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ORIGINAL ARTICLE

Improving 'Hand-Hygiene Compliance' among the Health Care Personnel in the Special Newborn Care Unit

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Abstract

Objectives To improve the hand-hygiene (HH) compliance among the health care personnel from 69 to 85% by 4 mo plan-do-study-act (PDSA) cycles, based on the WHO's five moments of hand hygiene and to study the impact of HH compliance upon the health care–associated infections (HAI) rate in the authors' special newborn care unit.

Methods HH compliance study was undertaken based on the prioritization matrix. The barriers to HH compliance were identified and evaluated using fishbone analysis. An operational team was formed, and measures for improvement were chalked out. The baseline score was recorded through observation. A total of three PDSA cycles were carried out. Appropriate education and counseling regarding the WHO's five moments of hand hygiene were taught to the health care personnel. Interventions such as posters and supply of nonmedicated liquid hand soap, autoclaved paper towels, and alcohol-based hand sanitizer were provided. The effect of interventions on HH compliance was assessed at the end of each PDSA cycle. HAI data were collected and compared with the previous records.

Results The HH compliance recorded during baseline, PDSA 1, PDSA 2, and PDSA 3 are respectively, as follows: 69% (16.75 ± 3.46), 74.58% (43.07 ± 7.50; $p = 0.043$), 63.75% (24.43 ± 5.16; $p = 0.083$), and 84.70% (47.45 ± 10.59; $p = 0.014$). The sum of HH scores from the three PDSA cycles when compared to the baseline is significant ($p = 0.022$). The HAI rate decreased from 13.81 to 1000 patient days to 10.43 per 1000 patient days ($p = 0.566$).

Conclusion HH compliance among health care personnel can be improved through information, education, and communication with constant monitoring.

Keywords Hand-hygiene compliance · Quality improvement · PDSA cycles · Late onset sepsis · Healthcare associated infections

Introduction

Hand hygiene (HH) is the single most important intervention for preventing nosocomial infection, the spread of multidrug-resistant pathogens, and mortality in a health care setting [1, 2]. Many studies have shown the overall adherence to hand-hygiene practices to be less than 50% [3]. The WHO, in 2009, developed "my five moments of hand hygiene" to reduce the burden of health care–associated infections (HAI), which include: before touching a patient, before procedures, after exposure to body fluids, after touching a patient, and after touching a patient's surroundings [4].

The authors carried out this project based on the WHO's five moments of hand hygiene to improve hand-hygiene compliance in their setup. The main objectives of the present project were to improve hand-hygiene compliance among the health care personnel from 69 to 85% by 4 mo, and study the impact of HH compliance upon the HAI rate in their special newborn care unit (SNCU).

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Table 1 Hand-hygiene techniques as per the WHO guidelines

HH technique with soap and water (duration 40–60 s)	HH technique with alcohol-based formulation (duration 20–30 s)
1. Wet hands with water by turning on the elbow faucet	1. Apply a palmful of the product in a cupped hand, covering all surfaces
2. Apply enough soap to cover all hand surfaces	2. Rub hands palm to palm
3. Rub hands palm to palm	3. Right palm over left dorsum with interlaced fingers and vice versa
4. Right palm over left dorsum with interlaced fingers and vice versa	4. Palm to palm with fingers interlaced
5. Palm to palm with fingers interlaced	5. Backs of fingers to opposing palms with fingers interlocked
6. Backs of fingers to opposing palms with fingers interlocked	6. Rotational rubbing of left thumb clasped in right palm and vice versa
7. Rotational rubbing of left thumb clasped in right palm and vice versa	7. Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa
8. Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa.	
9. Rinse hands with water	
10. Dry hands thoroughly with a single use towel	
11. Turn off faucet	

HH Hand hygiene, *WHO* World Health Organization

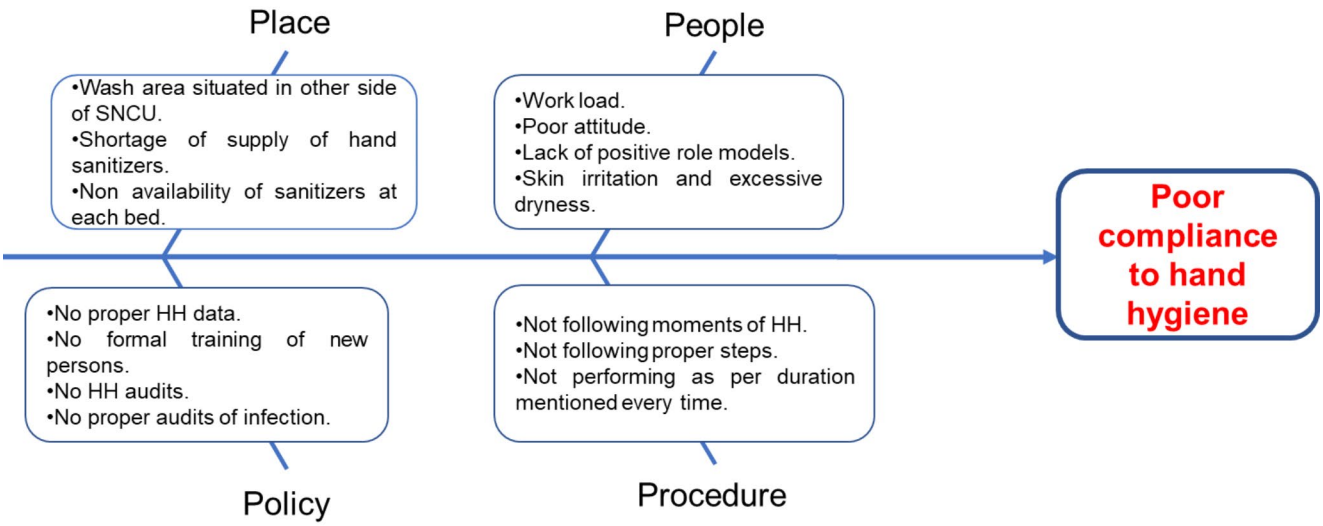

Fig. 1 Fishbone analysis of the reasons for missed hand-hygiene opportunities. *HH* Hand hygiene

Material and Methods

This was a hospital-based prospective study carried out among the health care personnel of the special newborn care unit of K. C. General Hospital, Bengaluru. The hospital caters to around 3000 deliveries annually and has around 500 SNCU admissions and another 500 admissions per year in the step-down ward. The health care personnel comprised a pediatrician, medical officers, postgraduate student, nurse-in-charge, nursing officers, a child health counselor, a data entry operator, and support staff providing 24-h services. The infant-to-nurse ratio ranged from 2–6:1 during the day shifts and 4–6:1 during the night shift.

HAI is not regularly tracked in the authors' SNCU. To prevent HAI, the authors used the prioritization matrix to choose the hand-hygiene compliance project. Consent was obtained from all the participants. Ethical clearance was obtained. The operational team comprised a pediatrician, medical officers, postgraduate students, nurse-in-charge, and two nursing officers. Baseline hand-hygiene compliance data were collected by the team leader during March. The HH techniques performed by the health care personnel during the five moments formed the baseline value (Table 1). The barriers that led to poor compliance with hand hygiene were identified using fishbone analysis, as shown in Fig. 1. These barriers and the baseline data were discussed with the team, and measures for improvement were laid out. The

consultant (pediatrician) educated the health care personnel on the proper hand-hygiene practices in accordance with the WHO's five moments of hand hygiene. A total of three plan-do-study-act (PDSA) cycles were conducted from April to July 2021. The duration of the first two PDSA cycles was 4 wk and the last cycle was 6 wk. All the working staffs were advised to practise proper hand hygiene practices for a week prior to the start of the project. The posters depicting the five moments of hand hygiene and hand-hygiene techniques were pasted near the handwashing area and other important areas. A round-the-clock supply of nonmedicated liquid hand soap and autoclaved paper hand towels was ensured. Each bed was supplied with alcohol-based hand sanitizer. A detailed PDSA cycle intervention is depicted in Table 2. Due to the second wave of COVID-19 and lockdown restrictions, the working hours for the nursing officers were changed to two 12-h shifts for the second PDSA cycle. The strategic approach to encouraging the staffs as well as team members to improve HH compliance was changed according to the circumstances. All the working staffs responded positively during review meetings and provided appropriate feedback.

Two team members were designated to observe the staffs who followed the five moments of HH and performed the HH techniques properly according to WHO guidelines. They collected the data in the morning and afternoon shifts, unknown to other staffs. The HH compliance rate was considered to be the primary outcome measure. It was calculated by dividing the number of observed HH moments adequately performed as per the WHO guidelines by the total number of observations for each of the moments, and the results were multiplied by 100. Sepsis data were collected by analysing the case records during the past 4 mo and also during the study period. HAI event was considered when an admitted newborn developed late-onset sepsis such as screen-positive/culture-positive/clinical sepsis and

Table 2 PDSA cycles

Cycle	PDSA 1	PDSA 2	PDSA 3
Time period	4 wk	4 wk	6 wk
Plan or change idea	1. To display posters of HH opportunities, handwashing and steps of hand wash/hand rub 2. To provide one alcohol-based hand rubs for every three beds. 3. Group education	1. To supply the nonmedicated liquid hand soap 2. To provide the hand rubs for every bed 3. Group education	1. To provide weekly group education about HH, twice a day (for two shifts) 2. Importance of asepsis following after touching patient's surroundings 3. Group specific feedback
Do (What was done and how it was done?)	1. Posters related to hand hygiene were pasted near the wash area and other important areas. 2. Alcohol-based hand rub provided. 3. Counseled all the staff regarding the importance of hand hygiene	1. Availability of nonmedicated liquid hand soap at all times 2. Hand rub availability to each bed at all times 3. Counselled all the staff regarding the importance of hand hygiene	1. Weekly educational sessions conducted 2. HH moment—after touching patient's surroundings stressed in educational sessions 3. Appropriate feedback obtained before the start of weekly counseling
Study (Measures done - HH compliance) how it was studied and who documented?	Numerator: Number of times HH was adequately performed as per the WHO guidelines for each of the moments × 100 Denominator: Total no. of observations Findings were recorded on the HH audit-sheet and then calculated, recorded by nursing officers and/or doctors Numerator: No. of HAI events in each month (admitted newborn developing late onset sepsis such as screen positive/culture positive/clinical sepsis and treated with 1st line antibiotic duration of > 5 d and/or with 2nd or 3rd line antibiotics for ≥ 5 d for the same) × 1000 Denominator: No. of patient days in the same month Data from the case sheets were recorded manually after each cycle, collected by the team leader		
Act (What was the result and what did the team do?)	HH compliance improved significantly and sepsis rates (HAI) declined Positive response from all the staffs noted	HH compliance decreased below baseline observational values and HAI increased. This was due to Non-availability of the staffs Long work hours Lack of positive role modeling No periodic team review meeting	Loopholes and lacunae in the previous cycle noted were addressed Feedbacks were appreciated and changes were made accordingly All the staffs responded positively

HH Hand hygiene, *PDSA* Plan-do-study-act, *WHO* World Health Organization

was treated with first-line antibiotic for > 5 d and/or with second- or third-line antibiotics for ≥ 5 d for the same. The HAI rate was considered a secondary outcome measure. The HAI rate was calculated for every month by recording the number of HAI events, dividing it by the patient days for that month, and multiplying the result by 1000. The data were compiled in Microsoft Excel 2019 (Microsoft Corporation, Redman, WA) and the statistical software SPSS version 28.0.1.1 (IBM, Corp. Armonk, N.Y.) was used to determine the statistical significance. The mean improvement in HH compliance among the working staffs was analysed using the *t*-test (paired, two-tailed). A $p \leq 0.05$ was considered statistically significant. Linear regression was used to determine whether LOS was associated with average duration of stay. The HAI data obtained during the study period was compared to that of the previous 4 mo.

Results

Baseline data comprised 194 observations. Overall hand-hygiene compliance stood at 69% (16.75 ± 3.46). The HH compliance along with their respective mean ± standard deviation (SD) values for each moment is as follows: before touching a patient (80%; 10 ± 2.18), before procedures (81.82%; 2.25 ± 1.48), after exposure to body fluids (92.86%; 1.63 ± 0.48), after touching a patient (52.78%; 2.38 ± 1.41), and after touching a patient's surroundings (18.18%; 0.5 ± 0.71).

The results of HH compliance are shown in Table 3. As per the table, there were 1617, 1073, and 2353 HH observations in the three PDSA cycles, respectively. Overall HH compliance along with the mean ± standard deviation (SD) and significance values for the three PDSA cycles are, respectively, as follows: 74.58% (43.07 ± 7.50; $p = 0.043$), 63.75% (24.43 ± 5.16; $p = 0.083$), and 84.70% (47.45 ± 10.59; $p = 0.014$). The *t*-tests were used to compare the values between the previous phases (i.e., between baseline and PDSA 1, between PDSA 1 and 2, and between PDSA 2 and 3). The sum of HH scores from the three PDSA cycles when compared to the baseline is significant ($p = 0.022$).

Every one day spent by the neonate in the authors' SNCU was considered 1 patient day. There were 178 SNCU admissions with 1534 patient days and the average duration of stay was 8.62 days during the study period with a bed occupancy rate of 104.78%. In the previous four months, there were 203 admissions with 1665 patient days and the average duration of stay was 8.20 days with the bed occupancy of 114.67%. The HAI rate was 13.81 per 1000 patient days as per records and 10.43 per 1000 patient days during the study period with $p = 0.566$. Four out of 8 deaths and 2 out of 20 deaths due to HAI were noted by records and during study period ($p = 0.495$), respectively. The HAI data are depicted in Table 4.

Discussion

Newborn care has been revolutionized in order to ensure best possible outcome for all neonates delivered, regardless of maternal health status. This is leading to prolonged neonatal intensive care unit (NICU) stay thereby overburdening the health care system, hospitals, and the parents. Neonatal sepsis is a major factor contributing to neonatal mortality accounting for more than a million neonatal deaths annually around the world [5]. In India, the incidence of neonatal sepsis is 17,000/100,000 live births and its case fatality rate ranges from 25 to 65% [6]. Health care–associated infection is one of the major contributing factors to late-onset neonatal sepsis due to the advancements in therapeutic practices and increased invasive procedures [7]. Along with the advancements in protocols and management and sophisticated practices, HAI are also on the rise, requiring NICU care bundles to reduce the incidence of HAI [8]. HH remains the most effective intervention among the care bundles in reducing HAI.

The fishbone analysis revealed numerous factors that hinder appropriate HH compliance, such as improper location of the wash area, shortage of essential materials, increased workload, lack of positive role models, poor attitude leading to ineffective HH procedures, complaints of skin irritation and dryness, no HH and sepsis audits, and no formal training of new personnel. These issues are similar to those explained by Lydon et al., Purva Mathur, Erasmus et al., and Sadule-Rios et al. regarding possible barriers that lead to poor HH compliance [9–12].

The improvement in the HH compliance in the PDSA cycles 1 and 3 were noted to be statistically significant. The overall percentage of HH compliance significantly increased from 69 to 84.7% after the third PDSA cycle. van den Hoogen et al. showed that multimodal strategies can improve HH compliance [13]. In the HH project by Lam et al., it was noted that overall HH compliance increased from 40 to 53% before patient contact and from 39 to 59% after patient contact, and the rate of HAI decreased from 11.3 to 6.2 per 1000 patient days. According to Sharek et al., implementation of an evidence-based handwashing policy resulted in a statistically significant improvement in between-patient handwashing from 47.4 to 87.4% [14, 15]. Rai et al. improved HH compliance from 27.2 to 57.1% in their SNCU in three phases using multiple PDSA cycles [16]. Gopalakrishnan et al. significantly improved the HH compliance in their setup from 61.8 to 77%. They used four-phased sequential

Table 3 Observational values of five moments of hand hygiene along with *t*-test significance

Parameters		Baseline	PDSA 1	PDSA 2	PDSA 3
Before touching a patient	Number of times HW or HR performed/ Total number of observations	80/100	345/393	230/286	563/589
	Mean ± SD	10 ± 2.18	12.32 ± 2.09	8.21 ± 1.80	13.40 ± 5.01
	Percentage	80%	87.79%	80.42%	95.59%
	p value*	-	0.012	0.703	< 0.001
Before clean/aseptic procedure	Number of times HW or HR performed/ Total number of observations	18/22	469/556	203/305	627/719
	Mean ± SD	2.25 ± 1.48	16.75 ± 4.87	7.25 ± 2.01	14.93 ± 3.57
	Percentage	81.82%	84.35%	66.56%	87.20%
	p value*	-	< 0.001	< 0.001	< 0.001
After body fluid exposure risk	Number of times HW or HR performed/ Total number of observations	13/14	69/75	44/54	117/123
	Mean ± SD	1.63 ± 0.48	2.46 ± 1.57	1.57 ± 1.32	2.79 ± 0.96
	Percentage	92.86%	92%	81.48%	95.12%
	p value*	-	0.023	0.025	< 0.001
After touching a patient	Number of times HW or HR performed/ Total number of observations	19/36	257/393	153/286	465/589
	Mean ± SD	2.38 ± 1.41	9.18 ± 1.65	5.46 ± 1.84	11.07 ± 3.95
	Percentage	52.78%	65.39%	53.50%	78.95%
	p value*	-	< 0.001	< 0.001	< 0.001
After touching a patient's surroundings	Number of times HW or HR performed/ Total number of observations	4/22	66/200	54/142	221/333
	Mean ± SD	0.5 ± 0.71	2.36 ± 1.44	1.93 ± 1.71	5.26 ± 1.94
	Percentage	18.18%	33%	38.03%	66.37%
	p value*	-	0.002	0.285	< 0.001
TOTAL	Number of times HW or HR performed/ Total number of observations	134/194	1206/1617	684/1073	1993/2353
	Mean ± SD	16.75 ± 3.46	43.07 ± 7.50	24.43 ± 5.16	47.45 ± 10.59
	Percentage	69.07%	74.58%	63.75%	84.70%
	p value*	-	0.043	0.083	0.014

HR Hand rub, *HW* Hand wash, *PDSA* Plan-do-study-act, *SD* Standard deviation

*two-tailed; significance level ≤ 0.05

interventions that included self-directed learning, participatory learning, closed-circuit TV (CCTV) monitoring, and CCTV with feedback. Rise in HH compliance was significantly higher for after-WHO moments (12.7%) as compared to before-WHO moments (5.2%) [17].

In PDSA 2, a reduction in HH compliance was observed as compared to the previous cycle. The low compliance observed in this cycle was due to lockdown restrictions, understaffing due to COVID-19, prolonged work hours, a lack of positive role modelling, and no periodic review team meetings. Pittet et al. showed that increased workload and the high demand for strict adherence to HH are the most significant risk factors for noncompliance [18].

The percentage of HH attempts was high before touching a patient; however, it decreased for interpatient contact and after contact with the patient's surroundings. The usage of HH after contact with the patient's surroundings significantly improved from the baseline of 18.18–66.37% after three cycles. But the result was still low when compared to other moments of hand hygiene. In an article by FitzGerald et al., the most common hand-hygiene opportunities that were missed were after touching a patient's surroundings, and they recommend that the health care workers be made aware of the bacterial spread that can occur even during activities of perceived low risk. Education and intervention programs should focus on the potential contamination of ward computers, case files, and door handles [19].

The present pilot project became the way to start auditing systems in the SNCU. The prioritization matrix helped the team focus on one problem rather than solving multiple problems at once. During the study period, the staffs were repeatedly exposed to the HH training, thereby improving their confidence. After the study period ended, the staff were encouraged constantly to improvise as they would be monitored during the LaQshya (Labor Room Quality Improvement Initiative) and NQAS (National Quality Assurance Standards) assessments. The mode of communication and interpersonal relationship improved during the course of the

Table 4 HAI data with significance values

Month and year			December 2020–March 2021	April 2021–July 2021	*t*-test *p* value*
Total admissions (inborn & outborn)			203	178	-
Total duration of stay of all admitted newborns (patient-days)			1665	1534	0.422
Average duration of stay of all admitted newborns (days)			8.20	8.62	0.301
HAI	Probable sepsis (screen positive)		13 (6.40%)	8 (4.5%)	0.874
	Definite sepsis (culture positive)	Blood culture	4 (1.97%)	3 (1.69%)	0.391
		Pus/Urine culture	1 (0.5%)	1 (0.56%)	
	Clinical sepsis		5 (2.46%)	4 (2.25%)	0.252
	Total		23 (11.33%)	16 (8.98%)	0.566
	HAI rate (per 1000 patient days)		13.81	10.43	
Outcome of total admissions	Successfully discharged		183 (90.15%)	152 (85.39%)	-
	Referred		11 (5.42%)	4 (2.25%)	-
	DAMA		1 (0.49%)	2 (1.12%)	-
	Death		8 (3.94%)	20 (11.24%)	-
Deaths due to HAI			4 (50%)	2 (10%)	0.495

DAMA Discharged against medical advice, *HAI* Health care–associated infections

*significance level ≤ 0.05

study, and feedback was appreciated from both ends. Overall positive effects were noted at the end of the study period.

The sample size was small and duration of study was short. Hand hygiene moments were not recorded during resuscitation outside the SNCU. Moments of HH were not recorded during the night shifts. There were lockdown measures and understaffing due to COVID-19 during the present study period. The total number of ventilator days, umbilical catheter days, and peripheral venous catheter days could not be recorded. The project did not involve the mothers in the hand hygiene project.

Conclusions

Hand hygiene remains the main theme in connecting various aspects of care bundles to reduce the HAI. Hand-hygiene compliance can be improved through information, education, and communication methods among the health care workers. However, these interventions need constant positive role models and monitoring. If implemented on a large scale, burden on the health care workers, hospitals, and the economy can be brought down significantly.

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Authors' Contributions SPKA, RP, and RC drafted the initial manuscript; SPKA and RP collected the data; SPKA contributed to literature search; RBG and RK reviewed and edited the manuscript; LSR overviewed the whole process. SR edited the final manuscript and had full access to all the data. LSR and SR verified the whole document and had final responsibility for the decision to submit for publication. SR will act as the guarantor for this paper.

Declarations

Consent Verbal consent was obtained from the participating health care personnel.

Ethical Approval The ethical committee of K. C. General Hospital has given clearance to the study.

Conflict of Interest None.

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