Reduction in nosocomial infection with improved hand hygiene in intensive care units of a tertiary care hospital in Argentina

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Background: Hand hygiene is a fundamental measure for the control of nosocomial infection. However, sustained compliance with hand hygiene in health care workers is poor. We attempted to enhance compliance with hand hygiene by implementing education, training, and performance feedback. We measured nosocomial infections in parallel.

Methods: We monitored the overall compliance with hand hygiene during routine patient care in intensive care units (ICUs); 1 medical surgical ICU and 1 coronary ICU, of 1 hospital in Buenos Aires, Argentina, before and during implementation of a hand hygiene education, training, and performance feedback program. Observational surveys were done twice a week from September 2000 to May 2002. Nosocomial infections in the ICUs were identified using the National Nosocomial Infections Surveillance (NNIS) criteria, with prospective surveillance.

Results: We observed 4347 opportunities for hand hygiene in both ICUs. Compliance improved progressively (handwashing adherence, 23.1% (268/1160) to 64.5% (2056/3187) (RR, 2.79; 95% CI: 2.46-3.17; $P < .0001$). During the same period, overall nosocomial infection in both ICUs decreased from 47.55 per 1000 patient-days (104/2187) to 27.93 per 1000 patient days (207/7409) RR, 0.59; 95% CI: 0.46-0.74, $P < .0001$).

Conclusion: A program consisting of focused education and frequent performance feedback produced a sustained improvement in compliance with hand hygiene, coinciding with a reduction in nosocomial infection rates in the ICUs. (Am J Infect Control 2005;33:392-7.)

Nosocomial infections are associated with considerable morbidity, extra cost, and attributable mortality. We have previously reported a very high rate of nosocomial infection in Argentina.[1,2] Hand hygiene is a fundamental aspect of infection control, with several studies showing a decline in nosocomial infection rates when compliance with hand hygiene is enhanced.[3-8] Despite universal acknowledgement of the pivotal role that hand hygiene plays in reducing nosocomial infection, compliance among health care workers remains poor, with rates ranging from 16% to 81%.[9-11] Numerous strategies have been attempted to enhance compliance with hand hygiene: some of which have resulted in improved short-term compliance[9,10,12]; however, achievement of sustained improvement remains elusive.[5]

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In a previous study in Argentina, with education and performance feedback, adherence to hand hygiene improved considerably.[13] We noted disappointing compliance rates with hand hygiene in our institution and developed a program consisting of focused, frequent education of health care workers, emphasizing adherence to published guidelines and performance feedback. We measured nosocomial infection rates at baseline[1] and during the intervention to determine whether improved compliance would be associated with a reduction in nosocomial infections.

METHODS

Setting

The study was conducted in 2 ICUs of a private, 180-bed tertiary care teaching hospital situated in the city of Buenos Aires. There is an infection control team composed of a medical doctor (with formal education and background in internal medicine, infectious diseases, and hospital epidemiology), an infection control nurse, and personnel support.[1] There is 1 medical surgical intensive care unit (12 beds) and 1 coronary intensive care unit (12 beds). Handwashing facilities are available, with 3 sinks in each intensive care unit with 4% chlorhexidine handwash dispensers and paper towels. The study proposal was submitted to

the infection control committee, which included representative leadership of each hospital and ICU personnel. The institutional review board at each center approved the study protocol. Patient confidentiality was protected by coding the recorded information only identifiable by infection control teams.

Hand hygiene definition

According with the last Guidelines for Hand Hygiene in Health-Care Settings, we defined *hand hygiene* as a general term that applies to either handwashing, antiseptic handwash, or antiseptic handrub. We defined *handwashing* as washing the hands with plain, nonantimicrobial soap and water. Antiseptic *handrub* was defined as a process when applying an antiseptic handrub product to the entire surface of the hand to reduce the number of present microorganisms.[14]

Hand hygiene intervention

The hand hygiene program started in September 2000. We divided the program into 2 phases: phase 1 (or baseline handwashing compliance), from September to December 2000 (4 months); and phase 2 (or intervention period), from January 2001 to May 2002 (17 months). A comprehensive infection control manual was distributed to health care workers (HCW), and we used the Association for Professionals in Infection Control (APIC) hand hygiene guideline as an educational tool for this study.[15] Baseline and postintervention data regarding compliance of HCW with hand hygiene before contact with patients were collected in the ICUs by a trained infection control practitioner, who covertly observed the handwashing techniques of the health care workers at random times, including all shifts, for 30-minute intervals during each phase of the study. Data on handwashing compliance including unit, shift, sex, and category of HCW (physician, nurse, and ancillary staff) were recorded on a specially designed form.

Interventions to improve hand hygiene compliance included monthly meetings at which visual displays of handwashing rates were presented. These were also posted monthly in the 2 ICUs. Focused education of all HCWs was provided. Educational classes were given in 1-hour group sessions for all shifts every day for 1 week. Each participant was given the infection control manual, and the APIC hand hygiene guideline was used as an educational tool to reinforce classroom teaching.

Attendance was voluntary, supported by the administrator, and monitored. Each HCW could attend the course as many times as desired. Theoretic and practical indications for the use of hand hygiene were reviewed. The guidelines were also posted at a strategic location in each ICU. Posttests to evaluate retention of educational material were given 1 month later. The primary investigator routinely held infection control review classes to provide an opportunity for infection control questions and share surveillance data. Frequent feedback was provided regarding hand hygiene rates and nosocomial infection rates, consisting of reports to the ICU manager and administrator, graphic presentations of hand hygiene rates displayed in meetings, and feedback data posted in the ICUs. We did not change soap or antibiotic use. The senior hospital management provided full administrative support for the study. No external funding was provided. The human resources for the intervention were those of the infection control program.

Outcome measures

Hand hygiene compliance was observed simultaneously along with multiple other infection control responsibilities in the ICU. The infection control program is well-known by the ICU staff, and, although the HCWs were informed that their hand hygiene practices were being monitored, the staff was not aware of precisely when these observations were being made. We commenced education on January 2001 and started performance feedback on May 2001, after which HCWs were aware that their hand hygiene practices were being monitored. Trained staff observed the handwashing technique of physicians, nursing staff, and technicians at random times twice a week, including all work shifts for 30-minute intervals during each phase of the study.

The contacts were monitored with direct observation, and the infection control practitioners (ICPs) recorded the handwashing processes before contact with each patient. One nurse was trained to detect handwashing compliance and to record it on a form designed for the study. To provide feedback, bar charts of handwashing rates were displayed at monthly meetings and posted each month in the ICUs.

Nococomial infections were identified by a trained infection control nurse in the ICUs according to adapted standard definitions of the Centers for Disease Control and Prevention.[16] The ICP obtained such information from the medical records nurse charts, microbiology laboratory reports, and other laboratory results, including white cell counts, radiographs, and other available tests. We followed the patients for 48 hours after discharge from the ICUs. Prospective surveillance for nosocomial infections has been carried out in our hospital since September 2000 to May 2002 with standardized methods.[17]

Nosocomial infection definitions

Ventilator-associated pneumonia. Criterion 1: a mechanically ventilated patient has rales or dullness

to percussion on physical examination of the chest and at least 1 of the following: new onset of purulent sputum or change in character of sputum; organism cultured from blood; isolation of an etiologic agent from a specimen obtained by transtracheal aspirate, bronchial brushing, or biopsy.[16]

Criterion 2: a mechanically ventilated patient has a chest radiographic examination that shows a new or progressive infiltrate, consolidation, cavitation, or pleural effusion and at least 1 of the following: new onset of purulent sputum or change in character of sputum; organism cultured from blood; isolation of an etiologic agent from a specimen obtained by transtracheal aspirate, bronchial brushing, or biopsy; or histopathologic evidence of pneumonia.[16]

Laboratory-confirmed, catheter-associated bloodstream infection. A patient with a central venous catheter has a recognized pathogen cultured from 1 or more percutaneous blood cultures, after 48 hours of vascular catheterization, and the pathogen cultured from the blood is not related to an infection at another site and patient has at least 1 of the following signs or symptoms: fever (≥38°C), chills, or hypotension. With common skin commensals (eg, diphtheroids, Bacillus species, Propionibacterium species, coagulase-negative staphylococci, or micrococci), the organism is cultured from 2 or more blood cultures drawn on separate occasions.[16]

Clinically suspected, catheter-associated bloodstream infection. A patient with a central venous catheter has at least 1 of the following clinical signs, with no other recognized cause: fever (≥38°C), hypotension (systolic blood pressure ≤90 mm Hg), or oliguria (≤20 mL/hr); but blood cultures were not obtained or no organisms were recovered from blood cultures, but there is no apparent infection at another site and the physician institutes treatment.[16]

Symptomatic catheter-associated urinary tract infection. Criterion 1: A patient with a foley urinary catheter has 1 or more of the following with no other recognized cause: fever (≥38°C), urgency, frequency, or suprapubic tenderness, and the urine culture is positive for $\geq 10^5$ CFU/mL with no more than 2 microorganisms.[16]

Criterion 2: A patient with a foley urinary catheter has at least 2 of the following signs of infection with no other recognized cause: positive dipstick for leukocyte esterase and/or nitrate; pyuria (≥10 WBC/mL); organisms are seen on Gram's stain; physician diagnoses a urinary tract infection; or physician initiates appropriate therapy for a urinary tract infection.[16] Nosocomial infection rates were calculated by dividing the total number of nosocomial infections by the number of patient-days and multiplied by 1000.

Statistical analysis

Our a priori hypothesis was that we could increase hand hygiene compliance to 70%, with reduction in nosocomial infection by 30% in keeping with results of the SENIC study.[18] Differences in proportions were compared by χ^2 tests providing relative risk, corresponding 95% confidence intervals, and P value. Changes in compliance over time were estimated in a univariate analysis with the first survey as the reference point (Epi Info, version 6.04b, Centers for Disease Control and Prevention, Atlanta, GA). Two-tailed P values of less than .05 were considered to indicate statistical significance.

RESULTS

Between September 2000 and May 2002, we obtained data on a total of 4347 opportunities for hand hygiene (Table 1). The baseline phase (or phase 1) was from September 2000 to December 2000 (4 months), and the intervention phase (or phase 2) was from January 2001 to May 2002 (17 months). Overall compliance improved from 23.1% in phase 1 to 64.5% in phase 2 (RR, 2.79; 95% CI: 2.46-3.17; $P < .0001$) (Table 1).

Divided into 4 periods, period 1 (from September to December 2000), period 2 (from January to June 2001), period 3 (from July to December 2001) and period 4 (from January to May 2002), we found that the compliance was higher in period 2 when comparing period 2 (724/1353, 53.5%) with period 1 (268/1160, 23.1%) (RR, 2.32; 95% CI: 2.01-2.66; $P = .0001$). The compliance was higher in period 3 when comparing period 3 (828/1148, 72.1%) with period 2 (724/1353, 53.5%) (RR, 1.35; 95% CI: 1.22-1.49; $P = .0001$). The compliance was similar comparing period 4 (518/701, 73.8%) with period 3 (828/1148, 72.1%) (RR, 1.02; 95% CI: 0.92-1.14, $P = .665$) (Table 2).

The compliance was higher for nurses (59.6%) compared with physicians (30.8%) (RR, 1.31; 95% CI: 1.11-1.54; $P = .0012$). The compliance was higher for nurses (59.6%) compared with ancillary staff (37.1%) (RR, 1.39; 95% CI: 1.18-1.64; $P < .0001$). The compliance was similar for physicians (30.8%) compared with ancillary staff (37.1%) (RR, 0.94; 95% CI: 0.76-1.17; $P = .6010$). The compliance was higher for women (57.8%) compared with men (43.2%) (RR, 1.23; 95% CI: 1.09-1.38; $P = .0005$). The compliance was higher for superficial (56.7%) compared with invasive procedures (48.1%) (RR, 1.21; 95% CI: 1.08-1.35; $P = .0008$). The compliance was higher during the night work shift (66.0%) compared with afternoon work shift (50.2%) (RR, 1.18; 95% CI: 1.02-1.37; $P = .02$). The compliance was similar during the night

Table 1. Improvement in compliance rates in 2 phases

Year	Opportunities for hand hygiene	Observed handwashing episodes	Adherence (%)	RR	95% CI	*P* value
2000	1160	268	23.1%	2.79	2.46-3.17	<.0001
2001-2002	3187	2056	64.5%			

Table 2. Improvement in compliance rates in 4 phases

Period	Year	Months	Opportunities for HH	Observed HH episodes	HH adherence (%)	RR	95% CI	*P* value
1	2000	9-12	1160	268	23.10			
2	2001	1-6	1353	724	53.5	1 vs 2 = 2.32	2.01-2.66	.0001
3	2001	7-12	1148	828	72.1	2 vs 3 = 1.35	1.22-1.49	.0001
4	2002	1-5	701	518	73.8	3 vs 4 = 1.02	0.92-1.14	.665

HH, hand hygiene.

work shift (66.0%) and morning work shift (52.2%) (RR, 1.08; 95% CI: 0.93-1.25; $P = .294$). The compliance was similar during the morning work shift (52.2%) compared with afternoon work shift (50.2%) (RR, 1.09; 95% CI: 0.97-1.23; $P = .1420$). The compliance was similar for medical surgical ICU (53.5%) compared with coronary care unit (53.6) (RR, 1.0; 95% CI: 0.9-1.11; $P = .97$) (Table 3). During the same period, overall nosocomial infection in both ICUs decreased from 47.55 per 1000 patient-days (104/2187) to 27.93 per 1000 patient days (207/7409) (RR, 0.59; 95% CI: 0.46-0.74; $P < .0001$) (Table 4).

DISCUSSION

A large body of literature exists on the challenging task of achieving compliance with hand-hygiene recommendations in the health care setting. Pittet et al studied predictors of noncompliance with hand hygiene in an observational study and found that, in multivariate analysis, physicians and nursing assistants had lower compliance rates than nurses. Of concern, compliance was lower in ICUs and during procedures that carried a high risk of contamination.[19] In a more recent cross-sectional survey of 163 physicians, the same investigators reported that adherence to hand hygiene was associated with awareness of being observed and ready availability of handrubs. Gaps in knowledge regarding guidelines and the importance of hand hygiene is another barrier reported in the literature.[20] Larson et al have reported some perceived barriers include ignorance of the importance and impact of hand hygiene and lack of information regarding the existence of published guidelines.[21] Several interventions have been attempted to improve hand hygiene practices; among the most effective have been those that emphasize targeted education and frequent performance feedback.[10,22-25] Dubbert et al found that, although education alone improved compliance rates transiently, performance feedback resulted in a more sustained improvement in compliance[10]; rates of infection were, however, not reported in this study. More recently, patient education has received attention as a possible means of improving adherence to hand hygiene in HCWs. In a pre- and postintervention study in an inpatient rehabilitation unit, McGuckin et al used a patient education model consisting of patients asking HCWs coming into contact with them whether they had washed their hands. Compliance (measured through soap/sanitizer usage per resident-day) improved to 94% during the 6-week intervention. However, adherence to hand hygiene fell to 40% in the follow-up period.[26]

Our study expands the current body of literature by showing the impact of a relatively low-cost strategy–education and performance feedback–in not only increasing adherence to hand hygiene but also a decline in nosocomial infection in a developing country and is the first showing reduction of nosocomial infection by improving hand hygiene in Latin America. We found a 42% relative reduction in nosocomial infection rates by emphasizing compliance with hand hygiene. Our results are in keeping with those of other studies that reported a considerable decline in nosocomial infections after enhanced compliance with hand hygiene.[4,6] We found lower adherence among physicians, and during invasive procedures, which is similar to the results reported by Pittet et al and represent an ongoing challenge to improve.[19]

In our study, we did not make a change in the choice of hand hygiene agent. Prior randomized trials using nosocomial infections as the outcome measure have found that handwashing with 2% to 4% chlorhexidine is associated with lower rates of nosocomial infection.[4,27,28] More recently, the use of alcohol-based hand sanitizers has become widespread. Alcohol-based handrubs are recommended in the most recent CDC hand hygiene guideline[29] and have been associated with increased compliance with hand hygiene and, in some studies, lower nosocomial infection rates.[5,6]

Table 3. Adherence to hand hygiene

Variable	Opportunities for HH	Observed HH episodes	Adherence (%)	RR	95% CI	*P* value
MS-ICU	1271	680	53.5	MS-ICU vs CO-CU = 1.0	0.9-1.11	.97
CO-CU	1293	693	53.6			
Women	1701	972	57.8	Women vs men = 1.23	1.09-1.38	.0005
Men	862	401	43.2			
Nurse	1806	1047	59.6	Nurse vs physician = 1.31	1.11-1.54	.001
Physician	375	166	30.8			
Ancillary staff	383	160	37.1			
Superficial	1534	882	56.7	Superfic vs invas = 1.21	1.08-1.35	.0008
Invasive	1030	491	48.1			
Night	428	253	66.0	Night vs morning = 1.18	1.02-0.37	.02
Morning	1107	605	52.2			
Afternoon	1029	515	50.2			

MS-ICU, medical surgical intensive care unit; *CO-CU*, coronary care unit; *superfic*, superficial contact; *invas*, invasive contact; *HH*, hand hygiene.

Table 4. Nosocomial infections distribution by phase

Phase	1	2	RR	95% CI	*P* value
Period	September 2000-December 2000	January 2001-May 2002			
Central vascular catheter-associated LCBI	15	12			
Central vascular catheter-associated CSEP	21	11			
Peripheral vascular catheter-associated LCBI	3	4			
Peripheral vascular catheter-associated CSEP	1	2			
Ventilator-associated pneumonia	29	69			
Pnuemonia not associated to ventilator	10	51			
Catheter-associated UTI	25	56			
UTI not associated to catheter	0	2			
Total nosocomial infections	104	207			
Bed days	2187	7409			
Nosocomial infections per 1000 bed days	47.55	27.93	0.59	0.46-0.74	.0001

LCBI, Laboratory confirmed bloodstream infections; *CSEP*, clinical sepsis; *UTI*, urinary tract infection.

Our study has several limitations. This was not a randomized study; randomization of hand hygiene versus no hand hygiene is not feasible because of ethical reasons and the recognized value of handwashing. The Hawthorne effect must be taken into consideration in every behavioral study in which a short-term impact of the intervention may be seen as a result of behavior change stemming from being observed. The relatively long follow-up period of our study and demonstration of sustained improvement in hand hygiene adherence make this effect less of a concern. Its quasiexperimental design and implementation of other simultaneous specific infection control interventions to reduce CVC-associated bloodstream infections,[30] and urinary catheter-associated UTIs,[31] make the true impact of the hand hygiene program difficult to assess.

Our results have, in part, been published in 2 previous reports, one reporting on rates of catheter-associated UTI,[31] which overlapped for 17 of 21 months with the present study and the other reporting rates of CVC-associated bloodstream infections,[30] which overlapped for 7 of 21 months with the present study. These 2 previous studies analyzed only catheter-associated UTI and CVC-associated bloodstream infections. We expand these results in our current study to include the effect of hand hygiene on the following nosocomial infections beyond those but including those previously reported: ventilator-associated pneumonia, nosocomial pneumonia not associated with ventilators, central vascular catheter-associated bloodstream infections, peripheral vascular catheter-associated bloodstream infections, catheter-associated UTI, and UTI not associated with catheterization. The performance feedback was effective in achieving increased adherence to hand hygiene; however, this strategy requires considerable institutional commitment and environmental changes to enhance compliance.

In conclusion, our study shows that a program focused on education and performance feedback of HCWs is effective in promoting hand hygiene and lowering nosocomial infection rates. Although institutional support and frequent observation is required for such a program to be successful, it is a relatively low-cost approach that may be especially attractive in developing countries.

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