



The effect of hand hygiene compliance on hospital-acquired infections in an ICU setting in a Kuwaiti teaching hospital

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Summary Hand washing is widely accepted as the cornerstone of infection control in the intensive care unit (ICU). Nosocomial infections are frequently viewed as indicating poor compliance with hand washing guidelines. To determine the hand hygiene (HH) compliance rate among healthcare workers (HCWs) and its effect on the nosocomial infection rates in the ICU of our hospital, we conducted an interventional study. The study spanned a period of 7 months (February 2011–August 2011) and consisted of education about HH indications and techniques, workplace reminder posters, focused group sessions, and feedback on the HH compliance and infection rates. The WHO HH observation protocol was used both before and after a hospital-wide HH campaign directed at all staff members, particularly those in the ICU. Compliance was measured by direct observation of the HCWs, using observation record forms in a patient-directed manner, with no more than two patients observed simultaneously. The overall HH compliance rate was calculated by dividing the number of HH actions by the total number of HH opportunities. The nosocomial infection rates for the pre- and post-interventional periods were also compared to establish the effect of the intervention on rate of infections acquired within the unit. The overall rate of HH compliance by all the HCWs increased from 42.9% pre-intervention to 61.4% post-intervention, $P < 0.001$. Individually, the compliance was highest among the nurses, 49.9 vs. 82.5%, respectively ($P < 0.001$) and lowest among the doctors, 38.6 vs. 43.2%, respectively ($P = 0.24$). The effect of the increase in the HH compliance rate on the nosocomial infection rate was remarkable. There were significant reductions in the following: the rate of overall health care-associated

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infections/1000 patient-days, which fell from 37.2 pre-intervention to 15.1 post-intervention ($P < 0.001$); the rate of bloodstream infections, which fell from 18.6 to 3.4/1000 central-line-days ($P < 0.001$); and the rate of lower respiratory tract infections, which fell from 17.6 to 5.2/1000 ventilator-days ($P < 0.001$). Similarly, there were significant reductions in the isolation rates of 4 major hospital pathogens ($P < 0.001$ and $P = 0.03$). These findings suggest that although cross-infection in the ICU is a complex process, its frequency can be affected by meticulous adherence to hand hygiene recommendations.

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Introduction

Nosocomial infections are a major challenge to the health-care system and are associated with significant mortality, morbidity and an economic burden. Hand hygiene (HH), i.e. hand washing with water and detergent and/or the use of alcohol-based hand sanitizers, is the single most important method of preventing nosocomial infections [1], and compliance with effective HH practices is recognized as the most important strategy for reducing the transmission of pathogens in health care settings [1,2]. Unfortunately, numerous studies have shown that adherence to HH recommendations remains low and that improvement efforts frequently lack sustainability [3,4]. The World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), and others have issued hand hygiene guidelines for health care workers [5,6]. Although most would agree that hand hygiene is of critical importance, many researchers have found that measuring adherence to hand hygiene guidelines is not a simple task. Haas and Larson [7] recently concluded that there is no recognized standard for measuring adherence to HH recommendations because the compliance rates vary considerably between studies, and each method has both advantages and disadvantages. The role of alcohol-based solutions in preventing the spread of infection in health care settings and in improving HH compliance has been explored [8]. However, the importance of this simple procedure is not sufficiently acknowledged by healthcare workers (HCWs), i.e. doctors, nurses and other medical professionals, and poor compliance have been repeatedly documented [9,10]. Although some of the previous interventions to improve compliance with HH guidelines have been successful [11], achieving lasting improvement has been daunting [12].

Since the beginning of intensive care in the 1960s, hand washing has been a procedure of primary importance. This emphasis on HH is

predominantly the result of the belief that, if ignored, nosocomial infections will become a major healthcare problem. Infections that occur more than two days after admission to an ICU are attributed to microorganisms originating within the unit and are caused by transmission from one patient to another via the unwashed hands of HCWs [13]. Infections that occur less than two days after admission are deemed to have been present or incubating at the time of entry to the ICU and cannot be the result of inadequate prophylactic hand washing. Thus, more than 40 years after the inception of intensive care, the necessity of hand washing remains a tenet of hospital hygiene, and nosocomial infections are viewed as markers of poor compliance with HH requirements. This widely held belief implies that hand washing is effective and an 'all-or-nothing' intervention [14]. Three important concepts associated with the effective measurement of HH adherence are indication, opportunity, and action. Of these concepts, indications are the principal rationale for performing HH. According to Sax et al. [1], HH is the single most important element necessary for the prevention of nosocomial infections. An indication is the reason why HH is necessary at a specific point in time, and it is justified by the risk of transmitting germs from one surface to another [15]. As a developing country, Kuwait has not collected information on how HH compliance affects nosocomial infection rates in its hospitals. Previous, unpublished observations from Kuwaiti hospitals have indicated that HH compliance is poor among the hospital staff members, especially among the HCWs on the ICU.

This study was undertaken to measure the rates of compliance with HH both before and after a campaign to educate HCWs about hand hygiene and to assess the nosocomial infection rates in the main ICU of our hospital before and after the intervention. The study employed the WHO hand hygiene observation method.

Materials and methods

Setting

The study was conducted between February 2011 and August 2011 in the main ICU of Mubarak Al-Kabir Teaching Hospital, a Ministry of Health hospital affiliated with the Health Sciences Center of Kuwait University. This hospital is a 500-bed tertiary hospital that contains a 23-bed adult medical/surgical ICU with 2 structurally identical wings and a 14-bed cardiac care unit (CCU). The ICU is headed by a consultant anesthesiologist/intensivist, who is ably assisted by 4 specialist doctors, 2 registrars, an assistant matron, a head nurse and the number of staff nurses necessary to maintain a 1:1 nurse:patient ratio. In addition, admitting doctors from each unit of the surgical and medical departments conduct daily rounds in the ICU to evaluate their patients. Ethical approval for this study was provided by the Joint Committee for the Protection of Human Subjects in Research (VDR/JC/180).

Design

This prospective, interventional study was conducted in 2 phases: a 3-month pre-intervention period from February-April 2011 to establish the baseline HH compliance rate and a post-intervention period from June to August 2011 to measure the improvement in the HH compliance rate. The interventional HH campaign was conducted in May 2011. The intervention was part of the Kuwait Hand Hygiene Improvement Program (an educational program for healthcare workers), which included direct lectures to 12 doctors and 26 members of the nursing staff concerning HH and the basic concepts of nosocomial infections, workplace reminder posters depicting the 5 moments for hand hygiene, instructions on the techniques of hand sanitizer use and hand washing, as well as leaflets explaining why, when and how to perform HH. The educational programs were conducted specifically to raise awareness among hospital healthcare workers at all levels [1,5]. Dispensers for alcohol-based hand sanitizers were installed at points of care, inside and outside each patient care room, at the bedsides of the patients in the open care area, and in other conspicuous and convenient locations. The senior staff fully supported the intervention. The results of the HH compliance campaign were regularly presented to the ICU staff, posted at the entrance of the unit and discussed at infection control committee meetings every 2 months.

The nosocomial infection rate calculations included infections acquired at least 48 h after admission or incubating within 30 days after discharge from the hospital. For this study, nosocomial infections were meticulously recorded during the months of February through April 2011 and June through August 2011.

Hand hygiene compliance

Direct observation of the HCWs was conducted using an observation record form. WHO guidelines were used to define HH opportunities and classify them into 5 categories [15]: (1) before patient contact, (2) before an aseptic task, (3) after exposure to bodily fluids, (4) after patient contact and (5) after contact with patient surroundings. The locations of the observations were prescheduled, and the observations were conducted daily, at prespecified 30-min periods during the morning work hours. The observations were conducted in a patient-directed manner, with no more than two patients observed at one time. The observers were members of the infection control team, which consisted of one infection control doctor (a senior specialist) and 6 infection control nurses. These HCWs conducted the HH compliance surveillance unobtrusively, but they were not hidden. The HCWs did not know the schedule of the observation periods. The HH compliance rate was calculated by dividing the number of HH actions (hand washing or hand sanitizing) by the total number of opportunities and multiplying by 100, where opportunities represented the points during the care process when HH should be performed, as specified by the indications. The performance of HH implied a recognition by the HCWs of the indications during their activities and within the process of organized care [15]. The HH compliance data were discussed regularly at the infection control committee (ICC) meeting and with the ICU staff. The data were reported in a composite unit by job category, e.g. doctors, nurses, and other HCWs (radiologists/radiographers, respiratory therapists and physical therapists).

Device use and nosocomial infections

The definitions and methods used for correlating device use and the incidence of nosocomial infections were according to the manual of the CDC National Nosocomial Infection Surveillance (NNIS) System [16]. The infections defined as device-associated included central venous catheter-related bacteremia, urinary

Table 1 Hand hygiene compliance in an adult intensive care unit pre- and post-intervention.

Period/HCW	Hand hygiene			
	Actions	Missed actions	Opportunities	Compliance rate* (%)
<i>Pre-intervention</i>				
Doctors	35	64	99	38.4
Nurses	68	75	144	50.0
Others	11	13	24	45.1
Total	114	152	267	43*
<i>Post-intervention</i>				
Doctors	116	152	268	43.2
Nurses	269	57	326	82.5
Others	49	64	113	43.4
Total	434	273	707	61.4*

HCWs, health-care workers. Others = physical therapists, radiologists, and respiratory therapists.

* Pre- versus post-intervention *P* values: total compliance, $P < 0.001$; doctors, $P = 0.24$; nurses, $P < 0.001$; other HCWs, $P = 0.47$; nurses vs. doctors, $P < 0.001$; nurses vs. other HCWs, $P < 0.001$.

catheter-associated urinary tract infections and ventilator-associated pneumonia. The incidences of multidrug-resistant bacteria, including *Acinetobacter baumannii*, methicillin-resistant *Staphylococcus aureus* (MRSA), *Clostridium difficile*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Klebsiella pneumoniae*, encountered during the study period were recorded.

Statistical analysis

The statistical analysis was performed using a one-sided *P*-value with a 95% confidence level and comparing proportions as percentages. All the statistical calculations were performed using the SAS System for Windows, version 9.1 (SAS Institute).

Results

Hand hygiene compliance rates

A total of 1508 events requiring HH were observed during all phases of the study. The data on the HH compliance rates (i.e. the percentages of opportunities for health care workers) pre- and post-intervention are shown in Table 1. There were 297 and 268 HH opportunities for doctors, 434 and 326 for nurses, and 73 and 113 for other professionals, pre- and post-intervention, respectively. The numbers of observations recorded during the study period averaged 10.1 opportunities/h. The overall rates of pre- and post-intervention compliance with the HH recommendations were 43 and 61.4%, respectively, which were significantly

different ($P < 0.001$). The relative rates of compliance among the job categories (doctors, nurses and other professionals), shown in Table 1, demonstrated that the nurses exhibited greater adherence (50%) to the HH recommendations than did the doctors (45%) and the other health care professionals (38.4%). The difference in the compliance rates of the nurses and doctors was not statistically significant ($P > 0.05$), but those two rates were significant compared to those of the other professionals ($P < 0.001$). Following the educational intervention, the increase in the nurses' compliance rate was significantly larger than the compliance rates of both the doctors (82.5% vs. 43.2%; $P < 0.001$) and the other professionals (82.51% vs. 43.36%; $P < 0.001$). There was only a marginal increase in the rate of compliance among doctors at the baseline versus post-intervention points (38.5% vs. 43.2%; $P > 0.05$), and the compliance rate of the other professionals actually decreased to 43.4% from a baseline rate of 45%.

Hand hygiene and nosocomial infection rates

The incidences of the three types of specific device-associated infections studied are shown in Table 2. There was a remarkable reduction in the total rates of nosocomial infections, calculated as the healthcare-associated infection (HCAI)/1000 patient-days, from 37.2 to 15.1 in the pre- and post-intervention periods, respectively; $P < 0.001$). There was another noteworthy reduction in nosocomial infections, which correlated with the improvements in HH compliance, in terms of bloodstream infections (BSI)/1000

Table 2 Nosocomial infections in the adult intensive care unit before and after the intervention.

Intervention period		Overall HCAI/1000 patient-days	UTI/1000 catheter-days	BSI/1000 central line-days	LRTI/1000 ventilator-days
Pre-intervention	February 2011	55.9	10.0	11.9	32.7
	March 2011	25.5	2.2	28	2.8
	August 2011	30.2	4.3	16.1	17.3
	Average	37.2*	5.5**	18.6***	17.6****
Post-intervention	June 2011	11	7.3	0	3.9
	July 2011	19.8	6.3	7.5	8.5
	August 2011	14.5	6.6	2.7	3
	Average	15.1*	5.9**	3.4***	5.2****

HCAI, healthcare-associated infection; BSI, bloodstream infection; UTI, urinary tract infection; LRTI, lower respiratory tract infection.

* $P < 0.001$.

** $P = 0.4$.

*** $P < 0.001$.

**** $P < 0.001$.

central-line days (18.6 vs. 3.4 pre- and post-intervention, respectively; $P < 0.001$) and lower respiratory tract infections (LRTI)/1000 ventilator-days (17.6 vs. 5.2 pre- and post-intervention, respectively; $P < 0.001$). However, the incidence of urinary tract infections (UTI)/1000 catheter-days was unaffected by the improved HH compliance after the intervention (5.5 versus 5.9 pre- and post-intervention, respectively; $P > 0.4$) (Table 3).

Hand hygiene compliance and infections caused by multidrug-resistant bacteria

The nosocomial infection rates, both pre- and post-intervention, were relatively low. However, the HCAI/1000 patient-days due to *A. baumannii* was reduced by approximately 35.5% after the intervention (5.4 vs. 3.5 pre- and post-intervention, respectively; $P < 0.02$). In addition, there was a significant 74.4% post-intervention

reduction in the rates of nosocomial infections due to *K. pneumoniae* and MRSA (2.7 vs. 0.7 pre- and post-intervention, respectively; $P < 0.001$ and 0.9 vs. 0 pre- and post-intervention, respectively; $P < 0.003$, respectively). The number of *E. coli* infections was reduced by approximately 50% (1.1 vs. 0.7 pre- and post-intervention, respectively), although the difference did not attain statistical significance ($P > 0.2$). The numbers of infections due to *P. aeruginosa*, and *C. difficile* were too small to allow any meaningful comparisons, although the pre-intervention rates of these two types of infection (2.7 and 0.2 per 1000 patient-days, respectively) were reduced to zero post-intervention.

Discussion

Hand washing is widely accepted as an effective measure to reduce nosocomial infections in

Table 3 The incidence of multidrug-resistant organisms in the main intensive care unit before and after the intervention.

Nosocomial organisms	HCAI/1000 patient-days due to nosocomial pathogens isolated in the adult ICU		P value
	Pre-intervention	Post-intervention	
<i>Acinetobacter baumannii</i>	5.4	3.5	0.02
<i>Pseudomonas aeruginosa</i>	2.7	0	<0.001
<i>Escherichia coli</i>	1.1	0.7	0.21
<i>Klebsiella pneumoniae</i>	2.7	0.7	<0.001
Methicillin-resistant <i>S. aureus</i>	0.9	0	0.003
<i>Clostridium difficile</i>	0.2	0	0.2

HCAI, healthcare-associated infection.

hospitals, including in intensive care units (ICUs), and nosocomial infections are frequently viewed as indicating poor compliance with hand washing recommendations. Our study was conducted using the direct observation method (the 'gold standard'), the most reliable method for measuring the rate of adherence to hand hygiene. The direct observations were performed by an infection control nurse (ICN) and the infection control doctor. This method has the advantage of being able to pinpoint areas of strength or weakness in HH behavior; for example, some studies have reported better compliance with HH after patient care compared with before care. Many studies have also found different HH compliance rates among physicians, nurses and nursing attendants. We were, however, cognizant of the disadvantages of direct observation. Some difficulties associated with this method are that it is labor-intensive and costly, and there are concerns about the methods used for training the observers, the assessment of inter-rater reliability and the potential for staff members to change their behavior when they know that they are being observed [7].

As demonstrated by this study, the intervention conducted during May 2011 had a significant influence on the overall HH compliance rate among the nurses but produced little or no change among the doctors and other allied health professionals. This observation is concordant with the findings of other studies [11,17], which showed that the improvements in HH compliance differed significantly between groups of HCWs, with compliance increasing remarkably among nurses and nursing assistants but remaining low among doctors and other HCWs, with no significant trends over time. The present study showed that most of the missed HH actions were before patient contact and after touching the patient environment (data not shown). This finding is in agreement with a hospital-wide, cross-sectional study that suggested that HCWs perform HH for their own protection, rather than to protect their patients [17]. Another study that supports this observation was conducted in an adult ICU by O'Boyle et al. [18], who showed that HH adherence (measured via direct observation) was the highest 'after completion of care' (87.1%) and 'after direct contact with body substances' (87.1%).

Our experience of higher compliance rates among HCWs after the intervention was similar to the rates observed in various hospital ICUs in the USA [11,19]. Concordant observations were also recorded in two ICUs in a hospital in Argentina before and during the implementation of an HH program, in which the overall HH adherence improved

significantly between the two periods (from 23.1% to 64.5%, $P < 0.0001$) [20]. The HH adherence among the doctors in this study's hospital ICU was poor, which was not surprising due to the results of numerous other studies on adherence among physicians [21,22]. This result was of great concern to the infection control team and the hospital administration, and we believe it should concern the senior staff members, particularly the accountable physicians and the senior nurses. Thus, we continue to emphasize that the consultants and head nurses should lead by example by adhering meticulously to the HH recommendations because experience has shown that when the junior staff members observe the senior staff members perform HH, they are more motivated to adhere to the guidelines.

We examined the use of medical devices and the incidence of nosocomial infections before and after the intervention to define the direct role of HH in the prevention of nosocomial infections. We observed a dramatic reduction in nosocomial infections, defined as the rate of device-associated infections/1000 patient-days, and a decreased incidence of multidrug-resistant (MDR) bacterial infections with improved HH compliance subsequent to the interventional program. This finding is in contrast to a report by Rupp et al. [23], which did not show any changes in the incidence of nosocomial infections and infections from MDR bacteria with improved HH compliance. Despite the improved infection rates with HH compliance documented in our study, we are mindful of the short duration of this study. Therefore, the improvements that we observed may not merit realistic expectations that nosocomial infections will always be reduced as a result of simple, unifocal interventions. However, improvements may be achieved with a concerted, vigorous intervention, as was conducted in the hospital during the national HH compliance campaign.

Alcohol-based hand sanitizing gels have been available in our hospital for a fairly long time. Because triclosan is a substrate for multidrug efflux pumps in bacteria, the rate of infections from *P. aeruginosa*, a strain that typically possesses multidrug efflux pumps, was examined to determine whether this type of infection was a problem that could be amenable to HH. Similarly, because alcohol has low antimicrobial activity against *C. difficile* spores, the rates of infection with *C. difficile* before and after the intervention were also investigated. In both cases, HH compliance appeared to have cleared the organisms, although the incidence of both bacteria was low at baseline. A limitation of our study was that it was performed only in a

combined adult medical/surgical ICU. Other limitations were that the rate of glove use by the health care workers was not noted during the routine HH observation periods and that the HH performance was not classified according to the procedure risks, as many other studies have done [15,24,25].

Conclusion

Our study showed that HH observation, in addition to the other orientation tools used in our campaign, is a useful tool for improving HH compliance in health care settings, especially in ICUs. A repeat of this study covering a longer period of time is needed to confirm the observed improvements in the rates of nosocomial infections and infections due to multidrug-resistant bacteria associated with the improved rate of HH compliance in our ICU. To sustain our current level of improvement, an ongoing observation of HH performance is needed.

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Competing interests

We have no conflict of interest.

Ethical approval

Not required.

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