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Original Research Article

Hand hygiene compliance of health care workers in a neonatal intensive care unit: a prospective observation study

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ABSTRACT

Background: We aimed to determine hand hygiene (HH) compliance of the healthcare workers (HCW's) and evaluate if there is an epidemiological relation between the microorganisms isolated from the hands of HCWs and patients clinical materials in the neonatal intensive care unit (NICU).
Methods: HH compliance was observed in two unannounced phases in March and in August within the scope of 5 indications determined by WHO. Between two phases personnel was trained to improve HH by educational sessions and introduction of Semmelweis system hand in scan (HIS, Sysmex) in the unit. A total of 22 nurses, 11 physicians and 5 staff was working in the NICU. Hand samples taken from HCW by glove juice method were inoculated quantitatively in culture plates and colonies were identified by MALDI-TOF MS. Epidemiological relation between clinical isolates and hand samples was investigated with arbitrary primed PCR.
Results: Although overall compliance remained only 50%, a significant increase in compliance was detected in August prior to aseptic procedures and after contact with patients and body fluids. Alcohol scrub was preferred as 60.4% in March and 75.2% in August. HH efficacy reached to 72% by implementing HIS. During this period, 10.7% of 607 patient's samples revealed clinically significant growth. Potential pathogens were isolated in 5.2% of 144 hand samples, but any epidemiological correlation with patient isolates was detected.
Conclusions: HH compliance observations should be done at regular intervals and current technology could be utilized in trainings to overcome hospital related infections.

Keywords: AP-PCR, Gloves juice method, Hand hygiene, Neonatal intensive care unit

INTRODUCTION

Hospital-acquired infections (HAIs) increase morbidity and mortality of the patients, prolong hospital stay and thus increase costs.[1,2] Microorganisms that are known to be the cause of hospital infection are transmitted to the hands of healthcare workers (HCWs) during direct contact with patients or contact with surrounding areas and are carried in the temporary flora of their hands. Despite the relative simplicity and the effectiveness of this procedure, HAIs continue to be one of the greatest challenges and continuous surveillance remains the mainstay to follow compliance.[3]

HAIs persist as a major problem in most neonatal intensive care units (NICU). Neonates are susceptible to infection due to their immature host defence and they also occupy an environment in which frequently used antibiotics and invasive interventions often permit the invasion of common nosocomial pathogens. The most common infections are ventilator-associated pneumonia and bloodstream infections.[4] In developing countries the incidence rate of HAIs ranges from 6 to 9%.[5,6] The incidence of HAI was reported 4.9% to 16.4% in Turkey.[7,8]

Several practices such as isolation of infected patient, expansion of compliance with hand hygiene, increased environmental cleanliness, and efficient catheter maintenance have been demonstrated to reduce HAIs in NICU.[9] The effect of the training for hand hygiene feedback to control the HAI density rates have been demonstrated to reduce 2.24%.[10]

In a study conducted in the NICU in our hospital in 2013, overall compliance to hand hygiene among HCWs was 37% and since then a tremendous effort was spent to improve hand hygiene practice in the unit.[11] We aimed to evaluate the current situation of the hand hygiene compliance in the same unit and to improve our practice in light of current data.

METHODS

Study type

This study was a prospective observational study for following hand hygiene compliance in neonatal intensive care unit (NICU). Patient's clinical isolates were obtained simultaneously from microbiology laboratory. Study was approved by Marmara University Faculty of Medicine Ethics Committee (2018.70) and informed consent was obtained from all participants.

Observation study

Observational hand hygiene data were collected in NCIU of Marmara University Pendik Hospital, Istanbul, Turkey. In two unannounced phases consisting March and August 2019, 739 and 320 contacts were evaluated respectively. One hour observation periods were randomized to different working shifts (07:00-16:00 and 16:00-07:00) including weekends and holidays. The NICU has a two-stage entrance, three patient rooms, and one isolation room in an affiliated unit. The unit has a total bed capacity of 14, four sinks, and 13 hand sanitizers. Hand washing sinks are available at the entrance of each room, and alcohol-based disinfectants are present at each bedside. Twenty-three nurses, 11 physicians, and five personnel serve as HCWs in the unit.

A trained observer who was unknown to the staff followed the hand hygiene activity. Observation of hand hygiene practices was carried out among nurses, physicians and personnel. There was no exclusion criteria for any of the staff during the observation period. The moments of opportunity for hand hygiene (HH) were based on the World Health Organization (WHO) HH guidelines definitions. The definition of before contact included the first two WHO moments (1) before touching a patient (e.g., handshaking, helping the patient move, examination); and (2) before a clean or aseptic procedure (e.g., oral/dental care, aspiration, dressing, catheter placement). After contact was defined by the last three WHO moments: (3) after exposure to patient body fluids (e.g., exhalation aspiration, blood collection and manipulation, urine/fecal cleaning); (4) after touching a patient; and (5) (handshake, clinical examination) after touching the patient and surroundings (e.g., changing bed sheets, adjusting perfusion rate). The time spent by the health personnel who performed HH was also recorded.

Hand sampling

A hand sampling method described in the American Society for Testing and Materials Standard Test Method E1115-10 was used to recover bacteria from the HCW's hands.[12] Briefly, a sterile, powder-free surgical glove was placed on the dominant hand of the participant, and 50 mL sterile sampling solution (0.075 mol/l phosphate buffer, pH 7.9, containing 0.1% polysorbate 80, 0.1% sodium thiosulfate, and 0.3% lecithin) was added to the gloves. The glove was secured at the wrist with a tourniquet, and the gloved hand was uniformly massaged for 1 minute by the research staff. While the glove remained on the hand, just over 50 ml sampling solution was aseptically removed from the glove and placed in a sterile sample cup. After sampling, the participants washed their hands to remove any residual sampling solution. Sex, HCW groups, age, years of experience, last performed HH were recorded.

Bacterial identification from hand sampling

The solution was centrifuged at 10,000 g for 10 minutes and then the supernatant was discarded. The pellet was resuspended and 10 µl of the sample was plated on 5% sheep blood agar and MacConkey agar after incubation at 37°C for 48 hours, and colonies were identified using MALDI-TOF MS.

Clinical samples

Clinical materials that were sent to the microbiology laboratory were inoculated in conventional media and colonies were identified using MALDI-TOF MS.

Genotypic analysis

To determine the similarity of the shared clones, genomic DNA was extracted from isolates using a commercial genomic DNA purification kit (QIAamp DNA mini kit QIAGEN) according to the manufacturer's procedure. Arbitrary primed polymerase chain reaction AP-PCR was used with the presence of primer M13: 5'-GAG GGT GGC GGT.[13]

Semmelweis system hand in scan

HIS is a new system that was developed to assess the accuracy of alcohol-based disinfectant use and based on the principle of ultraviolet (UV) scanning of the hands after use of alcohol-based disinfectant with a fluorescent dye.[14] If more than 95% of the hand surface has reached the antiseptic, it is accepted as an efficient hand hygiene technique. Random screening was performed in HCWs

after 3-5 ml alcohol-based hand disinfectant was applied as suggested by the manufacturer (Aniosrub 85 NPC). Then, the participant placed their hands in the scanner area of the device and the scan that resulted after about 30 seconds was saved by the system.

Statistical analysis

The data were initially recorded on paper and then entered directly into Microsoft Excel. Analysis was done using SPSS version 18.0 software and statistical significance was defined as a p value of less than 0.05. Analyses of all variables were conducted overall, and the results presented by frequencies and percentages. Chi-square analysis was used to categorical variables.

RESULTS

In March, 739 contacts were evaluated, and the HH compliance rate was found as 52% in nurses, 42% in physicians, and 50% in health personnel. In August, 320 contacts were evaluated, and the HH compliance rate was found as 49% in nurses, 60% in physicians, and 42% in health personnel. During the observation period, only 43 (5.8%) of the contacts in March and 63 (19.6%) of the contacts in August were performed by physicians, indicating that nurses were the primary HCWs in the unit.

Table 1: Hand hygiene compliance of health care workers (physicians, nurses, health care personnel) in neonatal intensive care unit.

	March	August	P value
Prior to patient contact	15.2%	13.1%	P=0.129
Prior to clean or aseptic procedures	2.6%	6.3%	P=0.001
After contact with body fluids	1.2%	3.8%	P=0.012
After patient contact	14.7%	15.0%	P=0.002
After contact with patient environment	17.5%	13.1%	P=0.129

A significant increase in moments 2, 3 and 4 was detected in August and the staff compliance was improved especially prior to aseptic procedures and after contact with body fluids. In moment 3, when the risk of contamination is highest, the increase after education was statistically significant (Table 1).

When the five WHO moments were recorded alcohol scrub was preferred as 60.4% in March (Table 2) and 75.2% in August (Table 3) for HH. In the 2013 study in the same unit (11), HCWs were more likely to use soap and water (63.6%) compared with alcohol-based HH disinfectant (36.3%), indicating that this percentages had inversely changed. HCWs were now convinced that alcohol-based disinfectants were efficient if the hands are not visibly dirty.

Table 2: Percentages of compliance regarding WHO 5 moments in March.

	Nurse		Physician		Health personnel		P value
	n	%	n	%	n	%	
Prior to patient contact							
Washing[a]	23	11.7	1	9	2	50	
Disinfectant[b]	83	42.3	5	45.5	0	-	0.199
None	90	46	5	45.5	2	50	
Prior to clean or aseptic procedure							
Washing[a]	9	25	1	50	0	-	
Disinfectant[b]	9	25	0		0	-	0.999
None	16	50	1	50	0	-	
After contact with body fluids							
Washing[a]	3	21	0		0	-	
Disinfectant[b]	6	42	0		0	-	0.999
None	5	37	1	100	0	-	
After patient contact							
Washing[a]	61	37	2	25	0	-	
Disinfectant[b]	43	26	3	37.5	0	-	0.747
None	57	37	3	37.5	0	-	
After contact with patient environment							
Washing[a]	44	15	1	4.7	2	50	
Disinfectant[b]	74	26	5	23.8	0	-	0.195
None	159	59	15	71.4	2	50	

a. Handwashing with soap and water; b. Hand hygiene with disinfectant; c. No hand hygiene

Table 3: Percentages of compliance regarding WHO 5 moments in August.

	Nurse		Physician		Health personnel		P value
	n	%	n	%	n	%	
Prior to patient contac							
Washing[a]	5	9	0	-	5	26	
Disinfectant[b]	26	46	10	71	8	42	0.123
None	24	45	4	28	6	31	
Prior to clean or aseptic procedures							
Washing[a]	1	3	1	20	0	-	
Disinfectant[b]	14	46	4	80	0	-	0.050
None	15	51	0	-	0	-	
After contact with body fluids							
Washing[a]	2	11.7	1	10	0	-	
Disinfectant[b]	6	35.3	4	40	0	-	0.999
None	9	53	5	50	0	-	
After patient contact							
Washing[a]	11	21	5	62.5	1	6	
Disinfectant[b]	10	19	3	37.5	5	33	0.017
None	31	60	1	20	9	61	
After contact with patient environment							
Washing[a]	3	8.8	0	-	3	15	
Disinfectant[b]	14	41	10	40	9	45	0.348
None	17	51	15	60	8	40	

a. Handwashing with soap and water; b. Hand hygiene with disinfectant; c. No hand hygiene

In the second observation period, a significant change was recorded in physician contacts before aseptic procedures and after patient contact, which might be due to the strict control of senior physicians. At the same time, a significant difference was observed in the compliance of the physicians after the training at moments 3, 4, and 5. In nurses, there was a significant difference only in changes in moment 1 and moment 5 after training. There was a significant difference after the training of health personnel before and after contact with the patient.

When the application time of HH was recorded in the two observation periods, 60-70% of the HH was performed for less than the suggested application time of 30 seconds. By inserting of Semmelweis HIS system and explaining the procedure in details, we were able to increase efficient hand antisepsis 80% of the physicians, 70% of the nurses, and 58% of the health personnel. Fingertips were the most and palms are the least commonly missing points. We may assume that HCWs are performing proper HH technique by following suggested application times when they are aware that data are being recorded, but this is not a permanent behaviour for them.

Hand sampling

On 11 random days from March to August, 146 samples were collected from the personnel without previous notification. No growth was detected in 44 (30%) and normal flora (coagulase-negative *staphylococcus, diphtheroid, Bacillus spp., Streptococcus spp*.) was detected in 94 (64%) specimens (Table 4). *Pseudomonas spp., Acinetobacter iwoffii, Klebsiella pneumoniae*, as potential pathogens were detected in five samples. There was no significant difference in the statistics between the groups for pathogens showing growth except normal flora ($p>0.05$).

Table 4: Microorganisms isolated from HCW hands.

	Nurse n (%)	Physician n (%)	Health personnel n (%)	Overall n (%)
Number of samples	66 (100)	46 (100)	34 (100)	146 (100)
No growth	25 (37.9)	9 (19.6)	10 (29.4)	44 (30.6)
Normal flora	40 (60.6)	35 (76.1)	21 (61.8)	94 (65.3)
Potential pathogens				
Pseudomonas spp.	-	2 (4.3)[c]	1 (2.9)[d]	3 (2.1)
Acinetobacter spp.	1 (1.5)[e]	-	1 (2.9)[e]	2 (1.4)
Klebsiella spp.	-	-	1 (2.9)[f]	1 (0.6)

Pseudomonas putida (n=2). *Pseudomonas stutzeri* (n=1) *Pseudomonas luteola* (n=3); *Acinetobacter Iwoffii* (n=2); *Klebsiella pneumoniae* (n=1)

Clinical samples

Between March and August, 90 patients were hospitalized in the NICU. During this period, 607 samples were sent to the microbiology laboratory and 65 (10.7%) revealed clinically significant growth. The most common pathogen was *Staphylococcus aureus* (28%), followed by *Enterococcus faecalis* (15.5) and other gram negative bacilli.

Molecular typing

In case of the isolation of same species of bacteria from HCW hands and clinical materials. AP-PCR analysis was done, however any related genotype was not detected in the given period.

DISCUSSION

The most effective measure to prevent nosocomial infections is HH compliance. Effective HH should be performed to prevent the transmission of potential pathogens between the hands of health workers and patients.[15,16]

In our study, the compliance of the HCWs to the WHO indications revealed that the overall rate was 48% in March, and despite all the educational activities, it increased to only 50.3% in August. In March, nursing staff had better adherence to HH compared with physicians. This is in agreement with other studies that demonstrated similar results.[17,18] Only 43 (5.8%) of the contacts in March and 63 (19.6%) of the contacts in August were performed by physicians, indicating that nurses were the primary HCWs who had more contact with patients in the unit. In the second observation period, the compliance of physicians was increased from 42% to 60%, and a significant change was recorded in physician contacts before an aseptic procedure and after patient contact. This may be related to the pressure of senior physicians in the unit and intense training sessions. Nurse compliance decreased from 52% to 49% in August, which could be due to the heavy workload or due to summer holidays of staff.

In an observational study performed at the same unit 5 years ago in our hospital, HH compliance for 704 opportunities was determined as 37% and HCWs were more likely to use soap and water (63.6%) compared with

waterless alcohol-based HH (36.3%). They concluded that adherence to HH practice and use of alcohol-based disinfectant was found to be very low, and effective education programs that improved adherence to HH and the use of disinfectants might be helpful to increase compliance. Indeed, in 2018, when 5 WHO moments were recorded, overall compliance was above 50% and alcohol scrub was preferred in 60.4% of HH attempts in March, and even increased to 75.2% in August.

In cases where hands are not visibly soiled, alcohol-based hand rubs for routine HH in clinical situations is an effective and preferred choice.[19] We investigated the effectiveness of HH by using the Semmelweis HIS system. In the scans, most of the participants had forgotten to rub their fingertips and their fingers. This is in agreement with other studies that demonstrated similar results.[20] In our study, although the use of alcohol-based disinfectants reached nearly 70%, the majority of applicants (69%) remained below the recommended application time, which is 30 seconds. Kramer et al investigated whether a shorter application time of 15 seconds was microbiologically safe in NICUs and might positively influence compliance with the frequency of hand antisepsis actions.[21] They reported that, microbiologically, reducing the application time to 15 seconds had a similar effect when compared with 30-second hand rubbing, but it resulted in a significantly increased frequency of hand antisepsis actions. In our case, we cannot conclude by to advising our personnel to shorten the application time to increase compliance.

Although the success rate of screening with HIS reached 72% in our study, it is clear that this activity, which was conducted under supervision and in front of everyone, did not reflect the actual data. We believe that the HIS system will be more effective if it is used to check people. Szilagyil et al performed a HH education and assessment program targeting 5200 clinical staff over 7 days.[14] Participants in small groups were guided by professional trainers through five educational stations, which included technique-training and UV light assessment supported by digital photography of hands. Despite the assessment taking place immediately after the training, only 72% of staff achieved satisfactory coverage.

The glove juice method is a simple, easy, and practical technique for the determination of colonization of hands of HCWs, which can be adapted as a methodology for screening the hands of HCWs. Out of 157 samples taken from the hands of HCWs, 67 (42.7%) showed growth and 97 (57.3%) showed no growth. Similarly, Visilachy et al reported the growth of potential pathogens in 8.3% of hand samples.[22] In case of the isolation of same species of bacteria from HCW hands and clinical materials. AP-PCR analysis was done, however any related genotype was not detected in the given period. Waters et al sought to characterize the molecular epidemiology of Gram-negative bacilli (GNB) causing infections in infants and associated with carriage on nurses' hands after HH was performed.[23] Only 9% of strains that caused infections were cultured from nurses' hands. The majority of clones were unique and were not shared among infants, among nurses, or between infants and nurses. These data suggest that practices beyond HH are needed to prevent horizontal transmission of GNB in the NICU.

Ferng et al performed a multicenter surveillance study to determine the rates of hand carriage of potential pathogens among healthcare personnel in four NICUs over two years.[24] Although only 12% of subjects carried potentially pathogenic flora, few were antimicrobial-resistant, the majority were colonized with CoNS, which is considered normal skin flora. Nevertheless, we cannot exclude transmission of potential pathogens via HCWs hands since because we did not screen continuously. More frequent culturing may have isolated a greater number of shared strains, or we may have found more shared strains if we had cultured hands before rather than after HH because nurses may carry organisms on their hands transiently.

Jamal et al used multimodal HH in a pediatric hospital.[25] They detected that HH compliance increased by 23% in 2006 with a quality improvement approach to 87% in 2011. Their multimodel quality improvement was based on strong leadership, sharing, easily accessible hand antiseptics, training programs, observation, HH practice recommendations and regular feedback. Hussein et al observed HH practices of HCWs in all adult and pediatric intensive care units (PICUs) before and after educational programs.[26] Before interventions, the mean adherence to HH in all ICUs was 54% with a significant difference between adult and PICUs. Following the interventions, there was a significant increase in HH adherence in adult ICUs (81%). They concluded that educational programs for HH must be continuously reinforced to achieve optimal adherence to recommended HH policies.

CONCLUSION

As conclusion, HH is the most important factor to reduce the number of hospital acquired infections and HH compliance of the health care workers should be monitored. HH practice can be improved by regular training programs. Current technology such as Semmelweis hand hygiene system that was used in our study could be utilized to increase the efficacy of trainings. Physicians had lower adherence than nursing staff and this condition should be managed by administrative reinforcement in the hospitals.

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