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Research Article

Improving Hand Hygiene Compliance in the Neonatal Intensive Care Unit at a Regional Children's Hospital

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Abstract

Objective: Poor Hand Hygiene Compliance (HHC) among healthcare workers is directly associated with High Hospital Acquired Infections (HAI) worldwide. In 2011, the Centers for Disease Control and Prevention (CDC) reported 721,800 HAI per year in the United States among acute care hospitals along with 75,000 associated patient deaths. The objective of this quality improvement study was to evaluate the effect of hand hygiene educational interventions on HHC among Healthcare Workers (HCW) in a Neonatal Intensive Care Unit (NICU).

Methods: This was a quality improvement project for increasing HHC at a tertiary care NICU using the Plan-Do-Study-Act design. This study was exempt from IRB review as it did not involve study subjects. The HCW staff included a comprehensive team of respiratory therapists, nurse practitioners, staff nurses, attending physicians, resident physicians, fellows, radiology technicians, child life staff, social workers, discharge planners, nutrition lab technicians, housekeeping staff, among others. The study consisted of recording HHC of HCW entering and leaving patient rooms before and after the educational intervention. The data collection instrument allowed recording of type of HCW, date, and HHC during day or night shifts. The instrument was completed by non-identified observers. No personal identifiers were collected in the study. The study implemented an educational intervention to all HCW based on CDC educational tools.

Results: Surveillance included a total of 762 observations, 381 were pre-intervention and 381 post-interventions. Overall, HHC significantly increased from 110 (28.9%) pre-intervention, to 227 (59.6%) post-intervention (p-value: < .001). Post intervention increase in HHC was specifically noted in subgroups of physicians, respiratory therapists and registered nurses.

Conclusion: HHC educational interventions among HCW in a tertiary care NICU are associated with significant improvement in HHC and may contribute to a decrease of HAI in the NICU.

Keywords: Hand hygiene; Pediatrics; Infection prevention; Compliance; Education

Introduction

Poor compliance with Hand Hygiene (HH) in hospitals across the United States, including children's hospitals [1], is associated with Hospital Acquired Infections (HAI). In 2011, the Centers for Disease Control and Prevention (CDC) reported 721,800 HAIs per year in the United States among acute care hospitals and 75,000 patient deaths from HAI. The CDC also found that 4% of inpatients in U.S. acute care hospitals had at least 1 HAI [2]. The Chief Public Health Officer's Report on the State

of Public Health in Canada in 2013 found that more than 200,000 Canadians acquire a HAI each year and, as a result, 8,000 of them died [2]. Baseline data collected from 67 nursing wards on three hospitals found that HHC reached only 20% [3]. Poor HHC is a not only a problem among healthcare workers, but it is also observed among parents, family members and other hospital visitors. One study that enrolled 1,143 parents and family members reported only 71% HHC [4]. Research on HHC and its association with HAI has led to statewide campaigns to increase HHC. The "Clean Hands Save Lives" campaign which originated from the World Health Organization (WHO) was launched in March 2006 by the Clinical Excellence Commission in New South Wales, Australia. The implementation of this campaign was successful in reducing HAIs through improving hand hygiene adherence [1]. It is well known that HH is an important measure for preventing Hospital Acquired Infections (HAI) [5].

Poor HHC is also related to high false-positive cultures and implementation of hand washing policies results in a significant decrease in false-positive coagulase negative staphylococcal blood and CSF culture rates [6]. The Joint Commission, a body that accredits health care organizations in the United States, sets the bar for hospitals to achieve greater than 90% hand hygiene compliance [7]. A retrospective cohort study in a Neonatal Intensive-Care Unit (NICU) found that the daily census of hospitalized children on this unit was above the capacity of the unit and as a result, the assigned staff on duty was insufficient for the workload. HHC measures in this NICU before contact with an invasive device (central line) was 25% during the workload peak and improved to 70% when there was sufficient staffing appropriate to the census [5].

Normal human skin is colonized with bacteria. Bacteria recovered from the hands are divided into two categories: transient and resident flora. Transient flora, which colonize the superficial layers of the skin, are more amenable to removal by routine handwashing. Transient flora is often acquired by Healthcare Workers (HCW) during direct contact with patients and/or contact with contaminated environmental surfaces. Transient flora are the organisms most frequently associated with health-care–associated infections. Resident flora, which are attached to deeper layers of the skin, are more resistant to removal. Because approximately 10^6 skin squames containing viable microorganisms are shed daily from normal skin, patient gowns, bed linen, bedside furniture, and other objects in the patient's immediate environment can easily become contaminated with patient flora [5]. Such contamination is particularly likely to be caused by staphylococci or enterococci [8]. Hand Hygiene Compliance (HHC) is defined as the action of hand hygiene performance when it is indicated [9]. Hand hygiene is defined as either proper use of Alcohol-Based Sanitizer (ABHS) by rubbing hands until dry or hand-washing with soap and water for at least 20 seconds. Both forms of hand hygiene aim to cover all surfaces of both hands

Poor HHC is a multi-factorial issue including Healthcare Workers' (HCW) poor compliance with HH policies. Reasons elicited for poor HHC include an excessive workload, contact dermatitis even with soap and hand sanitizers, and the belief that HH is not necessary. One study reported that nurses selected high workload and understaffing as the main reasons for poor HHC in critical care units. Also, they identified difficulty accessing sinks and lack of appropriately located hand sanitizers as major barriers to HHC [10]. Contact dermatitis is a common occurrence among healthcare workers with a reported prevalence of 10% to 45% [11].

The overall goal of this study was to improve HHC among health care personnel in a tertiary care NICU at a free standing Children's hospital through implementation of a HH education program that was measured by direct HHC observations.

Methods

Study Design

This was a prospective Plan-Do-Study-Act (PDSA) quality improvement project to compare HHC before and after an educational multidisciplinary intervention with staff at a tertiary care NICU [12]. The study was conducted in the NICU of Oishei Children's Hospital, Buffalo, NY, USA from March 30th 2018 to February 1st, 2019. This is a mostly single family room NICU with some twin rooms. Patients are taken care of by a multidisciplinary team that included respiratory therapists, nurse practitioners, staff nurses, attending physicians, resident physicians, fellows, radiology technicians, child life staff, social workers and discharge planners, nutrition lab technicians, housekeeping staff, among others. The NICU has a hands washing scrub sink upon entry for visitor use. Both visitors and staff are required to scrub their hands for 3 minutes before entering the unit. There are sinks in every patient room as well as Alcohol-Based Hand Rub (ABHR) dispensers inside and outside of every patient room.

The purpose of this study was to evaluate HHC among NICU staff and determine barriers to achieve adequate HHC. A multidisciplinary educational intervention to increase observed HHC was implemented and followed by a post-intervention surveillance period of HHC observations. To accomplish this goal, we conducted a pre-intervention surveillance of HH in the NICU among healthcare workers followed by a post-intervention surveillance. The main aims of the study were: i) To evaluate the overall rate of HHC among personnel at the study site; ii) To evaluate the rate of HHC among various subgroups of healthcare workers and determine differences among individual groups; iii) To establish reasons for poor NICU HCW compliance with HH; iv) To evaluate the efficacy of HHC educational intervention among HCW at the study site.

Questionnaires to Assess Reasons for Non-HHC by HCW in The NICU

To establish possible reasons NICU healthcare staff non-compliance with HH, we performed a survey. The questionnaire content was designed based on WHO guidelines on HH in healthcare [13], literature review [14] and feedback from the infection Prevention team at the hospital. Specific questions included in the survey are shown in Table 1.

Number	Question	Intended Information requested
1	Lack of knowledge base	Information of the importance of HH in infection prevention
2	Shortage of nursing staff	Information on whether nursing shortage affects HH
3	Sometimes I forget	Relevance of forgetfulness in HH
4	Too busy	Perception of HHW busy schedule on HHC
5	Skin irritation	Information on HH sanitizer side effects
6	Patient's needs are priority	Refers to patient emergencies that can't wait
7	Glove use is enough	HCW knowledge on infection prevention and HH specifically
8	Lack of HH products	Information on HH products limitations at the work place
9	Location of the dispensers	Information about access to HH sanitizers or HW sinks
10	20 seconds is too much time	Importance on following instructions on HH timing

Table 1: Questionnaire to address possible HCW barriers to HHC in the NICU.

Pre-Intervention Evaluation of HH Compliance by HHC Observation

To gather baseline compliance data, we conducted HHC observations of HCW at the study NICU. This surveillance was conducted by direct observation by adult volunteers. For this purpose, a group of volunteers, non-related to the hospital NICU staff, was trained to perform HHC observations in the NICU. Training methods consisted of a combination of short lectures and supervised HHC observations. The educational sessions were conducted by infection prevention registered nurses with expertise in HHC.

Each volunteer observed NICU HCW practicing HH before entering and while exiting the patient room. This observation was stratified into subgroups based on provider role. The instrument used to record information included date, time, HCW evaluated, and HH direct observations (Figure 1). If a HH moment was missed at one of these two opportunities points because of a medical emergency, it was not recorded. The completed form was then entered into an excel database by infection prevention personnel.

NICU Hand Hygiene Monitoring Tool

Month/Year _____
Initials of Monitor:_____
Healthcare Worker (HCW) Type:

HW = Hand Wash
HR = Alcohol Hand Rub
Y = Yes
N= No

1 = Physician
2A = House Officer
2B = Medical Student
2C = Physician Assistant
3 = Physician Support Staf
4 = Respiratory Therapist
5A = Registered Nurse
5B = Licensed Practical Nurse
5C = Clinical Technician
6 = IV Team
7 = Continuing Care/Social Worker
8 = Pastoral Care
9 = Physical Medicine Staff
10 = Environmental Services Worker
11 = Patient Transporter
12 = Radiology Tech.
13 = Dietitian
14 = Tray passer
15 = Other

Unit	# Obs	Date	Shift	HCW Type	Hand Hygiene BEFORE Entering Pt. Room				Hand Hygiene Exiting Pt Room			
			(Day, Eve, Night)	(See Key)	Yes HR	Yes HW	No	N/A	Yes HR	Yes HW	No	N/A
	1											
	2											
	3											
	4											
	5											
	6											
	7											
	8											
	9											
	10											
Totals												

Figure 1: NICU hand hygiene compliance monitoring tool for volunteer observer's use.

Education Intervention and Post-Intervention HHC Evaluation

Education on HH and HHC was provided to all HCW at the NICU. Education was delivered in the form of: i) PowerPoint presentations done twice during morning and night shifts; ii) Conferences scheduled on Tuesdays with attending and fellow physicians; iii) PowerPoint presentation to the pediatric residents during their scheduled lectures; iv) HH and HHC education booklets delivered to all clinical units and to each HCW; v) HHC workshop on the importance of proper hand washing, utilizing ultraviolet fluorescent hand lotion to detect contamination when deficient HH was practiced.

The protocol to evaluate HHC was identical to the one used for pre-intervention evaluation of HHC as described above. This protocol gathered data on HHC observation in all HCW personnel at the study NICU. HH surveillance of NICU healthcare personnel was conducted by means of non-NICU volunteers, previously trained in HH compliance.

Data Analysis

Descriptive characteristics for study variables were computed. Categorical variables were reported as proportions in percentage (e.g., provider role) and continuous level variables as means and standard deviations. The rate of pre and post-intervention HCW adherence to HH practices was measured as a proportion of the number of hand hygiene episodes divided by the number of hand hygiene opportunities. Change in HCW adherence from before to after the training was tested for statistical significance with chi-square. Crosstabs was also conducted separately for the various disciplines of HCW. Likewise, for exploring reasons why NICU HCW are not compliant with HHC, common themes were grouped and reported by highest level of responses in proportion of all responses, as a percentage. Only participants with both pre – and post-intervention data were included in the analysis. All statistical tests were two tailed, based on an alpha of 0.05, and conducted with SYSTAT 13 (SYSTAT Software, 2004).

The population size was estimated based on a 20%

difference in proportion in HHC between before and after HHC education implementation with an 80% power and a type 1 error of 0.01. Accordingly, a total of 381 HHC observations before and HHC observations after HHC education implementation were recorded.

Ethical Considerations

This study was exempt from Institutional Review Committed (IRB) of the University at Buffalo. No interventions were conducted on patients, and no patient health information was recorded.

Results

Health Care Workers (HCW) Participation in The HHC Observations

A total number of 762, 381 HHC observation were recorded during the pre-educational period and 381 during the post-educational intervention period. The main HCW groups analyzed were Registered Nurses (RNs), physicians, respiratory therapists and mid-level providers (Table 2). During the post-educational intervention period, no HHC observations were recorded on physical therapists, environmental service worker, or medical assistant.

HCW	Pre-Intervention		Post-Intervention	
	n	%	n	%
Physician	145	38.06	135	35.43
Medical Student	3	0.79	3	0.79
Mid-level Provider	16	4.20	21	5.51
Respiratory Therapist	16	4.20	29	7.61
RN	158	41.47	182	47.77
Radiology Tech	0	0.00	4	1.05
Physical Therapist	1	0.26	0	0.00
Environmental Service Worker	3	0.79	0	0.00
Medical Assistant	13	3.41	0	0.00
Other ancillary staff	22	5.77	7	1.84
Not recorded	4	1.05	0	0.00
Total	381	100.00	381	100.00

Table 2: Proportion of HCW evaluated pre- and post-educational intervention.

Reported Barriers Among Healthcare Workers for Hand Hygiene Compliance in The NICU

To understand reasons for non-HHC among HHW in the NICU, a survey was utilized to assess perceived reasons for poor HHC. We obtained a total of 148 surveys back with responses. The three most common reasons given by the HCW as a barrier to HHC were: i) "patient's needs" with 36 responses (27.9%); ii) "forgetfulness" with 21 responses (13.6%); and iii) "Not enough time to perform HHC" with 18 responses (11.6%). Other responses included "location of the dispenser" (9.7%) where it was difficult to obtain hand rub quickly and skin irritation (7.7%) due to repeated handwashing (Figure 2).

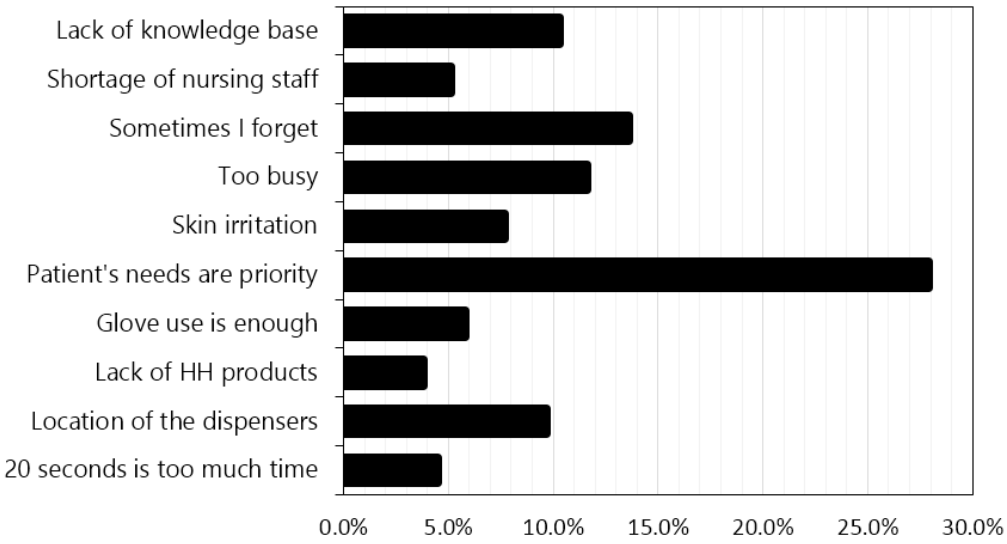

Figure 2: Proportion of HCW perceived barriers to HHC in the NICU. Information obtained from answers to a questionnaire.

HHC Among HCW During the Pre-Educational Interventional Period

The rationale to evaluate HHC among HCW in the NICU prior to any educational intervention was to have a baseline data of HHC among HCW in the NICU. We completed a total of 381 observations in 6 months. HCW personnel observed included predominantly RNs, physician, mid-level providers and respiratory therapists (Table 3). Overall, there was 28.9% HH compliance among HCW in the NICU. The HHC varied among difference HCW. It was 24.8% for physicians, 43.8% for mid-level providers, 43.8 for respiratory therapists, and 33.5% for RNs.

	HHC[1] Pre-intervention		HHC post-intervention		
HCW[2]	**Yes**	**No**	**Yes**	**No**	***p*- value[3]**
Physician	36	109	98	37	p<.001
Medical Student	3	0	2	1	
Mid-level Provider	7	9	11	10	0.603
Respiratory Therapist	7	9	19	10	0.157
RN[4]	53	105	97	85	p<.001
Radiology Tech	0	0	0	4	
Physical Therapy	1	0	0	0	
Environmental Services	0	3	0	0	
Medical Assistant	0	13	0	0	
Unknown	3	1	0	0	
Other	0	22	0	7	

Table 3: Proportion of hand hygiene compliance at a NICU facility before and after educational intervention based on type of health care worker position shows an increase among all groups. [1]HHC: Hand hygiene compliance; [2]HCW: Health care worker; [3]p-value based on Chi square analysis, [4]RN: Registered nurse.

At the end of the pre-educational intervention period, NICU HCWs underwent the educational intervention and after a period of 4 weeks, HHC observations of HCW in the NICU continued.

Effects of Educational Intervention On Hand Hygiene Compliance

During the post-educational intervention period the overall HHC was 59.6%, a statistically significant increase (p-value < .001) from 28.9% in the pre-educational intervention period.

During the post-educational intervention period, the data collected for HCW observation of HHC consisted were limited and only included physicians, mid-level providers, respiratory therapists and RNs. After educational intervention of HHC, there was an increased HHC among physicians $\chi^2(1, N=280) = 63.9$, $p<.001$ and among and RNs χ^2 (1, N=340) = 13.4, $p<.001$.

Discussion

HHC is a critical component of infection prevention against HAI. This PDSA quality improvement project determined barriers to HHC among HCW in a tertiary care NICU facility and found that the three most common perceived barriers to HHC were "patient's needs," "forgetfulness" and "not enough time to perform HHC." A systematic review on barriers to change physician behavior has reported that lack of awareness and familiarity with HHC and lack of agreement and complicated HHC guidelines seem to be the main issues associated with poor HHC [14,15]. Information acquired on perceived barriers to HHC among HCW in NICU in this study may be used to identify targets for interventions to improve HHC using a PDSA cycle format. Sharing information on the baseline HHC by NICU staff may serve as a tool to increase awareness and to enhance willingness for change. Future studies may be conducted to measure HHC information knowledge, interest level in this information, and how this information may promote behavior change.

This study evaluates HCC among HCW at a NICU facility before and after an educational intervention. We found that the overall rate of HHC increased from 28.9% to 59.6%, a difference that was statically significant. This study is relevant because it demonstrates that educational interventions not only improves HHC but also increases knowledge among HCW in the NICU. The success of HHC educational interventions may also encourage additional clinical units to adopt a similar strategy.

The three most commonly used methods in the evaluation of HCW adherence with HH practices are direct observation of HH opportunities, measurement of HH product use, and use of advanced technologies [2,16]. The direct observation method used in this study is considered the "gold standard" for assessing HHC [11]. HHC measurement may involve observation of the five moments established by the WHO. Measurement of 5 moments, however, is difficult to accomplish in practice due to limitations in observation and recording. For this study, we limited HHC observation to two moments, one moment while entering the patient's room, right before reaching the patient and a second moment, after touching the patient or patient's surroundings. In our single family room NICU, neonates were mostly in individual rooms.

Quality improvement projects have been shown to be more effective when multiple interventions cycles are implemented in a PDSA format [17]. This study implemented one intervention cycle and acquired information from HCW that may be used to identify targets for future intervention cycles. The main educational intervention implemented in this study was HH education in the form of oral presentations and workshops. NICU staff learned the proper technique and required time for HH. During all educational sessions the HCW had the opportunity to clarify concepts and have questions answered. Studies have shown that implementation of an evidence-based hand washing policy resulted in a significant increase in hand washing compliance and a significant decrease in false-positive coagulase negative staphylococcal blood and CSF culture rates [6]. Future studies may evaluate the relationship between HHC improvement and decrease in the number of HAI in the NICU facility.

This study had some limitations. There was a significant increase in HHC after the educational intervention, and it is likely that, this being an observational study, a Hawthorne effect may have included a bias. The Hawthorne effect (also referred to as the observer effect) is a type of reactivity in which individuals modify an aspect of their behavior in response to their awareness of being observed. This can undermine the integrity of research, particularly the relationships between variables. We tried to minimize this effect by requesting volunteers to be as discrete as possible during the observation periods. This study only implemented one cycle that increased compliance to a 60.1% level. More interventions may be necessary to increase to the expected level of >90% HHC and to determine how long this positive change is sustained.

In conclusion, a HH educational intervention among HCW in a tertiary care single family room NICU was associated with a significant improvement in HHC. HH education may contribute to a culture of infection prevention thus decrease HAI in NICU facilities. HCW perceived barriers for HHC, such as patient emergency, forgetfulness and lack of time, may be overcome by HHC education.

Contribution Statements

- Gouri Scheurmann, Tonya Lemonious, and Oscar G. Gómez-Duarte were responsible for the conceptualization and design of the study.
- Oscar G. Gomez-Duarte was responsible for writing the initial manuscript draft and submitting the final version to the journal.

- Gouri Scheurmann and Tonya Lemonious were responsible for conducting the surveys, collecting data, and conducting educational interventions.
- Jayasree Nair and Roberto Diaz Del Carpio contributed to the design of questionnaires, data collection tools, and educational interventions.
- Haiping Qiao was responsible for writing, submitting the protocol to the University at Buffalo Institutional Review Board.
- Brian H. Wrotniak was responsible for data analysis and interpretation of results.

All authors were responsible for reviewing, editing and approving the final manuscript.

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