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## MAJOR ARTICLE

Differences in psychosocial determinants of hand hygiene between healthcare professional groups: insights from a mixed methods analysis.

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## STRUCTURED ABSTRACT

**Background:** Good hand hygiene (HH) prevents healthcare-associated infections. We compared psychosocial and organizational factors associated with HH compliance and perceived need for improvement, between physicians, nurses, and allied health professionals (AHPs).

**Methods:** We conducted a mixed-methods study in a 1600-bed adult tertiary-care hospital in Singapore. Seven focus group discussions were conducted and data analyzed using the framework approach. The subsequent cross-sectional survey involved 1064 staff. Principal components analysis was performed to derive the latent factor structure that was applied in multivariable analyses.

**Results:** All staff acknowledged that HH was an integral part of work, but were noncompliant due to competing priorities. Physicians were forgetful but appreciated reminders. Nurses were intrinsically motivated for HH. After adjusting for gender, staff category, seniority, and dermatitis history, having positive knowledge-attitudes-behaviors (OR 1.44, 95%CI 1.23-1.69), personal motivators-enablers (OR 1.60, 95%CI 1.38-1.86), and emotional-motivators (OR 1.62, 95%CI 1.40-1.88) were positively associated with good HH compliance. Females (OR 3.91, 95%CI 1.37-11.11), seniors (OR 2.88; 95%CI 1.08-7.68), nurses (OR 4.05; 95%CI 1.51-10.87), and staff with personal motivators-enablers for HH (OR 1.60; 95%CI 1.08-2.37) were more likely to perceive the need for improvement.

**Conclusions:** Factors influencing self-reported HH differed between healthcare professional groups. Group-specific interventions are needed to improve compliance.

## BACKGROUND

Good hand hygiene (HH) is crucial for preventing healthcare-associated infections (HAIs). In 2009, the World Health Organization (WHO) published guidelines for improving HH and reducing nosocomial transmission in hospitals.<sup>1</sup> However, HH compliance rates vary widely from 4 to 100% with an overall median compliance rate of approximately 40% across various settings and healthcare workers (HCWs).<sup>2-3</sup> Reasons for non-compliance are complex and few interventions seem to have a lasting effect.<sup>2-3</sup> An important reason for the short-lasting effect was that interventions tended to be extrinsically driven. Scheithauer and Lemmen highlighted the need for clinical teams to take ownership of HH compliance, rather than rely on infection prevention and control teams.<sup>4</sup>

Intentions also do not necessarily translate to overt behaviors.<sup>5</sup> Although HCWs might have intended to adhere to HH practices, they are often influenced by various factors resulting in non-adherence in certain situations.<sup>6-9</sup> Many studies have also looked at improving compliance to hand hygiene using concepts from behaviourism.<sup>10-11</sup> Thus, HH interventions revolved around the use of positive reinforcements, reminders, and education.<sup>10-11</sup> However, it is important to note that cognitive, social, and organizational factors play a big role in determining HH compliance. Workload, forgetfulness, perceived severity of infections, and social pressures are factors commonly associated with HH non-compliance.<sup>9-13</sup>

More importantly, studies have revealed differences in compliance rates between physicians, nurses, and allied health professionals (AHPs).<sup>14-18</sup> It is well reported that nurses tended to have higher HH compliance rates,<sup>14</sup> and physicians seemed less compliant with HH than nurses and AHPs.<sup>15-16</sup> There are suggestions that factors influencing HH compliance among healthcare professional groups differ,<sup>16-17</sup> but these differences have not been well studied. Some studies cited differences in patient loads seen by the different HCW groups,<sup>14</sup>

while others noted insufficient time being set aside by HCWs for the performance of HH during their work shift.<sup>18</sup> Thus, there is a need for better understanding of group-specific influencing factors, before effective interventions can be designed and implemented.

Qualitative methods have been increasingly recognized as an important complement to quantitative methods for gaining better insights into clinical behaviors and practices.<sup>19-20</sup> Although qualitative methods are increasingly being used to study HH compliance, using it together with quantitative methods as part of a mixed methods study is still lacking. Triangulation of data from such a mixed methods study can help deepen the understanding of the complex interplay of cognitive, social, and organizational factors on HH compliance in HCWs.<sup>21-22</sup>

We, therefore, sought to assess for psychosocial and organizational factors associated with hospital staff's reported HH compliance and their perceptions on the need to improve on their HH compliance during routine patient care, comparing differences in influencing factors between healthcare professional groups (physicians, nurses, and AHPs), using a mixed-methods study design.

## **MATERIALS AND METHODS**

The study was conducted in a 1600-bed adult tertiary-care hospital in Singapore, with a qualitative phase followed by a dominant quantitative phase. Prior to and during the course of the study, the hospital routinely organized various HH promotion programs and activities throughout the year to remind HCWs on the importance of HH. These included the hospital's HH day held annually on May 5th, provision of easy access of HH guidelines and protocols via the hospital's intranet, and display of HH posters around the wards. Furthermore, sinks with antiseptic soaps and alcohol hand rubs are widely accessible in patient care areas.

Despite such efforts, data from HH audits in the hospital consistently showed HH compliance rates averaging at 50-60%. The data also revealed differences in compliance rates between healthcare professions: nurses, AHPs (physiotherapists, occupational therapists, speech therapists, pharmacists, dieticians) and physicians. Physicians and AHPs seemed to lag behind the nurses in adhering to the moments of HH.

Phase 1 of the study consisted of seven focus group discussions (FGDs) that were conducted separately with purposively sampled junior and senior physicians, junior and senior nurses, and AHPs, from February to June 2013. A facilitator and a note-taker were present during each FGD.

The facilitator for each FGD was carefully selected to ensure that he/she was well-known and well-respected individuals by the respective healthcare professional group in the hospital. It was also ensured that the facilitator was not the supervisor or co-worker of any member in the respective focus groups, and was not a member of the hospital's infection control committee and did not have the responsibility of promoting hand hygiene compliance in the hospital. Facilitators were trained in focus group discussion techniques which included probing, asking open-ended questions, verifying unclear responses, and encouraging positive group dynamics. A semi-structured interview guide was used by facilitators, to elicit perspectives from participants on the current state of HH compliance in the hospital, and the motivators and barriers to good HH practices. Participants were also reassured before and after each FGD that their responses in the transcripts would be de-identified and kept anonymous.

A member of the study team was present as a note-taker at each session. The note-takers have observed that the facilitators were able to build rapport with focus group participants who seemed forthcoming and candid with their responses. This was especially so when responding to questions regarding the challenges and barriers experienced with HH.

Each FGD lasted 45-60 minutes. All discussions were audio-recorded and transcribed verbatim.

Two coders independently coded the transcripts using content coding and thematic analysis. These were subsequently reviewed for consensus to ensure inter-coder reliability. Thereafter, the Social Ecological Model (SEM) was used to group and explain factors that influenced HH compliance. This framework allows the understanding of interactions between individuals and their environments and how they influence behaviors.<sup>23</sup>

Phase 2 involved a self-administered questionnaire survey conducted in July 2013. All HCWs who attended the hospital's annual town hall meetings were invited to participate in the study.

A survey instrument was developed, comprising 36 questions on attitudes towards HH, and perceived facilitators and barriers, adapted from the WHO's knowledge and perception surveys on HH and also based on the themes that emerged from the focus group discussions. Additionally, the survey instrument was also enhanced to incorporate two questions on the influence of role modelling by senior staff and reminders by peers on improving HH compliance, as these sub-themes emerged strongly from FGDs.

The WHO's knowledge and perception surveys contained elements of socio-cognitive theories applied to health-related behaviors, notably the Theory of Planned Behavior.<sup>7,12</sup> A five-point Likert scale ranging from 1("Strongly disagree") to 5("Strongly agree") was used for each response. In addition, the survey included a question on reported compliance (0-100%) ("On average, in what percentage of situations requiring HH did you perform HH?") and a Yes/No question on the perceived need to improve on one's HH compliance ("Do you think you can improve on your HH compliance?"). Participation in the survey was anonymous.

No language barriers were experienced during the FGDs and survey. English was the medium of instruction and used officially at work. All HCWs in the hospital spoke, read, and wrote fluently in English. Ethical approval was obtained from the Domain Specific Research Board, National Healthcare Group, Singapore.

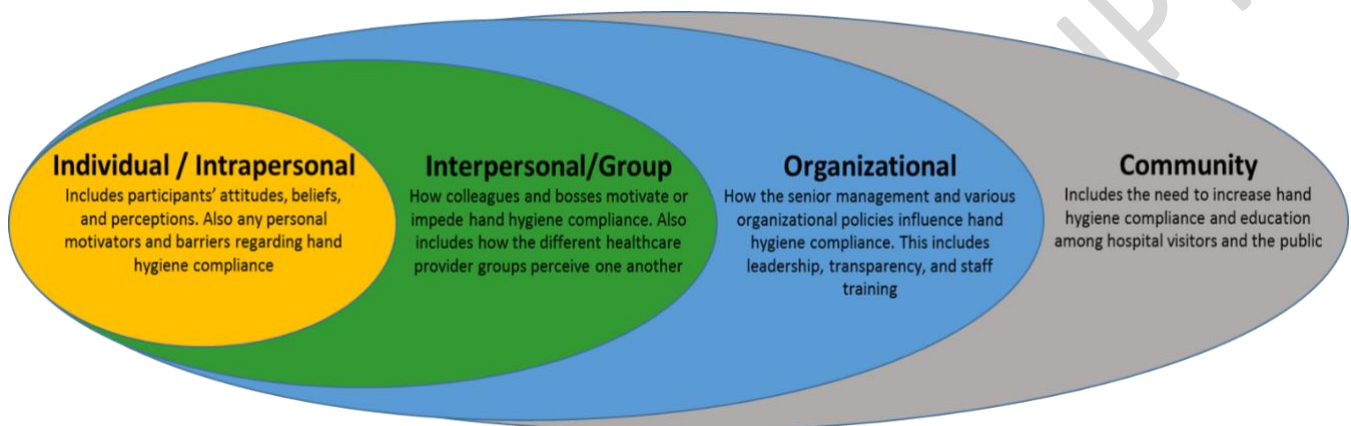
Means (standard deviations, *SD*) were computed for each question, and compared between healthcare professional groups. Student's *t*-test was used to compare the differences between group means. Chi-square test was used to compare differences between group characteristics and outcomes. Good HH compliance was defined as having a reported compliance of >90% of the time. We performed principal components analysis with varimax rotation to derive the latent factor structure that was later applied in the multivariable logistic regression analyses to assess for independent factors associated with good HH compliance and perceived need for HH improvement. Reliability of the survey scales was measured using Cronbach's alpha coefficient. All statistical analyses were conducted in SAS version 9.4 (SAS Institute Inc., Cary, NC).



## RESULTS

### Phase 1 - Qualitative Analysis

A total of 10 physicians (4 senior and 6 junior), 31 nurses (8 nurse managers, 7 senior registered nurses, 8 junior registered nurses, and 8 enrolled nurses), and 6 AHPs participated in the FGDs. Facilitators and barriers to HH were identified at the individual, interpersonal, organizational, and community levels using the SEM (Figure 1).



**Figure 1.** Themes from qualitative analysis, grouped according to the Social Ecological Model<sup>23</sup>

### Individual / Intrapersonal factors

#### Facilitators

##### *i) Self-protection from microorganisms*

All HCWs acknowledged that one major motivator for HH was to protect themselves from infections. HH would be performed especially when HCWs were caring for patients with obvious physical wounds and infections. Participants were cognizant that the hospital environment was contaminated with microorganisms, and tended to perform HH in order to protect themselves and their loved ones.

*“The fact is...the bugs are prevalent in the hospital. I do not want to bring want to bring the bugs home.” – Junior Physician, Focus Group Discussion 2*

*“I think it is mostly like you know for your safety...Because I am very, very sure like when you are seeing a MRSA case, you know you are definitely going to do your handwashing. As compared to if you see a patient who doesn't have any infection or doesn't have any infectious disease or something like that.” – Allied Health Professional, Focus Group Discussion 7*

## **Barriers**

### ***i) Negative attitude towards achieving 100% hand hygiene compliance***

All FGDs, except the one comprising junior physicians, felt that 100% HH compliance was an unrealistic target for routine hospital practice. Instead, a target of 70-80% was more reasonable and achievable.

*“I think 100% compliance is a stretch. I think it's reasonable [NT: if we achieve] 70%...80% compliance...if we work as a team.” Senior Physician, Focus Group Discussion 1*

*“Erm...I don't know. I feel it's impossible to achieve 100% compliance because...we have to consider so many other factors. This is not just about the nurses. It is also about the allied health professionals, health attendants. We also have to consider the relatives and the patients themselves.” – Senior Registered Nurse, Focus Group Discussion 4*

### ***ii) Heavy workload, and competing priorities leading to forgetfulness***

All FGDs highlighted heavy workloads and competing work priorities as reasons for forgetting HH, although they were aware of the need to do so. They were more focused on

resolving immediate issues in patient care and safety than the remote possibility of HAIs from HH non-compliance.

*“I think during the day we are quite compliant. But at night, no one’s watching, and you are so busy, especially when you need to take blood, got so many admissions waiting. You just want to go there, take the blood and run off.” – Junior Physician, Focus Group Discussion 2*

*“We have a lot of patients. We are the one who are attending to the patients...patients running out of the bed already even though [NT: they have] CD Toxin, or MRSA. Do you think we think about hand hygiene? No, you think about saving the patients first. How to do hand hygiene? A patient is going to fall down...so patient safety is more important.” – Senior Registered Nurse, Focus Group Discussion 4*

## **Interpersonal / Group Factors**

### **Facilitators and Barriers**

#### ***i) Reminders from colleagues and patients***

Whilst all HCWs acknowledged that reminders from colleagues and patients could help to improve their HH compliance, the effect of reminders could be double-edged depending on the manner they were given. HCWs preferred reminders given in a nice and positive way. They resented reminders that made them feel bad about themselves, which could reduce future receptivity to reminders.

*“...I have a patient who is always watching us... whether we do hand washing or not. And during the handover, the nurses will remind each other, make sure you wash your hands...other allied health staff may also pass the same message. Very effective, but on the*

*other hand, the feeling of receiving this reminder...it is really not good. But it works very well. – Senior Nurse Manager, Focus Group Discussion 3*

*“If I get checked by a senior, I don’t mind a friendly reminder. But if the reminder comes with a forfeit or punishment, I feel very bad. Because I might be compliant for 9 times...but for one time I forgot about hand hygiene. Then I get punished because of that.” – Allied Health Professional, Focus Group Discussion 7.*

## **ii) Seniors as role models for hand hygiene compliance**

Senior staff were perceived by most participants as critical role models in encouraging HH compliance in their teams. Participants highlighted how they would follow what their seniors and bosses exemplify. Senior HCWs also agreed that they had more influence and were more effective at reminding their juniors to comply with HH standards.

*“Certain consultants, they really do not care about handwashing part. It’s very bad for certain teams. Medical/Surgical whatever...so their juniors will also be like that as well. If the consultants start, then the whole team feels that they have to do it as their bosses are doing it as well. And they are good role models for their juniors as well.” - Junior Physician, Focus Group Discussion 2*

*“We can reinforce to relatives and visitors, but we ourselves have to be the role models, you know? That is the challenge I find. I think this should be the practice. We should do, then everybody will have to do.” – Senior Nurse Manager, Focus Group Discussion 3.*

## **Barriers**

### **i) Negative views about physicians’ poor compliance to HH**

Nurses and AHPs perceived that physicians were the least compliant with HH. Nurses and AHPs cited examples of physicians not performing HH after examining their patients.

*“I think comparing between doctors and nurses, it seems like the nurses are more compliant to hand hygiene than doctors. Because, I think it’s a trait doctors literally after touching patients...they just leave and just talk to colleagues and just touch the colleagues. Knowledge wise I think nurses they know better...when, before, how to perform hand hygiene and so on...so forth. So we often, nurses are often one to remind the doctors to actually do it.” – Senior Registered Nurse, Focus Group Discussion 4*

*“I think this is not targeting anyone. But I think we need to streamline the processes for the medical doctors. Because...what I realize is that, they always take their files into the wards. They touch the patient, and then they touch the file. Or they go into MRSA ward with it. I thought you were not supposed to bring the file to the patient bedside?” – Allied Health Professional, Focus Group Discussion 7*

***ii) Sense of neglect by allied health professionals***

AHPs seemed to feel somewhat neglected and to have received conflicting instructions on their HH practices and standards. They felt uncertain if their practices had any impact on patient care, due to lack of feedback. Of concern, AHPs expressed that no one on the ward would notice if they had missed performing HH.

*“Honestly I feel that this hand hygiene thing actually came to us more of like when we just entered the hospital. But as we work...hmmm no one actually comes up to you to tell you*

*whether if there is any impact or any changes. So it is based on what you know since then, later you just practice your way.” – Allied Health Professional, Focus Group Discussion 7*

*“...I mean if we miss the handwashing right, we will be hardly seen except in front of nurses because they are...they are I mean maybe doing IV infusion and things like that...” – Allied Health Professional, Focus Group Discussion 7*

## **Organizational Factors**

### **Facilitators**

#### ***i) Belief that hand hygiene was an integral part of hospital culture***

All FGDs believed that HH was an integral part of hospital culture. They felt that HH was the responsibility of every HCW and is an expected part of their clinical work. Some participants shared how they had felt embarrassed if patients acquired HAIs from their wards.

*“People feel that this is expected. This is an expected part of the clinical work. But, sometimes, I guess there’d be some people who, for example to say, just different types of contacts warrant different types of hand washing in different people.” – Senior Physician, Focus Group Discussion 1*

*“Sometimes it’s quite embarrassing. I come from MRSA ward. Like the family member do not know that why their loved ones have MRSA so like...because our colleague didn’t do hand hygiene very well. So they passed that kind of thing, and we don’t know how to explain. Hand hygiene is the most important in the hospital.” – Senior Nurse Manager, Focus Group Discussion 3*

**ii) Using more positive reinforcements to motivate good hand hygiene practices**

Nurses and AHPs felt that the hospital could use more positive reinforcements to motivate staff to improve on HH. These included compliments to individuals and wards who have done well. Participants were of the view that punitive actions were not useful in increasing HH compliance.

*“Sustaining hand hygiene compliance...still need to go back to recognition and rewards. The thing is the organization should support the ground even if it is a 5% increase [NT: referring to increase in hand hygiene compliance]. I think it’s worth the effort...you know, worth celebrating it – Nurse Manager, Focus Group Discussion 3*

*“Don’t know whether if this is feasible or not. But I agree, positive reinforcement is needed. Maybe we can appoint a committee? A hand hygiene committee? To give positive feedback? Give you a pat on your back. Like hey...well done. And perhaps some complimentary vouchers along the way? – Allied Health Professional, Focus Group Discussion 7*

**Barriers**

**i) Issues with current hand hygiene products in the hospital**

All FGDs highlighted various issues faced with HH products and hand washing facilities in the hospital, ranging from the drying time required by alcohol hand rubs to skin reactions caused by the products, and the insensitivity of sensors and water flow of taps.

*“The hand rub is very drying on the skin...it also takes quite a while to dry. It causes ink to smudge on paper. Plus we get that sticky feeling after using the hand rub. So...at the end of*

*the day...our hands become dry and cracked. That makes us not want to wash our hands...”*

*– Junior Physician, Focus Group Discussion 2*

*“I think because my colleagues, some of them have eczema. So actually...they are partly non-compliant because if they do hand hygiene too often for every patient right...they say that it is much...so that’s why. That’s what they actually feedback to me when asked why they are non-compliant.” – Allied Health Professional, Focus Group Discussion 7*

***ii) Lack of transparency on how hand hygiene audits were conducted and individualized feedback for improvement***

Participants from 4 FGDs (comprising senior and junior physicians, enrolled nurses, and AHPs) wanted to know how HH audits were conducted. Sharing the audit data openly would assure staff of the objectivity of the process. In addition to departmental feedback, HCWs felt that individual feedback would be useful to enable individuals to take steps to improve on their own compliance.

*“One more thing I find is that the data don’t come to us easily because I’m quite sure you don’t know how badly your ward is doing. Do you know that for your department...your team? – Senior Physician, Focus Group Discussion 1*

*“I think we do get feedback about how is the department doing, how is the hospital doing but not individually, ya? No one says that whether you...yourself...if you are actually compliant...” – Allied Health Professional, Focus Group Discussion 7*

***iii) Inadequacy of education and training for other healthcare staff***



Most FGDs agreed that HH training and education provided by the hospital was adequate. However, junior physicians felt that training and education and the risk of HAIs should extend beyond physicians, nurses, and AHPs to other staff including porters.

*“Another thing about the porters, is the education about hand hygiene. It should go beyond the doctors. I overheard one of the porters mentioning that she is living with two children and that’s why she doesn’t want to push the trolley for MRSA patients. And was very reluctant to do it. They do not know how it is spread. They think it’s like a contagious bug that can be spread through like coughing.” – Junior Physician, Focus Group Discussion 2*

## **Community Factors**

### **Facilitators and Barriers**

#### ***i) Inadequacy of hand hygiene awareness and education among the public***

Most participants believed that HH education should be provided to patients and visitors. Participants mentioned how they had to remind family members and other visitors to wash their hands, but to no avail. Additionally, most patients in the healthcare facility stayed in subsidized wards configured with 4-, 6- or 8-bedded cohort cubicles. This configuration allowed patients, their family members, and other visitors to socialize and mingle with one another during their time in the hospital, thus increasing the risk of infections. This was especially so amongst patients who were admitted to the hospital for long periods of time. Although it was uncommon for visitors to visit more than one patient, visitors of a patient might help attend to the needs of another patient in the same cubicle. HCWs felt that the lack of understanding of the severity of HAIs could be the reason and that education would be crucial to improve HH compliance among visitors.

*“I think coming back to the visitors... I think like last time during MRSA we always tell them...don't go to another patient, straight away wash hand and straight away go home. I remember this is the first time when MRSA started. But now I think it's everywhere already MRSA...they won't listen. We always advice the relatives, you know wash your hands straight away go home, don't go to another patient.” – Senior Nurse Manager, Focus Group Discussion 3*

*“Actually I feel part of the non-compliance issue or the spread of infectious disease, it is not really because of healthcare professionals. It could be because of family members. Like, they are like passing food around. Or...they touch each other. Moving from MRSA cubicle to non-MRSA cubicle. So...hmmm...we have to educate the family members also...” – Allied Health Professional, Focus Group Discussion 7*

## **Phase 2 – Quantitative Analysis**

A total of 1,565 HCWs attended the hospital's annual town hall meetings in July 2013. Of these, 1,064 (68.0%) participated in the study, with 67% ( $n=716$ ) being nurses, 19% ( $n=203$ ) AHPs, and 14% ( $n=145$ ) physicians. A higher proportion of nurses (93.7%) than physicians (42.1%,  $P<0.0001$ ) and AHPs (85.2%,  $P<0.0001$ ) were female. More than half of the physicians (55.9%,  $P<0.0001$ ) and nurses (57.7%,  $P<0.0001$ ) were senior staff (>5 years in the profession), compared to one-third (32.5%) of AHPs. Nurses (40.2%) were more likely than AHPs (31.0%) ( $P=0.0174$ ) and physicians (22.8%) ( $P<0.0001$ ) to report good HH compliance and even more likely (98.9%) to perceive the need to improve on their HH compliance than AHPs (94.1%) ( $P<0.0001$ ) and physicians (96.6%) ( $P=0.0358$ ) (Table 1).

Seven psychosocial factors were identified on principal components analysis (Cronbach's alpha 0.26-0.86): 1) positive knowledge, attitudes, and behaviours; 2) barriers to

HH; 3) personal motivators and other enablers; 4) preference for alcohol handrubs; 5) need for external reminders; 6) emotional motivators; and 7) embarrassed if reminded. Nurses were significantly more likely than physicians ( $P < 0.0001$ ) and AHPs ( $P = 0.0299$ ) to have positive knowledge, attitudes, and behaviours towards HH (Table 1). Of note, nurses were more likely than other HCWs to agree that HH was embedded in their day-to-day professional practice [nurses mean (*SD*), 4.54 (0.78) vs physicians 4.25 (0.79) ( $P=0.0002$ ) vs AHPs 4.28 (0.86) ( $P<0.0001$ )]. They were also more likely to engage in HH because they cared for their patients [nurses 4.59 (0.65) vs physicians 4.40 (0.64) ( $P=0.0050$ ) vs AHPs 4.38 (0.69) ( $P=0.0003$ )].

Furthermore, nurses were significantly more likely than physicians ( $P<0.0001$ ) and AHPs ( $P<0.0001$ ) to be intrinsically motivated to perform HH (Table 1). Among HCWs, nurses were most likely to agree that they would like feedback about their HH compliance to improve on their practice [nurses 3.94 (0.88) vs physicians 3.48 (1.05) ( $P<0.0001$ ) vs AHPs 3.45 (0.89) ( $P<0.0001$ )]. Nurses [4.46 (0.76)] were also much more likely than physicians [3.96 (0.85),  $P<0.0001$ ] and AHPs [3.93 (0.91),  $P<0.0001$ ] to consider HH as one of the top priorities in their work. Additionally, nurses tended to be emotionally motivated to practise good HH to the extent that many would be upset if appropriate HH was not carried out by others [nurses 4.05 (0.87) vs physicians 3.74 (0.84) ( $P=0.0004$ ) vs AHPs 3.62 (0.94) ( $P<0.0001$ )].

Interestingly, physicians were much more likely than nurses ( $P<0.0001$ ) and AHPs ( $P=0.0143$ ) to need external reminders, and tended to miss out on HH because they had forgotten to do so [physicians 3.14 (1.15) vs nurses 2.58 (1.24) ( $P<0.0001$ ) vs AHPs 2.75 (1.31) ( $P=0.0095$ )] (Table 1). However, physicians were more likely to agree that being reminded to perform HH by peers would help them when they forgot [physicians 4.21 (0.71) vs nurses 4.04 (0.91) ( $P=0.0828$ ) vs AHPs 3.94 (0.81) ( $P=0.0110$ )]. Furthermore, physicians

were less likely to mind if patients or visitors reminded them to perform HH [physicians 2.41 (1.02) vs nurses 2.65 (1.19) ( $P=0.0622$ ) vs AHPs 2.72 (1.11) ( $P=0.0396$ )].

Physicians much preferred alcohol handrubs than nurses ( $P=0.0002$ ) and AHPs ( $P<0.0001$ ) (Table 1). In particular, physicians were more likely than AHPs to prefer alcohol handrubs to handwashing [physicians 3.36 (1.16) vs AHPs 2.94 (1.25),  $P=0.0034$ ], and to like the alcohol handrub product used in the hospital [physicians 3.48 (0.98) vs AHPs 3.16 (1.08),  $P=0.0139$ ].

With regard to barriers to HH, nurses [3.81 (1.19)] were more likely than AHPs [3.55 (1.06),  $P=0.0045$ ] to perceive that emergencies and other priorities made HH more difficult. Nurses were also more likely than physicians and AHPs to find it difficult to prompt senior staff to perform HH when they missed it [nurses 3.46 (1.19) vs physicians 3.77 (1.09) ( $P=0.0101$ ) vs AHPs 3.69 (0.97) ( $P=0.0289$ )], and to be reluctant to ask others to engage in HH [nurses 2.79 (1.09) vs physicians 3.01 (0.92) ( $P=0.034$ ) vs AHPs 2.97 (0.88) ( $P=0.0849$ )].

**Table 1.** Characteristics of Healthcare Staff, Reported Good Hand Hygiene Compliance and Perceived Need to Improve Hand Hygiene, and Latent Psychosocial Factors associated with Hand Hygiene Compliance ( $n = 1064$ )

<i>Characteristics and Outcomes</i>	Nurses ( $n=716$ )		Physicians ( $n=145$ )		Allied Health Professionals (AHP) ( $n=203$ )		Nurse- Physician Difference <i>P</i> -value	Nurse- AHP Difference <i>P</i> -value	Physician- AHP Difference <i>P</i> -value
	<i>N</i>	(%)	<i>N</i>	(%)	<i>N</i>	(%)			
Female gender	671	( 93.7 )	61	( 42.1 )	173	( 85.2 )	<.0001	<.0001	<.0001
Senior level (>5 years working in the profession)	413	( 57.7 )	81	( 55.9 )	66	( 32.5 )	0.6862	<.0001	<.0001
History of dermatitis	61	( 8.5 )	24	( 16.6 )	13	( 6.4 )	0.0031	0.3282	0.0025
Reported good hand hygiene compliance	288	( 40.2 )	33	( 22.8 )	63	( 31.0 )	<.0001	0.0174	0.0886
Perceived need to improve hand hygiene	708	( 98.9 )	140	( 96.6 )	191	( 94.1 )	0.0358	<.0001	0.2933

Tukey's Honest Significant Difference comparisons

AC

	Mean	(SD)	Mean	(SD)	Mean	(SD)	Nurse-Physician Difference Adj P-value	Nurse-AHP Difference Adj P-value	Physician-AHP Difference Adj P-value
<i>Latent Factors and Question Items</i>									
<b>Factor 1: Positive Knowledge, Attitudes, &amp; Behaviors</b>	0.09	( 1.01 )	-0.31	( 0.87 )	-0.11	( 1.00 )	<.0001	0.0299	0.1492
<b>(Cronbach's alpha 0.86)</b>									
Q5. Hand hygiene is embedded into my day-to-day professional practice	4.54	( 0.78 )	4.25	( 0.79 )	4.28	( 0.86 )	0.0002	<.0001	0.9456
Q7. I can identify all the moments of hand hygiene in my work	4.59	( 0.65 )	4.21	( 0.66 )	4.36	( 0.75 )	<.0001	<.0001	0.0778
Q11. I know the correct technique for hand washing and hand rubbing	4.69	( 0.62 )	4.46	( 0.54 )	4.63	( 0.65 )	0.0001	0.4363	0.0296

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Q13. I engage in hand hygiene because I care for my patients	4.59 ( 0.65 )	4.40 ( 0.64 )	4.38 ( 0.69 )	0.0050	0.0003	0.9736
Q15. Hand hygiene is part of clinical care (in the same way as doing a physical examination on the patient or taking parameters or dispensing medicine or providing physical/occupational therapy interventions)	4.56 ( 0.68 )	4.50 ( 0.65 )	4.42 ( 0.69 )	0.5321	0.0273	0.5855
Q19. Alcohol handrub points are conveniently placed for hand hygiene	4.41 ( 0.76 )	4.03 ( 0.96 )	4.19 ( 0.82 )	<.0001	0.0024	0.1445
Q24. If I do not engage in hand hygiene, I may catch an infection	4.42 ( 0.86 )	4.10 ( 0.99 )	4.33 ( 0.72 )	0.0001	0.3996	0.0317
Q26. My patients expect good hand hygiene from me	4.48 ( 0.71 )	4.16 ( 0.82 )	4.07 ( 0.85 )	<.0001	<.0001	0.5541
Q30. I believe hand hygiene works in preventing transmission of infection	4.68 ( 0.61 )	4.52 ( 0.65 )	4.52 ( 0.63 )	0.0131	0.0030	0.9995

Q37. Every healthcare worker plays an important role in achieving hand hygiene compliance	4.65 ( 0.63 )	4.55 ( 0.56 )	4.50 ( 0.62 )	0.1776	0.0070	0.7459
Q39. Wearing jewellery and artificial fingernails increase the likelihood of colonisation of hands with harmful germs	4.39 ( 0.87 )	4.31 ( 0.74 )	4.30 ( 0.71 )	0.5767	0.3976	0.9934
<b>Factor 2: Personal Motivators &amp; Other Enablers</b>						
<b>(Cronbach's alpha 0.79)</b>						
Q21. I engage in hand hygiene because I want to be a role model for hand hygiene	3.94 ( 1.03 )	3.50 ( 1.10 )	3.34 ( 1.03 )	<.0001	<.0001	0.3175
Q22. Hand hygiene posters and screen savers in patient care areas remind me to perform hand hygiene	4.09 ( 0.95 )	3.46 ( 1.12 )	3.88 ( 0.96 )	<.0001	0.0173	0.0002

AC



Q23. I would like feedback about my hand hygiene compliance to improve my own practice	3.94 ( 0.88 )	3.48 ( 1.05 )	3.45 ( 0.89 )	<.0001	<.0001	0.9574
Q25. The sinks are within easy reach for hand hygiene	4.29 ( 0.83 )	3.74 ( 0.99 )	3.85 ( 1.00 )	<.0001	<.0001	0.4634
Q32. I will improve my hand hygiene compliance with increased support and promotion for hand hygiene by senior management (HODs and above)	4.08 ( 0.94 )	3.83 ( 0.88 )	3.75 ( 0.92 )	0.0118	<.0001	0.6726
Q38. Our healthcare workers receive regular feedback on hand hygiene performance in the hospital	4.00 ( 0.92 )	3.46 ( 1.00 )	3.57 ( 0.94 )	<.0001	<.0001	0.5174
Q40. Practicing hand hygiene is one of the top priorities in my work	4.46 ( 0.76 )	3.96 ( 0.85 )	3.93 ( 0.91 )	<.0001	<.0001	0.9460
<b>Factor 3: Barriers to Hand Hygiene (Cronbach's alpha 0.64)</b>	-0.02 ( 1.04 )	-0.06 ( 1.02 )	0.11 ( 0.80 )	0.9028	0.2551	0.2840

Q10. If I perform hand hygiene it gives me sore/dry hands	2.96 ( 1.32 )	2.72 ( 1.35 )	3.27 ( 1.21 )	0.1183	0.0091	0.0004
Q14. It is difficult to prompt senior staff when they miss out on hand hygiene	3.46 ( 1.19 )	3.77 ( 1.09 )	3.69 ( 0.97 )	0.0101	0.0289	0.8339
Q16. Emergencies and other priorities make hand hygiene more difficult at times	3.81 ( 1.06 )	3.72 ( 1.05 )	3.55 ( 1.06 )	0.6206	0.0045	0.2749
Q20. I am reluctant to ask others to engage in hand hygiene	2.79 ( 1.09 )	3.10 ( 0.92 )	2.97 ( 0.88 )	0.0034	0.0849	0.4746
Q33. Performing hand hygiene takes away my time from other more important work	2.33 ( 1.16 )	2.32 ( 1.08 )	2.39 ( 1.06 )	0.9996	0.7343	0.8364
Q34. I can skip hand hygiene if I use gloves	1.84 ( 1.06 )	2.20 ( 1.06 )	2.07 ( 0.98 )	0.0004	0.0142	0.4796
Q41. It is ethically acceptable not to practice hand hygiene	1.84 ( 1.18 )	1.82 ( 1.13 )	1.93 ( 1.08 )	0.9874	0.5579	0.6529
<b>Factor 4: Emotional Motivators</b> <b>(Cronbach's alpha 0.64)</b>	0.04 ( 0.98 )	0.15 ( 0.98 )	-0.24 ( 1.05 )	0.4211	0.0018	0.0011

AC

Q8. I feel upset if appropriate hand hygiene is not carried out by others	4.05 ( 0.87 )	3.74 ( 0.84 )	3.62 ( 0.94 )	0.0004	<.0001	0.4107
Q12. I feel guilty if I omitted hand hygiene	4.16 ( 0.91 )	4.01 ( 0.80 )	3.93 ( 0.86 )	0.1591	0.0035	0.6769
<b>Factor 5: Need for External Reminders (Cronbach's alpha 0.44)</b>	-0.07 ( 0.97 )	0.32 ( 1.06 )	0.01 ( 1.03 )	<.0001	0.5628	0.0143
Q6. Sometimes I miss out on hand hygiene because I forgot about it	2.58 ( 1.24 )	3.14 ( 1.15 )	2.75 ( 1.31 )	<.0001	0.2057	0.0095
Q9. Seeing senior staff performing hand hygiene appropriately will help me improve my compliance	4.30 ( 0.93 )	4.26 ( 0.83 )	4.07 ( 1.00 )	0.8386	0.0057	0.1728
Q17. I am more likely to pay attention to hand hygiene when I think I will be observed in hand hygiene audits	3.55 ( 1.28 )	3.58 ( 1.12 )	3.80 ( 1.07 )	0.9633	0.0258	0.2130

ACC

Q18. Being reminded to perform hand

hygiene by my peers will help me when I forget

4.04 ( 0.91 )	4.21 ( 0.71 )	3.94 ( 0.81 )	0.0828	0.2898	0.0110
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**Factor 6: Preference for Alcohol**

**Handrubs** -0.01 ( 0.99 ) 0.35 ( 0.90 ) -0.19 ( 1.06 ) 0.0002 0.0576 <.0001

**(Cronbach's alpha 0.45)**

Q27. I prefer to use alcohol handrub to handwashing

3.18 ( 1.19 )	3.36 ( 1.16 )	2.94 ( 1.25 )	0.2294	0.0278	0.0034
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Q29. I like the alcohol handrub product used in the hospital

3.32 ( 1.05 )	3.48 ( 0.98 )	3.16 ( 1.08 )	0.2139	0.1331	0.0139
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Q31. Alcohol handrub is effective in cleaning my hands

4.00 ( 0.90 )	4.13 ( 0.75 )	3.90 ( 0.83 )	0.2017	0.3589	0.0402
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**Factor 7: Embarrassed if Reminded**

0.03 ( 1.04 ) 0.00 ( 0.89 ) -0.09 ( 0.95 ) 0.9399 0.3360 0.7335

**(Cronbach's alpha 0.26)**

ACC

Q28. I would mind if my patients or their

visitors reminded me to perform hand hygiene 2.65 ( 1.19 ) 2.41 ( 1.02 ) 2.72 ( 1.11 ) 0.0622 0.7360 0.0396

Q35. I am embarrassed if I am reminded to

do hand hygiene by my peers 3.02 ( 1.20 ) 3.07 ( 1.05 ) 2.93 ( 1.09 ) 0.8808 0.5797 0.4957

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After adjusting for gender, staff category, seniority, and history of dermatitis, having positive knowledge-attitudes-behaviours toward HH (OR 1.44, 95%CI 1.23-1.69,  $P<0.0001$ ), having personal motivators and enablers (OR 1.60, 95%CI 1.38-1.86,  $P<0.0001$ ) and emotional motivators (OR 1.62, 95%CI 1.40-1.88,  $P<0.0001$ ) were positively associated with good self-reported HH compliance (Table 2). In contrast, perceived barriers to HH (OR 0.83, 95%CI 0.72-0.95,  $P=0.0062$ ) and the need for external reminders (OR 0.75, 95%CI 0.66-0.87,  $P<0.0001$ ) were negatively associated with good self-reported HH compliance.

In comparison, female staff (OR 3.91, 95%CI 1.37-11.11,  $P=0.0108$ ), senior staff (OR 2.88; 95%CI 1.08-7.68,  $P=0.0341$ ), nursing rather than AHPs (OR 4.05; 95%CI 1.51-10.87,  $P=0.0054$ ), staff who had personal motivators and enablers for HH (OR 1.60; 95%CI 1.08-2.37,  $P=0.0191$ ) and who needed external reminders (OR 1.54; 95%CI 1.07-2.20,  $P=0.0192$ ) were more likely to perceive the need to improve on their own HH compliance (Table 3).

**Table 2.** Multivariable Analysis of Factors associated with Good Hand Hygiene Compliance

Factor	Odds Ratio (OR)	(95% <i>CI</i> )	<i>P</i> -value
Male gender	1.11	0.71-1.75	0.6440
Senior level	0.98	0.73-1.32	0.8955
History of dermatitis	0.89	0.55-1.45	0.6451
Professional group			
Nurses	Ref	Ref	Ref
Physicians	0.68	0.41-1.14	0.1446
Allied Health Professionals	1.01	0.70-1.47	0.9505
Positive Knowledge, Attitudes, & Behaviours	1.44	1.23-1.69	< 0.0001
Personal Motivators & Other Enablers	1.60	1.38-1.86	< 0.0001
Barriers to Hand Hygiene	0.83	0.72-0.95	0.0062
Emotional Motivators	1.62	1.40-1.88	< 0.0001
Need for External Reminders	0.75	0.66-0.87	< 0.0001
Preference for Alcohol Handrubs	0.90	0.79-1.03	0.1286
Embarrassed if Reminded	0.97	0.85-1.11	0.6468

**Table 3.** Multivariable Analysis of Factors associated with Perceived Need to Improve Hand Hygiene

Factor	Odds Ratio (OR)	(95% <i>CI</i> )	<i>P</i> -value
Female gender	3.91	1.37-11.11	0.0108
Senior level	2.88	1.08-7.68	0.0341
Professional group			
Nurses	Ref	Ref	Ref
Physicians	0.89	0.21-3.72	0.8714
Allied Health Professionals	0.25	0.09-0.66	0.0054
Positive Knowledge, Attitudes, & Behaviours	0.76	0.47-1.22	0.2550
Personal Motivators & Other Enablers	1.60	1.08-2.37	0.0191
Barriers to Hand Hygiene	1.30	0.79-2.13	0.3011
Emotional Motivators	0.67	0.44-1.01	0.0547
Need for External Reminders	1.54	1.07-2.20	0.0192
Preference for Alcohol Handrubs	0.90	0.61-1.34	0.6132
Embarrassed if Reminded	0.95	0.64-1.43	0.8129



## DISCUSSION

This study identified several psychosocial and organizational factors that were independently associated with HCWs' HH compliance and perceived need for HH improvement during routine patient care. Regardless of professional group and seniority, a HCW who had a positive knowledge-attitude-behavior towards HH or who was intrinsically or emotionally motivated was 1.4-1.6 times as likely to report good HH compliance. In contrast, a HCW who needed external reminders was 25% less likely to have good compliance. Physicians were much more likely than nurses ( $P < 0.0001$ ) and AHPs ( $P = 0.0143$ ) to need external reminders for HH, and tended to miss out on HH because they had forgotten to do so. The heavy workloads and competing priorities had contributed to the forgetfulness.

We observed that physicians had the lowest reported HH compliance rate among HCWs. This was consistent with findings by other studies.<sup>15-16</sup> Although other HCWs looked to physicians as role models in HH,<sup>17</sup> most physicians do not see themselves as role models.<sup>21</sup> In our study, we found that nurses and AHPs had strong views about physicians' non-compliance to HH, and senior physicians were regarded as important role models by junior physicians. The importance of social norms set by senior physicians cannot be over-emphasized.<sup>17,21</sup> As physicians were more likely than other professionals to welcome reminders by peers, patients, and visitors, these individuals could provide nudges to the forgetful senior physician to set the right example for juniors to follow.

In comparison, nurses had the highest compliance rate and were the most likely to perceive the need to improve on their own compliance. Nurses tended to have positive knowledge-attitude-behavior, embedding HH in their day-to-day professional practices and were intrinsically motivated to do so, considering the practice of HH as one of the top

priorities in their work. With high motivations for HH and compliance improvement, senior nurses could serve as role models for HCWs, especially AHPs who often felt marginalized.

AHPs tended to work individually moving from ward to ward. Senior nurses in respective wards could set good examples for the AHPs working in their wards and include them in their ward's efforts to improve HH compliance.

As with many other studies,<sup>17,21-22</sup> HCWs in our study agreed that self-protection was a major motivator for HH. Although alcohol handrubs were widely available in the hospital, HCWs had differing opinions about the product. Whilst physicians liked the product, other HCWs had dermatological reactions to it. To enhance HH, more than one product could be made available in the hospital to meet the various needs of HCWs.

### **Strengths and Limitations**

Our study has several strengths. First, it used a balanced study design where both qualitative and quantitative aspects of the study were given equal weightage. To date, many studies on HH behaviors have been either qualitative or quantitative in nature.<sup>17,21-22,24-28</sup> Our study triangulated data from qualitative FGDs and a large quantitative study — to evaluate psychosocial and organizational factors associated with HH compliance among different healthcare professional groups. This allowed us to better understand the richness and complexity of the factors affecting HH compliance in the hospital. Second, it is the first attempt at comparing determinants of HH compliance between physicians, nurses, and AHPs. Understanding group-specific factors would help in designing more targeted and effective strategies to improve HH compliance.

Our study may have been limited by the small number of HCWs who were included in some FGDs. Nonetheless, participants were purposively sampled to provide the required contextual information. As discussions were conducted in non-confrontational settings and in

anonymity, with junior and senior staff in separate groups, we believe that the information gathered was authentic. Furthermore, we deliberately selected well-respected HCWs who were not directly involved with the hospital's HH promotional efforts, to facilitate the FGDs. The themes that arose from FGDs were also corroborated by results from the quantitative study. Although HH compliance was not observed in the study, the compliance rates reported by the participants were 30-40% lower than those from audit findings during the same period. Nonetheless, the trend in reported HH compliance (nurses 40.2%, AHPs 31.0%, physicians 22.8%) was consistent with audit findings (nurses 58.9%, AHPs 48.8%, physicians 36.8%) [unpublished data]. Although self-reported HH compliance have been shown to correlate poorly with observed HH practices,<sup>29</sup> and to over-report actual HH compliance<sup>26</sup>, self-reporting remains an important and good measure of self-assessment of HH compliance.<sup>30</sup> The self-reported compliance rates in our study was in fact lower than those observed in HH audits, and was expected as the study had defined good HH compliance as having a reported compliance of >90% of the time. Hence, the reported HH compliance was likely to have provided a good measure of the outcome of interest.

## **CONCLUSIONS**

Psychosocial and organizational factors influencing HH compliance differed between physicians, nurses, and AHPs. Physicians, although forgetful, were willing to receive reminders from peers, patients, and visitors. Nurses were intrinsically motivated for HH and senior nurses could serve as good role models for all HCWs. Professional group-specific interventions could be developed to improve HH compliance among HCWs.

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**Supplementary Table 1.** Rotated Factor Analysis of Response Variables from Survey Questionnaire

Variable	Factor Loadings						
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
Q5. Hand hygiene is embedded into my day-to-day professional practice	0.481	0.201	0.005	0.207	-0.200	-0.067	0.032
Q6. Sometimes I miss out on hand hygiene because I forgot about it	-0.194	-0.160	0.247	-0.074	0.439	0.195	0.002
Q7. I can identify all the moments of hand hygiene in my work	0.607	0.100	-0.071	0.188	0.067	-0.089	0.012
Q8. I feel upset if appropriate hand hygiene is not carried out by others	0.333	0.193	-0.100	0.610	0.025	0.002	0.046
Q9. Seeing senior staff performing hand hygiene appropriately will help me improve my compliance	0.246	0.329	-0.046	0.310	0.471	-0.091	0.011
Q10. If I perform hand hygiene it gives me sore/dry hands	0.158	-0.121	0.522	-0.040	-0.058	-0.268	0.066

Q11. I know the correct technique for hand washing and hand rubbing	0.652	0.046	-0.050	0.147	0.084	-0.038	0.054
Q12. I feel guilty if I omitted hand hygiene	0.376	0.134	-0.023	0.637	-0.050	0.043	-0.048
Q13. I engage in hand hygiene because I care for my patients	0.518	0.263	-0.126	0.420	0.022	0.065	0.014
Q14. It is difficult to prompt senior staff when they miss out on hand hygiene	0.177	-0.187	0.478	0.034	0.173	0.151	0.141
Q15. Hand hygiene is part of clinical care (in the same way as doing a physical examination on the patient or taking parameters or dispensing medicine or providing physical/occupational therapy interventions)	0.603	0.187	-0.125	0.326	0.122	0.043	0.014
Q16. Emergencies and other priorities make hand hygiene more difficult at times	0.288	-0.248	0.441	-0.186	0.290	0.037	0.068

Q17. I am more likely to pay attention to hand hygiene when I think I will be observed in hand hygiene audits	0.064	0.122	0.266	-0.221	0.583	0.031	0.038
Q18. Being reminded to perform hand hygiene by my peers will help me when I forget	0.271	0.054	0.036	0.179	0.582	0.081	-0.245
Q19. Alcohol handrub points are conveniently placed for hand hygiene	0.469	0.237	0.081	0.004	0.010	0.283	-0.072
Q20. I am reluctant to ask others to engage in hand hygiene	-0.110	0.033	0.621	-0.138	0.134	0.046	0.005
Q21. I engage in hand hygiene because I want to be a role model for hand hygiene	0.106	0.558	-0.146	0.326	0.164	0.047	0.095
Q22. Hand hygiene posters and screen savers in patient care areas remind me to perform hand hygiene	0.209	0.710	-0.020	0.056	0.108	-0.058	-0.151

Q23. I would like feedback about my hand hygiene compliance to improve my own practice	0.183	0.576	-0.104	0.265	0.218	0.052	-0.159
Q24. If I do not engage in hand hygiene, I may catch an infection	0.526	0.292	0.163	-0.054	-0.103	0.056	-0.247
Q25. The sinks are within easy reach for hand hygiene	0.363	-0.577	0.043	-0.087	-0.189	0.145	-0.117
Q26. My patients expect good hand hygiene from me	0.472	0.432	-0.047	0.267	-0.026	0.113	-0.018
Q27. I prefer to use alcohol handrub to handwashing	-0.072	0.016	0.100	0.061	0.062	0.759	-0.062
Q28. I would mind if my patients or their visitors reminded me to perform hand hygiene	0.002	-0.077	-0.027	-0.447	-0.077	-0.246	0.608
Q29. I like the alcohol handrub product used in the hospital	0.092	0.052	-0.460	-0.206	-0.046	0.477	-0.115

Q30. I believe hand hygiene works in preventing transmission of infection	0.698	0.183	-0.090	0.101	0.104	0.103	-0.003
Q31. Alcohol handrub is effective in cleaning my hands	0.246	0.069	-0.035	0.090	0.131	0.628	0.148
Q32. I will improve my hand hygiene compliance with increased support and promotion for hand hygiene by senior management (HODs and above)	0.123	0.514	-0.046	0.149	0.484	0.105	0.091
Q33. Performing hand hygiene takes away my time from other more important work	-0.236	0.032	0.665	-0.027	0.102	-0.038	0.009
Q34. I can skip hand hygiene if I use gloves	-0.376	0.017	0.478	0.015	-0.010	0.113	0.098
Q35. I am embarrassed if I am reminded to do hand hygiene by my peers	-0.018	0.033	0.247	0.141	-0.034	0.127	0.717

Q37. Every healthcare worker plays an important role in achieving hand hygiene compliance	0.690	0.178	-0.125	0.097	0.096	0.095	0.048
Q38. Our healthcare workers receive regular feedback on hand hygiene performance in the hospital	0.206	0.650	-0.007	-0.013	-0.029	0.017	0.196
Q39. Wearing jewellery and artificial fingernails increase the likelihood of colonisation of hands with harmful germs	0.518	0.112	-0.063	-0.015	0.146	0.041	-0.036
Q40. Practising hand hygiene is one of the top priorities in my work	0.440	0.496	-0.117	0.310	-0.136	0.031	-0.024
Q41. It is ethically acceptable not to practice hand hygiene	-0.383	0.005	0.486	-0.046	-0.141	0.055	-0.107

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