Quantification of diurnal variation in “glove hygiene” compliance in COVID ICUs: an exploratory study

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Title Page

***Title of Paper*:** Quantification of diurnal variation in "glove hygiene" compliance in COVID ICUs: an exploratory study

Running title: Quantification of diurnal variation in HHC

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Highlights:

- Diurnal variation in hand hygiene compliance is not monitored frequently
- We report “glove hygiene” diurnal variation in a COVID-19 unit using CCTV

- Compliance decreased significantly during nighttime
- Maximum variation was exhibited by nursing and housekeeping staff

Abstract

Background: Hand hygiene compliance (HHC) monitoring is almost always done in daytime. Documentation of HHC in healthcare workers (HCWs) is limited during odd hours and nighttime.

Aim: The objective of the study was to determine diurnal variation in HHC in different categories of health care workers in tertiary care hospital in North India.

Methods: A prospective, observational study was conducted in three COVID-19 intensive care units (ICUs) with closed-circuit television (CCTV) cameras. Dedicated infection control nurses monitored HHC among various HCWs (doctors, nursing staff, technicians, hospital and sanitary attendants) during day and nighttime, in 20-minute durations. The difference in HHC by-professional category and for each WHO moment was assessed using chi-square test and *p* value.

Findings: A total of 705 opportunities were observed over a period of seven days, with overall compliance of 53%. Day and nighttime compliance was recorded to be

60.7% and 42.1%, respectively (p<0.001). HCC was highest amongst resident doctors with little diurnal variation. However, nurses and housekeeping staff exhibited significant diurnal variation. The compliance at “after” moments was much higher than “before” moments in all professional categories.

Conclusion: There was a significant decrease in compliance during nighttime, amongst all HCWs, with maximum variation exhibited by nursing staff. The present study underlines the importance of monitoring HHC at odd hours, to elicit a more accurate picture round the clock. Healthcare facilities monitoring compliance only during the daytime may substantially overestimate HHC.

Keywords: Glove hygiene compliance, COVID-19, diurnal variation, India

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Quantification of diurnal variation in "glove hygiene" compliance in COVID-19 intensive care units: an exploratory study Introduction

Hand hygiene (HH) is recognized as one of the main evaluation points for improvement by 'WHO Clean Care is safer Care'[1]. HH compliance (HHC) monitoring is often done in the daytime due to logistic reasons. HHC decreases during evening and night shifts[2-4]; however, documentation of the same and the extent of variation are scarce. The five moments of HH as recommended by WHO include before touching a patient, before aseptic procedures, after body fluid exposure, after touching a patient and after touching patient surroundings. Moreover, the Centers for Disease Control and Prevention (CDC) or WHO have not addressed the diurnal variation pertaining to HH practices. Thereby, we designed the present study to find the gaps in compliance of different health care workers (HCWs) groups in day and night in our tertiary care hospital in North India.

Materials and methods

This prospective, observational study was conducted in April 2021 in three Coronavirus disease 2019 (COVID-19) intensive care units (ICUs) of a tertiary care hospital in North India. Our HCWs wore gloves all the time. Thus, we assessed glove hygiene with an alcohol hand rub rather than HH per se. The staff shift changes occurred at 08:00, 14:00, 20:00 and 02:00 hours. We selected 15:00 and 03:00 hours as the times for observations to represent daytime and night shifts, respectively. An infection control monitor observed HHC via closed-circuit television (CCTV)

cameras during the day and night shifts. The auditor recorded all the five moments and opportunities as per CDC in the World Health Organization (WHO) proforma and speedy audit app[5,6]. The auditor observed HCC in real time during the day via CCTV and retrospectively reviewed the recordings made at night to assess HHC during the night shift. The auditor observed HHC via the CCTVs or via the recordings to limit the auditor's exposure to patients with COVID-19 and to prevent the Hawthorne effect, since the subjects did not know when the audits were done. We provided feedback regarding weekly HHC levels to all staff in all categories.

The healthcare worker-patient ratio did not change over the three duty shifts for all HCW categories. All the staff members underwent mandatory HH and infection prevention and control (IPC) training before they began working in the COVID-19 hospital. The ICUs had alcohol hand solutions near all beds, doors, drug tables, and nursing and doctors' stations. Sinks for hand-washing purposes were present in each ICU and supplied with both warm and cold water, bars of soap, chlorhexidine- based soap solution and paper towels. Posters depicting all the steps and the five HH moments were posted on doors, near sinks and on the ICU walls, to remind staff members to do HH.

Data were analyzed to assess hand-hygiene compliance amongst different professional categories and for each of the five HH moments. The difference in overall compliance by day and night, by-professional category and for each WHO moment was assessed using chi-square test and $p<0.05$ was considered as significant.

Results

A total of 705 opportunities were observed over seven days. There were 161, 14, 64, 180 and 286 observations at Moments 1, 2, 3, 4 and 5 respectively. Overall, HCWs

performed HH at 374 opportunities (53% compliance). HHC was 64.7% amongst doctors, 48.4% among nursing staff and 46.3% among housekeeping staff (p=0.00025). The compliance at "after" moments was much higher than "before" moments for all three professional categories (Table 1).

Overall, compliance was 252/415 (60.7%) during the day and 122/290 (42.1%) during the night (p<0.001) (Table 2). Compliance was highest amongst residents for all five HH moments during both daytime and nighttime. Compliance by doctors did not vary much by time of day but that by nurses and housekeeping staff varied significantly (p<0.001). At night, nurses had significantly lower HHC at Moment 1 and housekeeping staff had had significantly lower HHC for Moment 5. The profession-wise and opportunity-wise compliance has been depicted in Figures 1.

Discussion

Generally, the compliance with HH, or for that matter, any infection prevention activity, is monitored during daytime hours due to obvious logistic reasons. This is especially true in resource poor settings where infection control nurses, who generally do this task, are short in supply. This limitation may explain why the overwhelming majority of studies on HHC in developing countries do not record compliance at odd hours like evening and night shifts. In the present study, CCTV cameras had been fixed in COVID-19 ICUs for other reasons. We utilized these cameras to monitor HHC, allowing us to minimize the Hawthorne effect since the HCW did not know when the audits were done. The remote-audio-visual auditing also allowed the observer to avoid contact with patients or their surroundings, during COVID-19 pandemic, thus, was an excellent HH observation method. Other healthcare facilities might find this method of observing HHC to be useful. However, they will need to

address issues regarding patients' and HCW's privacy. The study allowed us to observe HHC compliance in our HCWs at 3 am, which we have never done in our hospital. We also observed that all HCWs donned two pairs of gloves all the time and the outer pair was changed for each patient, despite CDC's guidelines on appropriate usage of gloves when caring for patients with SARS-CoV-2 infection[8]. Thus, we evaluated glove hygiene compliance rather than HHC. Compliance with glove hygiene was 53.7%, which is substantially lower than the 74% HHC found by a recent meta-analysis[7]. We did not study HAI rates in these ICUs. However, other groups have reported increased HAI rates on COVID-19 units[9-12]. Our findings suggest that the increase in HAI rates may be related in part to the abuse of gloves and failure to do glove hygiene, which led to spread of pathogenic organisms.

The overall compliance was higher during the day shifts (60.7%) than during the night shifts (42.1%). These results agree with previous studies that studied HH practices over 24 hours[4,13-18]. Lower HHC during the night shifts has been attributed to having fewer staff on the evening and night shifts[2,3,19,20] . However, our hospital had essentially the same number of staff during the day and night shifts. Suzuki *et al* calculated that 55% of all HH opportunities occurred during the nighttime and found that HCWs did HH less frequently at these opportunities than those during the daytime[19]. Santana *et al* also reported lower HHC in night than during the daytime.[20] In contrast, a study by Raboud *et al* found a non-significant higher HHC during the night than during the day[2]. However, the study included only five nurses. In the present study, compliance with all the indications except the fourth (after patient) decreased significantly during the night for all HCW categories, suggesting that HCWs' instinct to protect themselves persisted at night. The feeling of

"dirty hands" is a known phenomenon that results in higher HHC after touching patients. For example, Chang *et al* found that HCWs were significantly more likely to do HH after performing contaminating tasks rather than before critical tasks which could indicate that HCWs might experience a feeling of disgust and an associated "subconscious need" to do HH[21]. Whitby *et al*[22] and Chang *et al*[21] suggested that HCWs' HH behavior is more reactive (i.e., done in response to a trigger or reminder) than proactive (i.e., done in anticipation of the next task).' Chang *et al*, also found that HCWs were less likely to do HH when they transitioned from dirtier to cleaner tasks than when they transitioned from cleaner to dirtier tasks, which might increase the risk of HAIs[23]. They suggested that interventions including action planning might help HCWs do hand hygiene at critical points in care[21].

We previously found that nurses had the highest HHC.[24,25] Many studies from other hospitals, including a study by Rumbaua *et al* [26] have had similar results, which might be attributed to nurses' protracted involvement in patient care and acquaintance with infection control policies[26-29]. In contrast, our present study found higher compliance among doctors than among nursing personnel. A comprehensive survey conducted in US found similar results, although nursing staff had more positive attitude towards infection control practices in general[30]. Duo *et al* found higher compliance amongst doctors as compared with nurses, however a meta-analysis revealed that nurses had the highest HHC[7,31]. HHC was the lowest amongst housekeeping staff, which has also been observed by other investigators[3,8,30]. Higher compliance among doctors might be related to their higher education level and their knowledge of the literature about the role HH plays in preventing the HAIs.

Our study found that HHC was lowest for the first indication (i.e., before touching the patient). In contrast, Bischoff *et al* found the lowest compliance with HH before aseptic procedure in medical ICU[9]. This could be attributed to the different clinical situations in both the scenarios.

The present study underlines the importance of monitoring HH compliance at odd hours to gain a more accurate picture of HHC around the clock. Our results indicate that monitoring compliance only during the daytime may over estimate HHC. We found diurnal variation amongst all HCWs, with the maximum variation being exhibited by the nursing staff. This observation may have important implications for HAI prevention because nurses provide most of the direct patient care. The present study underlines the pre-requisite for periodic continuous teaching and training sessions, followed by monitoring and feedback, to raise the adherence to recommended guidelines, both during day and night.

The present study was limited by its duration since the auditing was done for one week, thus we had relative few observations for some WHO HH moments. Also given the times during which we observed, we observed only 14 aseptic procedures as these procedures are usually done during morning shifts between 9-11 am. We recorded observations via CCTV cameras, which had several advantages as mentioned above. However, the CCTV cameras were in fixed locations, some of which prevented the observer from seeing whether HCWs did HH before entering or after leaving patients' rooms, thereby affecting our assessment of moments 1 and 5.

Conclusions

We found significantly lower HHC during the night shift than during the day shift. Diurnal variation was noted amongst all HCWs, with nursing staff having the largest

variation. The present study underlines the importance of monitoring HHC at odd hours, to provide a more accurate assessment of HCC. Healthcare facilities monitoring compliance only during the daytime may substantially overestimate HHC.

Legends

Table I: Opportunity-wise compliance of hand hygiene among all categories of HCWs.

Table II: Variation in day and nighttime hand hygiene compliance among all categories of HCWs

Figure 1: Opportunity-wise diurnal variation in hand hygiene compliance

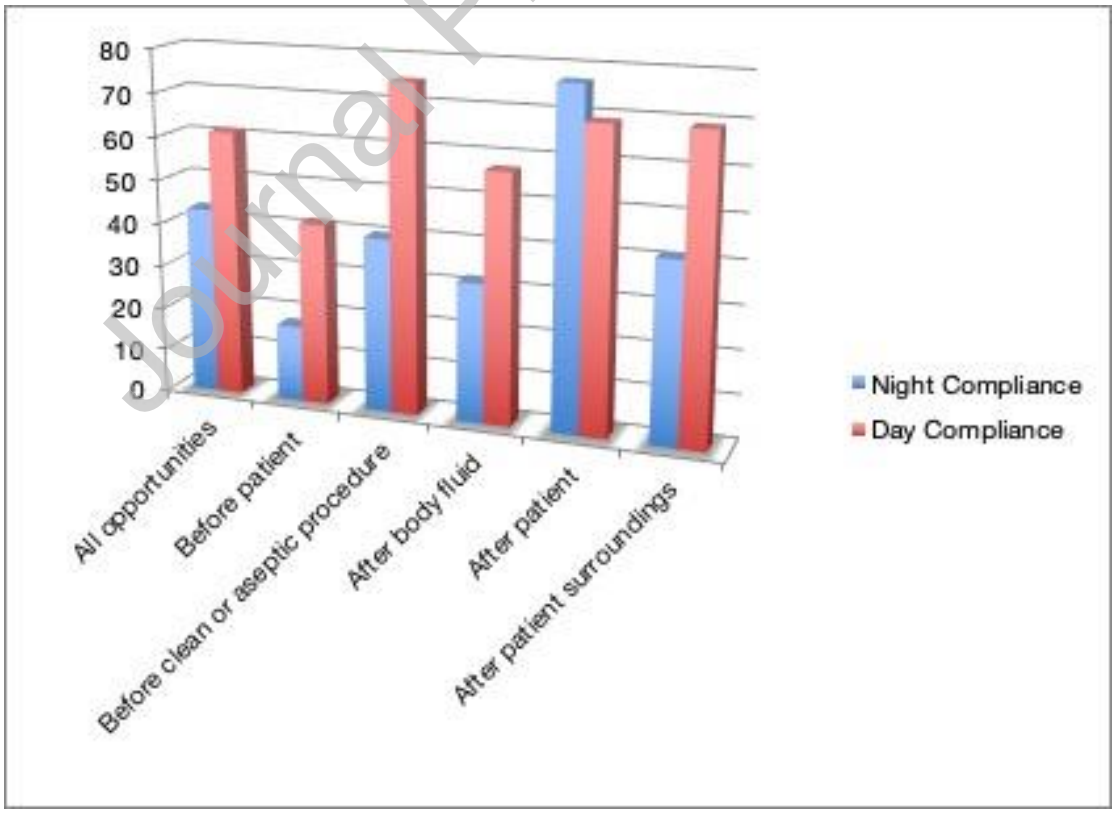

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Table I: Opportunity-wise compliance of hand hygiene among all categories of HCWs

	Doctors	**Nursing staff**	**Hospital/sanitary attendants**	**All HCWs**
	Hand hygiene performed/ Total number of opportunities observed (%)			
Indication 1	19/59 (32.0)	30/97 (30.3)	0/5	49/161 (30.4)

Indication 2	3/4 (75)	5/10 (50)	-	8/14 (57)
Indication 3	7/7 (100)	17/39 (43.6)	5/18 (27.8)	29/64 (45.3)
Indication 4	62/71 (87.32)	64/97 (65.98)	8/12 (66.67)	134/180 (74.4)
Indication 5	45/69 (65.21)	84/170 (49.41)	25/47 (52.2)	154/286 (82.8)
Total	136/210 (64.7%)	200/413 (48.4%)	38/82 (46.3%)	374/705 (53%)

Table 2: Variation in day and night time hand hygiene compliance among all categories of HCWs

	Doctors			**Nursing staff**			**Housekeeping staff**		
	Day	**Night**	***P* value†**	**Day**	**Night**	***P* value**	**Day**	**Night**	***P* value**
	Performed/total (%)	Performed/total (%)		Performed/total (%)	Performed/total (%)		Performed/total (%)	Performed/total (%)	

Total	95/139 (68.3)	41/71 (57.7)	0.13	132/233 (56.6)	68/180 (37.8)	**0.023**	25/43 (58.1)	13/39 (33.3)	**0.024**
Moment 1	16/38 (32.2)	3/21 (14.29)	**0.03**	25/58 (43.1)	5/39 (12.82)	**0.002**	0/2	0/3	-
Moment 2	3/4 (75)	-	-	4/7	1/3	-	-	-	-
Moment 3	5/5	2/2	-	14/25 (56)	3/14 (21.43)	**0.036**	2/9	3/9	0.6
Moment 4	42/51 (82.36)	20 /20 (100)	0.11	38/58 (65.52)	26/39 (66.67)	0.91	5/7 (71.43)	3/5 (60)	0.68
Moment 5	29/41 (70.73)	16/28 (57.14)	0.24	51/85 (60)	33/85 (38.82)	0.107	18/25 (72)	7/22 (31.8)	**0.006**

Percentage not calculated for small number of observations.

† The p values in bold are significant and chi-square test was used for statistical analysis.