











# Behavioural intention of hand hygiene compliance in an average Ecuadorian hospital

Pía Escudero<sup>1\*</sup> , Mireia Urrea Ayala<sup>2,3</sup> , Natalia Romero<sup>1,3</sup> , Cintia Pullas<sup>1</sup> ,  
Domenica Reina<sup>1</sup> , Edison Daniel Miranda Brazales<sup>1</sup> , María José Ayora Pérez<sup>1</sup> ,  
Ignacio Peñaherrera Suárez<sup>1</sup> , Emily Granadillo<sup>1,3</sup> , Miguel Martín<sup>2,4</sup> 

## SUMMARY

**OBJECTIVE:** This study aimed to characterize hand hygiene behavioural intention by hospital services clusters in a medium-sized hospital in an Ecuadorian city.

**METHODS:** This is a cross-sectional study based on the World Health Organization Hand Hygiene Knowledge Questionnaire for Health-Care Workers. The responses on hand hygiene behavioural intention for the Five Moments for hand hygiene according to the World Health Organization were recorded in three categories: before patient contact, before and after sterile technique and management of body fluids, and after contact with the environment of the patient. The variables were the knowledge regarding the source of germs causing nosocomial infections, the optimal time to achieve disinfection with alcohol, hospital services clusters (clinical medicine, surgery, and therapeutic services), and history of previous formal hand hygiene training. The variables in each moment were analysed using a saturated log-linear model.

**RESULTS:** The average age of participants was 34 years (Q<sub>1</sub> 32.1–Q<sub>3</sub> 36.4). Of them, 62% belonged to the clinic cluster and 87.6% had previous formal hand hygiene training. The incorrect response rates for before and after sterile technique and management of body fluids, before patient contact, and after contact with the environment of the patient were 30.2, 88.4, and 99.2%, respectively. In before patient contact, the incorrect responses for optimal time depended on the department (worse surgery cluster situation), and in before and after sterile technique and management of body fluids and after contact with the environment of the patient, the incorrect responses for source of germs depended on the previous formal hand hygiene training and the department (worse surgery and clinic clusters).

**CONCLUSION:** The incorrect answer related to hand hygiene behavioural intention was high compared to other reports, and the worse situation was found in after contact with the environment of the patient and before patient contact. These data suggest the need of strengthening permanently the hand hygiene programme.

**KEYWORDS:** Hand hygiene. Hospital medicine. Health education.

## INTRODUCTION

In 1846, Ignaz Semmelweis demonstrated that the hands of health personnel transmitted puerperal fever<sup>1</sup>, and 150 years later (2009), the World Health Organization (WHO) published the “Guidelines on Hand Hygiene in Health Care.” The WHO defines hand hygiene (HH) as any standard adopted for a hand cleaning procedure that applies hand scrubbing with an alcoholic base or handwashing with soap and water to eliminate or decrease germ colonization on hands and contribute to achieving a correct HH<sup>2</sup>.

Healthcare personnel should perform HH in “Five Moments” according to the WHO multimodal strategy in patient-centred

settings<sup>3-5</sup>. Although the implementation of strategy was successful worldwide and across all categories of health workers, hospitals, wards, and hospital departments, it is advisable to adapt the strategy to local resources, maintain training, and evaluate compliance<sup>6</sup>.

Lack of HH leads to an increased risk of healthcare-related infections, disability and mortality in patients, and high expense for the healthcare system<sup>7-9</sup>. Knowledge of the source of germs that cause nosocomial infections and the time required for an alcoholic disinfectant to act constitute two of the essential factors for achieving optimal HH; however, healthcare personnel have observed a significant gap between knowledge and practice of this technique<sup>10</sup>.

<sup>1</sup>International University of Ecuador, School of Medicine – Quito, Ecuador.

<sup>2</sup>Hospital Sant Joan de Déu Barcelona 2020 – Barcelona, Spain.

<sup>3</sup>The Network Grups de Recerca d'Amèrica i Àfrica Llatines – Barcelona, Spain.

<sup>4</sup>Universitat Autònoma de Barcelona, Facultat de Medicina, Unitat de Bioestadística – Barcelona, Spain.

\*Corresponding author: [piescuderobu@uide.edu.ec](mailto:piescuderobu@uide.edu.ec)

Conflicts of interest: the authors declare there is no conflicts of interest. Funding: Universidad Internacional del Ecuador (UIDE-DGIP-MAT-PROY-17-033). Received on February 24, 2022. Accepted on June 02, 2022.

In contrast, several questionnaires have been applied to measure hand hygiene behavioural intention (HHBI). The WHO Hand Hygiene Knowledge Questionnaires for Health-Care Workers (WHO-Q), revised in 2009, is previously validated and published in a Spanish version; correct answers were provided by WHO and the questionnaire items and domains are administered independently<sup>11</sup>. This questionnaire is used in cross-sectional studies, clinical trials, and results comparison. Another advantage is that it allows for unit, services, or ward analysis of a hospital.

In Ecuador, there are no data on the rate of HHBI by hospital services. With this background, we set out to characterize the HHBI compliance considering services clusters of a medium-sized hospital in a sizeable Ecuadorian city to better understand inappropriate HHBI and generate strategies to improve it.

## METHODS

### Context

The participating hospital has a level 2 complexity. It offers 81 beds, various medical specialties services, and outpatient consultation. For this study, we organized the services into three clusters: clinical medicine cluster (paediatric and internal medicine department, outpatient clinics, emergency department, and an intermediate care unit with 7 beds), surgery cluster (five operating theatres and gynaecology and obstetrics ward), and therapeutic services cluster (physiotherapy and respiratory therapy). The hospital has hand-rub dispensers according to the WHO standards.

### Participants

Resident doctors, nurses, nursing assistants, therapists, and cleaning staff with a full-time contract in the hospital at least 3 months before the study, and final-year medical students with a stay of not less than 3 months participated. Each of the participants worked in a specific hospital service in the 3 months before the survey. Of the 96 health workers, all comply with rotating shift work. Although shift work time was a maximum of 8 h for nurses, assistants, and therapeutic services department personnel, it was not possible to confirm if any participant was working a double shift at the time of the survey. For resident doctors and students, it was a maximum of 24 h. In addition, the 33 visiting medical specialists who do not have fixed hours were included. Of the 131 participants, 129 completed the questionnaire.

### Variables

We used the following WHO-Q questions: the identification of the source of the germs causing infections (SG) in two categories: germs in the hospital environment (correct response) and germs in the water or the patients; to point out that 20 s is the optimal time needed for an alcoholic disinfectant to eliminate most hand germs (OT), the fact of having received HH training at some point in their professional career (pT), and three services clusters (clinical medicine, surgery, and support). The survey was applied by three trained interviewers, keeping confidentiality and privacy and in the break time of the participants' working hours. The application took approximately 20 min. The data were collected from 4 May to 30 June 2019.

### Response variables

Hand hygiene behavioural intention was defined for each moment of HH in three categories, and the basis was the WHO-Q available in Spanish. Table 1 presents the questions

**Table 1.** General characteristics of the 129 participants.

Variable	n (%)
Cluster	
Clinical medicine	80 (62.0)
Surgery	41 (31.8)
Therapeutic services	8 (6.2)
Did you ever receive hand hygiene training during professional practice?	
Yes	113 (87.6)
No	16 (12.4)
Source of germs causing nosocomial infections	
Germs in the hospital environment	30 (23.3)
Germs from hospital water or present in the patient	99 (76.7)
Minimum time required for an alcoholic disinfectant to remove most germs from the hands	
20 s	86 (66.7)
Other than 20 s	43 (33.3)
BPC	
Complies	15 (11.6)
Fails	114 (88.4)
BAMF	
Complies	90 (69.8)
Fails	39 (30.2)
ACEP	
Complies	1 (0.8)
Fails	128 (99.2)

BPC: before patient contact; BAMF: before and after antiseptic technique and management of body fluids; ACEP: after contact and environment of the patient.

that feed each of these three moments: “before patient contact” (BPC), “before and after antiseptic technique and management of body fluids” (BAMF), and “after contact with the environment of the patient” (ACEP). The questions that were considered for the construction of the category “compliance of HH activities” in each moment were defined using the nominal group technique<sup>12</sup>. Based on the results of four rounds of the questionnaire sent to a panel of three experts, the identified responses were aggregated and shared with the experts after each round. The experts could adjust their answers in three subsequent rounds, based on how they interpret the compliance with HH activities in each moment.

### Pilot study

A pilot study was carried out in the last week of April 2019 to ensure understanding of the questions, apply the nominal group technique, and record the questionnaire application time. On average, participants' time was 20 min per survey (SD 5).

### Statistical analysis

Differences in proportions between study factors and incorrect responses of the HH methods in each moment were analysed with the  $\chi^2$  statistic. Due to all the variables' categorical nature and to analyse the interdependence between them, a multivariable descriptive analysis was carried out using a saturated log-linear model of the multidimensional table formed by all the variables considered for each moment. In the use of a single adjustment, the relationships between the variables were analysed, between two variables, as well as the orders of three dimensions (interactions) and higher orders. A p-value of 0.05 was considered the cut-off point for statistical significance.

### Ethics statement

All necessary permits were obtained from a Bioethics Committee of the International University of Ecuador and the hospital authorities (UIDE-DGIP-MAT-PROY-17-033).

## RESULTS

### Descriptive analysis

The average age of the participants was 34 years (Q1 32.1-Q3 36.4). Notably, 62% belonged to the clinic cluster. pT was recorded in 114 (87.6%) participants, of which 99 (79.7%) did not have a correct knowledge of SG. Table 2 presents the general characteristics of the study variables.

### Description of the moments and associated variables

In the BPC moment, 114 (88.4%) participants gave incorrect answers, while in BAMF, they were 39 (30.2%), and in ACEP, they were 128 (99.2%). The lowest incorrect response rates (12.5–39.5%) were found in BAMF compared to those of the other two moments (81.3–99.2%). Table 3 presents the factors related to non-compliance with the HH procedure in each study setting.

Table 4 shows the results of the saturated log-linear model between non-compliance with the HH procedure in each moment and the variables. In BPC and ACEP, the knowledge of SG depends on the pT ( $\chi^2$  4.69, p-value 0.03;  $\chi^2$  4.71, p-value 0.03, respectively), adjusted for other factors, and in BAMF, it depends on the department ( $\chi^2$  4.47, p-value 0.04) and pT ( $\chi^2$  6.40, p-value 0.04).

## DISCUSSION

From our literature review, this is one of the first works focusing on the analysis of HHBI in services considered as clusters and not in health professionals themselves<sup>13–15</sup>. The work at a hospital is assured when it is proposed to do so as a team, which leads to effective and efficient practices that offer the best possible patient care<sup>16</sup>. In this context, we found high rates of unawareness of HHBI in the services clusters (clinic, surgery, and therapeutic services). This lack of knowledge was equally high for the BPC and ACEP moments (81.3–99.2%, in both) and improvement for the BAMF moment (12.5–39.5%). The literature has not described ranges of HH unawareness before and after patient contact as high as that found in this study, suggesting the need to evaluate the strategy and reinforce on-going training of health care staff.

Studies outside Latin America that have analysed health professionals' command of WHO-Q knowledge have also shown worrying data. A study carried out in 105 health-care providers from private clinics in Pakistan revealed high rates of inadequate knowledge of the standard guidelines for HH<sup>17</sup>. Studies that analysed all dimensions of WHO-Q in hospitals in the Republic of Korea and Iran showed different levels of knowledge overall, and all had serious weaknesses in knowledge<sup>14,18</sup>. In a university hospital in Cairo, the assessment in different departments showed that the highest mean score was in the neonatal intensive care unit paediatric department<sup>19</sup>. In 2136, tests provided by Spanish nurses during their accreditation processes in 5 years, those with the highest accreditation level had the highest average number of correct answers<sup>18</sup>.

**Table 2.** Factors related to non-compliance with the hand hygiene procedure in each studied environment.

Environment	Study factor	n (%) <sup>a</sup>	$\chi^2$	p-value
BPC (n=114)	Cluster		2.71	0.26
	Clinical medicine	68 (85.0)		
	Surgery	39 (95.1)		
	Therapeutic services	7 (87.5)		
	Received training		0.90	0.34
	Yes	101 (89.4)		
	No	13 (81.3)		
	Germ source		0.10	0.75
	Hospital environment	27 (90.0)		
	Water and patient	87 (87.9)		
	Disinfecting time		1.36	0.24
	20 s	78 (90.7)		
	Other than 20 s	36 (83.7)		
BAMF (n=39)	Cluster		2.98	0.23
	Clinical medicine	22 (27.5)		
	Surgery	16 (39.0)		
	Therapeutic services	1 (12.5)		
	Received training		0.46	
	Yes	33 (29.2)		
	No	6 (37.5)		
	Germ source		0.24	0.63
	Hospital environment	8 (26.7)		
	Water and patient	31 (31.3)		
	Disinfecting time		2.65	0.10
	20 s	22 (25.6)		
	Other than 20 s	17 (39.5)		
ACEP (n=128)	Cluster		0.62	0.73
	Clinical medicine	79 (98.8)		
	Surgery	41 (100.0)		
	Therapeutic services	8 (100.0)		
	Received training		0.14	0.71
	Yes	112 (99.1)		
	No	16 (100.0)		
	Germ source		0.31	0.58
	Hospital environment	30 (100.0)		
	Water and patient	98 (99.0)		
	Disinfecting time		2.02	0.16
	20 s	86 (100.0)		
	Other than 20 s	42 (97.7)		

BPC: before patient contact; BAMF: before and after antiseptic technique and management of body fluids; ACEP: after contact and environment of the patient. <sup>a</sup>All the percentages express the total of the category.

**Table 3.** Results of the saturated log-linear model between non-compliance with the hand hygiene procedure in each moment and the study factors.

Environment	Interactions	$\chi^2$	p-value
BPC	Incorrect answers for the moment × Disinfecting time × Cluster	6.10	0.05
	Germ source × Cluster	5.65	0.06
	Germ source × Received training	4.69	0.03
	Disinfectant time × Cluster	0.27	0.88
	Incorrect answers for the environment × Disinfecting time	2.34	0.13
	Incorrect answers for the environment × Cluster	1.47	0.48
BAMF	Germ source × Cluster	6.40	0.04
	Germ source × Received training	4.47	0.04
ACEP	Germ source × Received training	4.71	0.03

BPC: before patient contact; BAMF before and after antiseptic technique and management of body fluids; ACEP after contact and environment of the patient.

The scope of the unawareness also includes healthcare students in training. A high percentage of medical and nursing students in Spanish universities reported always or almost always not carrying out HH at BPC or BAMF<sup>20</sup>. A study in 69 nursing students in Nigeria revealed that HHBI was lowest in the 1st year of study<sup>21</sup>. A study carried out in 2018 showed that 15.2% of healthcare personnel in Islamabad private clinics had inadequate knowledge about the OT<sup>17</sup>, and Soon's study showed serious weaknesses in knowledge of the question "What is the most frequent SG?"<sup>14</sup>. In our study, we also found that the analysis of the associations between the variables revealed the participants' lack of knowledge about the analysed indicators of HH knowledge, despite claiming to have received training.

The correct performance of the HH is an individual and collective responsibility<sup>22</sup>. It is important to emphasize that knowledge about the SG, the OT, and the technique to be used for HH, by itself, does not guarantee the adherence and effectiveness of HH in health personnel in the different hospital areas<sup>23</sup>, but the application of an HH educational plan, based on a standardized multimodal HH strategy, proved to be effective in improving HH compliance<sup>24</sup>.

Finally, in this study, we recognize the following limitations. (1) This study did not include the evaluation of patients' knowledge, an aspect that, according to Srigley et al. is essential for an overview of HH knowledge and educational interventions<sup>25</sup>. (2) It was not possible to confirm if the work shift influenced the knowledge of the activities to ensure HH. (3) This study concentrated on the characterization of HHBI in the three defined moments at the

hospital departments (as clusters); the analysis focused on participants or professions could vary the results. (4) We did not have the authorization to analyse by individuals. (5) We did not consider the role of each participant (i.e., senior, junior, and student).

## CONCLUSIONS

The general proportion of incorrect answers about HHBI among hospital services clusters in a medium-sized hospital in a sizeable Ecuadorian city is high. The worst situation is in the BPC and ACEP moments. The results highlight areas for improvement and the need to reinforce the WHO multimodal strategy in patient-centred settings.

## ACKNOWLEDGMENTS

This research was supported by International University of Ecuador Research grant 2017.

## AUTHORS' CONTRIBUTIONS

**PE:** Conceptualization, Funding acquisition, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing. **MU:** Conceptualization, Methodology, Writing – review & editing. **NR-S:** Conceptualization, Formal Analysis, Funding acquisition, Methodology, Writing – original draft. **CP:** Data curation, Formal Analysis, Writing – original draft. **MM:** Data curation, Formal Analysis, Methodology. **DR:** Writing – original draft. **EG:** Writing – original draft.

## REFERENCES

1. Miranda CM, Navarrete TL. Semmelweis y su aporte científico a la medicina: un lavado de manos salva vidas. *Rev Chil Infectol*. 2008;25(1):54-7. PMID: 18273526
2. WHO. WHO guidelines on hand hygiene in health care: first global patient safety challenge: clean care is safer care. Geneva: World Health Organization, Patient Safety; 2009.
3. Martínez LL, Leyva AMG, Pérez MR, Fernández KC, Pupo LL. Efectividad de Intervención educativa en el conocimiento del personal de salud sobre el lavado de manos. *Rev Cuba Enferm*. 2020;36(1):1-13. Available from: <http://www.revenfermeria.sld.cu/index.php/enf/article/view/1684>
4. Løyland B, Peveri AM, Hessevaagbakke E, Taasen I, Lindeflaten K. Students' observations of hand hygiene in nursing homes using the five moments of hand hygiene. *J Clin Nurs*. 2020;29(5-6):821-30. <https://doi.org/10.1111/jocn.15136>
5. Ye L, Zhang X, Lai X. Does hospital ownership influence hand hygiene compliance? *Curr Med Sci*. 2017;37(5):787-94. <https://doi.org/10.1007/s11596-017-1806-9>
6. Vermeil T, Peters A, Kilpatrick C, Pires D, Allegranzi B, Pittet D. Hand hygiene in hospitals: anatomy of a revolution. *J Hosp Infect*. 2019;101(4):383-92. <https://doi.org/10.1016/j.jhin.2018.09.003>
7. Allegranzi B, Bagheri Nejad S, Combescure C, Graafmans W, Attar H, Donaldson L, et al. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. *Lancet*. 2011;377(9761):228-41. [https://doi.org/10.1016/S0140-6736\(10\)61458-4](https://doi.org/10.1016/S0140-6736(10)61458-4)
8. Loftus MJ, Guitart C, Tartari E, Stewardson AJ, Amer F, Bellissimo-Rodrigues F, et al. Hand hygiene in low- and middle-income countries. *Int J Infect Dis*. 2019;86:25-30. <https://doi.org/10.1016/j.ijid.2019.06.002>
9. Allegranzi B, Gayet-Ageron A, Damani N, Bengaly L, McLaws M-L, Moro M-L, et al. Global implementation of WHO's multimodal strategy for improvement of hand hygiene: a quasi-experimental study. *Lancet Infect Dis*. 2013;13(10):843-51. [https://doi.org/10.1016/S1473-3099\(13\)70163-4](https://doi.org/10.1016/S1473-3099(13)70163-4)
10. Ahmed J, Malik F, Memon ZA, Bin Arif T, Ali A, Nasim S, et al. Compliance and knowledge of healthcare workers regarding hand hygiene and use of disinfectants: a study based in Karachi. *Cureus*. 2020;12(2):e7036. <https://doi.org/10.7759/cureus.7036>
11. World Health Organization. Hand hygiene knowledge questionnaire for health-care workers. WHO; 2017. Available from: [https://cdn.who.int/media/docs/default-source/integrated-health-services-\(ihs\)/hand-hygiene/monitoring/surveyform/hand-hygiene-knowledge-questionnaire.doc?sfvrsn=dbb4da65\\_2](https://cdn.who.int/media/docs/default-source/integrated-health-services-(ihs)/hand-hygiene/monitoring/surveyform/hand-hygiene-knowledge-questionnaire.doc?sfvrsn=dbb4da65_2)
12. Dekker M, Caris MG, Van Gunsteren AM, Van Mansfeld R, Lucas C, Vandenbroucke-Grauls CMJE. Effectiveness of a behavioral approach to improve healthcare worker compliance with hospital dress code. *Infect Control Hosp Epidemiol*. 2017;38(12):1435-40. <https://doi.org/10.1017/ice.2017.233>
13. Cambil-Martin J, Fernandez-Prada M, Gonzalez-Cabrera J, Rodríguez-Lopez C, Almaraz-Gomez A, Lana-Perez A, et al. Comparison of knowledge, attitudes and hand hygiene behavioral intention in medical and nursing students. *J Prev Med Hyg*. 2020;61(1):E9-14. <https://doi.org/10.15167/2421-4248/jpmh2020.61.1.741>
14. Oh HS. Knowledge, perceptions, and self-reported performance of hand hygiene among registered nurses at community-based hospitals in the Republic of Korea: a cross-sectional multi-center study. *J Prev Med Pub Health*. 2018;51(3):121-9. <https://doi.org/10.3961/jpmph.17.188>
15. Fernandez Sierra MA, Rodriguez del Aguila MdM, Navarro Espigares JL, Enriquez Maroto MF. Effect of patient safety strategies on the incidence of adverse events. *J Eval Clin Pract*. 2014;20(2):184-90. <https://doi.org/10.1111/jep.12105>
16. Vazquez CE. Successful work cultures: recommendations for leaders in healthcare. *Leadersh Health Serv Bradford Engl*. 2019;32(2):296-308. <https://doi.org/10.1108/LHS-08-2018-0038>
17. Bangash S, ul Haq MI, Hassan U, Rahim SK, Qadeer AA. Assessment of hand hygiene knowledge and practices among the health care providers working at private clinics in Islamabad, Pakistan. *Rawal Med J*. 2019;44(4): 856-60. Available from: [https://www.researchgate.net/publication/337719585\\_Assessment\\_of\\_hand\\_hygiene\\_knowledge\\_and\\_practices\\_among\\_the\\_health\\_care\\_providers\\_working\\_at\\_private\\_clinics\\_in\\_Islamabad](https://www.researchgate.net/publication/337719585_Assessment_of_hand_hygiene_knowledge_and_practices_among_the_health_care_providers_working_at_private_clinics_in_Islamabad)
18. Nabavi M, Alavi-Moghaddam M, Gachkar L, Moenian M. Knowledge, attitudes, and practices study on hand hygiene among Imam Hossein Hospital's residents in 2013. *Iran Red Crescent Med J*. 2015;17(10):e19606. <https://doi.org/10.5812/ircmj.19606>
19. Elsheikh RM, El-Belbasy RM. Assessment of knowledge, attitude and practice of hand washing among healthcare workers in Al-Azhar University hospitals in Cairo. *Life Sci J*. 2018;15(2). Available from: [http://www.lifesciencesite.com/ljs/life150218/07\\_33346lsj150218\\_53\\_60.pdf](http://www.lifesciencesite.com/ljs/life150218/07_33346lsj150218_53_60.pdf)
20. Brea Rivero P, Rojas de Mora Figueroa A, Julián Carrión J, Salguero Cabalgante R, Herrera Usagre M. Buenas prácticas en higiene de manos de las enfermeras que han acreditado su competencia profesional. *Metas Enferm*. 2017;20(3):20-8. <https://doi.org/10.35667/MetasEnf.2019.20.1003081048>
21. Oyapero A, Oyapero O. An assessment of hand hygiene perception and practices among undergraduate nursing students in Lagos State: a pilot study. *J Educ Health Promot*. 2018;7:150. [https://doi.org/10.4103/jehp.jehp\\_56\\_17](https://doi.org/10.4103/jehp.jehp_56_17)
22. Beyamo A, Dodicho T, Facha W. Compliance with standard precaution practices and associated factors among health care workers in Dawuro Zone, South West Ethiopia, cross sectional study. *BMC Health Serv Res*. 2019;19(1):381. <https://doi.org/10.1186/s12913-019-4172-4>
23. Lotfinejad N, Peters A, Tartari E, Fankhauser-Rodriguez C, Pires D, Pittet D. Hand hygiene in health care: 20 years of ongoing advances and perspectives. *Lancet Infect Dis*. 2021;21(8):e209-21. [https://doi.org/10.1016/S1473-3099\(21\)00383-2](https://doi.org/10.1016/S1473-3099(21)00383-2)
24. Saad AE, Al-Natig A-WT, Sadek MM, Afifi RM. A quasi experiment to implement multimodal strategy to improve hand hygiene behavior in a healthcare facility in central Saudi Arabia. *Adv Infect Dis*. 2019;9(1):49. <https://doi.org/10.4236/aid.2019.91005>
25. Srigley JA, Cho SM, O'Neill C, Bialachowski A, Ali RA, Lee C, et al. Hand hygiene knowledge, attitudes, and practices among hospital inpatients: a descriptive study. *Am J Infect Control*. 2019;48(5):507-10. <https://doi.org/10.1016/j.ajic.2019.11.020>

