



Original Research Article

IMPACT OF TRAINING ON HAND HYGIENE PRACTICES AMONG HEALTHCARE WORKERS: A WHO FIVE MOMENTS APPROACH

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ABSTRACT

Background: Hand hygiene (HH) is a fundamental component of infection prevention and control (IPC), with a well-established role in reducing healthcare-associated infections (HAIs). Despite its proven effectiveness, adherence among healthcare workers (HCWs) remains variable, particularly in low- and middle-income countries like India. Structured training has emerged as a key strategy to improve compliance, addressing both behavioural and systemic barriers. **Aim:** This study evaluates the impact of a training on HH adherence among doctors and nurses, aiming to enhance patient safety and strengthen IPC practices.

Materials and Methods: A quasi-experimental pre-post study was conducted from August 2024 to February 2025 in Medicine, Gynaecology, and Surgery wards of Adarsh Multispecialty Hospital. Hand hygiene (HH) adherence among doctors and nurses was assessed using WHO's "Five Moments" framework via direct, unannounced observation by trained microbiologists. A structured training was provided between phases. Data were analyzed using chi-square tests and mixed-effects logistic regression. Ethical approval was obtained from the Ananya Institutional Ethical Committee (AIEC).

Results: A total of 1,711 hand hygiene (HH) opportunities were observed (857 pre-training, 854 post-training). Overall compliance improved significantly from 38.8% pre-training to 57.0% post-training. Among doctors, adherence increased from 42.0% (192/457) to 65.5% (224/342; $\chi^2 = 13.46$, $p < 0.001$), while nurses improved from 35.3% (140/397) to 52.6% (271/515; $\chi^2 = 10.53$, $p = 0.001$). Department-wise, adherence rose significantly in Medicine (38.5% to 54.1%; $p = 0.0067$) and Surgery (41.7% to 62.9%; $p = 0.016$), whereas Gynaecology showed a non-significant increase (56.7% to 59.4%). Across WHO "Five Moments," the greatest gains were observed before patient contact and after procedures, though compliance before aseptic procedures remained lowest.

Conclusion: Structured training significantly improved hand hygiene (HH) compliance, increasing from 42.0% to 65.5% among doctors and from 35.3% to 52.6% among nurses, with overall adherence rising to 57%. While compliance improved across departments and WHO "Five Moments," rates remained below the WHO target of 80%, emphasizing the need for sustained, multimodal strategies to achieve optimal infection prevention.

Keywords: HH adherence rate, HH compliance, WHO five moments of HH, Healthcare workers.

INTRODUCTION

Hand hygiene (HH) has been practiced for centuries across diverse cultures, originally for ritualistic or aesthetic purposes rather than medical benefit. Its role in infection prevention became evident in the mid-19th century when Ignaz Semmelweis demonstrated reduced maternal mortality through handwashing, and Florence Nightingale emphasized cleanliness in surgical and hospital care. These early observations were later validated by Pasteur and Koch through the germ theory of disease, establishing microorganisms as central agents in infection transmission and underscoring the importance of antiseptic practices in healthcare.^[1,2] Despite these early insights, standardized HH protocols were not widely implemented until much later. The first national guidelines were introduced by the Centers for Disease Control and Prevention (CDC) in late 1980s in response to outbreaks of healthcare-associated infections (HAIs).^[3] Since then, the World Health Organization (WHO) and global initiatives like the Global Handwashing Partnership have promoted HH as a simple, cost-effective intervention for reducing HAIs, especially in resource-limited settings.^[4] The COVID-19 pandemic further reinforced its importance as a cornerstone of infection prevention measure worldwide. Globally, HAIs remain a pressing challenge, affecting an estimated 7 out of every 100 hospitalized patients in high-income countries (HICs) and up to 15 per 100 patients in low- and middle-income countries (LMICs).^[5] In India, HAI prevalence and related mortality are disproportionately higher than in developed nations, driven by systemic challenges such as resource constraints, overcrowding, and variations in IPC practices. Evidence consistently demonstrates that HH is one of the most effective strategies for reducing the transmission of HAIs and improving patient safety.^[6]

In clinical practice, HH adherence is defined as the proportion of times healthcare workers (HCWs) perform hand hygiene when indicated, most commonly evaluated through the WHO's "Five Moments for Hand Hygiene" outline.^[7] Monitoring HH adherence is complex, with direct observation by trained auditors regarded as the gold standard, though indirect methods such as product utilization and electronic surveillance are also used.^[8] Reported adherence rates vary widely in India, ranging from 20% to 85%, with improvements observed following structured training interventions. For example, studies from Gujarat have shown increases from 42% to nearly 70% following targeted educational programs.^[9,10]

These findings highlight the influence of both infrastructural availability (e.g., water, soap, alcohol-based hand rubs) and behavioural factors (awareness, workload, habitual practice) on HH compliance. Given that most HAIs are preventable and HH

compliance is a widely accepted quality indicator in healthcare delivery, improving HH adherence is critical to patient safety and HCW protection. Sustained compliance requires not only adequate resources but also regular training, reinforcement, and monitoring.^[10]

Against this backdrop, this study intended to evaluate the result of structured training on HH adherence rates among doctors and nurses, thereby contributing to the growing evidence supporting educational interventions as an effective IPC strategy.

MATERIALS AND METHODS

- **Study Design and Setting:** This study utilized a quasi-experimental pre-post design to examine compliance with HH practices among HCWs, based on the WHO 'Five Moments for Hand Hygiene' approach. This investigation was carried out in Medicine, Gynaecology and Surgical wards of a Adarsh Multispecialty hospital between August 2024 to February 2025.
- **Inclusion criteria:** Health care workers (Nurses & Doctors) of the Medicine, Gynec and Surgery wards who engaged in direct patient care during the observation periods.
- **Exclusion criteria:** Nursing and medical students, nursing assistants, Administrative staff & visitors.
- **Data Collection and Observation Procedures:** Hand hygiene adherence was assessed by direct observation, following the WHO Hand Hygiene criteria by questionnaire form. Trained observers recorded opportunities for HH and whether HH was performed correctly. There are multiple sessions were done to observe HH in wards. An opportunity was defined as any instance requiring hand hygiene according to WHO indications: (1) Prior to patient contact, (2) Before undertaking clean or aseptic procedures, (3) Following exposure to or risk of body fluids, (4) After direct patient contact, and (5) After contact with the patient's immediate environment. Adherence was defined as hand hygiene action performed during the opportunity. Observers were Microbiologist who underwent standardized training and inter-observer reliability testing prior to data collection. Observations were conducted during routine clinical care without prior announcement to staff and covered multiple shifts and weekdays to capture variability. Each observation session lasted approximately 20–25 minutes.
- **Study Periods:** Baseline observations were conducted over 3 months before the intervention. Post-training observations were performed over an equivalent period beginning (3 months) after training completion. An approximately equal number of opportunities (857 pre - training &

854 post – training) were recorded during both periods.

- **Sample Size:** The unit of analysis was the hand hygiene opportunity. A minimum of 800 opportunities per phase was targeted to allow detection of a 15 % absolute improvement in adherence with 80% power and $\alpha = 0.05$.

- **Outcomes**

- a. The primary outcome was overall hand hygiene adherence rate, calculated as:

$$\text{Adherence rate} = \frac{\text{Total number of observed opportunities}}{\text{Number of opportunities with hand hygiene performed}} \times 100$$

Number of opportunities with hand hygiene performed

- b. Secondary outcomes included adherence stratified by WHO moment, HCW category, and ward or area.

- **Data Management and Analysis:** Observation forms were checked for completeness and entered into a secure database. Descriptive statistics were used to summarize adherence rates. Pre- and post-training adherence proportions were compared using chi-square tests. To account for clustering by HCW or ward, mixed-effects logistic regression models with random intercepts were constructed. Analyses were performed using SPSS. Statistical significance was defined as two-sided $p < 0.05$.

Ethical Approval: The study protocol received ethical clearance from the Ananya Institutional Ethics Committee (AIEC) on 22.07.2024, Ref. No. AIEC/2024/005.

RESULTS

The study documented 1,711 instances of HH opportunities across the two study phases, with 857 opportunities recorded during the pre-training period and 854 during the post-training period. Overall hand hygiene opportunities identified (OI) and the

corresponding actions performed (AP) across two major clinical disciplines—doctors and nurses. Among doctors, 799 instances of HH opportunities were observed, of which 416 (52.1%) were performed. In comparison, nurses had a higher number of opportunities identified at 912, yet only 411 (45.1%) were performed. Although nurses had more opportunities, both groups demonstrated suboptimal compliance, with performance rates falling below 55%. Improvements were observed across all WHO Five Moments, though the magnitude of change varied by indication and HCW category. [Figure 1]

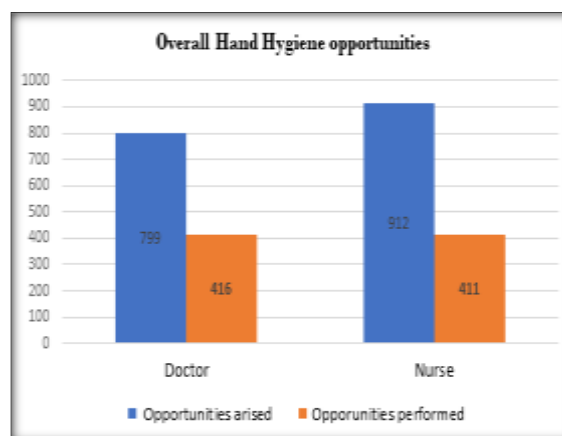


Figure 1: Chart depicts that Hand Hygiene opportunities identified & action performed Across Clinical Disciplines

Table 1 demonstrate the impact of hand hygiene training on adherence rates among doctors and nurses. Among doctors, 457 opportunities were identified before training, with 192 actions performed, corresponding to an adherence rate of 42.01%. Post-training, 342 opportunities were identified and 224 actions were performed, leading to a significantly higher adherence rate of 65.49% ($\chi^2 = 13.4601$, $p = 0.000251$). [Table 1]

Table 1: Pre & Post training HH Adherence Rate among HCWs with Opportunities Identified and Actions Performed

	Doctor		Nurses		Total
	Before training	After training	Before training	After training	
Opportunities identified	457	342	397	515	1711
Actions performed	192	224	140	271	827
Adherence rate	42.01	65.49	35.26	52.62	48.33
Chi square	13.4601		10.5309		
P value	0.000251		0.001174		

For nurses, 397 opportunities were recorded pre-training, with 140 actions performed (35.26% adherence). Following training, 515 opportunities were noted, with 271 actions performed, raising the adherence rate to 52.62% ($\chi^2 = 10.5309$, $p = 0.001174$). These results demonstrate a statistically significant improvement in HH adherence rate among both doctors and nurses after training.

Table 2 presents the outcome of a HH training intervention on adherence rates across three hospital

departments: Gynaecology, Medicine, and Surgery. In the Gynaecology department, adherence improved slightly from 56.66% to 59.4% following the training. However, this increase was not statistically significant (Chi-square = 0.0743, $p = 0.785151$). In the Medicine department, a more substantial improvement was observed, with adherence increasing from 38.51% pre-training to 54.14% post-training. This change was statistically significant (Chi-square = 7.3551, $p = 0.006687$), indicating the

training had a positive impact on HH adherence rate in this department. Similarly, in the Surgery department, adherence increased from 41.7% to

62.91% following the intervention. This improvement was also statistically significant (Chi-square = 5.8069, $p = 0.015963$). [Table 2]

Table 2: Ward-Wise Hand Hygiene (HH) Adherence Rates: Pre-Training Versus Post-Training Assessment

	Gynaecology		Medicine		Surgery	
	Pre training	Post training	Pre training	Post training	Pre training	Post training
Total opportunities	150	234	405	410	199	213
HH followed	85	139	156	222	83	134
Adherence rate (%)	56.66	59.4	38.51	54.14	41.7	62.91
Chi square	0.0743		7.3551		5.8069	
P value	0.785151		0.006687		0.015963	

Overall, the training program significantly improved HH adherence in the Medicine and Surgery departments, while the Gynaecology department showed a non-significant increase, suggesting varying levels of responsiveness to the training across departments.

Table 3 illustrates the distribution of HH opportunities identified (OI) and actions performed (AP) across the WHO's five moments of HH among doctors and nurses in clinical wards, before and after training. At follow up measurements progresses were observed in nearly all HH moments across departments and professional groups. In the Gynaecology ward, both doctors and nurses demonstrated moderate increases in adherence,

particularly after patient contact. In the Medicine ward, notable improvements were seen, especially among nurses, with significant increases in compliance after completing procedures (from 12 to 79 actions performed). Similarly, in the Surgery ward, both doctors and nurses showed marked improvement post-training, especially Prior to patient contact and after contact with the patient's immediate environment. Overall, data reflect a positive shift in hand hygiene behaviour post-training, with the most pronounced improvements among nurses in the Medicine and Surgery wards. This suggests that targeted training effectively enhances compliance with hand hygiene protocols, particularly during high-risk moments. [Table 3]

Table 3: HH opportunities data and adherence rate before and after training among HCWs in gynecology, medicine, and surgery wards, based on WHO Five Moments

Gynaecology Ward						
Staff	Training	Before touching patient	Before procedure	After procedure	After touching patient	After touching surroundings
Doctors	Pre (OI/AP)	28 / 7	22 / 8	22 / 12	29 / 10	34 / 12
	Post (OI/AP)	19 / 16	24 / 17	24 / 16	17 / 12	18 / 13
Nurses	Pre (OI/AP)	22 / 7	24 / 7	24 / 6	21 / 7	24 / 9
	Post (OI/AP)	18 / 12	38 / 18	38 / 12	15 / 11	23 / 12

Medicine Ward						
Staff	Training	Before touching patient	Before procedure	After procedure	After touching patient	After touching surroundings
Doctors	Pre (OI/AP)	42 / 11	41 / 14	38 / 19	43 / 24	52 / 21
	Post (OI/AP)	32 / 31	31 / 12	31 / 10	32 / 30	30 / 16
Nurses	Pre (OI/AP)	32 / 14	40 / 12	38 / 12	30 / 16	39 / 10
	Post (OI/AP)	32 / 29	82 / 25	79 / 30	34 / 24	27 / 17

Surgery Ward						
Staff	Training	Before touching patient	Before procedure	After procedure	After touching patient	After touching surroundings
Doctors	Pre (OI/AP)	20 / 3	22 / 9	20 / 11	20 / 9	20 / 11
	Post (OI/AP)	12 / 11	20 / 12	21 / 9	17 / 11	14 / 10
Nurses	Pre (OI/AP)	18 / 5	15 / 3	15 / 7	21 / 9	24 / 7
	Post (OI/AP)	16 / 14	33 / 18	32 / 19	20 / 12	28 / 18

Table 4 depicts that the percentage adherence to the five WHO moments of HH among doctors & nurses across the Gynaecology, Medicine, and Surgery wards, before and after the training intervention. The data is further supported by Chi-square values and corresponding p-values to assess statistical significance. In the Gynaecology ward, doctors

demonstrated a statistically significant improvement in overall adherence post-training (Chi-square = 13.7048, $p = 0.008299$), particularly in "after touching a patient" (70.6% to 73.3%) and "after touching surroundings" (72.2% to 52.17%). In contrast, nurses in this ward showed a non-significant Change (Chi-square = 4.9979, $p = 0.287512$),

Table 4: Pre- and Post-Training Hand Hygiene Adherence rate (%) by Clinical Ward and Discipline in respect to WHO's Five Moments of hand hygiene

Five Moments of Hand Hygiene	Gynec Ward				Medicine ward				Surgery Ward			
	Doctors		Nurse		Doctor		Nurse		Doctor		Nurse	
	PrTA (%)	PoTA (%)	PrTA (%)	PoTA (%)	PrTA (%)	PoTA (%)	PrTA (%)	PoTA (%)	PrTA (%)	PoTA (%)	PrTA (%)	PoTA (%)
Before touching patient	25	84.2	31.81	66.66	26.19	96.87	43.75	90.62	65	91.66	27.77	87.5
Before performing procedure	36.4	70.8	29.16	47.36	31.14	32.25	30	30.48	40.9	60	20	54.54
After completing procedure	54.5	66.7	25	31.57	50	32.25	31.57	37.97	55	42.85	46.66	59.37
After touching patient	34.5	70.6	33.33	73.33	55.81	93.75	53.33	70.58	42.85	64.7	38.09	60
After touching surroundings	29.5	72.2	37.5	52.17	46.15	53.33	25.64	62.96	39.13	71.42	37.5	64.28
Chi square value	13.7048		4.9979		37.0445		11.4005		10.9033		12.789	
P value	0.008299		0.287512		0.00001		0.022413		0.027672		0.012354	

* PrTA- Pre – training Adherence, PoTA- Post – training Adherence

In the Medicine ward, both doctors and nurses exhibited significant increases in adherence post-training. Doctors improved from 26.19% to 96.87% in the "before touching patient" category and achieved an overall Chi-square of 37.0445 ($p < 0.00001$). Nurses also showed notable improvements, especially in "after completing procedure" (31.57%) and "after touching patient" (73.53%), with a Chi-square of 11.4005 ($p = 0.022413$).

The Surgery ward showed significant gains in both professional groups. Doctors achieved 91.66% adherence in "before touching patient" and 71.42% in "after touching surroundings," with a Chi-square value of 10.9033 ($p = 0.027672$). Nurses improved significantly as well, especially in "before touching patient" (from 27.77% to 87.5%) and "after completing procedure" (46.66% to 59.37%), with an overall Chi-square of 12.789 ($p = 0.012354$). Overall, the data indicate that the hand hygiene training program significantly improved adherence among doctors in all wards and among nurses in the Medicine and Surgery wards. However, the impact was limited among nurses in the Gynaecology ward.

Overall, training interventions resulted in a marked improvement in adherence across all clinical disciplines. In the gynaecology ward, doctors' adherence increased from 36.29% to 72.54%, while nurses' adherence improved from 31.3% to 49.24%. In the medicine ward, adherence rose from 45.59% to 62.17% among doctors and from 35.75% to 49.21% among nurses. Similarly, in the surgery ward, adherence increased from 48.11% to 63.09% among doctors and from 34.4% to 62.79% among nurses. [Figure 2]

Notably, doctors demonstrated higher baseline adherence compared to nurses in all wards, and both groups achieved substantial gains following training. The most pronounced improvement was observed among gynaecology doctors, who nearly doubled their compliance rate, while surgical nurses demonstrated the greatest relative increase, rising from 34.4% to 62.79%. These findings confirm that structured training significantly enhances HH adherence, although variation persists across professional groups and clinical contexts.

DISCUSSION

HH adherence was evaluate by using the direct observation method, widely regarded as the gold standard for evaluating HH compliance. This approach enables comprehensive assessment of both HH opportunities and technique, while also allowing real-time feedback to healthcare workers (HCWs). Moreover, it facilitates the identification of additional lapses in infection prevention practices, supporting targeted interventions and continuous quality improvement. Various methods have been employed to assess hand hygiene (HH) compliance in different studies. Shah R et al. utilized video surveillance to

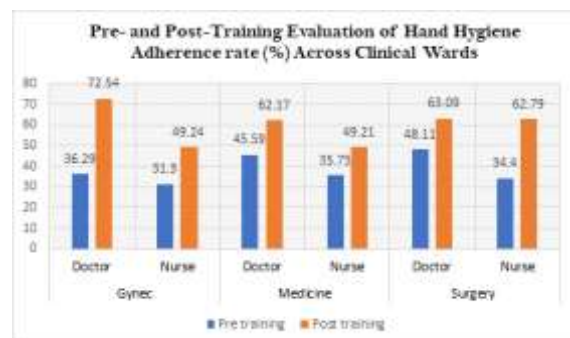


Figure 2: Graph depicts Pre- and Post-Training Evaluation of Hand Hygiene Adherence rate (%) Across Clinical Wards

monitor HH practices,^[11] while Marra AR et al. compared three approaches—direct observation, product usage monitoring, and electronic surveillance—to estimate overall adherence rates.^[12] Nair SS et al. measured the knowledge, attitude, and practice of HH in medical and nursing students in a teaching hospital at Raichur.^[13]

This study demonstrates that a structured training intervention significantly enhanced hand hygiene (HH) adherence among healthcare workers, particularly doctors and nurses. Baseline compliance rates were suboptimal (42.0% among doctors and 35.3% among nurses), a finding consistent with previous reports highlighting the persistent global challenge of sustaining optimal HH practices (Rachana Rashesh Solanki et al., 41%).^[14] Following targeted training, compliance increased markedly to 65.5% in doctors and 52.6% in nurses, findings comparable to those of Solanki et al. (69%),^[14] thereby reinforcing the effectiveness of structured educational interventions in bridging the gap between HH opportunities and practice. Despite this improvement, the overall post-training adherence rate in our cohort (57%) remains below the WHO-recommended benchmark of 80%. Nevertheless, it is comparable with rates reported globally, which range between 40% and 75%—for example, 43.2% reported by Sharma et al. (2011) in Ludhiana, India,^[15] 53.95% by Boora and Singh (2018) at AIIMS New Delhi, India,^[10] and 66% by Priyadarshi et al. (2024) in Nepal.^[8] By contrast, some recent studies have documented substantially lower adherence, such as 25.3% reported by Harun et al. (2023) Bangladesh,^[9] and 30% by Duwal et al. (2024), Nepal,^[6] highlighting considerable variability in HH compliance across settings and emphasizing the need for context-specific improvement strategies. Analysis by professional group revealed a noteworthy divergence from established patterns. In contrast to prior literature suggesting higher adherence among nurses due to structured workflows and more frequent patient interactions (Solanki et al.,^[14]2022), our findings demonstrated greater compliance among doctors (65.9%) compared with nurses (52.6%). This shift highlights the potential influence of training modality, professional hierarchy, and contextual factors on HH practices. Ward-specific analyses further substantiated the intervention's impact, with compliance improving across gynaecology (56% to 59%), surgery (41% to 62%), and medicine (38% to 54%) wards. These findings resonate with prior work by Chavali et al.^[16] and Pittet et al.,^[17] who observed sustained increases in compliance following ongoing educational and monitoring initiatives. When examined through the framework of the WHO “5 Moments for Hand Hygiene,” adherence in our study was highest before patient contact (Moment 1), followed by after risk of body fluid exposure (Moment 4) and after patient contact (Moment 5). In contrast, compliance was lowest before aseptic procedures (Moment 2). This distribution is consistent with prior observations that

healthcare workers are more likely to engage in HH practices when perceiving immediate personal risk, rather than focusing on patient safety alone (Gupta et al.).^[19] Such findings highlight the need to reinforce risk perception and patient-centered safety messaging within training modules.

This study adds to the growing evidence that structured training interventions can markedly improve hand hygiene (HH) compliance; however, the persistent gap between achieved adherence and WHO standards highlights the urgent need for sustained multimodal strategies, including continuous education, real-time feedback, leadership engagement, and behavioural nudges. As the single most effective and low-cost measure to prevent HAIs—a major reason of morbidity, mortality, and hospital expenditures worldwide—HH remains critically underutilized. Despite robust evidence and international guidelines, adherence among healthcare workers is consistently inadequate, and monitoring compliance serves as a vital indicator of the disconnect between recommended practices and real-world clinical behaviour.^[14]

Limitations

This study is limited by its single-center design, which may restrict generalizability, and by the use of direct observation, potentially introducing the Hawthorne effect. Long-term sustainability of the observed improvements was not assessed, and variations in patient load, workflow, or prior training may have influenced hand hygiene adherence.

CONCLUSION

This study demonstrates that structured training substantially improves hand hygiene (HH) compliance among healthcare workers, with adherence rising from 42.0% to 65.5% in doctors and from 35.3% to 52.6% in nurses, and an overall post-training rate of 57%. Statistically significant gains were also observed across the Medicine (38.5% to 54.1%) and Surgery (41.7% to 62.9%) departments, while the Gynaecology ward showed modest, non-significant improvement. Significant gains were observed across departments and WHO “Five Moments,” reflecting the effectiveness of targeted education in changing behaviour. These findings highlight that while focused training can substantially enhance HH behaviour, sustained multimodal approaches—combining continuous education, monitoring, feedback, and institutional support—are essential to embed HH as a main component of patient safety culture & to reduce burden of healthcare-associated infections globally.

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