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Factors associated with hand hygiene practices in two neonatal intensive care units

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Abstract

Objective—To determine whether hand hygiene practices differ between levels of contact with neonates; to characterize the hand hygiene practices of different types of personnel; and to compare hand hygiene practices in neonatal intensive care units (NICUs) using different products.

Methods—Research assistants observed staff hand hygiene practices during 38 sessions in two NICUs. Patient touches were categorized as touching within the neonates' environment but only outside the Isolette (Level 1), touching within the Isolette but not the neonate directly (Level 2) or directly touching the neonate (Level 3). Hand hygiene practices for each touch were categorized into five groups: cleaned hands and new gloves; uncleaned hands and new gloves; used gloves; clean hands and no gloves; uncleaned hands and no gloves.

Results—Research assistants observed 1472 touches. On average each neonate or his or her immediate environment was touched 78 times per shift. Nurses ($P = 0.001$), attending physicians ($P = 0.02$) and physicians-in-training ($P = 0.03$) were more likely to use appropriate practices during Level 3 touches, but only 22.8% of all touches were with cleaned and/or newly gloved hands. The mean number of direct touches by staff members with cleaned hands was greater in the NICU using an alcohol-based hand rub than in the NICU using antimicrobial soap ($P < 0.01$).

Conclusions—Hand hygiene was suboptimal in this high risk setting; administrative action and improved products may be needed to assure acceptable practice. In this study use of an alcohol-based product was associated with significantly improved hand hygiene and should be encouraged, as recommended in the new CDC hand hygiene guideline.

Keywords

Handwashing; hand hygiene; neonatal intensive care

INTRODUCTION

Adherence to hand hygiene protocols in hospitals, particularly in intensive care units, is recognized as one of the most important means to prevent and control the spread of health care-associated infections.¹ Newborns in neonatal intensive care units (NICUs) are at especially high risk of health care-associated infections because of a combination of innate characteristics including their fragile integumentary and underdeveloped immune systems as well as the frequent need for instrumentation (e.g. central venous catheters), invasive procedures and frequent contact with staff. Current best practices for hand hygiene for such high risk patients

include the cleaning or degerming of hands before and after patient contact, after touching patient equipment or environmental surfaces, before performing invasive procedures and after removing gloves.^{2, 3} However, many studies have examined the routine hand hygiene practices of health care workers, and most have found the overall adherence rates to be <50%.⁴⁻⁸

Because numerous factors could contribute to appropriate hand hygiene practices, it is critical to understand current behaviors of health care workers who contact high risk patients to develop appropriate, targeted interventions that might improve hand hygiene practices. These factors include the frequency of patient contact by different types of personnel frequency of handwashing and gloving, the frequency of contact with the patients' environment and equipment and the impact of different hand hygiene products. The aims of this study were to determine whether hand hygiene practices differ between different levels of contact with neonates, their environment and equipment; to characterize the hand hygiene practices of different types of personnel who touch neonates, including nurses, attending physicians, physicians-in-training (residents and fellows) and other health care workers, as well as visitors; and to compare hand hygiene practices in two different NICUs using different products.

METHODS

Design

This study was an observational component of a larger clinical trial (Staff Hand Hygiene Practices and Nosocomial Infections in Neonates) which was approved by the Institutional Review Boards of both participating hospitals.

Sample and setting

The study was conducted in two university-affiliated New York City Level III and IV NICU facilities: NICU A is a 44-bed NICU with an average of 16.0 nurses on staff per 12-h shift; NICU B is a 50-bed NICU with an average of 15.5 nurses per 12-h shift. In the 10 months before this observational study, NICU A averaged 88 admissions and 1390 patient-days per month, and NICU B averaged 60 admissions and 1234 patient-days per month. For the months of the study (June/July), the nurse-patient ratios were 0.46 and 0.45 for the 2 units, respectively. Both units were part of the same health system and shared similar infection control policies and procedures and staff education. In both units rooms held 6 to 12 Isolettes and had 3 to 4 sinks. Staff and visitors were instructed to perform hand hygiene before entering the unit, but no scrub was required. In the year before this observational study, the incidence rate ratio between the 2 units for all nosocomial infections, adjusted for differences in birth weight, was 1.33 (95% confidence intervals, 0.92 to 1.9; $P = 0.13$). That is, there was no significant difference in infection rates between the units. The sample population included any person whose hands made contact with a neonate under observation, their Isolette and/or equipment.

Procedure

The hand hygiene regimen in NICU A consisted of degerming with an alcohol-based hand rub (Avagard; 3M, St. Paul, MN) and washing the hands when physically soiled with a nonantimicrobial soap (Kindest Kare; Steris, St. Louis, MO). NICU B used traditional handwashing with an antimicrobial soap containing 2% chlorhexidine gluconate (Bactoshield; Steris, St. Louis, MO). These products had been in use on the units for 5 months before the study and were selected as part of the protocol for the larger clinical trial. Additionally NICU A had implemented a universal gloving policy when touching neonates (i.e. gloves were worn when directly touching a neonate). NICU B's policy called for glove use only when contacting body fluids. The policies in both NICUs were to perform hand hygiene before performing invasive procedures, before and after patient contact and after touching patient equipment or environmental surfaces. Observations were made by one of two research assistants during a 1-

month period. Interobserver reliability of >95% was confirmed before the trial. Both observers selected rooms at random during the day shift in either facility and determined the neonates to be observed, based on the number of Isolettes that could be viewed without obstruction. The observers recorded all staff or visitor touches that occurred to the infants under observation, their equipment and/or the immediate environment for the duration of the observation period, which varied in length from 30 min to 2 h.

Touches were classified by three additional variables: individual making hand contact (nurse, attending physician, physician-in-training, other health care worker or visitor); the condition of the hands, i.e. if hands were cleaned immediately before contact, if gloves were worn and if gloves were “used” rather than new, defined as gloves used to touch objects or persons outside the neonate’s environment and subsequently worn for contact with the neonate, equipment and/or immediate environment; and the level of contact (ranging from 1 to 3). Cleaned hands were defined as use of either the alcohol-based product or handwashing with the detergent-based antiseptic product immediately before the touch observed. The levels of contact were defined as: Level 1, a touch of the observed neonate’s immediate environment but outside the Isolette/bassinet (e.g. ventilator, intravenous infusion set or patient chart), Level 2, a touch inside the Isolette/bassinet but not to the neonate directly; and Level 3, a direct touch to the neonate. The highest level of touch to each neonate was recorded (i.e. if a staff member adjusted the neonate’s iv equipment and then touched the neonate, a Level 3 touch was recorded). Data were collected on a standard form.

Data analysis

The data were analyzed with SPSS software (Chicago, IL). The total number of touches in every category was entered as the rate of touches per neonate per h for each individual observation period and then multiplied by 12 to represent the rate per baby per shift. One way analysis of variance was used to compare mean differences in touches by type of individual making the contact, condition of the hands (i.e. gloved or ungloved, washed or unwashed), level of contact and differences between NICU A and NICU B.

RESULTS

Touches were observed by the study team during 38 observation periods; 25 occurred in NICU A and 13 in NICU B for a total of 41.6 h. Of the 1472 touches observed in this study, more than one-half (815 of 1472; 55.4%) were made by nurses, 16.7% by visitors, 13.1% by physicians in training, 7.9% by other health care workers and 6.9% by attending physicians. The individuals observed during this study were adherent with the policies for hand hygiene standards (i.e. the use of either new gloves and/or cleaned hands for contacts with neonates) only 28.2% (415 of 1472) of the time. In contrast the majority of contacts were made with uncleaned ungloved hands (864 of 1472; 58.7%) or with used gloves (193 of 1472; 13.1%).

Level 3 touches directly to the infants were most common, accounting for 50.3% (741 of 1472) (Table 1). Level 2 touches inside the Isolette and Level 1 touches outside the Isolette represented 12.3% ($n = 181$) and 37.4% ($n = 550$), respectively. Among all disciplines nurses were most likely to use all three types of touches and were responsible for 53.5, 65.2 and 54.4% of Level 1, 2 and 3 touches, respectively.

Differences in practices by type of touch and discipline

There were significant differences in the observed hand hygiene practices of staff during different levels of touches. Hand hygiene practices improved when the infants were touched directly. Nurses ($P = 0.001$), attending physicians ($P = 0.02$) and physicians-in-training ($P = 0.03$) were all significantly more likely to use appropriate practices during Level 3 touches

than during Level 1 and 2 touches, as shown in Table 1. During direct touches to the neonate (Level 3), new gloves and/or washed hands were used by attending physicians (55.1%; 27 of 49), physicians-in-training (49.4%; 40 of 81) other healthcare workers (55.3%; 21 of 38) and nurses (46.2%; 186 of 403). Nurses used ungloved, unwashed hands during 74.8% of touches outside the Isolette (Level 1), 48.3% of touches inside the Isolette (Level 2) and 31.5% of direct touches to the infants (Level 3). Similarly when the hand hygiene practices of all disciplines were combined, 82.2% of Level 1 touches were made with uncleaned, ungloved hands, and this practice was reduced to 53.1% with Level 2 touches and further reduced to 42.6% with Level 3 touches.

Visitors did not adhere to recommended hand hygiene practices. More than 80% of observed touches by visitors were made with unwashed hands, although it was possible that some had washed their hands at a sink in the outer hallway and were not observed doing so by the research assistants.

Differences in practices by NICU

There were several significant differences in hand hygiene practices of staff in NICU A, in which staff used an alcohol-based product, as compared with NICU B, in which staff used a detergent-based product containing 2% chlorhexidine gluconate. On average each neonate, their Isolette or equipment was touched by staff or visitors 78 times during a 12-h shift. However, the total number of touches (all levels) was significantly greater in NICU B (103.4 vs. 65.2 touches per neonate per shift, respectively; $P = 0.02$). Neonates were directly touched (Level 3) by staff members a mean of 29.1 times per shift in NICU A and 36.7 times in NICU B. However, the mean number of Level 3 touches by staff members (excluding visitors) with “clean” hands (i.e. new gloves and/or cleaned hands) was greater in NICU A than in NICU B, (18.21 vs. 6.69 touches/shift, respectively; $P < 0.01$), as shown in Table 2. For attending physicians and other health care workers (but not for nurses or physicians-in-training), significantly more Level 3 touches in NICU A were with cleaned hands, both gloved and ungloved (all $P < 0.03$).

DISCUSSION

This represents one of the first studies to characterize differences in hand hygiene practices not only by profession but also by level of patient contact. Additionally this study demonstrates that staff members in the NICU using an alcohol-based product were significantly more likely to touch neonates with clean hands than staff on the NICU using an antiseptic detergent. The findings of this study are consistent with previous reports of suboptimal hand hygiene,⁹⁻¹³ as well as reports of differences in hand hygiene behavior between different disciplines of hospital staff^{5, 14, 15} or different hand hygiene regimens.¹⁶⁻¹⁸ More than one-half of the touches made directly to neonates were with unwashed ungloved hands, providing a means of contaminating the immediate environment of each neonate and a potential reservoir for patient-to-patient spread of potential pathogens. Although adherence to appropriate hand hygiene by every profession did increase as the level of contact with the neonate increased (i.e. staff were least likely to have uncleaned, ungloved hands when they directly touched an infant), unchanged gloves were still worn for 15.9% of direct contacts with neonates, and cleaned, gloved hands were used in only 17% of direct contacts.

A recent study reported that gender and profession may interact, because it was shown that women and nurses of both genders tended to wash more often than men and physicians.¹⁹ However, in this study we did not find that nurses demonstrated greater adherence to hand hygiene protocols than other health care professionals. We observed that nurses wore used gloves for 22.3% of direct contacts and no gloves with uncleaned hands for almost one-third of direct neonatal contacts. Nurses also had cleaned gloved hands for direct contact with

neonates less frequently than any other professional group. These findings are concerning, considering that more than one-half of all contacts with neonates and their equipment and environment were made by nurses.

This study had strengths and limitations. The large number of observations allowed for good statistical power and there was excellent interrater reliability between the two observers. Because the observations were conducted openly by research assistants involved in the larger clinical trial, the NICU nurses and physicians were probably more aware of their own hand hygiene practices and of the fact that observations were being made. However, workers who came to the unit less frequently may not have been aware of the study or the purpose of the research assistants. The groups of workers least likely to be aware of the observations (i.e. other health care workers such as phlebotomists, respiratory therapists or radiology technicians) had the highest rates of appropriate hand hygiene when directly touching a neonate.

The data collection was limited to a single month, and observations were only made during the day shift. Hence we were unable to compare the hand hygiene practices of staff and visitors during other shifts. Because our primary aim was to examine the overall types and numbers of contacts to neonates in the NICU while protecting the anonymity of individual staff members, we did not identify hand hygiene practices of specific members of the staff. Therefore it was not possible to analyze the data for gender differences in practice or to count the number of different individuals contacting each neonate. Further we could not determine whether only certain staff members practiced poor hand hygiene repeatedly whereas others habitually practiced good hand hygiene. Finally the observation instrument was developed for the purposes of this study and has not been tested in other studies.

The hand hygiene practice differences between the two hospitals were substantial. NICU A has a smaller, older, more crowded unit whereas NICU B is a newer, spacious facility. We are uncertain why neonates were touched significantly more often in NICU B, but this could be a surrogate marker for care needs or for differences in practice patterns. The universal gloving policy of NICU A almost certainly influenced practice, but this was not the only explanation for practice variations because both gloved cleaned hands and ungloved but cleaned hands were used significantly more often in NICU A than NICU B. Also the difference in protocols does not explain the large difference in the rate of touches with unwashed ungloved hands.

Staff in the two NICUs were using two different hand hygiene products. Staff members on the unit using the alcohol product (NICU A) were significantly less likely to touch neonates with unclean or ungloved hands than staff on the unit using a traditional antimicrobial soap. The fact that the alcohol hand rubs were available in pocket size bottles as well as being placed at each bedside precludes the necessity to travel to a sink and facilitates hand hygiene. Others have found that such alcohol products are more convenient and have been associated with increased adherence to accepted hand hygiene standards.^{10, 20-22} Our data are consistent with this observation and with the recently published CDC Guideline for Hand Hygiene in Health Care Settings³ which recommends alcohol-based rubs over antimicrobial soaps for staff hand hygiene.

In previous research traditional interventions to change hand hygiene behavior such as staff education and feedback have not resulted in sustained improvements.²³ One intervention study demonstrated a significant positive association between overt administrative commitment to hand hygiene and improved frequency of handwashing as well as reductions in rates of certain infections. The administrative support was demonstrated by communications in the hospital newsletter, posters, pay stubs and other formats encouraging handwashing and by requiring that each staff member complete a competency demonstration in handwashing during

orientation.²⁴ Hence it would seem that an intervention which includes the adoption of the newer alcohol-based products accompanied by strong administrative support has the potential to improve hand hygiene practices. Because staff often overestimate the frequency with which they practice hand hygiene,^{15, 25-27} observational studies such as our study can be used as baseline data to increase staff awareness of actual practices and to evaluate the effects of interventions to improve hand hygiene behavior.

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REFERENCES

1. Farr BM. Reasons for noncompliance with infection control guidelines. *Infect Control Hosp Epidemiol* 2000;21:411–16. [PubMed: 10879574]
2. Larson EL. APIC guideline for handwashing and hand antisepsis in health care settings. *Am J Infect Control* 1995;23:251–69. [PubMed: 7503437]
3. Boyce J, Pittet D. Am J Infect Control. Guideline for hand hygiene in health-care settings. *Am J Infect Control* 2002;30:S1–46. [PubMed: 12461507]
4. Watanakunakorn C, Wang C, Hazy J. An observational study of hand washing and infection control practices by healthcare workers. *Infect Control Hosp Epidemiol* 1998;19:858–60. [PubMed: 9831945]
5. Pittet D, Mourouga P, Perneger TV. Compliance with handwashing in a teaching hospital. *Ann Intern Med* 1999;130:126–30. [PubMed: 10068358]
6. Albert RK, Condie F. Hand-washing patterns in medical intensive-care units. *N Engl J Med* 1981;304:1465–6. [PubMed: 7248048]
7. Sproat LJ, Inglis TJ. A multicentre survey of hand hygiene practice in intensive care units. *J Hosp Infect* 1994;26:137–48. [PubMed: 7911148]
8. Maury E, Alzieu M, Baudel JL, et al. Availability of an alcohol solution can improve hand disinfection compliance in an intensive care unit. *Am J Respir Crit Care Med* 2000;162:324–7. [PubMed: 10903262]
9. Pittet D. Improving adherence to hand hygiene practice: a multidisciplinary approach. *Emerg Infect Dis* 2001;7:234–40. [PubMed: 11294714]
10. Pittet D. Improving compliance with hand hygiene in hospitals. *Infect Control Hosp Epidemiol* 2000;21:381–6. [PubMed: 10879568]
11. Larson E, McGinley K, Foglia A, et al. Handwashing practices and resistance and density of bacterial hand flora on two pediatric units in Lima, Peru. *Am J Infect Control* 1992;65–72. [PubMed: 1590601]
12. Larson EL, Kretzer EK. Compliance with handwashing and barrier precautions. *J Hosp Infect* 1995;30 (Suppl):88–106. [PubMed: 7561001]
13. Karabey S, Ay P, Derbentli S, Nakipoglu Y, Esen F. Handwashing frequencies in an intensive care unit. *J Hosp Infect* 2002;50:36–41. [PubMed: 11825050]
14. Pittet D, Hugonnet S, Harbarth S, et al. Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. *Lancet* 2000;356:1307–12. [PubMed: 11073019]
15. Larson EL, McGinley K, Grove G, Leyden JJ, Talbot G. Physiologic, microbiologic and seasonal effects of handwashing on the skin of health care personnel. *Am J Infect Control* 1986;14:51–9. [PubMed: 3635374]
16. Larson EL, Aiello AE, Bastyr J, et al. Assessment of two hand hygiene regimens for intensive care unit personnel. *Crit Care Med* 2001;29:944–51. [PubMed: 11378602]
17. Larson E, Silberger M, Jakob K, et al. Assessment of alternative hand hygiene regimens to improve skin health among neonatal intensive care unit nurses. *Heart Lung* 2000;29:136–42. [PubMed: 10739490]
18. Hugonnet S, Perneger TV, Pittet D. Alcohol-based handrub improves compliance with hand hygiene in intensive care units. *Arch Intern Med* 2002;162:1037–43. [PubMed: 11996615]

19. Van De Mortel T, Bourke R, McLoughlin J, Nonu M, Reis M. Gender influences handwashing rates in the critical care unit. *Am J Infect Control* 2001;29:395–9. [PubMed: 11743487]
20. Voss A, Widmer AF. No time for handwashing!? Handwashing *versus* alcoholic rub: can we afford 100% compliance? *Infect Control Hosp Epidemiol* 1997;18:205–8. [PubMed: 9090551]
21. Widmer A. Replace hand washing with use of a waterless alcohol hand rub? *Clinical Infect Dis* 2000;31:136–43. [PubMed: 10913411]
22. Bischoff WE, Reynolds TM, Sessler CN, Edmond MB, Wenzel RP. Handwashing compliance by health care workers: the impact of introducing an accessible, alcohol-based hand antiseptic. *Arch Intern Med* 2000;160:1017–21. [PubMed: 10761968]
23. Kretzer EK, Larson E. Behavioral interventions to improve infection control practices. *Am J Infect Control* 1998;26:245–53. [PubMed: 9638287]
24. Larson EL, Early E, Cloonan P, Sugrue S, Parides M. An organizational climate intervention associated with increased handwashing and decreased nosocomial infections. *Behav Med* 2000;26:14–22. [PubMed: 10971880]
25. Cohen HA, Matalon A, Amir J, Paret G, Barzilai A. Handwashing patterns in primary pediatric community clinics. *Infection* 1998;26:45–7. [PubMed: 9505181]
26. Seto WH. Staff compliance with infection control practices: application of behavioural sciences. *J Hosp Infect* 1995;30(Suppl):107–15. [PubMed: 7560941]
27. Nishimura S, Kagehira M, Kono F, Nishimura M, Taenaka N. Handwashing before entering the intensive care unit: what we learned from continuous video-camera surveillance. *Am J Infect Control* 1999;27:367–9. [PubMed: 10433677]

TABLE 1
Staff hand hygiene practices by level of contact and hand hygiene practice expressed as number of touches

Level of Touch	Discipline	New Gloves ± Cleaned Hands (%)	Used Gloves (%)	No Gloves/Uncleaned Hands (%)	Total Touches by Discipline and Contact Level [†]
Level 1: touch outside Isolette only	Nurse	13.6 (40) [‡]	11.6 (34)	74.8 (220)	294
	M.D. attending	8.7 (4)	0 (0)	91.3 (42)	46
	M.D. training	3.2 (3)	6.5 (6)	90.3 (84)	93
	Other worker	7.6 (5)	1.5 (1)	90.9 (60)	66
	Visitors	9.8 (5)	0 (0)	90.2 (46)	51
Level 2: touch inside Isolette, but not infant	Row total	10.4 (57)	7.4 (41)	82.2 (452)	550 (37.4%)
	Nurse	33.1 (39)	18.6 (22)	48.3 (57)	118
	M.D. attending	16.7 (1)	11.5 (1)	77.0 (4)	6
	M.D. training	5.3 (1)	36.8 (7)	57.9 (11)	19
	Other worker	53.8 (7)	23.1 (3)	23.1 (3)	13
Level 3: touch infant directly	Visitors	16.0 (4)	0 (0)	80.6 (21)	25
	Row total	28.7 (52)	18.2 (33)	53.1 (96)	181 (12.3%)
	Nurse	46.2 (186)	22.3 (90)	31.5 (127)	403
	M.D. attending	55.1 (27)	4.1 (2)	40.8 (20)	49
	M.D. training	49.4 (40)	22.2 (18)	28.4 (23)	81
	Other worker	55.3 (21)	23.7 (9)	21.0 (8)	38
	Visitors	18.8 (32)	0 (0)	81.2 (138)	170
	Row total	41.3 (306)	16.1 (119)	42.6 (316)	741 (50.3%)
	Column totals	28.2 (415)	13.1 (193)	58.7 (864)	100% (1472)

* Cleaned hands handwashing or application of an alcohol-based hand product.

[†] Statistically significant differences in hand hygiene practices between levels of baby contact for nurses ($P = 0.001$), attending physicians ($P = 0.02$), physicians-in-training ($P = 0.03$), visitors ($P < 0.000$) and all groups combined ($P < 0.000$), but not for other health care workers ($P = 0.27$), analysis of variance.

[‡] Numbers in parentheses, number of touches, unless otherwise noted.

Comparison of hand hygiene practices in two NICUs using different hand hygiene products*

TABLE 2

NICU	New Gloves and/or Cleaned Hands [†]	Used Gloves	No Gloves and Uncleaned Hands
NICU A (using alcohol product)	18.21	6.69	4.23
NICU B (using antiseptic detergent)	11.37	5.68	19.62

Chi-square comparing practices between the two units: 10.87, $P < 0.01$.

* Data compared are the mean number of Level 3 (direct) touches by all staff members per neonate per shift.

[†] Cleaned hands handwashing or application of a waterless alcohol hand product.