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Changes in hand hygiene compliance after a multimodal intervention among health-care workers from intensive care units in Southwestern Saudi Arabia

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Abstract The aim of this study is to measure the degree of compliance with hand hygiene practices among health-care workers (HCWs) in intensive care facilities in Aseer Central Hospital, Abha, Saudi Arabia, before and after a multimodal intervention program based on WHO strategies. Data were collected by direct observation of HCWs while delivering routine care using standardized WHO method: ''Five moments for hand hygiene approach''. Observations were conducted before (February–April 2011) and after (February–April 2013) the intervention by well-trained, infection-control practitioners during their routine visits.

The study included 1182 opportunities (observations) collected before and 2212 opportunities collected after the intervention. The overall, hand hygiene compliance increased significantly from 60.8% (95% CI: 57.9–63.6%) before the intervention to reach 86.4% (95% CI: 84.9–97.8%) post-intervention ($P = 0.001$). The same trend was observed in different intensive care facilities. In logistic regression analyses, HCWs were significantly more compliant (aOR = 3.2, 95% CI: 2.6–3.8) after the intervention. Similarly, being a nurse and events after patient contact were significant determinants of compliance.

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It is important to provide sustained intensified training programs to help embed efficient and effective hand hygiene into all elements of care delivery. New approaches like accountability, motivation and sanctions are needed.

1. Introduction

Numerous studies document the pivotal role of health-care workers' (HCWs) hands in the propagation of micro-organisms within the health-care environment and ultimately to patients [1]. Hand hygiene (HH) has been known to reduce health care-associated infections (HAIs) since Ingaz Semmelweis demonstrated dramatic reductions in puerperal sepsis after instituting a hand washing regimen in the Vienna Lying-in Hospital in 1847 [2].

Hospitalization in an intensive care unit (ICU) further increases the risk of HAIs. Noncompliance with HH protocols in hospitals, particularly in ICUs, is widely recognized as one of the most important contributing and preventable causes of HAIs. Most ICU-endemic infections result from the carriage of micro-organisms on HCWs' hands, and outbreaks of infections due to cross-transmission are frequent [3,4]. Contributing factors are the high intensity of patient care in ICUs, the frequent contacts between HCWs and ICU patients, and the performance of procedures with a high risk of cross-transmission [5]. Unfortunately, in health-care, compliance with HH practices has been below an acceptable level of at least 60% [6–8]. HCWs must understand that hands are often the vessel by which pathogens are passed from patient to patient. It has been found that an aggressive education program that is continuous can help to improve HH compliance [5]. The WHO noted that successful and sustained HH improvement is achieved by implementing multiple actions to tackle different obstacles and behavioral barriers [9]. Based on the evidence and recommendations from the WHO Guidelines on Hand Hygiene in Health Care [9], the following components make up an effective multimodal strategy for HH: (i) System change; (ii) Training/Education; (iii) Evaluation and feedback; (iv) Reminders in the workplace; and (v) Institutional safety climate.

The Aseer region is located in southwest Saudi Arabia covering an area of more than 80,000 km^2. The region extends from the high mountains of Sarawat (with an altitude of 3200 m above sea level) to the Red Sea, and lies a few kilometers from the northern border of neighboring Yemen. The population of Aseer is 1,688,368. Health service delivery in the southern region is provided by a network of 244 primary health-care centers, 16 referral hospitals and 1 tertiary hospital—Aseer Central Hospital (ACH), which has 500 beds [10] and is run by the Ministry of Health and the College of Medicine of King Khalid University (KKU), Abha.

The purpose of the current study is to measure the compliance with HH practices among HCWs in intensive care facilities at ACH before and after a multimodal intervention program for HH based on WHO strategies.

2. Materials and methods

Observations of HH compliance were conducted in the different ICUs of Aseer Central Hospital, Abha, Saudi Arabia, before (February–April 2011) and after (February–April 2013) the multimodal interventions.

2.1. Sample size

Using the WHO manual for ''Sample Size Determination in Health Studies'' [11], the minimal sample size required for each group was calculated to be 969 observations to be selected from each of two groups to estimate a risk difference to within 5% points of the true difference with 95% confidence and with an anticipated population estimate of 60% (the compliance figure in a similar study in Saudi Arabia) [6] and 80% (expected compliance after the intervention). To avoid possible non-response, a total of 1100 cases were initially planned for the study. After reaching the minimal sample size, researchers decided to continue collecting observations during the assigned study periods.

2.2. Hospital setting

The Intensive Care Unit (ICU) has 12 beds; the Intermediate Care Unit (IMCU), 32 beds; the Cardiac Care Unit (CCU), 15 beds; the Pediatric Care Unit (PICU), 7 beds; and the Neonatal Intensive Care Unit (NICU), 10 beds. All of the ICUs follow the same infection control policies and procedures and provide the same staff orientation. Each unit

has a single secured entrance. Hand washing facilities are available at a frequency of 1 sink for every 3 beds. Alcohol-based hand rub dispensers are available at each ICU entrance, and 1 dispenser per every ICU bed is dispersed within each unit. All physicians, nursing and allied health staff received an infection control and hand hygiene orientation. During the study periods, no massive changes occurred in the manpower structure of the hospital that might affect the study.

2.3. Direct observation

Data were collected by direct observation (anonymously and confidentially) of HCWs in ICUs while delivering routine care (in direct contact with patients) using a standardized WHO method for direct observation: ''Five moments for hand hygiene approach'' [7]. To overcome the Hawthorne effect (the observer effect where behaviors are not always normal when being observed) and ensure the process improvements are accurate, observations were discrete and anonymous. The five moments are before touching a patient, before the clean/aseptic procedure, after body fluid exposure/risk, after touching a patient, and after touching patient surroundings. Observer training involved a three-day workshop comprising a daily two-hour hands-on session that included how to monitor HH adherence according to the World Health Organization's (WHO) ''indication moments'' for HH [7].

The moment the observer identified an indication, it was counted as an opportunity to which there should be a corresponding positive or negative action (hand washing/rubbing).

2.4. Multimodal interventions

Initiation and execution of WHO recommended activities for implementation of interventions: This involved the implementation of strategies that promoted HH compliance as a health-care facility priority. The sustained intervention program started in May 2011, and its major activities were as follows:

- *Consultation and advocacy meetings* were held in May 2011 by the Research Team with the hospital management. The purpose of the meetings was to canvass for their cooperation and support toward achieving the goals and objectives of the project. A local multidisciplinary committee appointed a study coordinator to deliver training for health-care workers and to ensure correct implementation of the intervention. A formal launch took place with an official ceremony attended by health-care workers and health authorities, the senior health directorate, and senior hospital managers.
- *Intensifying the provision of alcohol hand rub:* Actions were taken to ensure availability of alcohol-based hand rub at the point of care in ICUs. Commercially produced hand rub was used. After the launch, alcohol-based hand rub was distributed at sites where it was not previously available and actions were taken where it was already in use to increase the number of dispensers and to optimize their locations at the point of care. Units of 1000 mL 70% isopropyl alcohol hand rub were procured by the Project Team and were placed in strategic 'points of care' places within the hospital. The Head of Nursing Services Department (HNSD) was in-charge of its distribution to the various ICUs.
- *Training and Education:* Further activities executed were training, education and use of reminders in the workplace as recommended by WHO. Hand hygiene posters were displayed in all ICUs. Later on, all health-care workers of these units attended intensive education sessions based on WHO methods, and hand rubbing was promoted as the gold standard for HH according to the so-called ''my five moments for hand hygiene'' concept [7]. The training was conducted by the Research Team at the Hospital's conference hall using a Power Point presentation, a video show and training handouts given to each participant. The training on HH focused on: background to WHO Patient Safety and the First Global Patient Safety Challenge; definition, effect and burden of HCAI; major patterns of transmission of healthcare-associated pathogens, with a particular focus on hand transmission; prevention of HCAI and the critical role of HH; WHO Guidelines on Hand Hygiene in Health Care and their implementation strategy and tools, including why, when and how to perform HH in a health-care situation [8]. Each training session lasted for 2—3 h. Continuous regular meetings were held for staff during educational and feedback sessions to motivate workers and administrators to understand the local situation, appreciate deficiencies, and secure support for sustainability.
- *Intensifying use of reminders in the workplace:* Materials used as reminders were reproduced in the forms of posters, prescription notebooks, and computer screen savers. Two posters were produced, and these include: (i) ''My 5 Moments for Hand Hygiene,'' and (ii) ''How to Hand Rub and Hand Wash.'' The HH posters were displayed in all ICUs at strategic locations, such as: hand wash sinks, beds, and consultation rooms — all points where health worker/patient contact occur.
- Involvement of hospital leaders in HH improvement activities through active participation in HH days.
- Evaluation and feedback: monitoring HH compliance rates in intensive care units on a monthly basis and communicating reports to the concerned staff and to the hospital leader.

- Provision and insurance of a continuous supply of soaps and paper towels through regular daily rounds by infection control practitioners in ICUs.

2.5. Statistical analysis

Data were coded, validated and analyzed using the SPSS PC+ version 13 software package. Frequency, percentage and 95% confidence intervals (95% CI) were used to present the data. Chi square was used as a test of significance at the 5% level of significance. Binary logistic multivariate regression analysis was conducted. Adjusted Odds ratio (aOR) and antecedent 95% confidence intervals were used to identify potential determinants of HH compliance. Regarding dichotomous variables included in the model, HH compliance was the dependent variable and the independent variables were health-care worker profession (nurses vs. physicians and others), the event and indication of HH (indications after contact with the patient vs. indications before contact with the patient), status and timing of the observation (after the intervention vs. before the intervention), and the observed intensive care unit (IMCU vs. other ICUs). The method used was ''enter'' method.

2.6. Ethics

The work was approved by the Ethics Committee of King Khalid University.

3. Results

The present study included 1182 opportunities (observations) collected before the interventions (February—April 2011), and 2212 opportunities collected after the intervention (February—April 2013). Observations covered 179 nurses and 34 physicians and 23 other health-care workers (including X-ray and ECG technicians, physiotherapists and respiratory therapists) working in these units.

Table 1 shows that the overall HH compliance increased from 60.8% (95% CI: 57.9—63.6%) before intervention to reach 86.4% (95% CI: 84.9—97.8%) post intervention. The increase was statistically significant ($P = 0.001$). The same significant ($P = 0.001$) trend of increase of HH compliance was observed in different intensive care units (ICU, IMCU, PICU, CCU, and NICU).

Among physicians working in ICUs, the HH compliance increased from 53.5% (95% CI: 48.2—58.4%) before intervention to reach 83.64% (95% CI: 80.6—86.3) post intervention. The increase was statistically significant ($P = 0.001$). The same trend of significant increase ($P = 0.001$) of HH compliance was also observed among nurses and other health-care workers (Table 1). HH compliance of nurses was significantly ($P = 0.001$) higher compared with compliance of physicians pre- and post-intervention.

Regarding HH indication, before patient contact, the HH compliance increased from 49.6% (95% CI: 44.4—54.7%) before intervention to reach 88.1% (95% CI: 85.3—90.5%) post-intervention. The increase was statistically significant ($P = 0.001$). The same trend of increase of HH compliance was also observed among different HH indications (Table 1). HH compliance rates before patient contact and before aseptic procedures were significantly ($P = 0.001$) lower compared with compliance rates after body fluid exposure, after patient contact and after patient surrounding contact. This trend was observed pre- and post-intervention.

After adjusting all variables to each other in a logistic regression analysis model (Table 2), the study showed that HCWs were more significantly (aOR = 3.2, 95% CI: 2.6—3.8) HH compliant after the multi-modal intervention; nurses were significantly (aOR = 1.3, 95% CI: 1.1—1.9) more compliant compared with physicians and other HCWs; compliance was more significant in events after patient contact (aOR = 2.0, 95% CI: 1.7—2.4) and compliance was more significant among HCWs working in IMCU (aOR = 1.8, 95% CI: 1.5—2.3).

4. Discussion

Healthcare-associated infections have a great impact on morbidity, mortality, length of hospital stay, and costs [8]. Intensive care units (ICUs) represent a center of healthcare-associated infections because of patients' characteristics. Particularly, the use of various invasive devices is one of the most important risk factors for acquiring health-care-associated infections [9].

Erasmus et al. in 2010 [8] reviewed 65 global studies on compliance with HH guidelines in ICUs and found an overall compliance rate of 30—40%, and they concluded that noncompliance with HH guidelines is a universal problem. They concluded that to develop successful interventions, more research into the behavioral determinants is needed.

The results of the present study showed that implementation of the WHO's multimodal promotion strategy was associated with a significant increase in overall hand-hygiene compliance in intensive care facilities from 60.8% before interven-

Table 1 Hand hygiene compliance rates (% and 95% CI) pre- and post-multimodal intervention program in intensive care units of Aseer Central Hospital.

Variable*	Compliance rate % (95% CI)	
	Pre-intervention	Post-intervention
Unit		
ICU	57.1 (52.7–61.4)	69.0 (59.1–78.7)
IMCU	42.6 (30.7–55.2)	92.1 (90.2–93.7)
PICU	68.0 (61.4–74.1)	95.4 (91.7–97.8)
CCU	63.6 (51.8–74.3)	79.2 (75.7–82.4)
NICU	65.2 (59.5–70.6)	86.3 (82.4–89.5)
Healthcare provider		
Physicians	53.5 (48.2–58.4)	83.6 (80.6–86.3)
Nurses	69.4 (65.9–73.5)	88.5 (86.1–90.6)
Other HCWs	59.2 (51.7–66.6)	86.3 (84.1–89.1)
Hand hygiene indication		
Before patient contact	49.6 (44.4–54.7)	78.1 (75.3–80.5)
Before aseptic procedure	51.7 (43.3–59.8)	70.9 (63.4–77.9)
After body fluid exposure	65.2 (54.5–74.8)	85.2 (81.4–87.6)
After patient contact	78.6 (73.6–83.0)	89.7 (86.9–92.0)
After patient surrounding contact	69.6 (63.1–75.7)	86.3 (83.2–88.9)
Overall	60.8 (57.9–63.6)	86.4 (84.9–87.8)

* All are significant ($P = 0.001$).

Table 2 Multivariate analysis, binary logistic regression model showing adjusted Odds ratio (aOR) and antecedent 95% confidence intervals (CI) of potential factors determining hand hygiene compliance in intensive care units of Aseer Central Hospital, southwestern Saudi Arabia.

Variable	aOR	95% CI	
		Lower	Upper
HCWs*: Nurses vs. Physicians and other HCWs	1.306	1.104	1.990
Event*: After vs. before patient contacts	2.010	1.693	2.386
Status*: Post-intervention vs. pre-intervention	3.167	2.613	3.838
Intensive care unit*: IMCU vs. other ICUs	1.818	1.464	2.258

* Significant ($P < 0.05$).

tion to reach 86.4% after intervention. The same trend of increased HHC was observed in different intensive care units (ICU, IMCU, PICU, CCU, and NICU) in the hospital. A similar increase in HHC was noticed in a study on multiple intervention programs for HHC in ICUs in Spain in 2012 and in Brazil in 2013 [12,13]. A study in Lebanon in mixed ICUs found increased HHC and a reduction in ventilator-associated pneumonia after initiation of the HH program [14]. Results of a study in NICUs in Holland showed improvement of HH practices among health-care professionals due to an education program, and the improved HH resulted in a reduction in nosocomial bloodstream infections [15].

The high overall compliance rate of 86.4% observed in the present study after intervention may be attributed to the positive effect of the Interventional programs which included systematic HH training using the WHO materials/tools and the use of HH posters and other reminders in the hospital facilities. This could also be attributed to the support of the hospital authority and the enthusiasm demonstrated by the health workers to comply, particularly those who participated in the training program. Findings from some recent studies have consistently indicated that HHC rates improve significantly following interventional efforts of training and use of reminders in the workplace [16].

Recently, a multi-center study at six pilot sites (55 departments in 43 hospitals) in Costa Rica, Italy, Mali, Pakistan, and Saudi Arabia used WHO's multimodal strategy for improvement of HH [17]. Researchers assessed the HHC of healthcare work-

ers. Overall compliance increased from 51.0% before the intervention to 67.2% after the intervention. Researchers concluded that: ''Implementation of WHO's hand-hygiene strategy is feasible and sustainable across a range of settings in different countries and leads to significant compliance and knowledge improvement in healthcare workers''.

In the present study HHC differed depending on the five moments of HH ($P = 0.001$). HHC rates before patient contact and before aseptic procedures were significantly ($P = 0.001$) lower compared with compliance rates after body fluid exposure, after patient contact and after patient surrounding contact. This trend was observed pre- and post-intervention. The WHO found poor levels of compliance before an aseptic task, and it is suggested that activities that are high risk to the patient have lower compliance [18]. HCWs' compliance is high when hands are visibly dirty or sticky [19—21]. These activities have a perceived element of risk to them, for example, after exposure to body fluids. Lower levels of compliance were found across all groups for the moment 'after contact with patient surroundings'. There is growing evidence that the environment and the issue of environmental cleaning and decontamination are important factors in minimizing HCAIs. The environmental cleaning needs to be improved generally and specifically at hand touch sites. Hand touch sites with the highest risk to patients are those which are next to the patient, for example, bedrails, lockers, over bed tables and door handles [22]. This instinctive tendency toward privileging of oneself rather than toward patient protection has been identified repeatedly [23—25]. It is mandatory to tailor programs in the future to show HCWs their actual behavior and responsibilities and to call for accountability with regard to patient safety. New approaches like accountability, motivation and sanctions are needed to urge HCWs to be more engaged in the program. Further studies are needed to test for the continuity of the study and whether high compliance rates are achieved at different post-intervention periods.

HHC of nurses was significantly ($P = 0.001$) higher compared with compliance of physicians pre- and post-intervention. Studies showed that doctors in general have previously been found to have poor compliance with infection prevention and control standards [26]. It may be that doctors have a distinct culture associated with levels of power, which means that they can be 'difficult' [27]. Some studies have looked into the effect of role models on HHC. One study found that HH behavior of senior practitioners plays a crucial part in influencing junior staff [28]. It is suggested that targeting of consultants is the way forward to improve compliance levels.

5. Conclusion

The observed increase in HHC warrants sustaining the intensified local HH promotion education and training programs to help embed efficient and effective HH into all elements of care delivery in ICUs in ACH. New approaches like accountability, motivation and sanctions are needed to urge HCWs to be more engaged in the program.

Conflict of interest

No conflict of interest to declare.

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References

[1] Allegranzi B, Pittet D. Role of hand hygiene in healthcare-associated infection prevention. J Hosp Infect 2009;73:305—15.
[2] Semmelwies I. In: Carter K, editor. Etiology, concept, and prophylaxis of childbed fever. Madison, WI: University of Wisconsin Press; 1983.
[3] Pittet D. Hand hygiene: improved standards and practice for hospital care. Curr Opin Infect Dis 2003;16:327—35.
[4] Mahfouz AA, Al Azraki TA, Abag FI, Al Gamal MN, Seef S, Bello CS. Nosocomial infection in a neonatal intensive care unit in Southwestern Saudi Arabia. East Mediterr Health J 2010;16:40—4.
[5] Pittet D. Hand hygiene: it's all about when and how. Infect Control Hosp Epidemiol 2008;29:957—9.
[6] Alsubaie S, Maither AB, Alalmaei W, et al. Determinants of hand hygiene noncompliance in intensive care units. Am J Infect Control 2013;41(2):131—5.
[7] Al-Azraqi T. Hand hygiene among doctors and nurses in a tertiary-care hospital in Abha, KSA. J Bahrain Med Soc 2007;19:53—5.
[8] Erasmus V, Daha TJ, Brug H, et al. Systematic review of studies on compliance with hand hygiene guidelines in hospital care. Infect Control Hosp Epidemiol 2010;31:283—94.
[9] World Health Organization. Save lives clean your hands — guide to implementation. A guide to the implementation of the WHO multimodal hand hygiene improvement strategy. Geneva: WHO/IER/PSP/2009.02.

[10] Preliminary results of 2004 census. Central Department of Statistics, Riyadh, KSA: Ministry of Economy and Planning; 2005.
[11] Lwanga SK, Lemeshow S. Sample size determination in health studies: a health manual. Geneva: World Health Organization; 1991.
[12] García-Vázquez E, Murcia-Payá J, Allegue JM, Canteras M, Gómez J. Influence of a multiple intervention program for hand hygiene compliance in an ICU. Med Intensiva 2012;36:69—76.
[13] Dos Santos RP, Konkewicz LR, Nagel FM, et al. Changes in hand hygiene compliance after a multimodal intervention and seasonality variation. Am J Infect Control 2013. http://dx.doi.org/10.1016/j.ajic.2013.05.020 [Epub ahead of print].
[14] Koff MD, Corwin HL, Beach ML, Surgenor SD, Loftus RW. Reduction in ventilator associated pneumonia in a mixed intensive care unit after initiation of a novel hand hygiene program. J Crit Care 2011;26:489—95.
[15] Helder OK, Brug J, Looman CW, van Goudoever JB, Kornelisse RF. The impact of an education program on hand hygiene compliance and nosocomial infection incidence in an urban neonatal intensive care unit: an intervention study with before and after comparison. Int J Nurs Stud 2010;47:1245—52.
[16] Tschudin-Sutter S, Pargger H, Widmer AF. Hand hygiene in the intensive care unit. Crit Care Med 2010;38(Suppl.): S299—305.
[17] Allegranzi B, Gayet-Ageron A, Damani N. Global implementation of WHO's multimodal strategy for improvement of hand hygiene: a quasi-experimental study. Lancet Infect Dis 2013. http://dx.doi.org/10.1016/S1473-3099(13)70163-4 [Epub ahead of print].
[18] WHO. Guidelines on hand hygiene in health care. First global patient safety challenge: clean care is safer care. Geneva: World Health Organization; 2009.
[19] Whitby M, McLaws ML, Ross MW. Why healthcare workers don't wash their hands: a behavioral explanation. Infect Control Hosp Epidemiol 2006;27(5):484—92.
[20] Allegranzi B, Pittet D. The role of hand hygiene in healthcare-associated infection prevention. J Hosp Infect 2009;73:305—15.
[21] McLaws ML, Maharlouei N, Yousefi F, Askarian M. Predicting hand hygiene among Iranian health care workers using the theory of planned behavior. Am J Infect Control 2012; 40(4):336—9.
[22] Dancer SJ. The role of environmental cleaning in the control of hospital acquired infection. J Hosp Infect 2009; 73:378—85.
[23] Lee A, Chalfine A, Daikos GL, et al. Hand hygiene practices and adherence determinants in surgical wards across Europe and Israel: a multicenter observational study. Am J Infect Control 2011;39:517—20.
[24] Cheng VC, Tai JW, Ho SK, et al. Introduction of an electronic monitoring system for monitoring compliance with moments 1 and 4 of the WHO ''My 5 Moments for Hand Hygiene'' methodology. BMC Infect Dis 2011;11:151.
[25] Stewardson A, Sax H, Longet-Di Pietro S, Pittet D. Impact of observation and analysis methodology when reporting hand hygiene data. J Hosp Infect 2011;77:358—9.
[26] Venier A, Zaro-Goni M, Pefau J, et al. Performance of hand hygiene in 214 healthcare facilities in South-Western France. J Hosp Infect 2009;71:280—2.
[27] Brooks I, Brown RB. The role of the ritualistic ceremonial in removing barriers between subcultures in the National Health Service. J Adv Nurs 2002;38:341—52.
[28] Lankford M, Zembower T, Trick W, et al. Influence of role models and hospital design on hand hygiene of healthcare workers. Emerg Infect Dis 2003;9:217—23.