge, nursing students had a slightly significantly higher mean score compared to medical students (4.77 ± 0.79 vs 4.53 ± 0.73, p = 0.027), ranging from 3 to 6 for both groups. The least known item by both groups was "HH requires specific technique and duration of the procedures", as 60% of nursing and 70% of medical students answered incorrectly. A significant difference between the two groups was observed only

TABLE 1

HAND HYGIENE (HH) PRACTICES AND CLINICAL ACTIVITIES FREQUENCIES: COMPARISON OF THE TWO GROUPS				
		DISCIPLINE		
HH PRACTICES		NURSING (n=100)	MEDICINE (n=100)	p VALUE
AT LEAST ONE PRACTICE	(%)	100	61	<0.001
HAND WASHING	(%) once twice three or more times	99 2.0 12.1 85.9	30 63.3 16.7 20.0	<0.001 <0.001
HAND RUBBING	(%) once twice three or more times	80 5.0 21.2 73.8	47 38.3 31.9 29.8	<0.001 <0.001
GLOVES USE	(%) 1-3 pairs 4-10 pairs 11-20 pairs > 20 pairs	95 3.1 45.3 37.9 13.7	7 85.7 14.3 0 0	<0.001 <0.001
HH AT THE ENTRY	(%)	75	27	<0.001
HH AT THE EXIT	(%)	76	24	<0.001
TYPES OF ACTIVITY	(%) one type two types three types four types five types	10 32 37 18 3	74 21 5 0 0	<0.001

TABLE 2

MEAN SCORES OF HH KNOWLEDGE ACCORDING TO SELF-REPORTED HH PRACTICES IN THE OVERALL GROUP			
		HH KNOWLEDGE SCORE	
HH PRACTICES		MEAN ± SD	p VALUE
HH AT THE ENTRY	YES (102) NO (98)	4.85 ± 0.79 4.44 ± 0.69	<0.001
HH AT THE EXIT	YES (100) NO (100)	4.75 ± 0.74 4.55 ± 0.78	0.066
HH	hand washing and hand rubbing (95) only one procedure (66) none (39)	4.80 ± 0.79 4.52 ± 0.73 4.51 ± 0.72	0.031
GLOVES USE	YES (102) NO (98)	4.79 ± 0.77 4.50 ± 0.74	0.007
HH IN CLINICAL PRACTICE	always/frequently (167) hardly ever/never (33)	4.71 ± 0.79 4.36 ± 0.60	0.007

for the awareness of HH as a tool for self-protection (72% of nursing vs 39% of medical students gave the correct answer, p < 0.001).

Table 2 shows the HH knowledge scores in the overall group (n = 200) in relation to the self-reported practices. Mean scores

FIGURE 1

SELF-REPORTED OPINION ON HH EDUCATION ACQUIRED
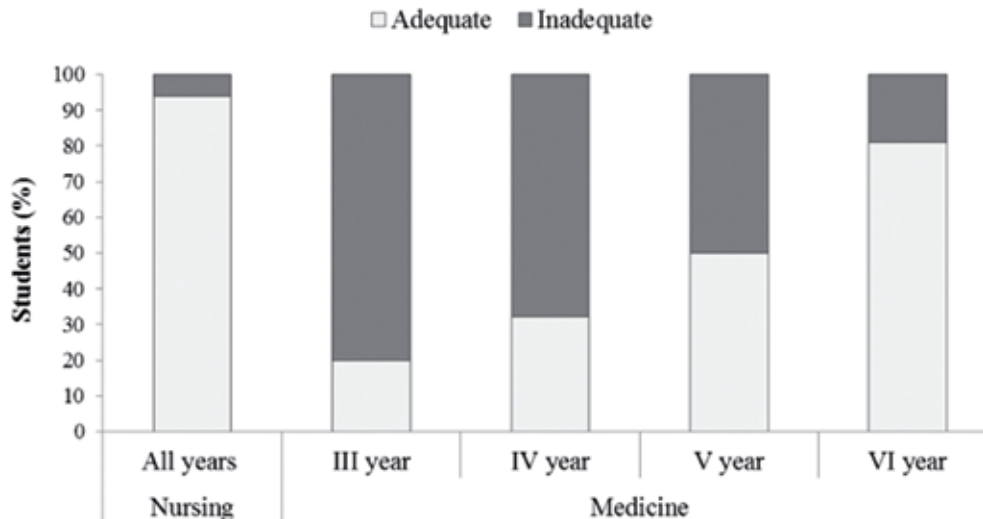
were significantly higher in students who applied HH compared to those not applying it, particularly at the ward entry. The lowest scores were measured in those who declared hardly ever/never implementing HH teaching during daily practice.

Students were asked to give their opinion on HH education received during academic courses (Figure 1). Ninety-four percent of nursing students stated that they received adequate HH theory teaching, with no difference among the years of course. Only 50% of medical students, instead, considered the HH education appropriate, but a significant increase in adequacy was found from third to sixth year of course (p < 0.001).

Bacterial contamination

All collected swabs (200 before and 200 after training shifts) were culture positive. Total number of bacterial (HPC) before training ranged from 23 to 157.750 CFU/hand (median, 1000) and from 20 to 776.875 CFU/hand (median, 450) at the end of training. The predominant flora was normal skin flora: coagulase-negative staphylococci and *Micrococcus* species, together hereinafter named as gram-positive cocci. Among pathogens, only *Staphylococcus aureus* and *Enterococcus* spp were recovered. S. aureus (25 - 450 CFU/hand) was isolated from 30 swab samples (7.5%): 19 at the entry

(median, 187.5) and 11 at the exit (median, 40.0). *Enterococcus* spp were isolated only in 5 samples at the entry and in 1 at the exit, ranging from 25 to 125 CFU/hand.

Gram-positive cocci counts were higher before the training shift than after, but the reduction was significantly stronger for nursing than for medical students (geom. mean 756.5 vs 204.1 CFU/hand, $p < 0.001$ and 946.0 vs 514.6 CFU/hand, $\underline{p}$ = 0.031, respectively).
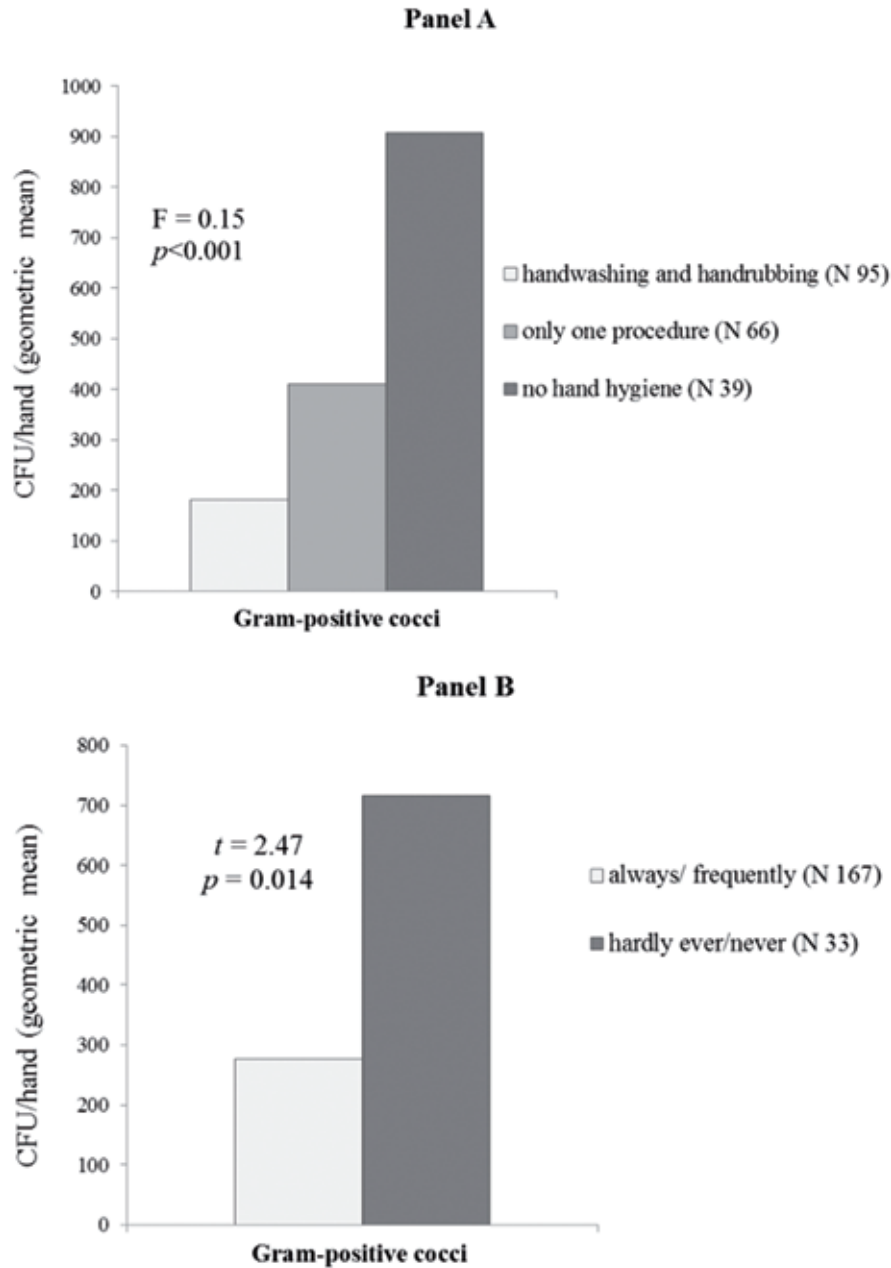
Figure 2 shows hand contamination of the overall group at the exit from the ward according to HH procedures and self-reported compliance. Gram-positive cocci count was significantly higher in the absence of HH practices, and the most effective procedure in reducing bacterial contamination was the alternate use of hand washing and hand rubbing (Panel A). Hand contamination was significantly higher in students who declared to hardly ever/never implement HH teaching during clinical practice compared to those who stated having done it frequently/always (Panel B).

DISCUSSION

This study faces three relevant aspects of hand hygiene in order to reduce nosocomial infection risk: the effectiveness of education in healthcare students, the weight of knowledge in the application of appropriate practices during clinical training, and the relationship

FIGURE 2

HAND CONTAMINATION AT WARD EXIT ACCORDING TO HH PROCEDURES (PANEL A) AND SELF-REPORTED HH COMPLIANCE (PANEL B)

Panel A

$F = 0.15$
$p < 0.001$

□ handwashing and handrubbing (N 95)
■ only one procedure (N 66)
■ no hand hygiene (N 39)

Gram-positive cocci

Panel B

$t = 2.47$
$p = 0.014$

□ always/ frequently (N 167)
■ hardly ever/never (N 33)

Gram-positive cocci

between HH and hand bacterial contamination.

Our examined sample, although not representative of the entire student population, showed a distribution in gender and age similar to those found in another investigation recently carried out on these groups [15]. We found that nursing students were more likely to have a higher level of HH knowledge, to have a higher perceived risk of acquiring a HCAI, and

reported better HH compliance than medical students, confirming previous investigations [16-18]. The undergraduate nurses received HH education right from the beginning of their course, and consequently were accustomed to applying HH practices during training activities. This approach is mandatory as these students are professionally trained to execute the entire spectrum of basic nursing activities during their

3-year course. The role of mentors and teachers appears of primary importance in increasing student's awareness of the risk of nosocomial acquired infections and the need for effective hand hygiene compliance, as documented in other studies [19,20]. In Italy, medical students generally attend hygiene and public health teaching during the fifth/sixth year course with a delay in proper knowledge of HH practices, as documented in our investigation (Figure 1). We stress the opportunity to anticipate the teaching of basic hygiene when students begin clinical training. The limited HH performed by the examined medical students may also depend on the rare occasions of patient contact as the most frequent clinical activity deducted by the questionnaires was *"observation during the ward round"*, a tradition which nowadays should give way to a more appropriate professional training.

Concerning student's knowledge, HH techniques and duration of the procedures are not clearly known by both groups, as reported in another recent study [21]. In our opinion, these issues of HH have to be reinforced in the basic educational program, including pragmatic presentations of effective hand hygiene during the lessons, and feedback from teachers at the bedside. In our study, the relevance of knowledge on the practical application of HH is confirmed [16]. Students declaring to have not or rarely implemented any hand disinfection/washing are those who achieved the lowest score in HH knowledge. Similarly, low scores resulted in students stating lack of hand washing and/or hand rubbing at the ward entry. Proper hand hygiene at this moment represents another aspect which requires reinforcement during the educational programs, especially within the medical studies curricula.

A self-report questionnaire may be a critical point in the assessment of the effective HH application, because students can overestimate their compliance [13]; for this reason we introduced the measure of hand bacterial contamination to corroborate information obtained by questionnaire. A decreased microbiological load was found at the end of the training shift, more relevant for nursing than medical students, despite the former group being heavily involved in many clinical activities. We support the conclusion that the reduction is linked to HH practices, as higher self-reported HH frequency was clearly associated with a reduction in contamination (Figure 2, Panel B). Both bacterial contamination levels and microbe species are in line with the results of other investigations, despite the different method of sampling [22-24]. The swabs collection, conducted by a single trained operator, was decided on the basis of feasibility: this method being simple, quick, sensitive and able to isolate and to quantify many different microorganisms with a single specimen. It permits the sampling of large numbers of subjects with little disturbance even in a busy hospital environment [25].

A number of experimental studies examined the adequacy of hand cleansing by microbiological proof [26-28]. Our field-study seems to confirm the experimental data demonstrating the reduction of hand contamination after proper application of alcohol-based hand rub and/or soap and water. From our results, the alternate use of the two procedures was proved to be the most effective in reducing bacterial contamination, and we agree with the need to use both, depending on time, opportunity, accessibility and hand soiling degree (Figure 2, panel A) [8].

A possible limitation of our study includes the use of a non-validated questionnaire. Our questionnaire was designed ad-hoc to be administered in the field, in order to collect an amount of information in the shortest time, such as training activities and HH practices performed during the morning clinical practicum as well as general knowledge about hand hygiene, thus requiring a brief and simplified tool. More detailed questionnaires have been recently designed but are mainly devoted to deepening the knowledge of HH and in many cases take time to be filled out [16,17]. Although our questionnaire wasn't validated, it was developed after an accurate literature review and consulting expert opinions; final content, comprehensibility, clarity, and format were assessed conducting a pilot study [29].

Other limitations are that the study does not distinguish between hand hygiene attempts and proper hand hygiene, it also does not directly link bacterial contamination with both clinical activities and hygiene practices. These limitations could be overcome only by the direct observation of actual practice, although the effect of being monitored may improve compliance by itself [18]. On the other hand our microbiological results, obtained

from a consistent number of subjects, are in agreement with the students' statements, thus demonstrating their internal validity.

CONCLUSIONS

Our investigation adds something new to the topic of HH that is the measure of bacterial hand contamination to verify the reliability of the information obtained by questionnaire. The findings, while pointing out some critical aspects in HH teaching among healthcare students, highlight that solid knowledge results in correct behaviour and consequently in a reduction of hand bacterial contamination.

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