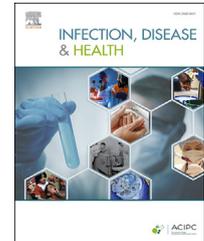




Available online at www.sciencedirect.com

ScienceDirect

journal homepage: <http://www.journals.elsevier.com/infection-disease-and-health/>



Research paper

The effect of a hand hygiene program featuring tailored religion-relevant interventions on healthcare workers' hand rubbing compliance and beliefs in the United Arab Emirates: A cohort study^{☆, ☆ ☆}

Wai Khuan Ng^{a,b,*}, Ramon Z. Shaban^{b,c}, Thea van de Mortel^{d,e}

^a Nursing Division, Mafraq Hospital, P.O. Box 2951, Abu Dhabi, United Arab Emirates

^b Faculty of Medicine and Health, Susan Wakil School of Nursing and Midwifery & Marie Bashir Institute for Infectious Diseases and Biosecurity, University of Sydney, NSW, Australia

^c Nursing, Midwifery and Clinical Governance Directorate, Western Sydney Local Health District, Westmead, NSW, Australia

^d School of Nursing and Midwifery, Griffith University, Clinical Sciences 2 Building (G16), Parklands Drive, Southport, Qld, 4215, Australia

^e Menzies Health Institute Queensland, Griffith University, Health Sciences Building (N48), 170 Kessels Road, Nathan, Qld, 4111, Australia

Received 20 November 2018; received in revised form 22 January 2019; accepted 22 January 2019

Available online 20 February 2019

KEYWORDS

Hand hygiene;
Alcohol-based hand rub;
Modified hand hygiene program;
Religion-relevant culturally-specific interventions;
Cohort study design;
Survey

Abstract *Background:* Hand hygiene with ABHR is more effective, time-saving and skin-friendly than traditional handwashing. However, alcohol-based hand rub (ABHR) use can be an obstacle for specific religions. The study aimed to test the effect of a modified hand hygiene program featuring religion-relevant, culturally-specific interventions on compliance and beliefs about ABHR use.

Methods: A cohort study design was employed between August and November 2017 at a large tertiary hospital in the United Arab Emirates. Hand hygiene audit data and a cross-sectional survey were used to measure the impact of the modified hand hygiene program on compliance with, and beliefs about, ABHR use.

Results: The intervention group had higher mean compliance with overt ($p = 0.002$) and covert ($p = 0.04$) ABHR use post-intervention, and higher mean compliance with overt ABHR use ($p = 0.002$) than the control group. The intervention group had more positive religious

[☆] Approval obtained for reproduction or modification of material published elsewhere: Not applicable.

^{☆☆} Commercial affiliations: Not applicable.

* Corresponding author. Nursing Division, Mafraq Hospital, P.O. Box 2951, Abu Dhabi, United Arab Emirates. Fax: +971 25821549.

E-mail addresses: nkhuan@seha.ae (W.K. Ng), ramon.shaban@sydney.edu.au (R.Z. Shaban), t.vandemortel@griffith.edu.au (T. van de Mortel).

beliefs ($p = 0.01$) about ABHR use than the control group.

Conclusion: Implementing a hand hygiene program featuring tailored religion-relevant interventions in a culturally appropriate way had a positive effect on compliance with, and beliefs about, ABHR use.

© 2019 Australasian College for Infection Prevention and Control. Published by Elsevier B.V. All rights reserved.

Highlights

- Religion-relevant, culturally-specific interventions had a significant positive effect on compliance with ABHR use.
 - Religion-relevant, culturally-specific interventions had a significant positive effect on beliefs about ABHR use.
 - Strategies to promote compliance and beliefs should include religion-relevant, culturally-specific interventions.
-

Introduction

Healthcare-associated infections (HAIs) are a leading global preventable threat to safe healthcare [1]. Hand hygiene with alcohol-based hand rub (ABHR) significantly reduces the transmission of infection [2], and is more effective, time-saving and skin-friendly than traditional handwashing [3]. However, hand hygiene with ABHR can be problematic for specific religions such as Sikhism, Hinduism and Islamism given that the consumption of alcohol is prohibited [4,5]. This prohibition of consumption is widely considered to also apply to general use due to fears of absorption via the skin, making the adoption of best-practise recommendations for use of alcohol-based solutions difficult [4,5].

Personal cleanliness is important in Islamic worship [6]. The Qur'an mandates personal hygiene including hand hygiene [7]. Although the 2002 Muslim World League determined that the Qur'an permits the use of medicinal agents containing alcohol in any percentage to alleviate illness or contribute to better health if there is no feasible substitute [8], some Muslim HCWs are not willing to use alcohol-based solutions due to religious concerns [4]. For example, a 2017 Iranian study demonstrated that 24.6% of nurses were concerned about respiratory inhalation of alcohol during ABHR use and 22.7% reported that possible alcohol absorption through the skin would be a problem, although a majority were not concerned about either inhalation or absorption presenting a possible religious conflict [9].

The hand hygiene program in one tertiary hospital in the United Arab Emirates (UAE) improved hand hygiene compliance between 2011 and 2015, but this was not sustained at its highest level [10,11]. A previous mixed-methods study in this setting demonstrated that religious and cultural beliefs influence self-reported alcohol-based hand rubbing behaviour [11]. Thus, the existing program was modified to integrate religion-relevant, culturally-specific interventions, where local Islamic scholars (Imams) were invited to provide advice to Muslim healthcare workers and support the religious interventions. The study aims were to examine the effect of this modified hand hygiene program on: 1) HCWs' compliance with ABHR use,

and 2) religious beliefs in relation to ABHR use. The specific research questions were:

1. What effect did a modified hand hygiene program featuring religion-relevant, culturally-specific interventions have on HCWs' compliance with ABHR use?
2. What effect did a modified hand hygiene program featuring religion-relevant, culturally-specific interventions have on HCWs' religious beliefs about ABHR use?

Methods

Setting and study design

A cohort study design was used to examine the effect of a modified hand hygiene program featuring religion-relevant culturally-specific interventions on HCWs' compliance with, and religious beliefs about, ABHR use at a tertiary healthcare facility in Abu Dhabi, UAE. The modified program was delivered to two intervention wards and the existing program to two control wards between August and November 2017. The study was conducted in 2 parts. The first involved collection of overt and covert hand hygiene audit data to determine how the modified program influenced HCWs' compliance with ABHR use, which was calculated as the number of individuals with observed compliance with any of the World Health Organization (WHO) Five Moments [5] divided by number of observed opportunities for ABHR use where the WHO Five Moments apply. The audits were conducted across all types of shifts, i.e. day, afternoon and night. Subsequently, a cross-sectional survey was conducted to determine how the modified program influenced religious beliefs about ABHR use amongst HCWs.

Participants

Four surgical wards (Ward A – adult trauma, Ward B – adult neurosurgical, Ward C – adult female, and Ward D – adult male) that shared similar characteristics (Table 1), were chosen as intervention and control groups. The availability

Table 1 Comparative statistics of intervention and control groups.

Ward	Bed #	Occupancy	No. of Healthcare Workers	Mean overt alcohol-based hand rubbing compliance over previous 12 months (August 2016–July 2017)	Mean covert alcohol-based hand rubbing compliance over previous 12 months (August 2016–July 2017)
A	23	91.3%	54	83.58%	64.86%
B	22	90.9%	56	82.67%	63.16%
C	23	91.3%	54	83.66%	65.79%
D	24	91.7%	55	83.66%	64.86%

and placement of ABHR in all four wards was consistent. Since these wards shared similar characteristics, they were not randomly assigned. Intervention wards A and B received the 12-element modified hand hygiene program (Table 2), while control wards C and D received the original eight element hand hygiene program (Table 3).

Monitoring of compliance with ABHR use within and between groups

Data collection

In both hand hygiene programs, the original and the modified, a monthly overt audit of hand hygiene opportunities was performed on HCWs by infection preventionists and link practitioners, and a quarterly covert audit of hand hygiene opportunities was performed by covert auditors. The link practitioners and covert auditors were trained for the observational audit by the infection preventionists, and competency was assessed prior to data collection. The covert auditors were regular HCWs visiting the units for other tasks (e.g., case managers, medical residents) who were conducting the audit at the same time. The auditors were rotated around the wards. An audit tool and clear definitions (supplementary file 1) were provided to increase interrater reliability. The percentage overt and covert alcohol-based hand rubbing compliance of the intervention and control groups from August 2016–July 2017 (12 months) was used as baseline data; post intervention comparison data were collected over six months for both groups between December 2017 and May 2018.

Sample size. All personnel working in the intervention and control wards—118 nurses, 62 medical staff and 39 allied health staff (Hospital Human Resources, 2017, pers. comm.)—were included in the audits (Table 1).

Data analysis

Frequencies and percentages were calculated for the audit data. Due to different shifts and staff attrition there was a mix of previously captured and never captured staff in the pre and post intervention periods. Pre and post data were therefore analysed as independent samples within and between groups. A Z-Test was conducted using the EpiTools epidemiological calculator [12] to compare the mean overt and covert compliance with ABHR use between two independent samples (i.e., pre and post intervention periods; intervention and control groups), as proposed by Field [13]. All tests were two-tailed. The alpha level for statistical significance was set at 0.05. Higher mean compliance reflected

better compliance with ABHR use. Preliminary assumption testing was not required for the Z-Test as the data are categorical (i.e., hand hygiene counts/percentage).

Evaluation of religious beliefs between intervention and control groups

Data collection

Instrument. The survey (supplementary file 2) utilised the previously piloted and validated 'Hand Hygiene Behaviour Determinants Questionnaire [11], which contained three sections: respondents' demographics; a five-item Religious Beliefs Scale, and a four-item cultural factors scale on a 7-point Likert scale ranging from 1 (Strongly disagree) to 7 (Strongly agree); and the 13 item Marlowe-Crowne Social Desirability Scale (MCSDS) short form C [14]. Two infection prevention and control experts confirmed the content validity of the survey, while reliability and face validity were determined via inter-item correlations and pilot testing. The demographic section examined respondents' age, gender, profession, and religion. Respondents were asked if they participated in the modified hand hygiene program to differentiate between groups. The Religious Beliefs Scale and Cultural Factors Scale measured the extent to which participants agreed that the ABHR use was supported by their religion and culture, respectively. The likelihood of socially desirable responding (SDR) is based on the social value placed on scale items [15]. For instance, those that referred to religious beliefs were probably susceptible to SDR because of social expectations that participants might want to comply with. Thus, participants' responses were more likely to be influenced by SDR when they were being asked to self-report on socially sensitive topics [16] such as religious beliefs. Hence, the MCSDS was used to determine, and provide the opportunity to control for, respondents' tendency to present themselves in a 'socially desirable' way [14].

Sample size. Assuming a 5% margin of error, a 95% confidence level, and a 50% response distribution, the minimum recommended sample size was 91, 54, and 36 for nursing, medical and allied health staff, respectively [17]. The number of respondents were 114, 57, and 28. The minimum recommended total sample size was 181, and 199 staff responded reducing the margin of error (2.10%) [17].

Survey administration. The anonymous electronic survey, which took ~10 min to complete, was distributed to

Table 2 Modified hand hygiene program element and variables.

Element	Description
1 <i>Integration of facts about alcohol-based hand rub in revised hand hygiene policy (Revised)</i>	<p>The existing hand hygiene policy was revised to incorporate the following facts about alcohol-based hand rub:</p> <ul style="list-style-type: none"> • No objection is raised to the use of alcohol-based products for hand hygiene, from any religious or cultural perspectives. All religions and cultures permit the use of medicines that contain alcohol in any percentage that may be necessary for manufacturing if it cannot be substituted (Muslim World League, 2002; World Health Organization, 2009); and • Published studies to date have shown that after using alcohol-based handrubs, alcohol levels found in the blood are insignificant (ethanol) or undetectable (iso-propyl) (World Health Organization, 2009). <p>The revised hand hygiene policy was approved by the infection prevention and control committee and only shared with the intervention group through email. The intervention group were alerted to, and educated about, the alcohol-based hand rub facts in the revised policy by the student researcher twice a week and the unit managers of the intervention group daily during the intervention period (August till November 2017).</p>
2 <i>Integration of facts about alcohol-based hand rub on hand scanner during in-house hand hygiene education sessions (Revised)</i>	<p>This element was modified by posting signage on the hand scanner and adding the new facts into the standard operating procedures for hand scanning. The signage and standard operating procedures were shared during the in-house hand hygiene education sessions held monthly during the intervention period. The intervention group was instructed to read the facts on the poster and raise any concerns in the presence of the student researcher.</p>
3 <i>Integration of religious elements into hand hygiene education workshop (Revised)</i>	<p>This element integrated two alcohol-based hand rub facts (as delineated in element 1) into a hand hygiene education workshop held for the intervention group in August 2017.</p>
4 Hand hygiene direct observation audit Implementation (overt)	<p>A monthly hand hygiene audit of hand hygiene opportunities was performed on healthcare workers and visitors by infection preventionists and infection prevention and control link practitioners. An audit tool and clear definitions (supplementary material 1) were provided to the observers to increase interrater reliability, so that different data collectors interpreted hand hygiene events in the same way.</p>
5 Hand hygiene direct observation audit implementation (covert)	<p>The quarterly covert audit of hand hygiene opportunities was performed on healthcare workers and visitors by covert auditors. Data collectors were provided with an audit tool and clear definitions (supplementary material 1) of what constitutes hand hygiene to ensure that different data collectors interpreted hand hygiene events in the same way to increase interrater reliability.</p>
6 <i>Integration of facts about alcohol-based hand rub during performance feedback to healthcare worker of concern (Revised)</i>	<p>The alcohol-based hand rub facts (as delineated in element 1) were reinforced by the trained hand hygiene auditors when providing performance feedback on hand hygiene to healthcare workers of concern.</p>
7 Consistent hand hygiene performance feedback to department of concern	<p>This element provided performance feedback on departmental hand hygiene compliance status to unit or department managers immediately after the overt audit. The feedback was also shared with department chiefs and chairs, the senior management team, the infection</p>

Table 2 (continued)

Element	Description
8 <i>Posting of alcohol-based hand rub facts on alcohol-based hand rub hand hygiene agents (Revised)</i>	prevention and control committee, and at the infection prevention and control link practitioner meeting and daily and monthly safety huddles. The alcohol-based hand rub facts were posted on the alcohol-based hand rub dispensers in the intervention units.
9 <i>Educate hand hygiene auditors on facts about alcohol-based hand rub (New)</i>	The hand hygiene auditors in the intervention units were educated and assessed for competency about the alcohol-based hand rub facts.
10 <i>Integration of alcohol-based hand rub facts in unit specific infection prevention and control audit (New)</i>	The facts about alcohol-based hand rub described above were added into the hand hygiene section of the audit tool and intervention group was tested whether they know about the alcohol-based hand rub facts during the audits.
11 <i>Academic Islamic scholars to highlight alcohol-based hand rubbing (New)</i>	The academic Islamic scholars were guided to understand the scientific evidence underlying the recommendation to use alcohol-based hand rub; Islamic scholars were invited twice to the intervention units to promote hand hygiene and highlight the facts about alcohol-based hand rub in September 2017. The participants were allowed to openly raise religious concerns regarding the use of ABHR in the presence of the Islamic scholars. To ensure coverage, all healthcare workers in the intervention wards (Table 1) were required to complete the attendance sheet after attending the session.
12 <i>Alcohol-based hand rub facts on various changeable visual reminders (New)</i>	The facts about alcohol-based hand rub were displayed as screensavers on electronic notice boards and computers/laptops in the intervention units.

eligible participants in December via an email containing a web link and information sheet. Reminders were sent weekly. Data collection was finalised a month after survey initiation.

Data analysis

IBM SPSS Statistics Version 25 was used for statistical analyses. Scale mean total scores and standard deviation were calculated. Higher mean scores on the religious beliefs and cultural factors scales reflected greater religious and cultural acceptance of ABHR, respectively. Higher scores on the MCSD reflected socially desirable responding [18].

Reliability indices. Scale mean inter-item correlation was calculated and a threshold of 0.20 was used to determine internal consistency. The internal consistency [19] was satisfactory; the mean inter-item correlation value of the religious beliefs scale was 0.29. The alpha coefficient (K-R 20) of the MCSD Scale was much lower (0.31) than that in Reynold [14] study (0.76), possibly due to the smaller sample.

Inferential statistics. The General Linear Model (GLM) was used to investigate relationships between a dependent variable (DV) and independent variables (IVs). Model 1: The dependent variable was religious beliefs, and demographic variables (age, gender, profession and religion), cultural factors, group (intervention/control) and MCSD score were the IVs. Model 2: MCSD score was the DV and religious beliefs, demographic variables (age, gender, profession and

religion), cultural factors, and group (intervention/control) were the IVs. All tests were two-tailed. The alpha level was set as 0.05. Richardson [20] guidelines were used to interpret effect size: 0.01 = small; 0.06 = moderate; 0.14 = large. A Bonferroni Adjustment was not made as analyses were pre-planned. However, the potential for Type I error is acknowledged. Assumption testing was performed for homogeneity of variance, normality, linearity and multicollinearity [13]. After inspection of normal Q-Q plots, plots of the residuals against the expected values, histograms of the residuals, the multicollinearity VIF and Tolerance statistics and the distribution of error variance, the assumptions were deemed plausible.

Results

Hand hygiene compliance

A within groups comparison (pre and post intervention), found that the mean compliance in overt alcohol-based hand rubbing ($p = 0.002$) and covert alcohol-based hand rubbing audits ($p = 0.04$) was significantly higher in the intervention group, following the intervention (Table 4). Mean overt and covert alcohol-based hand rubbing compliance did not differ significantly in the control group over the same period (Table 4).

A between groups comparison found that the mean overt alcohol-based hand rubbing compliance ($p = 0.002$) was

Table 3 Original hand hygiene program elements and variables.

Element	Description
1 Hand hygiene policy implementation and compliance	The hand hygiene policy provided guidelines outlining the indications and technique for proper hand hygiene to HCWs on an ongoing basis. New healthcare workers were introduced to the hand hygiene policy during induction. The hand hygiene policy was accessible in the policy manager system where all policies were stored. Once the healthcare worker had read the policy, compliance was captured by the policy manager system.
2 The use of ultraviolet hand scanner with glow germ solution during hand hygiene education sessions	The in-house hand hygiene education sessions provided education on the importance of hand hygiene practise and reinforced hand hygiene indications and technique to patients, healthcare workers and visitors. It was carried out biannually. The healthcare workers, patients and visitors signed to indicate their attendance during the education sessions, to capture the number of attendees. Hand hygiene education was conducted by infection preventionists based on the World Health Organization Five Moments for Hand Hygiene. Hand scanning was performed and an evaluation was provided to the attendees for feedback. The proper hand hygiene technique was also demonstrated during the education sessions.
3 Hand hygiene education workshop	The annual hand hygiene workshop educated healthcare workers on the importance of hand hygiene practise and reinforced hand hygiene indications and technique. The hand hygiene session using the hand scanner was one of the agenda items of the infection prevention and control workshop. A post-test was administered to determine participants' knowledge of the World Health Organization Five Moments for Hand Hygiene.
4 Hand hygiene direct observation audit Implementation (overt)	A monthly hand hygiene audit of hand hygiene opportunities was performed on healthcare workers and visitors by infection preventionists and infection prevention and control link practitioners. An audit tool and clear definitions (supplementary material one) were provided to the observers to increase interrater reliability, so that different data collectors interpreted hand hygiene events in the same way.
5 Hand hygiene direct observation audit implementation (covert)	The quarterly covert audit of hand hygiene opportunities was performed on healthcare workers and visitors by covert auditors. Data collectors were provided with an audit tool and clear definitions (supplementary material 1) of what constitutes hand hygiene to ensure that different data collectors interpreted hand hygiene events in the same way to increase interrater reliability.
6 Consistent hand hygiene performance feedback to healthcare workers of concern	This element provided prompt feedback on hand hygiene non-compliance to healthcare workers who were found to be non-compliant immediately after the observation when non-compliance with hand hygiene was observed.
7 Consistent hand hygiene performance feedback to department of concern	This element provided performance feedback on departmental hand hygiene compliance status to unit or department managers immediately after the overt audit. The feedback was also shared with department chiefs and chairs, the senior management team, the infection prevention and control committee, and at the infection prevention and control link practitioner meeting and daily and monthly safety huddles.
8 Provision of easily accessible and safe hand hygiene agents (i.e., hand soap; alcohol-based hand solution)	The facility consistently provided hand hygiene agents that were accessible and safe for the skin for patients, healthcare workers and visitors to use. Hand soaps were only accessible in the toilets of all patient rooms, except for the isolation unit where hand soaps were available in all anterooms. Alcohol-based hand rub facilities were available inside and outside all patient rooms.

Table 4 Alcohol-based hand rubbing mean compliance within groups (overt and covert).

Variable (within group)	Pre-intervention % (95% CI) (n = 403)	Post-intervention % (95% CI) (n = 224)	Difference % (95% CI)	Variable (between groups)	Pre-intervention % (95% CI) (n = 404)	Post-intervention % (95% CI) (n = 202)	Difference % (95% CI)
Alcohol-based hand rubbing overt (intervention group) (n = 627)	83 (79.3–86.7)	92 (88.5–95.6)	9 (3.4–14.6)**	Alcohol-based hand rubbing overt (control group) (n = 606)	84 (80.4–87.6)	82 (76.7–87.3)	2 (–4.3–8.3)
	Pre-intervention % (95% CI) (n = 75)	Post-intervention % (95% CI) (n = 45)	Difference % (95% CI)		Intervention % (95% CI) (n = 75)	Control % (95% CI) (n = 39)	Difference % (95% CI)
Alcohol-based hand rubbing covert (intervention group) (n = 120)	64 (53.1–74.9)	82 (70.8–93.2)	18 (1.2–34.8)*	Alcohol-based hand rubbing covert (control group) (n = 114)	65 (54.2–75.8)	64 (48.9–79.1)	1 (–17.5–19.5)

** $p < 0.01$; * $p = < 0.05$

significantly higher in the intervention group than the control group (Table 5). Mean covert alcohol-based hand rubbing compliance did not differ significantly (Table 5).

Cross sectional survey

Sample demographics

Of 219 eligible participants, 199 (90.9%) responded: 114 nurses (57.3%), 57 medical staff (28.6%) and 28 allied health staff (14.1%). Respondents' mean age (years) was 37.45 ($SD = 7.86$), and 65.8% were female, while 58% were non-Muslim and 42% were Muslim. The intervention and control groups contained 100 (50.3%) and 99 participants (49.7%), respectively. The intervention group included 50 nurses, 35 medical staff and 15 allied health staff. The control group included 64 nurses, 22 medical staff and 13 allied health staff.

Religious beliefs

Group (intervention/control) was statistically significantly associated with religious beliefs (Table 6). After controlling for age, gender, religion, profession, cultural factors and

MCS-D score, the intervention group had a significantly (7.5%) higher religious beliefs score than the control group, although the effect size was small.

Discussion

The purpose of this study was to examine the extent to which religion-relevant culturally-specific interventions influenced HCWs' hand hygiene beliefs about, and compliance with, ABHR use. This study, which is the first of its kind, found that religion-relevant, culturally-specific interventions in a modified hand hygiene program significantly enhanced participants' overall compliance with, and beliefs about, ABHR use, in one setting in the UAE, which is similar with several studies [4,5,9,21]. Specifically, religious beliefs about ABHR use were significantly more positive in the intervention group than the control group following the intervention. Additionally, overt and covert hand hygiene compliance with ABHR use increased significantly in the post intervention period compared to the pre-intervention period in the intervention group while remaining unchanged in the control group. Overt hand

Table 5 Alcohol-based hand rubbing mean compliance between groups (overt and covert).

Variable (between groups)	Intervention % (95% CI) (n = 224)	Control % (95% CI) (n = 202)	Difference % (95% CI)	Variable (between groups)	Intervention % (95% CI) (n = 45)	Control % (95% CI) (n = 39)	Difference % (95% CI)
Alcohol-based hand rubbing overt (post-intervention) (n = 426)	92 (88.5–95.6)	82 (76.7–87.3)	10 (3.7–16.3)**	Alcohol-based hand rubbing covert (post-intervention) (n = 84)	82 (70.8–93.2)	64 (48.9–79.1)	18 (–0.8–36.9)

** $p < 0.01$

Table 6 Coefficients for religious beliefs and Marlowe-Crowne Social Desirability.

Parameter	B	Sig.	95% Confidence Interval B coefficient		Partial Eta Squared
			Lower Bound	Upper Bound	
Model 1: Coefficients for religious beliefs					
Marlowe Crowne Social Desirability	.566	<.001	.366	.767	.142 (L)
Cultural Factors	.455	<.001	.355	.555	.301 (L)
Group: Intervention versus Control	1.075	.010	.257	1.893	.035 (S)
Profession: Doctors versus Nurses	1.330	.041	.057	2.603	.022 (S)
Profession: Allied Health versus Nurses	.236	.739	-1.159	1.631	.001 (S)
Age	.032	.312	-.030	.094	.005 (S)
Gender: Male versus Female	-.628	.173	-1.533	.277	.010 (S)
Religion: Muslim versus non-Muslim	-.050	.911	-.927	.828	.000 (S)
Model 2: Coefficients for Marlowe-Crowne Social Desirability					
Religious Beliefs	1.000	<.001	.646	1.355	.142 (L)
Cultural Factors	-.563	<.001	-.870	-.256	.065 (M)
Group: Intervention versus Control	-.852	.002	-1.391	-.313	.049 (S)
Profession: Doctors versus Nurses	-.288	.541	-1.214	.639	.002 (S)
Profession: Allied Health versus Nurses	-.859	.047	-1.706	-.013	.021 (S)
Age	-.001	.956	-.043	.040	<.001 (S)
			-.691		
Gender: Male versus Female	-.087	.777		.518	<.001 (S)
Religion: Muslim versus non-Muslim	-.616	.036	-1.193	-.040	.023 (S)

hygiene compliance with ABHR use in the intervention group was also higher post intervention than in the control group, although changes to mean covert ABHR compliance were not statistically significant between groups, possibly because the sample size was underpowered to detect small differences in compliance [13] or true mean compliance was overestimated due to the Hawthorne Effect [22].

A research conducted in Saudi Arabia demonstrated that religious beliefs could influence HCWs' observed hand hygiene behaviour, while another conducted in Iran found that religious beliefs could influence self-reported HCWs' hand hygiene behaviour [4,9]. However, there was no published research beyond this in related jurisdictions. Additionally, to date there have been no published studies that have attempted to influence observed hand hygiene compliance with ABHR use through a hand hygiene program that includes interventions to address religious beliefs about ABHR, and no published research evaluating the effects on beliefs and observed behaviour.

Moreover, religious beliefs can influence community culture [23]. As culture influences hand hygiene behaviour [24], the diverse cultural backgrounds of HCWs should be considered when introducing new interventions. Thus, implementing a hand hygiene program featuring religious interventions in a culturally appropriate manner is a crucial aspect of maximizing compliance [25], particularly in a setting where there are potentially widespread strong religious beliefs that may proscribe the use of ABHR.

This study had several limitations. The results may not be representative of population hand hygiene compliance [26] due to the nature of overt and covert observation in quasi-experimental studies and the smaller number of observations in the covert observation arm may have increased the risk of type II error. It is also difficult to ascertain, without sufficient information about implementation fidelity, whether the impact of the strategies is due to the

strategy composition or the implementation process, a Type III error [27]. In addition, convenience sampling may create a selection bias [19] towards HCWs with an interest in hand hygiene. It is also possible that contamination of the control group (i.e., interventions on units A & B may have had some effect on units C & D) may have occurred, although this is unlikely given there was no significant change in hand hygiene compliance between the pre and post intervention periods. Finally, the low allied health response restricts the findings to nursing and medical staff and the lack of random assignment makes it harder to exclude confounding variables, and determine causal relationships [28].

Conclusion

This is the first study to examine the effect of a modified hand hygiene program with religion-relevant, culturally-specific interventions on compliance and beliefs about ABHR use in the UAE. The results suggest that introducing religious interventions in a culturally appropriate way can positively influence compliance with, and beliefs related to, ABHR use. Local studies exploring this hand hygiene program will provide a more accurate picture in specific contexts.

Ethics

Ethics approval was obtained from Griffith University (2016/318) and Mafraq Hospital Human Research Ethics Committees (MAF-REC_12/2015_03).

Authorship statement

NWK collected the data. All authors conceived of the study, contributed to the design, data analysis, manuscript writing, and approved the final version of the manuscript.

Conflicts of interest

Author RZS is a Senior Editor for *Infection, Disease and Health* but had no role to play in the peer review or editorial decision-making of this paper whatsoever. The authors declare no other conflicts of interest associated with this publication and there has been no financial support for this work that could have influenced its outcome.

Funding

This study was supported by a Griffith University post-graduate student stipend.

Provenance and peer review

Not commissioned; externally peer reviewed.

Acknowledgements

The authors would like to thank Judith Fethney, Statistician from the University of Sydney Susan Wakil School of Nursing and Midwifery, for her assistance with data analysis, and the doctors, nurses and allied health staff who participated in this study.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.idh.2019.01.002>.

References

- [1] Rosenthal VD, Al-Abdely HM, El-Kholy AA, AlKhawaja SAA, Leblebicioglu H, Mehta Y, et al. International nosocomial infection control consortium report, data summary of 50 countries for 2010–2015: device-associated module. *Am J Infect Control* 2016;44(12):1495–504.
- [2] Huang GKL, Stewardson AJ, Grayson AL. Back to basics: hand hygiene and isolation. *Curr Opin Infect Dis* 2014;27(4):379–89.
- [3] Centers for Disease Control and Prevention. Show Me the Science – situations where hand sanitizer can be effective & How to Use it in community settings. 2018. <https://www.cdc.gov/handwashing/show-me-the-science-hand-sanitizer.html>. [Accessed 27 October 2018].
- [4] Ahmed QA, Memish ZA, Allegranzi B, Pittet D. Muslim health-care workers and alcohol-based handrubs. *Lancet* 2006;367:1025–7.
- [5] World Health Organization. WHO guidelines on hand hygiene in health care: first global patient safety challenge clean care is safer care. 2009.
- [6] Lawrence P, Rozmus C. Culturally sensitive care of the Muslim patient. *J Transcult Nurs* 2001;2:228–33.
- [7] Muftic D. Maintaining cleanliness and protecting health as proclaimed by Koran texts and hadiths of Mohammed SAVS, in Croatian. *Med Arh* 1997;51:41–3.
- [8] Muslim World League. Resolutions of the Islamic fiqh council. In: Proceedings of the six resolutions of the 16th session; 2002. <http://www.themwl.org>.
- [9] Nematian SSS, Palenik CJ, Mirmasoudi SK, Hatam N, Askarian M. Comparing knowledge and self-reported hand hygiene practices with direct observation among Iranian hospital nurses. *Am J Infect Control* 2017;45:65–7.
- [10] Ng WK, Shaban RZ, van de Mortel TF. Healthcare professionals' hand hygiene knowledge and beliefs in the United Arab Emirates. *J Infect Prevent* 2016;1:1–9.
- [11] Ng WK, Shaban RZ, van de Mortel T. The influence of religious and cultural beliefs on hand hygiene behaviour in the United Arab Emirates. *Infect Dis Health* 2018;23(4):225–36.
- [12] Sergeant E. Epitools epidemiological calculators. 2018. <http://epitools.ausvet.com.au>.
- [13] Field AP. Discovering statistics using SPSS. 4th ed. London: Sage Publications Ltd.; 2013.
- [14] Reynolds WM. Development of reliable and valid short forms of the Marlowe–Crowne social desirability scale. *J Clin Psychol* 1982;38(1):119–25.
- [15] van de Mortel TF. Faking it: social desirability response bias in self-report research. *Aust J Adv Nurs* 2008;25(4):40–8.
- [16] Henning K, Jones A, Holdford R. "I didn't do it, but if I did I had a good reason": minimisation, denial, and attributions of blame among male and female domestic violence offenders. *J Fam Violence* 2005;20(3):131–9.
- [17] Raosoft. Sample size calculator. 2004. <http://www.raosoft.com/samplesize.html>.
- [18] Crowne DP, Marlowe DA. A new scale of social desirability independent of pathology. *J Consult Psychol* 1960;24(4):349–54.
- [19] Pallant J. SPSS survival manual: a step by step guide to data analysis using IBM SPSS. 6th ed. Australia: Allen & Unwin; 2016.
- [20] Richardson JTE. Eta squared and partial eta squared as measurements of effect size in educational research. *Educ Res Rev* 2011;6:135–47.
- [21] de Oliveira AC, de Paula AO. Factors related to poor adherence to hand hygiene in healthcare delivery: a reflection. *Cienc Cuid Saude* 2014;13(1):185–90.
- [22] McDonald EG, Smyth E, Smyth L, Lee TC. Hand hygiene "hall monitors": leveraging the Hawthorne effect. *Am J Infect Control* 2018;46:706–7.
- [23] UNESCO. Culture & religion for a sustainable future. 2010. http://www.unesco.org/education/tlsf/mods/theme_c/mod10.html?panel=1#top.
- [24] Allegranzi B, Memish ZA, Donaldson L, Pittet D. Religion and culture: potential undercurrents influencing hand hygiene promotion in health care. *Am J Infect Contr* 2009;37:28–34.
- [25] Zimmerman B. A culture of support: 4 ways to improve hand hygiene compliance. *Clin Leadersh Infect Contr* 2016. <https://www.beckershospitalreview.com/quality/a-culture-of-support-4-ways-to-improve-hand-hygiene-compliance.html>.
- [26] Alsubaie S, Maitheer A, Alalmaei W, Al-Shammari AD, Tashkandi M, Somily AM, et al. Determinants of hand hygiene nonadherence in intensive care units. *Am J Infect Contr* 2013;41:131–5.
- [27] Carroll C, Patterson M, Wood S, Booth A, Rick J, Balain S. A conceptual framework for implementation fidelity. *Implement Sci* 2007;2:40–9.
- [28] LaMorte WW. Prospective and retrospective cohort studies. In: University B, editor. Overview of analytic studies. Boston University: Boston University School of Public Health; 2017.