Impact of a multicomponent hand hygiene intervention strategy in reducing infection rates at a university hospital in Saudi Arabia

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Abstract: *Background and aims:* Few studies have reported the correlation between hand hygiene (HH) practices and infection rates in Saudi Arabia. This work was aimed to study the effect of a multicomponent HH intervention strategy in improving HH compliance and reducing infection rates at King Fahd Hospital of the University, Al-Khobar, Saudi Arabia between January 2014 and December 2016. *Methods:* A yearlong multicomponent HH intervention, which included various strategies recommended by the World Health Organization, was introduced. HH compliance among staff and infection rates observed in the inpatient wards were assessed and compared at pre- and post-interventional phases. *Results:* There was a significant increase in mean HH compliance from 50.17% to 71.75% after the intervention ($P < 0.05$). Hospital-acquired infection (HAI) and catheter-associated urinary tract infection (CAUTI) rates decreased from 3.37 to 2.59 and from 3.73 to 1.75, respectively ($P < 0.05$). HH compliance was found to be negatively correlated with HAI ($r = -0.278$) and CAUTI ($r = -0.523$) rates. *Conclusions:* Results show that multicomponent intervention is effective in improving HH compliance, and that an increase in HH compliance among hospital staff decreases infection rates. Further studies on cost-effectiveness of such a model could augment to these findings.

Keywords: hand hygiene, healthcare-associated infection, nosocomial infection, hospital-acquired infection, catheter-associated urinary tract infections, infection control, Saudi Arabia

Introduction

Globally, hospital-acquired infections (HAIs) pose a significant burden to healthcare workers and patients with respect to health, time, resources, and cost. The prevalence of HAIs widely varies from 5.7% to 19.1%, and the data pertaining to it are often reported unconventionally due to lack of unified strategies [1]. Although reports on the nationwide prevalence of HAIs in Saudi Arabia are not readily available, a few studies have reported the prevalence of HAIs in different provinces of the Kingdom. For example, studies conducted in Taif Hospitals reported that the infection type in 48.3% of hospitalized patients with identified infections was diagnosed to be of nosocomial origin [2, 3].

Up to 23% of healthcare-associated infections occurring in intensive care units and about 40% of infections occurring in all units of a hospital are device-associated [4]. Catheter-associated urinary tract infections (CAUTIs) are regarded as some of the most common nosocomial infections. About 2%–4% of hospitalized patients with CAUTIs are reported to have been affected with bacteremia, and their fatality rate is three times higher than that of patients with no bacteriuria [5, 6]. A recent study on the incidence of CAUTI in three Gulf Cooperation Council (GCC) countries, such as Bahrain, Oman, and Saudi Arabia, reported that the risk of urinary tract infection was 35% higher in the hospitals of these GCC nations than in those of the United States National Healthcare Safety Network [7].

Of the various causes of HAI that have been identified, unclean hands are often considered to be unrecognized sources of transmission [8, 9]. Hand hygiene (HH) and infections are inversely related. Strict adherence to HH is a vital step in preventing healthcare-related infections. Unfortunately, this basic step is often ignored by workers in healthcare settings. Various methods have been tried and tested by clinicians and researchers across regions to improve HH compliance among healthcare workers. The "Clean Care is Safer Care" initiative by the World Health Organization (WHO) is reported to have had a positive impact on HH compliance. Many studies augmenting this WHO approach with numerous multifaceted improvement techniques have been implemented. Such studies have reported remarkable decreases in the infection rates of HAI and CAUTI with even slight increases in HH compliance [10–14].

Despite there being a growing concern worldwide on the increase in HAI and CAUTI rates, very few studies on this issue have been reported from the Middle East [15]. The correlation between HH practices and infection rates has rarely explored in the Saudi Arabian context. This work was conducted with the aim of studying the effect of a multicomponent HH intervention in improving HH compliance and reducing healthcare-associated infection rates at a university hospital in Saudi Arabia.

Methods

This prospective interventional study was conducted at King Fahd Hospital of the University (affiliated to Imam Abdulrahman Bin Faisal University), Al-Khobar, Saudi Arabia, between January 2014 and December 2016. First, the HH compliance rate was assessed among the staff with direct patient access in the inpatient wards of the hospital by directly observing the number of HH opportunities and the number of positive actions taken against those who did not follow HH conventions. The observations were recorded in a discrete manner to avoid the Hawthorne/observer effect. A period of five moments, as suggested by the WHO, for a healthcare staff to practice HH while making patient contact were considered [16, 17]. Based on this recommendation, any incident that required HH was considered an opportunity, and the corresponding response to that opportunity was considered an action.

HAI and CAUTI rates in the inpatient wards were then observed. While the HAI rate was calculated per 1,000-patient days, the CAUTI rate was calculated per 1,000-catheter days. A yearlong multicomponent intervention was introduced for improving HH practices. HH compliance among hospital staff and rates of HAI and CAUTI observed in the inpatient wards were again assessed after the intervention and were compared with pre-interventional values.

The Ethical Committee of Imam Abdulrahman Bin Faisal University (formerly University of Dammam) reviewed the study procedures and gave its approval for the conduct of this research.

The author of this manuscript has certified that he comply with the principles of ethical publishing in *Interventional Medicine & Applied Science*: Szél Á, Merkely B, Hüttl K, Gál J, Nemes B, Komócsi A: Statement on ethical publishing and scientific authorship. IMAS 2, 101–102 (2010).

Multimodal intervention

The multicomponent intervention to improve HH compliance used in this study was carried out for a period of 12 months, and it mainly comprised WHO's multimodal HH intervention strategy [18, 19]. The interventional steps that fall under the five-point WHO strategy [20] include the following:

1. Increasing the availability and ease of access to alcohol-based hand rub and water supply;
2. Holding educational events on HH and infection control;
3. Offering training and support with monthly evaluation and feedback analysis;
4. Presenting visual displays to promote HH practices; and
5. Ensuring a climate of institutional safety.

In addition, the following interventional steps were carried out:

- Holding timely meetings with the hospital management and staff to involve them in achieving effective HH practices;
- Assessing the infrastructural and consumable requirements at the hospital;
- Providing intensive education sessions on "five moments for hand hygiene" based on WHO methods;
- Using PowerPoint presentations, video screening, and training handouts in English and Arabic;
- Placing posters above washbasins in the wards and theaters;
- Installing screensavers on computers to display HH moments;
- Providing adequate personal protection equipment to healthcare workers and teaching them how to use such equipment properly;
- Adhering strictly to visitors' policy and educating visitors to keep hands clean and not contact vulnerable patients.

Statistical analysis

SPSS version 20.0 was used for data analysis. A value of $P \leq 0.05$ was considered statistically significant. Percentages and 95% confidence intervals (95% CIs) were used to present HH adherence, whereas frequency and 95% CI

were used to present infection rates. A correlation analysis was conducted to confirm the presence of any relationship between HH compliance and nosocomial infections.

Results

There was a significant increase in mean HH compliance from 50.17% (95% CI: 44.84, 54.67) to 71.75% (95% CI: 70.59, 72.83) after the multicomponent intervention ($P < 0.05$) *(Table I)*.

HAI rates observed in the inpatient wards showed a decreasing trend from 3.37 (95% CI: 3.05, 3.69) pre-intervention to 2.59 (95% CI: 2.23, 2.90) post-intervention. Furthermore, CAUTI rates reduced from 3.73 (95% CI: 2.47, 5.04) to 1.75 (95% CI: 0.90, 2.74) *(Tables II* and *III)*. The reduction in the rates of both of these nosocomial infections was statistically significant ($P < 0.05$).

The correlation analysis showed that there is a weak-negative correlation between HH compliance and the HAI rate. However, a moderate negative correlation was found between HH compliance and CAUTI rate was negatively correlated with HAI ($r = -0.278$) and CAUTI rates ($r = -0.523$) *(Table IV)*.

Table I Hand hygiene compliance rates over years

Hand hygiene compliance rates		Statistic	Bias	Standard error	95% confidence interval Lower	Upper
2014	*N*	12	0	0	12	12
	Mean	50.1667	−0.0804	2.4829	44.8355	54.6667
	Standard deviation	9.00337	−0.48201	1.62234	5.19012	11.43343
2015	*N*	12	0	0	12	12
	Mean	66.0833	−0.0792	2.0361	61.5833	69.8333
	Standard deviation	7.42794	−0.40076	1.19513	4.57935	9.17602
2016	*N*	12	0	0	12	12
	Mean	71.7500	0.0024	0.6055	70.5833	72.8333
	Standard deviation	2.17945	−0.10972	0.25319	1.49747	2.50303
Overall	*N*	12	0	0	12	12
	Mean	62.6667	−0.0524	1.5078	59.1667	65.3319
	Standard deviation	5.44949	−0.28858	0.98159	2.96895	6.65778
Valid *N* (listwise)	*N*	12	0	0	12	12

Table II Healthcare-acquired infection rates over years

Hospital-acquired infection rates		Statistic	Bias	Standard error	95% confidence interval Lower	Upper
2014	*N*	12	0	0	12	12
	Mean	3.3700	−0.0024	0.1674	3.0476	3.6925
	Standard deviation	0.59809	−0.03620	0.10593	0.34613	0.75865
2015	*N*	12	0	0	12	12
	Mean	2.4208	0.0035	0.1498	2.1292	2.7166
	Standard deviation	0.52460	−0.03351	0.09733	0.30342	0.67577
2016	*N*	12	0	0	12	12
	Mean	2.5483	−.0047	0.1750	2.2292	2.9000
	Standard deviation	0.63221	−0.04112	0.12802	0.31149	0.80114
Overall	*N*	12	0	0	12	12
	Mean	2.7797	−0.0012	0.0890	2.6129	2.9586
	Standard deviation	0.31647	−0.02017	0.04649	0.19846	0.38261
Valid *N* (listwise)	*N*	12	0	0	12	12

Table III Catheter-associated urinary tract infection rates over years

Catheter-associated urinary tract infection rates		Statistic	Bias	Standard error	95% confidence interval Lower	Upper
2014	*N*	12	0	0	12	12
	Mean	3.7267	−0.0015	0.6356	2.4693	5.0444
	Standard deviation	2.40777	−0.12836	0.36623	1.53112	2.92702
2015	*N*	12	0	0	12	12
	Mean	2.2083	−0.0030	0.8113	0.6756	3.9667
	Standard deviation	2.92806	−0.21823	0.72969	1.22249	3.98839
2016	*N*	12	0	0	12	12
	Mean	1.7508	0.0095	0.4624	0.9021	2.7407
	Standard deviation	1.70099	−0.09149	0.25289	1.14012	2.05290
Overall	*N*	12	0	0	12	12
	Mean	2.5619	0.0017	0.3835	1.7996	3.2944
	Standard deviation	1.44927	−0.07875	0.22845	0.90036	1.78200
Valid *N* (listwise)	*N*	12	0	0	12	12

Table IV Correlation analysis between hand hygiene and infections

Correlation		HH	HAI	CAUTI
HH	Pearson correlation	1	−0.278	−0.523
	Sig. (two-tailed)		0.381	0.081
	N	12	12	12
HAI	Pearson correlation	−0.278	1	−0.143
	Sig. (two-tailed)	0.381		0.656
	N	12	12	12
CAUTI	Pearson correlation	−0.523	−0.143	1
	Sig. (two-tailed)	0.081	0.656	
	N	12	12	12

CAUTI: catheter-associated urinary tract infection; HAI: hospital-acquired infection; HH: hand hygiene

Discussion

This work studied the impact of a multicomponent HH intervention in reducing infection rates in a university hospital in Saudi Arabia. The results showed that the yearlong intervention improved the HH practices among the hospital staff. Furthermore, such an increase was observed to be correlated with the decrease in infection rates in the inpatient wards.

Most studies on HH within the Kingdom have focused mainly on the knowledge, attitude and behavior of hospital staff, and healthcare students toward such practices; however, only a few studies have analyzed the rate of adherence to the number of HH opportunities [21–23]. A 12-month observational study conducted in a general hospital in Makkah, Saudi Arabia, reported that the rate of compliance to HH was 50.3%, which was like the pre-interventional compliance rate (50.17% ± 9.00%) observed in this work [24]. Appropriate education and training are imperative in enhancing staff knowledge on HH [25].

Many studies across the world have highlighted the need for a multifaceted approach to improve HH practices; the types and number of approaches that are documented in the literature vary widely from hospital to hospital and country to country, mostly depending on the availability of resources, knowledge of hospital staff, as well as the cost involved in implementing each model [16]. Despite the availability of modern interventions in improving HH compliance, certain standard strategies as used in this study remain effective even in a low-resource setting. Active and passive educational programs,

motivational campaigns, displays of posters, distribution of pamphlets, increased numbers of alcohol hand rub solution stations, and implementation of WHO's five-moments scheme form important elements of the list of proven approaches [26–29]. In this study, the author has chosen these standard tactics, along with the use of accountability and performance feedback and regular audits.

Adherence to HH in this study gradually increased from 50.17% ± 9.00% in 2014 to 66.08% ± 7.43% in 2015 and 71.75% ± 2.18% in 2016, indicating the success of the multicomponent approach implemented in this study in enhancing the HH practices. A similar trend in the gradual increase of compliance (37.5%–51.7%) was reported in studies by Sastry et al. [30] after implementing an HH audit as an intervention strategy, and by Chhapola and Brar [31] after implementing an educational program (46%–69%). Some studies reported the effectiveness of multifaceted approaches on HH improvement based on the WHO strategy; one regional example on this could include a study by Mahfouz et al. [16], which reported that a multimodal program involving the WHO approach showed an increase in HH practices from 60.8% in 2011 to 86.4% in 2013 in an intensive care unit in Abha, Saudi Arabia. Al-Tawfiq et al. [32] reported that a multimodal HH program improved the adherence from 38% to 85% over a period of 5 years, which highlights the sustainable benefits of such multifaceted initiatives. However, Mazi et al. [33] documented that even though a multicomponent strategy involving WHO approach could enhance the HH compliance rate, the results were not sustainable in certain critical care areas that lacked team leaders.

Improvement in HH compliance had been reported to indirectly minimize nosocomial infections, thereby ensuring patient safety. In this study, the rates of HAI decreased from 3.37 ± 0.60 to 2.55 ± 0.63 after the multicomponent intervention. A similar decrease in HAI rate was reported by a Taiwanese study wherein the implementation of the WHO multimodal strategy resulted in the reduction of HAI rates from 3.7 to 3.1 [34]. The results of a three-year study with step-by-step interventions showed significant hospital-wide improvement in HH compliance and infection control (4.8–3.3) [35].

The rates of CAUTI in this study showed a gradual decline from 3.73 ± 2.41 in 2014 to 2.21 ± 2.93 in 2015 and 1.75 ± 1.70 in 2016. HH practices form a vital strategy in preventing CAUTI rates [11]. An Egyptian study investigated the use of a combined interventional strategy with HH as a key component, and the results showed that the pre-interventional rate of 90.12 reduced to 65.69 after the intervention [36]. In another study, a multimodal supervision program, involving HH as one of the interventions, resulted in 47.1% reduction of CAUTI incidence [37]. Al-Tawfiq et al. [32] observed that there was a reduction of CAUTI rates from 7.08 to 3.5 after HH intervention in a community hospital in the Eastern Province of Saudi Arabia.

A landmark study published in 1988 reviewed the literature data available over more than 100 years and studied the casual link between handwashing and infection control [38]. There were strong evidences available on the correlation between the improvement in HH practices and reduction in HAI rates. The results obtained in this study add more value to the existing literature, especially with respect to the Saudi context. HH compliance was found to be negatively correlated with HAI and CAUTI rates, and the relationship observed between HH compliance and HAI rate was weak-negative, whereas between HH compliance and CAUTI rate was moderate-negative.

Limitations

Although the results of this study add value to the available literature on the link between HH practices and infection control, the study has certain inherent limitations. First, the infection rates of methicillin-resistant *Staphylococcus aureus* (MRSA) were not assessed before, during, or after the mentioned interventions. MRSA infection is a critical setback for a hospitalized patient, as it involves multiple factors, including HH. Further studies may focus on analyzing this infection. Second, unlike other studies from Saudi Arabia that have focused on the knowledge and attitude of hospital staffs and students, this study did not assess the individual adherence rates among different stakeholders. Further studies can also assess diurnal variation in compliance rate and suggest methods to prevent such variation.

Conclusion

Multicomponent intervention is effective in improving HH compliance and reducing nosocomial infection rates. The results suggest that active educational intervention with timed evaluation of practices help reduce infection rates significantly. Although many novel methods are being introduced in enhancing HH compliance among healthcare staff, improvement strategies as suggested by WHO seem to be simple and practically easy to implement. Further studies on cost-effectiveness of such a model could augment the evidence obtained in this study.

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Conflict of interest: The author declares no conflict of interest.

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