

Efficacy of Non-Interventional Hand Washing on Frequency of Hand Carriage of *Staphylococcus aureus*

¹Sedighah Akhavan Karbasi, ²Hakimah Kalantari, ³Fariba Binesh,
¹Motahhareh Golestan and ¹Razieh Fallah

¹Department of Pediatrics, Growth Disorders of Children Research Center,
Shahid Sadoughi University of Medical Sciences, Yazd, Iran

²General Physician

³Department of Pathology, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

Submitted: Aug 27, 2013; **Accepted:** Oct 4, 2013; **Published:** Oct 25, 2013

Abstract: *Background:* Hand washing is the simplest effective method for the prevention of nosocomial infections. The purpose of this study was to evaluate efficacy of observational hand washing on frequency of *Staphylococcus aureus* (*S.aureus*) hand carriage in medical staff (physicians, medical students, nurses) and mothers of neonates in neonatal intensive care unit (NICU). *Methods:* In a descriptive cross-sectional study, hand specimen cultures of medical staff and mothers of the admitted neonates to the NICU of Shahid Sadoughi Teaching Hospital, Yazd, Iran in 2011 were evaluated before entering the NICU and after non-interventional hand washing. *Results:* 164 persons including 58 mothers, 56 nurses, 40 medical students and 10 physicians with mean age of 29.75 ± 6.7 years, were evaluated. Frequency of *S.aureus* hand carriage was not different before and after observational hand washing (23.2% vs. 22%, $p = 0.85$). Frequency of methicillin resistant *S. aureus* positivity was not different before and after non-interventional hand washing [19.5% (32 of 164) vs. 18.3% (30 of 164), $p = 0.95$]. *Conclusion:* Non-interventional hand washing was not effective in decreasing of *S.aureus* hand carriage and educational programs to improve quality and compliance of hand hygiene are necessary to prevent nosocomial *S.aureus* infections.

Key words: *Staphylococcus aureus* • MRSA • Hand carriage • Hand washing

INTRODUCTION

Nosocomial infection is one of major causes of morbidity and mortality of premature newborns in neonatal intensive care unit (NICU) and preterm neonates have more susceptibility to bacterial infections and sepsis due to immaturity of their immune system, low birth weight and use of different invasive devices in them. Preterm infants may acquire infection from the nursery, their mothers or from other sources in the community [1, 2].

Staphylococcus aureus (*S. aureus*) and methicillin resistant *S.aureus* (MRSA) are well-known nosocomial pathogens for preterm neonates that could lead to serious infections and mortality in NICU [3].

Health care workers (HCWs) may carry *S. aureus* in their noses and on their hands. Transmission of MRSA to infants may occur not only by health care workers nasal carrier but also through transient carriers that have positive culture of their hands [4, 5]. Frequent hand washing, diminishing usage of invasive procedure, limitation in antibiotic use, environmental hygiene, educating of health care workers and detection of potential reservoirs or sources of infections are strategies for prevention and control of infection [2]. Improvement of hand hygiene and hand washing is considered as the simplest and effective method for prevention of nosocomial infections in NICU but, staff compliance with hand hygiene protocols is generally poor and improvement of standard hand washing is associated with

a significant decrease in the rate of nosocomial infection [5-7]. Health care workers training about hand decontamination and standard hand washing is an important program for infection control practice and increases compliance of health care workers in hand hygiene [8, 9].

The purpose of this study was to evaluate efficacy of observational and non- interventional hand washing on frequency of hand carriage of *S.aureus* and MRSA in medical staff (physicians, medical students, nurses) and mothers who entered the neonatal intensive care unit (NICU) in Yazd, central city of I.R. Iran.

MATERIALS AND METHODS

A descriptive cross-sectional study was conducted on medical staff and mothers of the admitted neonates who entered the NICU of Shahid Sadoughi Hospital of Shahid Sadoughi University of Medical Sciences, Yazd, Iran in May-June 2011. The NICU of this teaching hospital is a 22-bed tertiary which admits in-born and out-born neonates of less than one month with medical and surgical conditions. All health care workers who provide direct patient care in the NICU include nurses, pediatric residents and neonatologists. The medical students are attached to the NICU only in two weeks rotations. Bed occupancy of the NICU is usually about 100% and on average, three newborns are admitted daily. The NICU have five rooms with three to five incubators or bassinets per room. Each room has one hand washing sink with electronic tap and always running water, soap, povidone-iodine antiseptic solution and disposable cotton towels. A central workstation with 70% alcohol solution for hand rub and ubiquitously pasted posters reminding everyone to wash hands are available in each room and at the ward entrance. The hand hygiene protocol in the NICU is hand washing with soap and water before and after patient contact, before and after invasive procedures, use of alcohol hand rub on unsoiled hands during emergencies; use of gloves on clean hands; and disposal of gloves after each patient contact. They should wash their hands as follows: remove all accessories (bracelet, watches and rings, if possible), turn on the tap by hands, wet hands, apply antimicrobial soap, rub palm to palm, rub palm over dorsum, rub fingers interlaced, rub back of fingers, rotational rubbing of thumbs, rub wrists, rub forearms, rinse under running water, keep hands higher than elbows while rinsing, wipe hands dry with paper towel, wipe hands in fingertip to wrist direction and take away hands from tap to turn off water without contamination. Persons with dermatologic

diseases, skin rash or those who had received systemic or topical antibiotic within the past one month were excluded. Sample size was assessed to be 170 persons based on Z formula and a confidence interval of 95% with 80% power to detect any significant difference between the two groups with a level of 0.05. Hand culture of the participants was obtained before entering the NICU and after hand washing and drying with disposable cotton towels. General physician of research observed hand washing process of all participants and no intervention was exerted. The participants were aware of being observed and method of observed hand washing was homogenous in all of the participants. Specimens were obtained from the hands of the participant after touching of Mannitol salt agar plates with their palms and fingertips of the dominant hand. All of the specimens were incubated at 35°C for 48 hour. *S. aureus* colonies were identified based on their morphological characteristics and laboratory methods (gram stain, catalase, coagulase and DNase test). Muller-Hinton agar screen plates using 2µg/ml oxacillin with 4% saline was used for identification of methicillin resistant *S. aureus*. Coagulase positive *S.aureus* were subjected to oxacillin agar plates to detect methicillin resistant *S. aureus* (MRSA) and if it did not grow in the antibiotic-containing medium, they were considered as methicillin susceptible *S. aureus* (MSSA).

Variables such age, sex, educational level, type of hand hygiene agent (soap or detergent solution) and duration of hand washing, were recorded.

The data were analyzed using Statistical Package for the Social Sciences version 15 (SPSS, Chicago, IL, USA) statistical software. Chi-square test was used for data analysis of qualitative variables and mean values were compared using T-test. Differences were considered significant at P values of less than 0.05. Informed consent was taken from participants of the research and the study has been approved by the Ethic Committee of Shahid Sadoughi University of Medical Sciences, Yazd, Iran.

The tested hypothesis was whether non-interventional hand washing was effective in decrease of frequency of hand carriage of *S. aureus* and MRSA in participants or not.

RESULTS

Six medical students and eight nurses, refused to take part in this research.

Finally, 164 persons including 58 mothers, 56 nurses, 40 medical students and 10 physicians with mean age of 29.75 ± 6.7 years were evaluated.

Table 1: Results of participants hand culture before and after hand washing based on some characteristics

Data		Hand culture							
		Before hand washing				After hand washing			
		Negative	<i>S. aureus</i> positive	MRSA positive	P. value	Negative	<i>S. aureus</i> positive	MRSA positive	P. value
Participants	Mother (Total number =58)	44	14	10	0.46	44	14	10	0.44
	Nurse (Total number = 56)	42	14	12		44	12	11	
	Medical student (Total number = 40)	32	8	8		32	8	7	
	Physician (Total number =10)	8	2	2		8	2	2	
	Total	126	38	32		128	36	30	
Sex	Female	94	21	18	0.22	95	20	16	0.20
	Male	32	17	14		33	16	14	
Age group	<20 years	25	8	6	0.92	25	8	6	0.88
	20-40 yr	96	29	25		98	27	24	
	>40 years	5	1	1		5	1	0	
Educational level	Illiterate	10	2	2	0.61	10	2	2	0.58
	Primary/secondary school	15	3	2		15	3	1	
	High school	18	6	4		19	5	3	
	Higher education	83	27	24		84	26	24	

Table 2: Frequency of hand carriage of *S.aureus* and MRSA after hand washing based on the hand washing agent and duration of hand washing

Data		Culture					
		<i>S. aureus</i>			Methicillin resistant <i>S.aureus</i>		
		Positive	Negative	P.value	Positive	Negative	P.value
Hand washing agent	Liquid soap	29	86	0.11	25	90	0.13
	Povidone iodine	7	42		5	44	
Duration of hand washing in second (mean ± SD)		24.25±11.31	55.75±20.01	0.002	32.14±12.54	58.2±15.12	0.001

Table 3: Comparison of duration of washing hands and the colonies number of *S.aureus* and MRSA before and after hand washing in different groups

Group	Duration of hand washing in second		Number of <i>S.aureus</i> colonies (mean ± SD)			Number of MRSA colonies (mean ± SD)		
	Mean ± SD	P. value	Before hand washing	After hand washing	P. value	Before hand washing	After hand washing	P. value
	Mother	56.1±10.11	0.01	37579±657	26437±116	0.02	33224±458	24436±118
Nurse	30.1±11.12		38722±378	36797±204	0.5	36236±392	36112±345	0.7
Medical student	49.1±13.24		36722±312	34542±214	0.6	31242±675	3056±345	0.4
Physician	25.1±10.21		39234±456	35743±314	0.4	38128±542	36289±214	0.5

Educational level of participants was: 12 illiterates, 18 had primary or secondary school studies, 24 were high school graduates and higher education was reported in 110 of them.

Twenty four percent of mothers (14 of 58) and 22.6% of medical staff (24 of 106) carried *S. aureus* on their hands.

Frequency of *S. aureus* positive hand culture was not statistically different before and after non- interventional hand washing [23.2% (38 of 164) vs. 22% (36 of 164), p = 0.85]. Frequency of MRSA hand carriage was not different before and after observational hand washing [19.5% (32 of 164) vs. 18.3% (30 of 164), p = 0.95]. Results of participants hand culture before and after non- interventional hand washing based on some characteristics are shown in Table 1 which indicates that frequency of *S.aureus* and MRSA positivity in both cultures was not statistically significant different in both sexes, all age groups and in different educational levels.

Frequency of hand carriage of *S.aureus* and MRSA after observational hand washing based on the type of hand washing agent and duration of hand washing is shown in Table 2 which indicates that the longer the duration of hand washing, the less isolation rate of *S.aureus* and MRSA, or in other words, duration of hand washing was longer in both *S.aureus* and MRSA negative persons.

Comparison of duration of washing the hands and number of the colonies of *S.aureus* and MRSA before and after hand washing in different groups is shown in Table 3 which indicates that physicians had the lowest duration of hand washing. Also, washing hands was effective in reduction of the colony count of *S. aureus* in mothers.

DISCUSSION

Majority of studies have evaluated the rate of nasal carriage of *S. aureus* and MRSA. In present study,

Table 4: Rate of S.aureus and MRSA hand carriage in researches

Research site	Participants	Rate of <i>S. aureus</i> hand carriage	Rate of MRSA hand carriage
Present study (Yazd, Iran)	Mothers of neonates and medical staff of NICU	24% in mothers 22.6% in medical staff	17.2% in mothers 11.3% in medical staff
Columbia [11]	Nonmedical and medical personnel	18.1% in nonmedical personnel 10.2% in medical personnel	-
Sweden [12]	HCWs of Surgery Department	9.6% in women 16.7% in men	-
Ireland[13]	HCWs of a hospital	-	5%
Turkey [14]	Nursing students	-	6.1%
Taiwan [15]	HCWs of pediatric ICU	67.2%	26.2%
Brazil [16]	Nursing staff	25.8%	12.8%
Egypt [17]	HCWs of ICU	4%	-
Nepal [18]	Staff of a hospital	59.2%	5.7%
Gorgan, Iran [19]	HCWs of three hospitals	13.8 %	12.5%

efficacy of routine and non- interventional hand washing on frequency of hand carriage of *S.aureus* in medical staff and mothers of neonates, was evaluated.

Rate of *S. aureus* carriage in health care workers varies in different countries and it depends on hospital specialty, setting (endemic, non-endemic or outbreak), site of culture sampling, laboratory techniques and etc. Non-outbreak carriage rates of 0-15% is reported by the conducted recent studies in endemic hospital settings. [10].

Rates of *S.aureus* and MRSA hand carriage in present study are compared to other researches in Table 4 [11-19].

In this study, before hand washing, 23.2% of all participants carried *S. aureus* on their hands, 95% of which was MRSA. But, non-interventional hand washing was not effective in decreasing of *S. aureus* and MRSA hand carriage.

In Creamer et al study in Dublin, Ireland, sampled fingertips of 5% of HCWs in a tertiary referral hospital were MRSA-positive. Recovery rate of MRSA was 3% by soap and water and 5% as no hand hygiene had been performed [13].

In a study in Cairo, Egypt, 28% and 4% of HCWs in intensive care units were nasal and hand carriers of *S. aureus*, respectively. Twenty percent of nasal and 4% of hand carriages were MRSA [17].

Since, hand carriers of *S. aureus* in medical staff and failure of health care workers to perform appropriate hand hygiene have an important role in the development of nosocomial infections [14, 20], educational programs to improve quality and compliance of hand hygiene and implementation of periodic and routine active surveillance cultures are necessary to prevent and control nosocomial *S.aureus* infections [13, 15].

Recommendations to health care workers such as removing of finger rings and watches during the work, having shorter than 2 mm fingernails and using nail polish may be useful in decreasing of *S. aureus* hand carriage [21].

In present study, 24% of mothers were hand carriers of *S. aureus* who could transmit infection to their neonates. Transmission of MRSA in a NICU from father to infant had been reported previously [22].

In conclusion, non-interventional hand washing was not effective in decreasing of *S. aureus* hand carriage and educational programs to improve quality and compliance of hand hygiene are necessary to prevent nosocomial *S. aureus* infections.

ACKNOWLEDGMENTS

This study was funded by a grant from the Research Deputy of Shahid Sadoughi University of Medical Sciences, Yazd, Iran.

REFERENCES

1. Vergnano, S., E. Menson, N. Kennea, N. Embleton, A.B. Russell, T. Watts, *et al.*, 2011. Neonatal infections in England: the NeonIN surveillance network. Arch Dis Child Fetal Neonatal Ed., 96: F9-F14.
2. Decembrino, L., S. Perrini and M. Stronati, 2010. Surveillance of infection events in neonatal intensive care. Minerva Pediatr., 62(Suppl): 41-5. [Article in Italian].
3. Maraqa, N.F., L. Aigbivbalu, C. Masnita-Iusan, P. Wludyka, Z. Shareef, C. Bailey, *et al.*, 2011. Prevalence of and risk factors for methicillin-resistant *Staphylococcus aureus* colonization and infection among infants at a level III neonatal intensive care unit. Am. J. Infect Control., 39: 35-41.
4. Huang, Y.C., Y.H. Chou, L.H. Su, R.I. Lien and T.Y. Lin, 2006. Methicillin-resistant *Staphylococcus aureus* colonization and its association with infection among infants hospitalized in neonatal intensive care units. Pediatrics, 118: 469-74.

5. Leung, Y.H., R.W. Lai, A.C. Chan, J.Y. Lo, P.L. Ho, M.M. Wong, *et al.*, 2012. Risk factors for community-associated methicillin-resistant *Staphylococcus aureus* infection in Hong Kong. *J. Infect.*, 64: 494-9.
6. Matsumoto, K., A. Shigemi, K. Yaji, Y. Shimodozono, Y. Takeda, K. Ikawa, *et al.*, 2012. Reduction in the incidence of MRSA with use of alcohol-based hand rub solutions and gloves. *J. Infect Chemother.*, 18: 269-71.
7. Scheithauer, S., J. Oude-Aost, K. Heimann, H. Haefner, T. Schwanz, B. Waitschies, *et al.*, 2011. Hand hygiene in pediatric and neonatal intensive care unit patients: daily opportunities and indication- and profession-specific analyses of compliance. *Am. J. Infect Control*, 39: 732-7.
8. Creedon, S.A., 2005. Healthcare workers' hand decontamination practices: compliance with recommended guidelines. *J. Adv. Nurs.*, 51: 208-16.
9. Lepelletier, D., S. Corvec, J. Caillon, A. Reynaud, J.C. Rozé and C. Gras-Leguen, 2009. Eradication of methicillin-resistant *Staphylococcus aureus* in a neonatal intensive care unit: which measures for which success? *Am. J. Infect. Control.*, 37: 195-200.
10. Hawkins, G., S. Stewart, O. Blatchford and J. Reilly, 2011. Should healthcare workers be screened routinely for methicillin-resistant *Staphylococcus aureus*? A review of the evidence. *J. Hosp Infect.*, 77: 285-9.
11. Cespedes, C., M. Miller, B. Quagliarello, P. Vavagiakis, R.S. Klein and F.D. Lowy, 2002. Differences between *Staphylococcus aureus* isolates from medical and nonmedical hospital personnel. *J. Clin Microbiol.*, 40: 2594-7.
12. Tammelin, A., F. Klötz, A. Hambraeus, E. Ståhle and U. Ransjö, 2003. Nasal and hand carriage of *Staphylococcus aureus* in staff at a Department for Thoracic and Cardiovascular Surgery: endogenous or exogenous source? *Infect Control Hosp Epidemiol.*, 24: 686-9.
13. Creamer, E., S. Dorrian, A. Dolan, O. Sherlock, D. Fitzgerald-Hughes, T. Thomas, *et al.*, 2010. When are the hands of healthcare workers positive for methicillin-resistant *Staphylococcus aureus*? *J. Hosp. Infect.*, 75: 107-11.
14. Akpınar, R.B., A. Celebioglu, H. Uslu and M.H. Uyanik, 2009. An evaluation of the hand and nasal flora of Turkish nursing students after clinical practice. *J. Clin Nurs.*, 18: 426-30.
15. Lin, Y.C., T.L. Lauderdale, H.M. Lin, P.C. Chen, M.F. Cheng, K.S. Hsieh, *et al.*, 2007. An outbreak of methicillin-resistant *Staphylococcus aureus* infection in patients of a pediatric intensive care unit and high carriage rate among health care workers. *J Microbiol Immunol Infect.*, 40: 325-34.
16. Da Silva, E.C., T.M. Samico, R.R. Cardoso, M.A. Rabelo, A.M. Bezerra Neto, F.L. De Melo, *et al.*, 2012. Colonization by *Staphylococcus aureus* among the nursing staff of a teaching hospital in Pernambuco. *Rev Esc Enferm USP.*, 46: 132-7. [Article in Portuguese].
17. Abdel Rahman, A.T., S.F. Hafez, S.M. Abdelhakam, Z.A. Ali-Eldin, I.M. Esmat, M.S. Elsayed, *et al.*, 2010. Antimicrobial resistant bacteria among health care workers in intensive care units at Ain Shams University Hospitals. *J. Egypt. Soc. Parasitol.*, 40: 71-83.
18. Pant, J., S.K. Rai, A. Singh, B. Lekhak, B. Shakya and G. Ghimire, 2006. Microbial study of hospital environment and carrier pattern study among staff in Nepal Medical College Teaching Hospital. *Nepal Med. Coll J.*, 8:194-9.
19. Rahimi-Alang, S., M. Asmar, F. Cheraghali, S. Yazarlou, A. Amini, F. Shakeri, *et al.*, 2010. Frequency of methicillin resistant *Staphylococcus aureus* in health care workers in Gorgan. *Zahedan J. Res. Med. Sci (ZJRMS).*, 13: 17-22. [Article in Persian].
20. Hedin, G., A. Blomkvist, M. Janson and A. Lindblom, 2012. Occurrence of potentially pathogenic bacteria on the hands of hospital patients before and after the introduction of patient hand disinfection. *APMIS*, 120: 802-7.
21. Fagermes, M. and E. Lingaas, 2011. Factors interfering with the microflora on hands: a regression analysis of samples from 465 healthcare workers. *J. Adv. Nurs.*, 67: 297-307.
22. Al-Tawfiq, J.A., 2006. Father-to-infant transmission of community-acquired methicillin-resistant *Staphylococcus aureus* in a neonatal intensive care unit. *Infect Control Hosp Epidemiol.*, 27: 636-7.