



Research Article

Infection Control Audit of Health Care Workers in a Tertiary Care Unit: An Observational Study

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Abstract: Background: Hand hygiene (HH) and correct use of personal protective equipment (PPE) are the cornerstones of preventing healthcare-associated infections (HAIs), yet audits in Indian hospitals have focused largely on doctors and nurses. Support staff, students and allied workers who share the same patient zone are seldom studied. **Aim:** To audit compliance with HH, PPE use and hand-adornment ("bare below the elbows") practices across all categories of healthcare workers (HCWs) in a tertiary care unit, and to identify factors associated with non-compliance. **Methods:** A prospective, direct-observation audit was conducted over 16 sessions from 2 to 22 September 2026 in 13 clinical units (adult and neonatal intensive care units, labour room, general wards, casualty and dialysis) of a tertiary care teaching hospital. A trained infection-control auditor used a structured mobile audit tool based on the WHO "My Five Moments for Hand Hygiene". HH action, method and duration, glove, mask, gown and respirator use, isolation-precaution status, and wearing of rings or long/polished nails were recorded. Compliance was expressed with Wilson 95% confidence intervals (CI); factors associated with HH compliance were analysed by generalised estimating equations (GEE) accounting for clustering of opportunities within HCWs. **Results:** A total of 131 HCWs, namely 28 physicians, 29 nurses, 20 students/interns, 24 allied and ancillary staff, and 30 multi-tasking staff (MTS)/sweepers, contributed 262 HH opportunities. Overall HH compliance was 63.7% (95% CI 57.8–69.3), ranging from 75.4% among physicians to 38.5% among allied and ancillary staff ($p < 0.001$). Compliance was highest in the labour room (90.9%) and neonatal ICUs (80.4%) and lowest in adult ICUs (52.8%). Only 5 of 161 timed HH episodes (3.1%) met WHO duration standards; the median hand-rub time was 11 s (IQR 10–14). Gloves were missed by 41.6% and masks by 31.2% of HCWs for whom they were indicated; 64 of 65 mask failures were masks worn below the chin or nose. Rings were worn by 42.0% of HCWs, and long or polished nails were most frequent among students (30.0% vs 5.4%; $p = 0.003$). Only 21 HCWs (16.0%) were compliant with every audited element. On GEE analysis, allied and ancillary staff had significantly lower odds of HH compliance than physicians (adjusted OR 0.21, 95% CI 0.06–0.70). **Conclusions:** HH was performed at roughly two of every three opportunities but almost never for long enough, and PPE misuse and hand adornments were common in every staff category. Allied, ancillary and MTS/sweeping staff formed the weakest link. Infection-control training and audit feedback must be extended beyond doctors and nurses, and should emphasise technique and duration, not HH frequency alone.

Keywords: Hand hygiene; Infection prevention and control; Personal protective equipment; Healthcare workers; Audit; Multi-tasking staff; India.

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INTRODUCTION

Healthcare-associated infections (HAIs) are the most frequent adverse events in health care. Their burden in low- and middle-income countries is estimated to be two to three times that of high-income settings, and device-associated infection rates in intensive care units (ICUs) are several-fold higher.^{1,2} The hands of healthcare workers (HCWs) are the principal vehicle of cross-transmission, and improving hand hygiene (HH) compliance is among the most cost-effective measures to reduce HAIs and the spread of antimicrobial-resistant organisms.^{3,4}

The World Health Organization (WHO) "My Five Moments for Hand Hygiene" framework defines when HH is required and has become the international standard for observational auditing.^{3,5} The WHO also specifies how HH should be performed: an alcohol-based hand rub should take 20–30 s and a soap-and-water wash 40–60 s.³ Direct observation by trained auditors remains the reference method for measuring compliance.³ Complementary practices, namely appropriate use of gloves, masks, gowns and respirators, and keeping hands free of rings, long nails and nail polish, are part of standard and transmission-based precautions.^{6–8} Rings and artificial or long nails harbour higher bacterial loads and impair effective HH.^{8,9} Published compliance with HH varies widely. A systematic review reported a median compliance of about 40% in hospital care, with lower rates among physicians than nurses and before rather than after patient contact.¹⁰ Studies from Indian tertiary hospitals and other limited-resource settings have reported compliance ranging from under 30% to over 80%, depending on setting, observer and definition.^{11–13} However, most audits have been confined to doctors and nurses. In Indian hospitals, a large and heterogeneous workforce of multi-tasking staff (MTS), sweepers and housekeeping staff, ward

attendants, patient transporters, technicians, physiotherapists and trainees also enters the patient zone repeatedly. These groups receive less formal infection prevention and control (IPC) training, yet their contribution to cross-transmission is rarely quantified.¹⁴

The National Guidelines for IPC in Healthcare Facilities (2020) of the Ministry of Health and Family Welfare and the National Accreditation Board for Hospitals and Healthcare Providers (NABH) standards call for regular HH and PPE audits covering all staff categories.¹⁵ We therefore undertook a multidisciplinary infection-control audit with the following objectives: (i) to estimate HH compliance among physicians, nurses, students/interns, allied and ancillary staff, and MTS/sweepers in a tertiary care unit; (ii) to assess HH technique (method and duration), PPE use and hand-adornment practices; and (iii) to identify staff-, moment- and area-related factors associated with non-compliance.

MATERIALS AND METHODS

Study design and setting

This was a prospective, observational, cross-sectional audit conducted at a tertiary care teaching hospital in India [name withheld for peer review]. Sixteen audit sessions were held on 16 working days between 2 and 22 September 2026, during routine daytime working hours. Thirteen clinical units were covered and grouped into five areas for analysis: adult ICUs (medical ICU and surgical ICU); neonatal ICUs (inborn and outborn NICU); labour room; general wards (male and female surgical wards, male medical ward, orthopaedics, and gynaecology wards on two floors); and casualty and dialysis.

Participants

All HCWs who had contact with patients or the patient environment in the audited unit during a session were eligible. Each observed HCW was counted once per encounter; one to three HH opportunities were recorded per HCW. For analysis, HCWs were grouped into five categories: (1) **physicians** (consultants and resident doctors); (2) **nurses**; (3) **students/interns** (nursing students and medical students/interns); (4) **allied and ancillary staff** (physiotherapists, radiology technicians, patient transporters, dietician, patient-care assistants and other support staff); and (5) **MTS/sweepers** (multi-tasking staff, sweepers, housekeeping staff and ward attendants). Because the audit application has a fixed designation menu that does not include Indian cadre titles, MTS/sweeping staff were entered under the application's "Social Worker" and "Pastoral Care" fields and were re-coded to the MTS/sweeper category before analysis. The target was about 20 or more HCWs per category and a total of 120–140 HCWs.

Data collection

A single trained infection-control auditor collected data by direct, unobtrusive observation using the SpeedyAudit mobile application, a structured tool aligned with the WHO Hand Hygiene Observation Form.³ For each HCW the following were recorded: date and time, unit, designation, WHO moment (indication), HH action (hand rub, hand wash or missed), and HH duration in seconds (timed from the start of product application to the end of rubbing or rinsing); glove, gown, goggle, mask and respirator use, each categorised as complied, missed, or not indicated/not recorded; whether the patient was under contact, droplet or airborne precautions; and hand adornments (rings, bracelets, long or polished nails). Free-text comments on incorrect practice, such as mask position, were also noted. Observations were made without identifying individual HCWs by name.

Definitions

- **HH opportunity:** a WHO moment requiring HH (before patient contact, before an aseptic procedure, after body-fluid exposure risk, after patient or patient-environment contact).⁵
- **HH compliance (opportunity level):** HH action (rub or wash) performed at an opportunity ÷ total opportunities × 100.
- **HCW-level HH compliance:** HH performed at every observed opportunity of that HCW.
- **Adequate HH duration:** ≥ 20 s for alcohol-based hand rub and ≥ 40 s for soap-and-water hand wash.³
- **PPE non-compliance:** a glove, mask, gown or respirator recorded as "missed" when indicated; a mask worn below the nose or chin was classed as missed.
- **Bare-below-the-elbows non-compliance:** wearing a ring or bracelet, or having long or polished nails.
- **Full-bundle compliance:** compliance with HH at all opportunities, no missed PPE, and no hand adornment.

Statistical analysis

Data were exported from the application to Microsoft Excel, cleaned (harmonising spelling variants of unit names and responses), and analysed in Python 3 (pandas, SciPy, statsmodels). Categorical variables are presented as frequencies and percentages with Wilson score 95% CIs. Compliance across HCW categories, moments and areas was compared by the χ^2 test or Fisher's exact test, and HH durations by the Kruskal–Wallis test. Because opportunities were clustered within HCWs, factors associated with opportunity-level HH compliance were modelled by logistic regression fitted with generalised estimating equations (GEE; binomial family, logit link, exchangeable working correlation, robust standard errors), with HCW category,

WHO moment, clinical area and audit week as covariates. Owing to small numbers, "after body-fluid exposure risk" (n = 7) was merged with "after patient/environment contact". Unadjusted and adjusted odds ratios (OR) with 95% CI are reported, and a two-sided p < 0.05 was considered significant.

Ethical considerations

The audit was conducted as part of the hospital's routine IPC quality-improvement programme. No patient identifiers or HCW names were recorded, and results were reported only in aggregate. [Insert Institutional Ethics Committee approval number/waiver and date.]

RESULTS

Participant characteristics

A total of 131 HCWs were observed across 16 sessions (median 8 HCWs per session; range 6–12), contributing 262 HH opportunities (mean 2.0 per HCW). The study population comprised 28 physicians (21.4%), 29 nurses (22.1%), 20 students/interns (15.3%; 14 nursing and 6 medical), 24 allied and ancillary staff (18.3%) and 30 MTS/sweepers (22.9%) (Table 1). Most HCWs were observed in general wards (34.4%) and adult ICUs (32.8%). Of the 262 opportunities, 118 (45.0%) were before patient contact, 99 (37.8%) after patient/environment contact, 38 (14.5%) before an aseptic procedure, and 7 (2.7%) after body-fluid exposure risk.

Table 1. Distribution of healthcare workers by category and clinical area (n = 131)

HCW category	Adult ICUs	Neonatal ICUs	Labour room	General wards	Casualty & dialysis	HCWs, n (%)	Opportunities, n
Physicians	8	5	4	10	1	28 (21.4)	57
Nurses	8	5	2	11	3	29 (22.1)	58
Students/Interns ^a	6	2	1	10	1	20 (15.3)	41
Allied & ancillary ^b	12	4	1	6	1	24 (18.3)	39
MTS/Sweepers ^c	9	8	2	8	3	30 (22.9)	67
Total	43	24	10	45	9	131 (100)	262

^aNursing students 14, medical students/interns 6. ^bOther support staff 9, physiotherapists 5, radiology technicians 4, patient transporters 4, dietician 1, patient-care assistant 1. ^cMulti-tasking staff, sweepers, housekeeping staff and ward attendants. ICU, intensive care unit.

Hand hygiene compliance

HH was performed at 167 of 262 opportunities, giving an overall compliance of **63.7% (95% CI 57.8–69.3)**. Compliance differed significantly by staff category ($\chi^2 = 19.84$, df = 4, p < 0.001). It was highest among physicians (75.4%) and nurses (74.1%), followed by students/interns (70.7%) and MTS/sweepers (55.2%), and lowest among allied and ancillary staff (38.5%) (Table 2, Figure 1).

By WHO moment, compliance was highest before aseptic procedures (76.3%) and lowest after body-fluid exposure risk (42.9%, 3/7) and before patient contact (59.3%); these differences were not statistically significant (p = 0.17). Compliance was similar for "before" moments (63.5%) and "after" moments (64.2%). Compliance varied significantly by clinical area (p = 0.001): it was highest in the labour room (90.9%) and neonatal ICUs (80.4%) and lowest in adult ICUs (52.8%) (Figure 2). In adult ICUs, MTS/sweepers complied at only 5 of 22 opportunities (22.7%) and allied staff at 6 of 19 (31.6%), whereas MTS/sweepers in neonatal ICUs complied at 17 of 18 (94.4%).

At the HCW level, 81 of 131 HCWs (61.8%) performed HH at every observed opportunity, and 48 (36.6%) missed every opportunity. Full HCW-level compliance was 75.0% among physicians, 72.4% among nurses, 70.0% among students/interns, 56.7% among MTS/sweepers and 33.3% among allied and ancillary staff (p = 0.013).

Table 2. Hand hygiene compliance by HCW category, WHO moment and clinical area (opportunity level, n = 262)

Variable	Opportunities, n	HH performed, n	Compliance, % (95% CI)	p-value ^a
HCW category				< 0.001
Physicians	57	43	75.4 (62.9–84.8)	
Nurses	58	43	74.1 (61.6–83.7)	
Students/Interns	41	29	70.7 (55.5–82.4)	
Allied & ancillary	39	15	38.5 (24.9–54.1)	
MTS/Sweepers	67	37	55.2 (43.4–66.5)	
WHO moment				0.17
Before patient contact	118	70	59.3 (50.3–67.8)	

Before aseptic procedure	38	29	76.3 (60.8–87.0)	
After body-fluid exposure risk	7	3	42.9 (15.8–75.0)	
After patient/environment contact	99	65	65.7 (55.9–74.3)	
Clinical area				0.001
Adult ICUs	89	47	52.8 (42.5–62.8)	
Neonatal ICUs	46	37	80.4 (66.8–89.3)	
Labour room	22	20	90.9 (72.2–97.5)	
General wards	91	55	60.4 (50.2–69.9)	
Casualty & dialysis	14	8	57.1 (32.6–78.6)	
Overall	262	167	63.7 (57.8–69.3)	

^a χ^2 test. CI, Wilson score confidence interval; HH, hand hygiene.

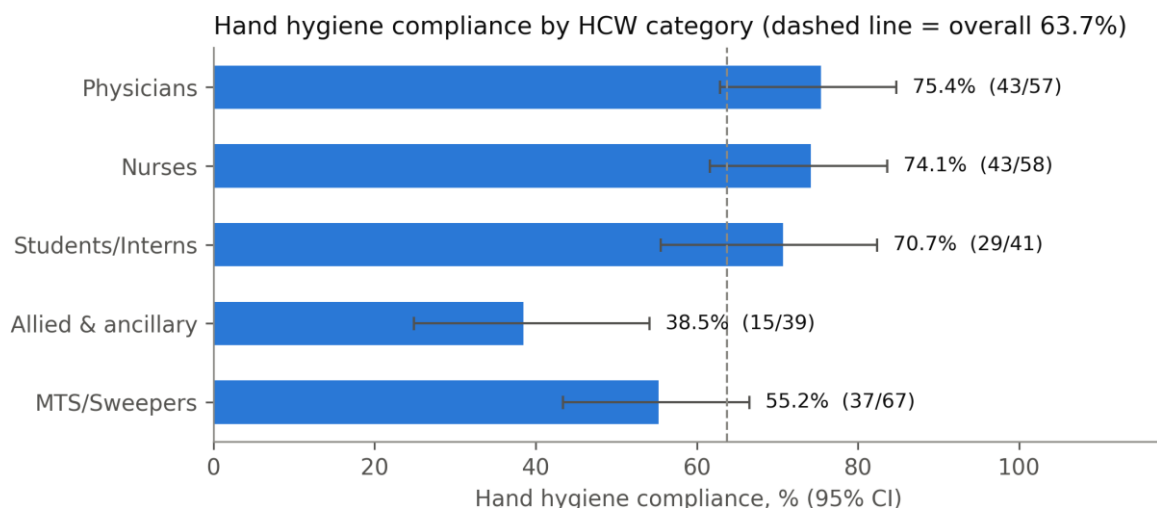


Figure 1. Hand hygiene compliance by HCW category, with 95% confidence intervals. The dashed line marks overall compliance (63.7%).

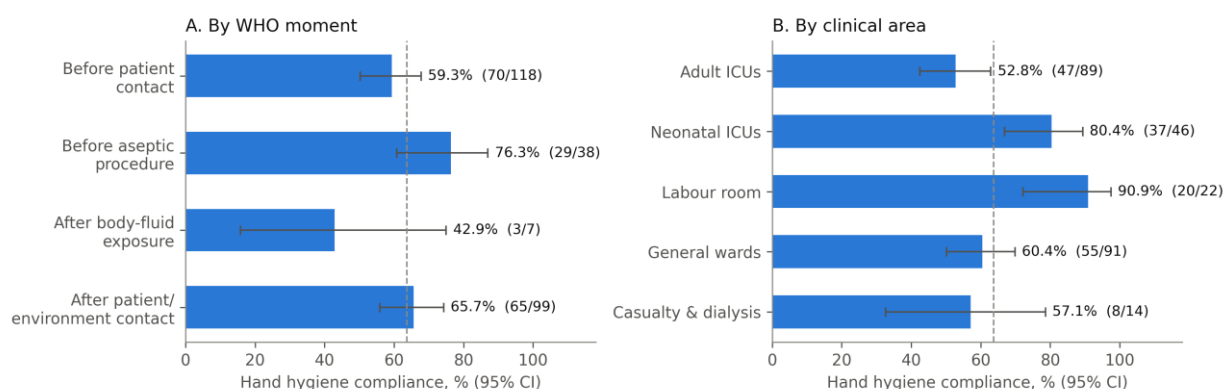


Figure 2. Hand hygiene compliance (A) by WHO moment and (B) by clinical area, with 95% confidence intervals. The dashed line marks overall compliance.

Hand hygiene technique: method and duration

Of 167 HH actions, 119 (71.3%) were alcohol-based hand rubs and 48 (28.7%) were soap-and-water washes. The choice of method differed by category ($p = 0.011$): allied and ancillary staff used only hand rub, whereas nurses and physicians used hand wash for 39.5% of their actions (Table 3).

Duration was recorded for 161 actions. The median hand-rub time was 11 s (IQR 10–14; range 5–24) and the median hand-wash time was 23 s (IQR 16–29; range 10–37). Only 5 of 116 hand rubs (4.3%) lasted the recommended ≥ 20 s, and none of the 45 hand washes reached 40 s, so the overall adequacy of HH duration was **3.1% (5/161)**. One in five hand rubs (24/116, 20.7%) lasted less than 10 s. Median duration (all methods combined) differed across categories (Kruskal–Wallis $H = 14.42$, $p = 0.006$). It was longest among physicians (16 s) and nurses (14.5 s) and shortest among allied staff (11 s) and MTS/sweepers

(12 s) (Figure 4). Accordingly, "effective" HH, meaning HH that was both performed and of adequate duration, was achieved at no more than 5 of 262 opportunities (1.9%).

Table 3. Hand hygiene method and duration by HCW category

HCW category	HH actions, n	Hand rub, n (%)	Hand wash, n (%)	Rub duration, s, median (IQR)	Wash duration, s, median (IQR)	Adequate duration ^a , n/N
Physicians	43	26 (60.5)	17 (39.5)	12 (10–16)	23 (18–27)	3/43
Nurses	43	26 (60.5)	17 (39.5)	11 (10–14)	31 (25–31)	0/42
Students/Interns	29	22 (75.9)	7 (24.1)	12 (10–14)	20 (19–20)	2/28
Allied & ancillary	15	15 (100)	0	11 (9.5–13)	n/a	0/15
MTS/Sweepers	37	30 (81.1)	7 (18.9)	11 (10–13)	14 (14–16)	0/33
Total	167	119 (71.3)	48 (28.7)	11 (10–14)	23 (16–29)	5/161 (3.1%)

^aHand rub $\geq$ 20 s or hand wash $\geq$ 40 s (WHO); denominators are actions with a recorded duration. Method distribution $p = 0.011$ (χ^2); duration across categories $p = 0.006$ (Kruskal–Wallis).

Personal protective equipment and hand adornments

Gloves were indicated for 113 HCWs and were missed by 47 (41.6%). Glove omission was most frequent among nurses (57.1%) and allied staff (55.0%) and least frequent among MTS/sweepers (25.0%) ($p = 0.084$). Masks were indicated for 125 HCWs and were non-compliant in 39 (31.2%), ranging from 10.0% among students/interns to 40.7% among physicians ($p = 0.18$) (Table 4, Figure 3). The failures were almost entirely due to incorrect wearing rather than absence of a mask: of 65 opportunity-level mask failures, 45 (69.2%) were masks positioned below the chin and 19 (29.2%) below the nose, and only one mask was not worn at all.

Twenty HCWs attended patients under contact precautions. A gown was documented as worn by only 4 of them (20.0%), missed by 1, and not documented for the remaining 15. Nineteen HCWs attended patients under airborne precautions, and an N95 respirator was documented for only 5 (26.3%). Paradoxically, respirators were also worn by 21 HCWs attending patients not under airborne precautions. Six HCWs attended patients under droplet precautions. Eye protection (goggles) was not recorded for any HCW.

Rings were worn by 55 HCWs (42.0%), with the highest proportions among MTS/sweepers (53.3%) and physicians (50.0%) ($p = 0.071$). Long or polished nails were observed in 12 HCWs (9.2%) and were significantly more common among students/interns than among all other HCWs (30.0% vs 5.4%; Fisher's exact $p = 0.003$). No HCW wore a bracelet. Overall, only **21 of 131 HCWs (16.0%)** complied with every audited element (the full bundle). Bundle compliance was lowest among MTS/sweepers (6.7%) and allied staff (12.5%).

Table 4. Compliance with PPE and bare-below-the-elbows practices by HCW category (HCW level, n = 131)

Practice	Physicians (n = 28)	Nurses (n = 29)	Students/ Interns (n = 20)	Allied & ancillary (n = 24)	MTS/ Sweepers (n = 30)	Total (n = 131)	p-value
HH at all opportunities	21 (75.0)	21 (72.4)	14 (70.0)	8 (33.3)	17 (56.7)	81 (61.8)	0.013
Gloves missed ^a	7/23 (30.4)	16/28 (57.1)	7/18 (38.9)	11/20 (55.0)	6/24 (25.0)	47/113 (41.6)	0.084
Mask missed/incorrect ^a	11/27 (40.7)	11/28 (39.3)	2/20 (10.0)	7/24 (29.2)	8/26 (30.8)	39/125 (31.2)	0.18
Mask below chin ^b	6	7	1	6	7	27 (20.6)	
Mask below nose ^b	5	5	2	1	1	14 (10.7)	
Gown worn ^c	8	6	1	4	4	23	
N95 respirator worn ^c	8	9	3	1	5	26	
Wearing rings	14 (50.0)	11 (37.9)	3 (15.0)	11 (45.8)	16 (53.3)	55 (42.0)	0.071
Long/polished nails	0	1 (3.4)	6 (30.0)	2 (8.3)	3 (10.0)	12 (9.2)	0.006
Full-bundle compliance	5 (17.9)	6 (20.7)	5 (25.0)	3 (12.5)	2 (6.7)	21 (16.0)	

Values are n (%). ^aDenominator is HCWs for whom the item was indicated. ^bFrom auditor comments; an HCW may have more than one comment. ^cDocumented use; one physician missed a gown when indicated. p-values by χ^2 test.

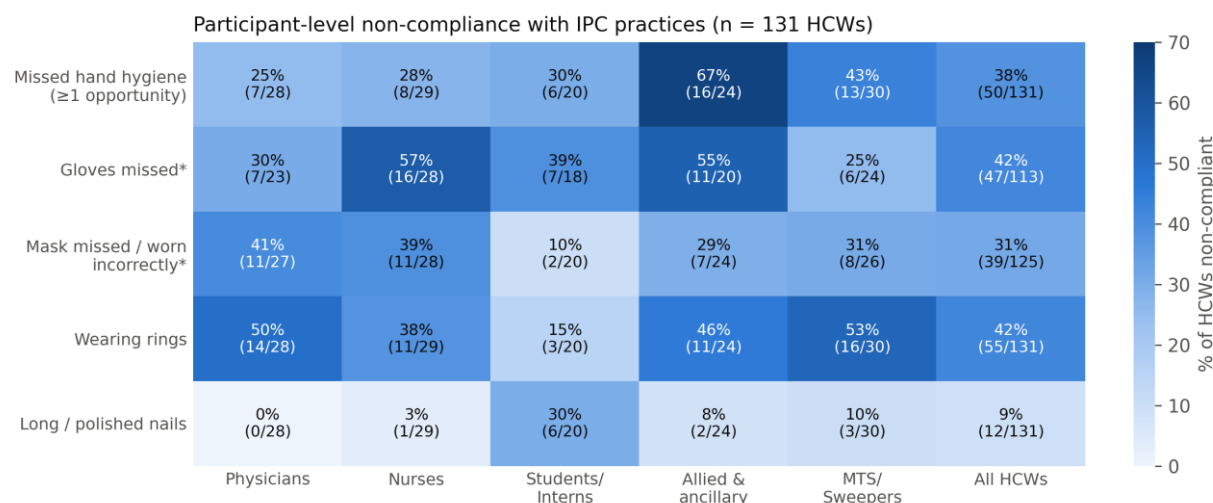


Figure 3. HCW-level non-compliance with IPC practices by staff category (darker = higher non-compliance).

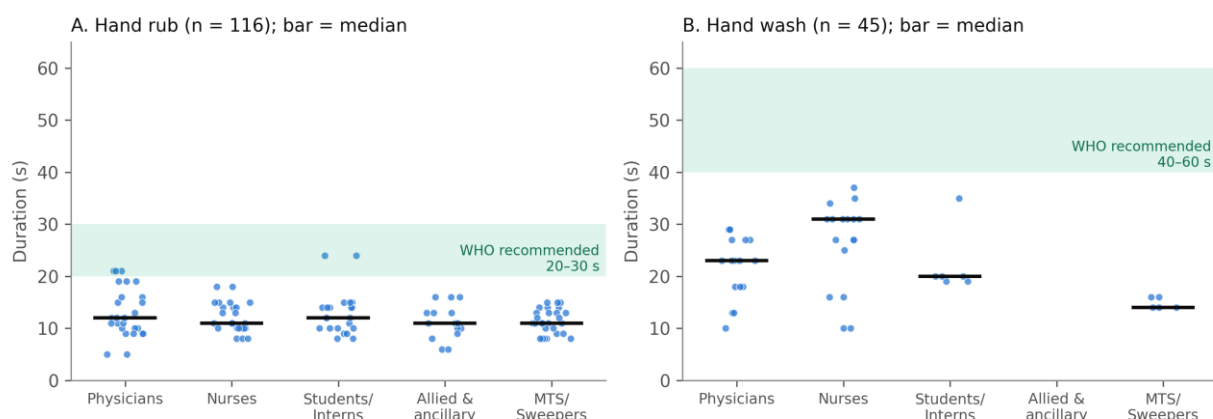


Figure 4. Duration of (A) hand rub and (B) hand wash by HCW category. Each dot is one HH action; black bars show medians; the shaded band is the WHO-recommended duration.

Factors associated with hand hygiene compliance

On unadjusted GEE analysis, allied and ancillary staff (OR 0.19, 95% CI 0.06–0.61) had significantly lower odds of HH compliance than physicians, whereas working in neonatal ICUs (OR 3.04, 1.02–9.11) or the labour room (OR 8.94, 1.04–76.65) was associated with higher odds than working in adult ICUs. After adjustment for moment, area and audit week, allied and ancillary staff remained independently associated with lower compliance (adjusted OR 0.21, 95% CI 0.06–0.70; $p = 0.011$). MTS/sweepers showed a non-significant trend in the same direction (aOR 0.42, 0.14–1.30). The area effects were attenuated after adjustment (neonatal ICUs aOR 3.19, 0.98–10.41; $p = 0.055$). WHO moment and audit week were not associated with compliance (Table 5). Compliance by audit week was 60.9%, 65.6%, 59.0% and 81.3% in weeks 1–4.

Table 5. Factors associated with hand hygiene compliance: GEE logistic regression (262 opportunities clustered in 131 HCWs)

Variable	Unadjusted OR (95% CI)	p	Adjusted OR (95% CI)	p
HCW category (ref: Physicians)				
Nurses	0.94 (0.29–3.03)	0.91	0.96 (0.27–3.46)	0.96
Students/Interns	0.78 (0.22–2.82)	0.71	0.94 (0.25–3.59)	0.93
Allied & ancillary	0.19 (0.06–0.61)	0.005	0.21 (0.06–0.70)	0.011
MTS/Sweepers	0.44 (0.14–1.34)	0.15	0.42 (0.14–1.30)	0.13
WHO moment (ref: before patient contact)				
Before aseptic procedure	1.22 (0.94–1.58)	0.14	1.25 (0.91–1.70)	0.17
After contact/body-fluid exposure	1.05 (0.96–1.14)	0.31	1.05 (0.95–1.17)	0.31

Clinical area (ref: Adult ICUs)				
Neonatal ICUs	3.04 (1.02–9.11)	0.047	3.19 (0.98–10.41)	0.055
Labour room	8.94 (1.04–76.65)	0.046	7.88 (0.69–90.31)	0.097
General wards	1.54 (0.67–3.55)	0.31	1.23 (0.51–2.98)	0.65
Casualty & dialysis	1.93 (0.43–8.71)	0.39	1.75 (0.39–7.89)	0.47
Audit week (per week)	1.10 (0.77–1.56)	0.61	0.98 (0.66–1.45)	0.93

GEE, generalised estimating equations (binomial, logit link, exchangeable correlation, robust SE); OR, odds ratio.

DISCUSSION

This multidisciplinary audit of 131 HCWs from five staff categories found that HH was performed at about two of every three opportunities (63.7%), which is higher than the median reported in international reviews and within the range reported from Indian tertiary hospitals.^{10–13} Three findings, however, show that this headline figure overstates the protection actually delivered to patients: HH was almost never performed for the recommended duration; PPE was frequently omitted or worn incorrectly; and compliance was markedly lower among the allied, ancillary and MTS/sweeping staff who are usually left out of audits.

The duration gap

The most striking finding was that only 3.1% of timed HH actions met WHO duration standards, with a median hand-rub time of 11 s. Laboratory and clinical studies show that the antimicrobial efficacy of hand rub depends on contact time and volume, and that rubbing for less than 15 s leaves hands inadequately decontaminated.^{3,16} Pires et al. showed that 15 s may be non-inferior to 30 s only when an adequate volume is applied and the full technique is followed.¹⁶ Even against this more lenient threshold, fewer than one-fifth of rubs in our study would qualify. Compliance audits that count only whether HH was performed, as most Indian studies do, may therefore give false reassurance. Adding duration and technique to routine audits, and training with a timer or fluorescent-marker feedback, should be a priority.

Differences between staff categories

Contrary to much of the literature, which reports lower compliance among physicians than nurses,¹⁰ physicians and nurses in our unit performed similarly (75% and 74%). This may reflect the teaching-hospital environment and recent IPC training. The lowest compliance was among allied and ancillary staff (38.5%), and this category remained independently associated with non-compliance after adjustment (aOR 0.21). MTS/sweepers also had lower compliance (55.2%) and the lowest full-bundle compliance (6.7%). These workers move between patients, beds, equipment and waste, and are therefore well placed to transmit multidrug-resistant organisms through the patient environment. Similar gaps among support staff have been documented elsewhere.¹⁴ They usually reflect limited formal training, high workload, language and literacy barriers, and the perception that IPC is a clinical responsibility. The near-perfect compliance of MTS/sweepers in neonatal ICUs (94%) compared with adult ICUs (23%) suggests that unit culture and supervision can overcome these barriers.

Students and interns had HH compliance comparable to qualified staff and the lowest mask non-compliance, but they were six times more likely to have long or polished nails. Since trainees model their behaviour on seniors, the high prevalence of rings among physicians (50%) is also a concern. Rings increase hand carriage of Gram-negative bacilli and *Staphylococcus aureus* and are a recognised barrier to effective HH;⁹ a "bare below the elbows" policy should be enforced for all categories.

Area and moment effects

Compliance was highest in the labour room and neonatal ICUs, where the vulnerability of the patients is obvious to staff, and lowest in adult ICUs. The adult ICU finding is of particular concern because this is where device use, antimicrobial pressure and HAI rates are highest.² Unlike earlier reports,¹⁰ compliance did not differ between "before" and "after" moments. However, the lowest compliance was seen before patient contact (59%), the moment that protects the patient, and after body-fluid exposure, although the latter was based on only seven opportunities.

PPE and transmission-based precautions

Glove omission (42%) and incorrect mask use (31%) were common. Almost every mask failure involved a mask worn below the chin or nose, a practice that negates source control and contaminates the mask and hands. Gowns and respirators were documented for only a minority of HCWs attending patients under contact and airborne precautions. At the same time, respirators were worn where they were not indicated. This pattern suggests poor understanding of transmission-based precautions rather than lack of supplies, and is consistent with the need for targeted training on the national IPC guidelines.^{6,15} The absence of recorded eye protection also warrants review.

Implications and recommendations

- Extend IPC induction, refresher training and competency checks to all MTS/sweepers, housekeeping, transport, technical and trainee staff, using the local language and practical demonstration.
- Audit HH duration and technique, not just performance, and provide immediate, category-specific feedback, as part of the WHO multimodal improvement strategy.¹⁷
- Prioritise adult ICUs for intensified audit, point-of-care hand-rub placement and ward-level IPC link staff.
- Enforce "bare below the elbows" (no rings, short unpolished nails) through the institutional dress code, particularly for students.
- Reinforce training on correct mask wearing and on PPE selection for contact, droplet and airborne precautions, supported by isolation signage at the bedside.

Strengths and limitations

The strengths of this study are the inclusion of five staff categories, among them the rarely studied MTS/sweeping and ancillary staff; the simultaneous assessment of HH, duration, PPE and hand adornments; the use of a standardised, WHO-aligned electronic tool; and the use of a clustering-adjusted analysis. It also has limitations. Direct observation is subject to the Hawthorne effect, which may overestimate compliance.¹⁸ A single auditor reduced inter-observer variability but may have introduced observer bias, and the audit covered only daytime sessions in one institution over three weeks. The number of opportunities per HCW was small (one to three), and some subgroups (e.g., body-fluid exposure, casualty and dialysis, labour room) were small, which widened the confidence intervals. Staff designations had to be mapped from the application's fixed menu to local cadres, and some MTS may have been misclassified. For PPE items recorded as "not indicated/not recorded", indication could not be verified retrospectively, which may underestimate non-compliance with transmission-based precautions. Finally, being observational, the study cannot establish causal links with HAI rates.

CONCLUSION

In this tertiary care unit, HCWs performed HH at 63.7% of opportunities, but almost no HH action lasted the recommended time. Glove omission, incorrect mask use and ring wearing were common, and only one in six HCWs complied with the complete infection-control bundle. Allied and ancillary staff and MTS/sweepers were the least compliant groups, and adult ICUs were the least compliant area. IPC programmes should move beyond doctors and nurses to include every worker who enters the patient zone, and should measure and teach the quality of HH, not just whether it was performed. A repeat audit after a targeted multimodal intervention is planned to assess improvement.

Declarations

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