



HAND HYGIENE PRACTICES AMONG MEDICAL AND ALLIED HEALTH STUDENTS BASED ON WORLD HEALTH ORGANIZATION INFECTION PREVENTION AND CONTROL GUIDELINES: A CROSS-SECTIONAL OBSERVATIONAL STUDY

Muhammad Yasir Rishi^{1*}, Usama Ali², Sufain Azam³, Sadia Hayat⁴, Tooba Salman⁵, Ayesha Shakeel⁶, Muhammad Uzair⁷, Maria Rishi⁸

^{1*}Senior Lecturer, Baqai Medical College, Email: yasirrishi@yahoo.com

²4th Year MBBS, Baqai Medical College, Email: uali72085@gmail.com

³4th Year MBBS, Baqai Medical College, Email: sufainak03312692491@gmail.com

⁴4th Year MBBS, Baqai Medical College, Email: saadiahayat876@gmail.com

⁵4th Year MBBS, Baqai Medical College, Email: toobasalman0@gmail.com

⁶4th Year MBBS, Baqai Medical College, Email: ayesha.shakeelkhann@gmail.com

⁷Lecturer, Baqai Medical College, Email: muhammaduzair1243@gmail.com

⁸MPhil Pharmacology Student, Baqai Institute of Pharmaceutical Sciences, Email: mariarishi123@gmail.com

Abstract

Background: Hand hygiene is the single most effective measure for preventing healthcare-associated infections. Despite wide recognition of its importance, a gap frequently exists between health sciences students' knowledge of hand hygiene principles and their actual practice.

Objective: To assess compliance with WHO Five Moments for Hand Hygiene and the WHO Ten-Step Handwashing Technique among health sciences students.

Methods: A cross-sectional observational study was conducted at Baqai Medical University, Karachi, Pakistan, from March, 2025 to August, 2025. Using stratified random sampling, 280 undergraduate students from five academic programmes were enrolled. Compliance was recorded in real time using a structured observational checklist incorporating both the WHO Five Moments framework and the WHO Ten-Step Handwashing Technique. Data were analyzed using SPSS v26. Chi-square tests examined associations while Spearman rank-order correlation assessed relationship between continuous scores. Statistical significance was set at $p < 0.05$.

Results: Overall, 88.9% of students demonstrated good Five-Moment hand hygiene practice, whereas only 26.4% achieved good compliance with the WHO Ten-Step Handwashing Technique. Academic programme was significantly associated with both Five-Moment practice ($\chi^2 = 27.504$, $df = 4$, $p < 0.001$) and Ten-Step compliance ($\chi^2 = 20.926$, $df = 4$, $p < 0.001$). A weak, non-significant correlation was observed between Five-Moment practice scores and Ten-Step compliance scores (Spearman's $\rho = 0.088$, $p = 0.141$).

Conclusion: A significant knowledge–practice gap was observed among health sciences students, with good awareness of hand hygiene not translating into adequate handwashing technique. Compliance varied by academic programme but not by year of study.

Keywords: Hand hygiene, WHO Five Moments, Ten-Step Hand-washing Technique, Infection Prevention and Control

Introduction

Infections acquired while receiving healthcare that are neither sustained nor experienced amid incubation period at the time of admission to the hospital are known as healthcare associated infections (HAIs) [1]. Such infections can cause a significant burden worldwide as it is a global health issue that contributes towards mortality and morbidity, delayed hospitalization and increasing of healthcare expenditure [2].

Annually, as per World Health Organization (WHO), millions of population is affected due to HAIs. At any point in time, it is estimated that around 7 % of the hospitalized population residing in high income status and as high as 15 % in middle and low income status populations (LMICs) tend to suffer from once from HAIs. Among LMICs, an abnormally high incidence of HAIs is reported due to patient overcrowded healthcare setups, sub-optimal infrastructure for preventing infections and limited trained health care personnel availability [3].

Among local literature, since Pakistan is a developing country, it tends to face substantial challenges in infection prevention and control (IPC). Due to limited funds, IPC tends to have insufficient effect because of lack in trained personnel and inconsistent adhering towards protocols that are evidence-based that collectively tend to cause transmission of pathogens [4]. World over, hand hygiene has been regarded as a cost-effective and single most efficient technique in order to prevent infections that are associated with healthcare [5].

Researches recommend as high as 50 % HAIs can be prevented by simply practicing hand hygiene practices [6]. There is emphasis from both WHO and CDC (Center for Disease Control and Prevention) on practicing hand hygiene specifically at specific times, i.e. prior to and post-direct contact with patients, prior to performance of aseptic procedures, after being exposed to bodily fluids and post-contact to immediate environment of patient [7, 8].

For standardization of infection control practices related to HAIs on a global level, WHO designed an evidence-based comprehensive guideline for IPC. The guidelines recommend various methods such as hand hygiene practices, surveillance of HAIs, usage of PPEs (Personal Protective Equipment), environmental sanitation and decontamination and strategies for management of disease outbreaks [9]. The hand hygiene guidelines by WHO have been widely accepted as well as adopted for reduction of HAIs in healthcare setting [10].

WHO “Five Moments for Hand Hygiene”

One of the most vital components of WHO Hand Hygiene Guidelines is “My Five Moments for Hand Hygiene. It is defined by 5 critical clinical termed “moments” in which healthcare professionals should practice hand hygiene techniques for preventing cross contamination and transmission of pathogens [11]. It is an intuitive and practice framework, which can be easily applied across various healthcare situations. Adhering to the given guidelines has been linked to significantly reduced incidences of HAI,

improvement in outcomes of patient safety and enhancement of the overall healthcare standards (Figure 1) [12].

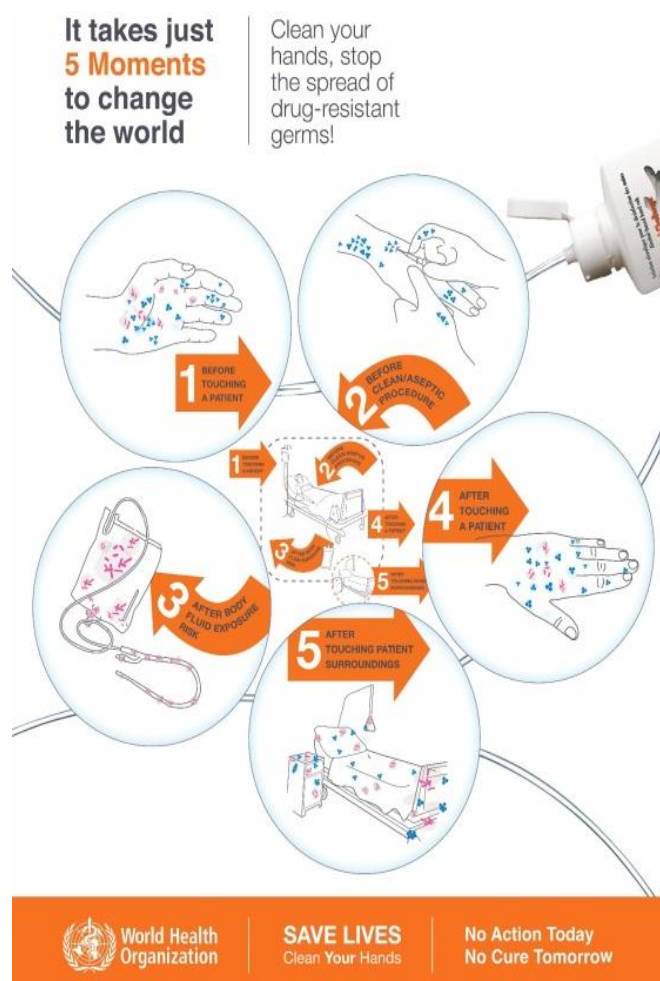


Figure 1 WHO Five Moments for Hand Hygiene
Adapted from the World Health Organization (WHO)

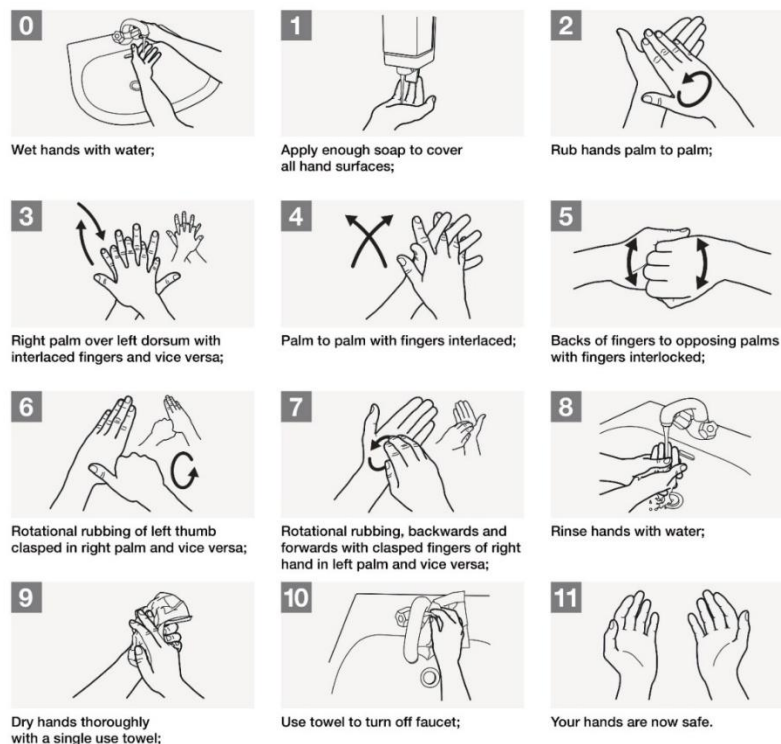
WHO Ten-Step Hand Washing Technique

In line with the identification of the times as to when performance of hand hygiene should be done, WHO specifies Ten-Step Hand washing Technique for ensuring a thorough decontamination of all hand surfaces [13]. Omitting any step within the sequence might lead to residual contamination of surface of hand and therefore may compromise effectiveness of the efforts for control of infection (Figure 2) [14].

How to Handwash?

WASH HANDS WHEN VISIBLY SOILED! OTHERWISE, USE HANDRUB

 Duration of the entire procedure: 40-60 seconds



Patient Safety
A World Alliance for Safer Health Care

SAVE LIVES
Clean Your Hands

**Figure 2 WHO Ten Steps of Hand Washing Technique
Adapted from the World Health Organization (WHO)**

Medical students are the future workforce responsible for implementation and sustainment of infection control practices [15]. Researches done on nursing and medical students in various developing and developed populations have observed that hand hygiene rates of compliance have ranged in-between 30 to 70 %. This reflects a substantial variation and highlights significant gap in-between the current knowledge and practices which exist at student level [16, 17].

This research aims to identify gaps in practical adherence towards protocols of hand hygiene for guiding targeted educational interventions and for enhancing long term efforts at infection prevention. The objectives were to evaluate student compliance with WHO "My Five Moments for Hand Hygiene" and 10 step hand hygiene technique and identify gaps in adherence to hand hygiene practices as well as propose strategies for improving student training, compliance, and adherence to WHO IPC guidelines.

Methodology

This was a cross-sectional analytical study carried out at Baqai Medical University, Karachi, Pakistan, from March, 2025 to August, 2025 involving undergraduate students enrolled in various healthcare and allied health programs.

Using stratified random sampling, students were stratified according to academic programmes (MBBS, BDS, DPT, BSN, and MLT) and year of study. Participants were then selected proportionally from each stratum to ensure representative distribution across university's undergraduate student population. A total of 280 students were enrolled with sample size calculated using OpenEpi latest version (v. 3.0.1). Keeping confidence level of 95% and 5% margin of error, 23.9 % as prevalence rate of proper hand hygiene technique reported in a research, the sample size came out to be 280.

122.12.22.32.42.52.6 Students currently enrolled at Baqai Medical University, from any academic programs (MBBS, BDS, BSN, DPT, & MLT) and agreeing to give informed consent to participate in the study were included. Pre-clinical students of 1st and 2nd year of any program, students with any known medical or dermatological condition that precluded handwashing or participation in the hand hygiene assessment were excluded from the research.

Data Collection Procedure

After approval from the Institutional Review and Ethics Board (IREB) of Baqai Medical University, data was collected using a structured observational checklist developed directly from two globally validated WHO hand hygiene instruments: the WHO Five Moments for Hand Hygiene framework and the WHO Ten-Step Handwashing Technique. No modification was made to content or sequence of either instrument; the checklist served as a direct observational recording tool for the established WHO criteria.

The data collection tool aim at assessing 3 domains viz. demographical, academic, year of study and program enrolment. In addition, recognition and acting upon five critical indications for hand hygiene adherence and performance to WHO Ten-Step Hand washing Technique were assessed and lastly the correctness and completeness of each procedural step during the process of hand washing was assessed. Every one of the participant was observed directly whilst performing the technique of hand washing according to the prescribed guideline. The primary observations were done by the principal investigator, with supports from other co-researchers as well. Real time compliance were recorded through a checklist (structured). Such an approach was carried out rather than self-reporting data collection for minimizing bias towards social desirability and for obtaining objective behavioral information. Participating in this research was made to be completely voluntary, without any incentives. Informed consent was taken from all students and their identifications were kept completely anonymous and confidential.

Operational Definitions

- **Hand Hygiene:** For the purposes of this study, hand hygiene is defined as any act of hand cleansing performed with the intent to remove dirt, transient microorganisms, and potential contaminants from the hands, carried out using soap and water in accordance with WHO Infection Prevention and Control guidelines.

- **Good Practice (WHO Five Moments for Hand Hygiene):** Participants who scored ≥ 4 out of 5 (80% or higher) on the Five-Moment Hand Hygiene observational checklist were classified as demonstrating good practice, indicating adequate recognition and performance of the appropriate clinical indications for hand hygiene.
- **Poor Practice (WHO Five Moments for Hand Hygiene):** Participants who scored < 4 out of 5 (below 80%) on the Five-Moment Hand Hygiene observational checklist were classified as demonstrating poor practice, indicating inadequate adherence to the WHO-recommended indications for hand hygiene performance.
- **Good Compliance (WHO Ten-Step Handwashing Technique):** Participants who scored ≥ 8 out of 10 (80% or higher) on the Ten-Step Handwashing Technique observational checklist were classified as demonstrating good compliance, indicating satisfactory execution of the complete standardized handwashing procedure.
- **Poor Compliance (WHO Ten-Step Handwashing Technique):** Participants who scored < 8 out of 10 (below 80%) on the Ten-Step Handwashing Technique observational checklist were classified as demonstrating poor compliance, indicating failure to adequately complete the required procedural steps of the WHO Ten-Step Handwashing Technique.

Data Analysis

Data was analyzed by SPSS v26.0. For reporting of categorical variables, frequency and percentages were used while for continuous variables, after normality testing by Shapiro Wilk test, if data was found to be normally distributed, mean and standard deviation were reported. If data distribution was skewed then median and interquartile range (IQR) were reported. For testing the association, chi-square test was applied in-between academic programs and five-moment and ten-step hand hygiene techniques as well as year of study.

Since that both score distributions were deviated substantially ($p < 0.001$), therefore non-parametric tests were applied. Spearman correlation was used for examining relation between Five-Moment Practice and Ten-Step Compliance scores. P-value < 0.05 was taken as statistically significant.

Results

Regarding academic programme, majority of participants were enrolled in MBBS programme, accounting for 53.6 %. Participants included from other programmes along with year of study are mentioned in Table I.

Table I: Demographic Characteristics of Participants (n = 280)

Variables	n (%)
Academic Programme	
MBBS	150 (53.6)
BDS	68 (24.3)
DPT	36 (12.9)

BSN	22 (7.9)
MLT	4 (1.4)
Year of Study	
3rd Year	119 (42.5)
4th Year	96 (34.3)
5th Year	65 (23.2)

As shown in Table II, the majority of participants, 271 (96.8 %) believed that adherence to the WHO Five Moments for Hand Hygiene reduces the risk of infection transmission. Only 1.8 % disagreed, while 1.4% were unsure, indicating a high level of awareness regarding the importance of hand hygiene among the study participants. Only 26.4 % participants demonstrated good compliance with the WHO Ten-Step Hand washing Technique, whereas 73.6 % were classified as having poor compliance. The mean Five-Moment practice score was 4.53 ± 0.84 . The mean Ten-Step compliance score was 6.14 ± 2.13 . The Ten-Step scores exhibited greater variability than the Five-Moment scores, as indicated by the higher standard deviation.

Table II: Belief Regarding the WHO Five Moments for Hand Hygiene and Ten-Step Hand washing Technique Compliance (n = 280)

Response	Value
Yes	271 (96.8)
No	5 (1.8)
Not Sure	4 (1.4)
Practice Category	
Poor Practice	31 (11.1 %)
Good Practice	249 (88.9 %)
Five-Moment Score	4.53 ± 0.84
Compliance Category	
Poor Compliance	206 (73.6 %)
Good Compliance	74 (26.4 %)
Ten-Step Score	6.14 ± 2.13

Table III shows the proportion of participants with good Five-Moment hand hygiene practice varied across academic programmes. Good practice was observed among 88.0% of MBBS students, 98.5% of BDS students, 91.7% of DPT students, 72.7% of BSN students, and 25.0% of MLT students. BDS

students demonstrated the highest proportion of good practice, whereas MLT students showed the lowest. A statistically significant association was found between academic programme and Five-Moment hand hygiene practice ($\chi^2 = 27.504$, $df = 4$, $p < 0.001$).

Table III: Association between Academic Programme and Five-Moment Practice

Academic Programme	n	Poor Practice n (%)	Good Practice n (%)	χ^2	P value
MBBS	150	18 (12.0%)	132 (88.0%)	27.504	<0.001
BDS	68	1 (1.5%)	67 (98.5%)		
DPT	36	3 (8.3%)	33 (91.7%)		
BSN	22	6 (27.3%)	16 (72.7%)		
MLT	4	3 (75.0%)	1 (25.0%)		
Total	280	31 (11.1%)	249 (88.9%)		

As shown in Table IV, the proportion of participants demonstrating good compliance with the WHO Ten-Step Handwashing Technique varied across academic programmes. Good compliance was observed among 26.0% of MBBS students, 20.6% of BDS students, 13.9% of DPT students, 63.6% of BSN students, and 50.0% of MLT students. BSN students demonstrated the highest proportion of good compliance, whereas DPT students showed the lowest. A statistically significant association was found between academic programme and Ten-Step Handwashing Technique compliance ($\chi^2 = 20.926$, $df = 4$, $p < 0.001$).

Table IV: Academic Programme and Ten-Step Hand washing (n=280)

Academic Programme	Total n	Poor Compliance n (%)	Good Compliance n (%)	χ^2	P value
MBBS	150	111 (74.0%)	39 (26.0%)	20.926	< 0.001
BDS	68	54 (79.4%)	14 (20.6%)		
DPT	36	31 (86.1%)	5 (13.9%)		
BSN	22	8 (36.4%)	14 (63.6%)		
MLT	4	2 (50.0%)	2 (50.0%)		
Total	280	206 (73.6%)	74 (26.4%)		

As shown in Table V, omission rates varied across the ten handwashing steps and academic programmes. The lowest omission rates were observed for Step 1 (application of soap) and Step 8 (rinsing hands with water), indicating good adherence to these basic handwashing actions. In contrast, higher omission rates were recorded for Steps 4 to 7, which involve interlacing fingers, cleaning the backs of fingers,

rotational thumb rubbing, and rotational rubbing of fingertips. Step 10 was most commonly missed step by all academic programmes, with omission rates ranging from 87.3% in MBBS to 100% in MLT students.

Table V: Frequency and Percentage of Missed WHO Hand-Washing Steps by Program

WHO Hand-Washing Step	MBBS (n=150)	BDS (n=68)	DPT (n=36)	BSN (n=22)	MLT (n=4)
1. Apply enough soap	14 (9.3%)	3 (4.4%)	5 (13.9%)	1 (4.5%)	0 (0%)
2. Rub hands palm to palm	7 (4.7%)	14 (20.6%)	7 (19.4%)	2 (9.1%)	0 (0%)
3. Right palm over left dorsum.	49 (32.7%)	29 (42.6%)	23 (63.9%)	5 (22.7%)	1 (25.0%)
4. Palm to palm with fingers interlaced	91 (60.7%)	46 (67.6%)	26 (72.2%)	7 (31.8%)	3 (75.0%)
5. Backs of fingers to opposing palms.	114 (76.0%)	56 (82.4%)	31 (86.1%)	9 (40.9%)	3 (75.0%)
6. Rotational rubbing of left thumb.	105 (70.0%)	45 (66.2%)	30 (83.3%)	10 (45.5%)	3 (75.0%)
7. Rotational rubbing, backwards/ forwards.	96 (64.0%)	48 (70.6%)	28 (77.8%)	7 (31.8%)	3 (75.0%)
8. Rinse hands with water	20 (13.3%)	14 (20.6%)	6 (16.7%)	0 (0%)	0 (0%)
9. Dry hands thoroughly	60 (40.0%)	30 (44.1%)	17 (47.2%)	5 (22.7%)	1 (25.0%)
10. Use towel to turn off faucet	131 (87.3%)	64 (94.1%)	35 (97.2%)	21 (95.5%)	4 (100%)

Spearman rank-order correlation analysis demonstrated a weak positive correlation between Five-Moment Practice scores and Ten-Step Compliance scores ($\rho = 0.088$). However, this association was not statistically significant ($p = 0.141$), indicating no significant relationship between the two variables [Table VI].

Table VI: Correlation between Five-Moment Practice and Ten-Step Compliance Scores

Variables	Spearman's rho	p-value
Five-Moment Practice Score vs. Ten-Step Compliance Score	0.088	0.141

Discussion

The study included 280 students from five health sciences programmes. Most participants (96.8%) believed that adherence to the WHO Five Moments reduces infection transmission. This finding is consistent with previous studies that reported positive attitudes toward hand hygiene among healthcare students [18, 19]. However, despite strong awareness, actual technique compliance remained low, supporting the existence of a knowledge–practice gap in infection prevention and control [20].

Good Five-Moment practice was observed in 88.9% of participants. This rate is comparable to the 86.7% compliance reported following sustained intervention programmes and higher than rates reported in several low- and middle-income countries [21]. The high compliance may reflect effective theoretical teaching as well as the Hawthorne effect associated with direct observation [22].

Only 26.4% of students demonstrated good Ten-Step compliance, indicating poor technical performance despite good awareness. Similar deficiencies have been reported in previous studies, which found that completion of all recommended hand hygiene steps remained poor even after training [23]. These findings suggest that practical handwashing skills remain a challenge for healthcare students.

BSN students demonstrated the highest Ten-Step compliance, while DPT students showed the lowest. These findings support previous studies that reported superior hand hygiene performance among nursing students due to greater emphasis on practical clinical skills and repeated procedural training [24, 25].

A weak, non-significant correlation was found between Five-Moment practice and Ten-Step compliance. This finding indicates that knowledge of when to perform hand hygiene does not necessarily ensure correct technique. Similar observations have been reported in infection prevention literature, emphasizing that hand hygiene timing and handwashing technique represent separate competencies that require independent teaching and assessment [26, 27].

This was a single-centered research with limited sample of students, thereby limiting generalizability. Moreover, a directed observation (Hawthorne effect) might have influenced participants' behavior, resulting in higher hand hygiene compliance than would occur during routine practice. The study recommends integrating and formally assessing WHO Five Moments and Ten-Step Handwashing Technique training across all health sciences programmes. Moreover, regular simulation-based training sessions and supervised demonstrations should be conducted, with emphasis on commonly missed hand

washing steps. Lastly, implementation of refresher training for programmes with lower compliance rates and adoption of successful teaching strategies from high-performing programmes ought to be done.

Conclusion

Majority of students showed positive attitude towards hand hygiene and adequate five-moment practices; however only a handful demonstrated adequate compliance towards the ten-step technique thereby highlighting a substantial gap between knowledge and practice. Compliance was significantly affected by academic programme. The findings of the study emphasize needs for training of students, designing, implementing and standardizing curricula and reinforcing the required practical skills for improving practices of hand hygiene.

Conflict of Interest: None

Source of Funding: None declared.

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