

Surveillance of nosocomial infections: a preliminary study on hand hygiene compliance of healthcare workers

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Key words

Handwashing • Hand hygiene compliance • Transient flora • Microbiological hand contamination

Summary

The observance of hand hygiene compliance is important to reduce cross-infection by micro-organisms. The aim of this preliminary study was to evaluate the level of hand hygiene in healthcare workers from different departments, with particular emphasis on transient flora. The study was conducted in three departments (Surgery, Intensive Care Unit, Obstetrics and Gynecology) of a hospital in Campania, southern Italy. Over a six-month period, 50 healthcare workers were randomly tested. Imprints of palms and fingertips were taken monthly during the morning shift. The number of colonies per plate was counted and transient pathogens were identified. Risk factors for hand

contamination were determined. Total flora was found in the following CFU means per palm and per five fingertips (95% CI): Obstetrics and Gynecology [palms 130 CFUs (95% CI 85-180); fingertips 125 CFUs (95% CI 92-160)]; ICU [palms 80 CFUs (95% CI 58-99); fingertips 62 CFUs (95% CI 45-82)]; Surgery [palms 75 CFUs (95% CI 41-120); fingertips 70 CFUs (95% CI 52-90)] Transient flora was found on 39% of healthcare workers' hands.

The only factor associated with hand contamination by transient flora was the absence of gloving during healthcare procedure ($P = 0.02$).

Introduction

Hand washing by clinical staff is the single most important measure to prevent hospital-acquired infection [1-3]. Compliance with handwashing using soap and water by healthcare workers has been measured as below 50% in most observational studies in European and American hospitals [4]. The micro-organisms on human skin can be divided in two groups, transient flora and permanent flora. Transient flora organisms were defined as all organisms except *methicillin-resistant coagulase-negative staphylococci* [5] whereas *Corynebacterium sp.*, *Micrococcus sp.* and *Bacillus sp.* were not considered to be transient pathogens [6], as it is the case with our study. Nearly all the causative micro organisms of infectious diseases belong to the transient group [7]. It has been reported that the transient micro-organisms found on hands vary significantly according to the surfaces contacted, and that there are micro-organisms characteristic for skin, the respiratory system, stools, and the peri-anal region [8].

Gloving is recommended as a barrier protection for healthcare workers (HCWs) to reduce the risk of contamination during contact with body fluids, mucous membranes or the damaged skin of patients [9-11]. When used properly, gloving may also reduce cross-transmission of micro-organisms from healthcare workers' hands [12-15]. In a study evaluating the dynamics of bacterial contamination of the hands of healthcare workers in daily hospital practice, the wear-

ing of gloves was associated with a marked reduction of bacterial contamination of hands [16]. However, when gloves are not removed after each contact, they become a "second skin" and expose patients to cross-transmission of micro-organisms [10, 17-20].

Therefore, our preliminary study carried out on healthcare workers in 3 departments of a hospital (high beds capacity) located in a health care district of the Campania region, has evaluated the level of hands' microbiological contamination, with particular emphasis on transient flora, and has determined the risk factors for hand contamination.

Materials and methods

The study was conducted in three departments: Surgery, Intensive Care Unit, Obstetrics and Gynecology between January and July 2005.

HEALTHCARE WORKERS

A total of 50 HCWs were monitored in this study (28 females, 22 males); for details concerning their number in each department and their categories see Table I.

MICROBIOLOGICAL SAMPLES AND PROCESSING

Imprints of the two palms and relative fingertips of the healthcare workers were taken after each healthcare procedure or during routine clinical work. If the healthcare worker had performed patient care with gloves,

Tab. I. Number of HCWs for departments and categories.

Category	Departments					
	Surgery		Intensive care Unit		Obstetrics and Gynaecology	
	Males	Females	Males	Females	Males	Females
Physician	4	2	2	1	3	3
Nurse Assistant	4		2	1		4
Nurse	4	4	2	1		8
Radiology technician	1	1				
Stretcher-bearer				1		2
	13	7	6	4	3	17
	20		10		20	

these were removed before the sampling. Both palms and relative fingertips were pressed on to blood agar plates (one for each palm and one for each group of five fingertips) for 20", with the observer helping to achieve identical pressure. The samples were carried out between 09:00 and 11:00 a.m. since these were the times when the most intensive work occurred.

Plates were incubated aerobically at 37 °C for 48 h. Colonies were counted at 24 h and 48 h. No anaerobic cultures were performed. Results were expressed as the number of colony-forming units (CFUs) per palm and per fingertips. The maximum count was 300 CFUs/plate. Beyond this figure, confluence was considered and a bacterial count of 350 CFUs was assigned to sample. Micro-organisms were identified using standard procedure, and the susceptibility of pathogenic bacteria to antibiotics was determined. Micro-organisms other than coagulase-negative staphylococci, *Corynebacterium sp.*, *Micrococcus sp.* and *bacillus sp.*, were considered to be transient flora and therefore, potentially pathogenic organisms.

STATISTICAL ANALYSIS

Statistical analyses were carried out with STATS DIRECT program (STATS DIRECT Ltd version 2,4,4). Descriptive statistics regarding all the variables were given as geometric mean with 95% confidence intervals (95% CI). Uni-variate analysis was performed to detect predictors among variables. Multivariate analysis was then performed, including variables with $P < 0.1$ in unvaried analysis. Chi-square or Fisher's exact tests were used as appropriate to test for proportion difference. Values of $p < 0.05$ were considered as statistical significant [21].

Results

A total of 1,200 specimens (600 palms and 600 fingertips) obtained after healthcare procedure or during routine clinical work, were analyzed. The geometric mean number of CFUs was 95 [95% confidence intervals (CI) 70-120] for palms and 87 [95% CI 60-114] for fin-

gertips. Factors associated with increased hand contamination (total flora) after healthcare procedure or during routine clinical work are shown in Table II. Hand contamination for both palms and fingertips significantly increased in HCWs working in the Obstetrics and Gynecology department [palms 130 CFUs (95% CI 85-180); fingertips 125 CFUs (95% CI 92-160)] compared with ICU [palms 80 CFUs (95% CI 58-99); fingertips 62 CFUs (95% CI 45-82)] and Surgery [palms 75 CFUs (95% CI 41-120); fingertips 70 CFUs (95% CI 52-90)] and when HCWs did not wear gloves during the health care procedure: wear gloves [palms 45 CFUs (95% CI 35-56); fingertips 42 CFUs (95% CI 30-55)]; no wear gloves [palms 87 CFUs (95% CI 63-121); fingertips 90 CFUs (95% CI 68-112)]. By uni-variate analysis, there was no significant difference in hand contamination regarding sex and job title of HCWs. Hand contamination was lower after direct contact with patients compared with contact with patients' environments, but the difference was not significant. By multivariate analysis, working in the Obstetrics and Gynecology department rather than in the ICU department or in the Surgery department was significantly associated with increased hand contamination for both palms and fingertips ($P = 0.025$ and $P = 0.02$, respectively). Glove wearing during the procedure was associated with reduced hand contamination for fingertips ($P = 0.02$); for palms, the contamination was also reduced with gloving, but the difference was not statistically significant ($P = 0.058$).

Transient pathogens were recovered from 39% of HCWs hands (52% males, 28% females) see Table III. Specifically, they were recovered from 45% of physicians' hands, from 25% of nurse assistants' hands, from 15% of nurses, from 10% of stretcher-bearers and from 5% of the radiology technicians' hands; however, the difference between all categories of HCWs was not significant ($P = 0.18$). The absence of gloving during healthcare procedure was the only factor associated with hand contamination by transient pathogens ($P = 0.02$ in multivariate analysis).

Transient flora was isolated from 468 specimens obtained from 21 different HCWs (ten physicians, five

Tab. II. Risk factors associated with total microbial hand clinical routine work. N = Number of samples.

Variables	Mean* CFU (95% CI) per palm	P-value univariate	P-value multivariate	Mean* CFU (95% CI) per five fingertips	P-value univariate	P-value multivariate
<i>Type of department</i>						
ICU (N = 120)	80 (58-99)			62 (45-82)		
Surgery (N = 240)	75 (41-120)	0,018	0,025	70 (52-90)	0,008	0,02
Obstetrics and Gynecology (N = 240)	130 (85-180)			125 (92-160)		
<i>Job title</i>						
Physician (N = 132)	120 (72-170)	0,85		128 (79-180)	0,63	
Nurse assistant (N = 132)	93 (49-153)			96 (52-142)		
Nurse (N = 228)	78 (37-122)			65 (43-90)		
Radiology technician (N = 24)	82 (35-132)			70 (42-100)		
Stretcher-bearer (N = 36)	158 (75-263)			145 (80-220)		
<i>Sex</i>						
Male (N = 264)	116 (62-170)	0,55		120 (74-172)	0,49	
Female (N = 324)	84 (47-132)			78 (50-110)		
<i>Healthcare procedure</i>						
Contact with patient (N = 510)	69 (35-105)	0,15		65 (45-90)	0,32	
Contact with environment (N = 90)	118 (74-162)			120 (48-200)		
<i>Gloving during procedure</i>						
Yes (N = 290)	45 (35-56)	0,022	0,058	42 (30-55)	0,019	0,2
No (N = 310)	87 (63-121)			90 (68-112)		

* Geometric mean.

nurse assistants, three nurses, two stretcher-bearers and one radiology technician). Some transient organisms were isolated from both the palms and fingertips of the same hand, others either from palms or fingertips only.

The species that were identified are reported in Table IV. Among these pathogens, out of the nine *S. aureus* isolated, three were methicillin-resistant. Moreover, the following species were found with higher frequency:

Tab. III. Risk factor associated with transient microbial hand flora in 50 healthcare workers during clinical routine work.

Variables	Number of samples with transit flora*/ all samples	Percentage (%)	P-value univariate	P-value multivariate
<i>Type of department</i>				
ICU	60/240	25		
Surgery	168/480	35		
Obstetrics and Gynecology	240/480	50	0,5	
<i>Job title</i>				
Physician	211/360	59	0,18	
Nurse assistant	117/264	44		
Nurse	70/456	15		
Radiology technician	23/48	47		
Stretcher-bearer	47/72	65		
<i>Sex</i>				
Male	280/528	52	0,3	
Female	188/672	28		
<i>Healthcare procedure</i>				
Contact with patient	388/970	40	0,4	
Contact with environment	80/ 230	35		
<i>Gloving during procedure</i>				
Yes	68/580	11%	0,06	0,024
No	400/620	64%		

* Transient flora was defined as any pathogen other than coagulase-negative staphylococci, *Corynebacterium* sp., *Micrococcus* sp. or *Bacillus* sp.

Tab. IV. Species identified.

Bacteria	Number of times found
Staphylococcus Aureus	9
Staphylococcus epidermidis	170
Enterobacter agglomerans	300
Yersinia pseudotuberculosis	240
Yersinia putida	130
Escherichia coli	370
Acinetobacter anitratus	340
Acinetobacter baumannii	30
Citrobacter freundii	80
Shigella boydii	200
Morgenella morgani	55
Streptococcus salivaris	40
Micrococcus	28
Pseudomonas aeruginosa	20
Pseudomonas putida	180

Enterobacter agglomerans, *Yersinia pseudotuberculosis*, *Escherichia coli*, *Acinetobacter anitratus*, *Shigella boydii*, *Staphylococcus epidermidis*.

The *Shigella boydii* species was found in the last period of our study (possible outbreak going on), and with higher frequency on HCWs hands that worked without wearing gloves.

Discussion

Almost all studies concerning hand washing have indicated that the frequency of hand washing of healthcare workers was lower than required. Our preliminary study carried out in three departments of a hospital (high beds capacity) located in a health care district of the Campania region, during routine hospital practice, has shown a higher workers' hand contamination. Fifteen per cent of HCWs hands were found contaminated with at least one pathogen belonging to transient flora during clinical routine work. Among the category, the

physicians has shown the higher mean of CFU per palm and fingertips, followed by nurse-assistants, the lower mean was found in the nurses' category. The transient flora was found more on physicians' hands (60%). Data about carriage of transient pathogens on the hand of staff are available from some recent study [22, 23].

In this study were also analyzed which factors could influence hand contamination in routine practice. Working in an ICU or Surgery department rather than in an Obstetrics and Gynecology department was significantly associated with increased hand contamination. The link between HCWs hand contamination and hospital department location was described in some studies [16, 22]. The explanation for this is unclear. It would be of interest to compare the compliance with standard precautions of HCWs working in these three types of departments, to determine whether this high microbiological load is related to different practices involving hand hygiene and gloving. In our preliminary study, gloving was significantly associated with a reduction in the total microbiological load recovered on hands (only on fingertips in the multivariate analysis), and was a protective factor against the presence of any transient pathogen on hands. The effectiveness of gloving in prevention of hand contamination has been observed [16] particularly when multi-drug-resistant pathogens are involved [14], though the impact of wearing gloves on compliance to hand hygiene has not been definitively established, because published studies have yielded contradictory results [18, 24-27]. However, HCWs need to use gloves carefully. As protection has been shown to be incomplete [28], they should remove their gloves immediately after patient care [27], and perform a hand hygiene procedure immediately after glove removal.

In conclusion, our preliminary study has shown a high level of hands' microbiological contamination on HCWs; this once more emphasizes the importance of the observance of hand hygiene compliance. Careful use of gloving may reduce microbiological contamination of hands, particularly with multi-drug-resistant pathogens, but cannot eliminate it.

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