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Major article

Impact of the International Nosocomial Infection Control Consortium multidimensional hand hygiene approach in 3 cities in Brazil

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Background: Hand hygiene (HH) is the main tool for cross-infection prevention, but adherence to guidelines is low in limited-resource countries, and there are not available published data from Brazil.
Methods: This is an observational, prospective, interventional, before-and-after study conducted in 4 intensive care units in 4 hospitals, which are members of the International Nosocomial Infection Control Consortium (INICC), from June 2006-April 2008. The study was divided into a 3-month baseline period and a follow-up period. A multidimensional HH approach was introduced, which included administrative support, supplies availability, education and training, reminders in the workplace, process surveillance, and performance feedback. Health care workers were observed for HH practices in each intensive care unit during randomly selected 30-minute periods.
Results: We recorded 4,837 opportunities for HH, with an overall HH compliance that increased from 27%-58% ($P < .01$). Multivariate analysis showed that some variables were associated with poor HH compliance: men versus women (49% vs 38%, $P < .001$), nurses versus doctors (55% vs 48%, $P < .02$), among others.
Conclusions: With the implementation of the INICC approach, adherence to HH was significantly increased. Programs should be aimed at improving HH in variables found to be predictors of poor HH compliance.

Over more than a century ago, when the relation between improved hand antisepsis and reduced mortality from puerperal sepsis was being studied by Semmelweis,[1] it was shown that appropriate hand hygiene (HH) before patient contact was a fundamental tool for infection prevention. Different studies have reported that an improved HH practice was associated with the

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reduction of antimicrobial resistance and rates of health care–associated infection (HAI).[2-4]

The threat to patient safety posed by HAIs includes morbidity and mortality.[5] As shown in the mainstream scientific literature, most studies addressing HAIs have been conducted in developed countries.[6] In 2002, the International Nosocomial Infection Control Consortium (INICC) began to apply standardized definitions and methods, contributing to systematically measuring and analyzing HAI rates worldwide.[7-11]

HH serves a crucial role in preventing cross transmission of HAIs, and successful interventions to improve HH have been reported both from developed countries[12] and limited-resource countries.[3,13,14] From the 1980s, investigators have analyzed the effectiveness of interventions to improve HH, including the impact of supplies availability,[15] the use of reminders and posters at the workplace,[16] the use of monitoring and performance feedback,[17] administrative support,[18] the introduction of alcohol-based hand rub (AHR),[19] and the effectiveness of education.[20,21] In 1997, Larson et al[18] explicitly referred to a multidimensional approach that considered several interventions in a study conducted in the United States. Likewise, Rosenthal et al implemented programs in Argentina combining administrative support, supplies availability, education and training, process surveillance, and performance feedback, which produced a sustained improvement in HH compliance,[14] with a reduction in HAI rates.[3]

In 2002, the Centers for Disease Control and Prevention published a HH guideline.[22] With a view to promote HH from a global angle, in 2005 the World Health Organization (WHO) launched the program Clean Care is Safer Care.[23] In 2009, the WHO published its guidelines presenting a compilation of previously published data, a new formulation for AHR products, among several other recommendations.[4]

This is the first multicentric study from Brazil that aims to establish the baseline HH compliance rate by health care workers (HCWs) before patient contact, to analyze risk factors for poor adherence, and to implement and evaluate the impact of an INICC multidimensional hand hygiene approach (IMHHA) in 4 intensive care units (ICU) in 4 hospitals in 3 cities in Brazil. The approach includes the following elements: administrative support, supplies availability, education and training, reminders in the workplace, process surveillance, and performance feedback.

MATERIAL AND METHODS

Background on the INICC

The INICC is an international, nonprofit, open, multicentric HAI surveillance network with a methodology based on the Centers for Disease Control and Prevention's National Healthcare Safety Network in the United States.[24] The INICC is the first research network established to measure and control HAIs in hospitals worldwide through the analysis of standardized data collected on a voluntary basis by its member hospitals. Gaining new members since its international inception in 2002, the INICC is now composed of nearly 1,000 hospitals in 200 cities in 50 countries in Latin America, Asia, Africa, the Middle East, and Europe and has become the only source of aggregate standardized international data on the epidemiology of HAI worldwide.[11]

Study setting

This study was conducted in 4 adult ICUs in 4 INICC member hospitals from Brazil, which were successively incorporated into the study over a period of 3 years.

Each hospital has an infection control team (ICT) composed of at least 1 infection control practitioner and 1 physician. The HCW in charge of process surveillance at each hospital has at least 2 years of infection control experience.

The study protocol was approved by the institutional review board at each hospital.

Study design

An observational, prospective, cohort, interventional, before-and-after, multicentric study was conducted from June 2006-April 2008. The study was divided into 2 periods: a baseline period and a follow-up period. The baseline period for HH compliance included episodes documented at each hospital during their first 3 months of participation, and the follow-up period included episodes following the fourth month of participation. Each ICU started to participate in the study at different times and therefore have different lengths of follow-up (5-24 months). For comparison of compliance rates, the ICUs were aligned independently of the date at which they started its participation in the study.

IMHHA

The IMHHA is implemented at each hospital from the beginning of their participation in the INICC. The approach includes the following 6 components: administrative support, supplies availability, education and training, reminders in the workplace, process surveillance, and performance feedback. Although the components are presented individually, they are interactive elements that must concur for the effective implementation of any multidimensional approach.

Administrative support

Hospital administrators of the participating hospitals agreed and committed to the study, attended infection control meetings to discuss study findings, and allocated supplies of HH products.

Supplies availability

During the study period, AHRs bottles were available at the ICUs' entrances, nursing stations, and near the site of patient care (individual patient room entrances, at bedside tables, and on the feet of patient beds). Sinks with water supply, soap, and paper towels were available at the ICUs' entrances, nursing stations, and common areas of the ICUs.

Education and training

In the ICUs, the ICT members provided 30-minute education sessions to HCWs in each work shift, at the beginning of the study period and periodically (every month, every 2 months, and every 6 months, depending on the ICU) during the follow-up period. Education included basic information about indications of HH and the correct procedures and technique for HH.

Reminders in the workplace

Poster reminders were displayed all around the hospital settings (ie, hospital entrance, corridors, ICT office, ICU entrances, nursing stations, beside each sink, and beside each AHR bottle). They included simple instructions on HH performance, in line with the contents of the education and training program.

Process surveillance

Process surveillance of HH practices consisted of the registration of potential opportunities for HH[4] and the actual number of HH episodes, either with water and soap or AHR. HCWs' HH practice

was directly monitored by a member of the ICT following a standardized protocol and included completing HH process surveillance INICC forms that included a questionnaire.[7] The monitoring included HH compliance before patient contact and before an aseptic task and also included use of HH products over time. We did not monitor all My 5 Moments for HH according to the WHO recommendations because we started this approach several years before the launching of the WHO HH program advising on the 5 moments.[4]

Observations were conducted unobtrusively at specific time periods distributed at random in 3 work shifts (morning, afternoon, evening). HCWs were not aware of the schedule of the monitoring period. Potential confounders of HH included type of ICU, professional category, sex, work shift, and type of contact.

Performance feedback

Every month, the INICC Headquarters team prepares and sends to each participating ICU a final month-by-month report on compliance with HH. These charts contain a running tally of HH compliance by HCWs of the ICUs and compliance comparing several variables (eg, sex, HCW professional status, ICU type, contact type, work shift). Those charts were reviewed at monthly ICT meetings and also posted in the ICUs to give performance feedback to the HCWs of the participating ICUs.[7] The performance feedback process started in the third month of participation.[7]

Training of the ICT for process surveillance

The ICT member investigators were self-trained with a procedure manual sent from the INICC Headquarters in Buenos Aires specifying how to carry out the HH process surveillance and how to fill in the INICC forms.[7] ICT members had continuous telephone or e-mail access to a support team at the INICC Headquarters.

Data collection and processing

Completed INICC process surveillance forms of HH were sent monthly by ICT members from each participating ICU to the INICC Headquarters. The team at the INICC Headquarters uploaded the data into a database, analyzed and sent a report of HH compliance to ICT members of each participating ICU, showing HH compliance by month, sex, HCW profession, ICU, work shift, and type of contact.[7]

Statistical methods

Univariate analysis of variables associated with poor HH and impact of the HH approach

The aggregated independent variables (sex of HCWs, profession of HCWs, type of ICU, type of contact, etc) of all observed HH opportunities and HH compliance during the study and comparison of HH compliance during the baseline period and follow-up period were compared using Fisher exact test for dichotomous variables and unmatched Student *t* test for continuous variables. Relative risk ratios were calculated for comparisons of analyzed variables associated with HH using Epi Info version 6. The 95% confidence intervals were calculated using VCStat (Castiglia). *P* values <.05 by 2-tailed tests were considered significant.

Multivariate analysis of variables associated with poor HH

The aggregated described independent variables of all observed HH opportunities and HH compliance during the study were compared using logistic regression for dichotomous and continuous variables. Odds ratios with 95% confidence intervals were calculated for comparisons of analyzed variables associated with HH using PASW Statistics 18. *P* values <.05 by 2-tailed tests were considered significant.

Table 1
Characteristics of the participating hospitals (June 2006-April 2008)

Data	ICUs and hospitals	ICU HH observations
Type of ICU		
Medical surgical	4 (100)	4,837
Type of hospital		
Academic teaching	2 (50)	1,330
Private	2 (50)	3,507
All hospitals	4 (100)	4,837

NOTE. Values are n or n (%).
HH, hand hygiene; *ICU*, intensive care unit.

Multivariate analysis of impact of the INICC HH multidimensional approach

HH opportunities and compliance during baseline and follow-up were explored for changes in HH compliance rates following an ICU joining the INICC. We looked at the follow-up period stratified by 3-month periods over the first year and yearly for second year. We present the results of a logistic regression model to consider change in HH compliance in the INICC participating ICUs over time since the beginning of the HH surveillance. Odds ratios are presented, comparing each time period since the start of the surveillance with the baseline of 3 months. This is a large data set, with 4,837 observations; therefore, we were able to adjust for the effect of each ICU on HH compliance as a categorical variable in the analysis. Because of the different length of follow-up of each ICU (1 month-2 years), for each time period, only ICUs with follow-up in that time period were included in the baseline period used for calculating the odds ratio of HH compliance for that period.

RESULTS

From June 2006-April 2008, we recorded a total of 4,837 opportunities for HH before patient contact and before aseptic task.

Predictors of poor HH compliance

Table 1 presents the characteristics of the participating hospitals and ICUs.

We observed 1,068 procedures in men and 3,769 in women. There were 738 in nurses, 572 in physicians, and 3,527 in ancillary staff. There were 3,653 prior to noninvasive patient contact and 1,184 prior to invasive procedures. All 4,837 were in adult ICUs. There were 1,604 during the morning, 1,579 during the afternoon, and 1,654 during the night shift.

Table 2 shows HH compliance according to each variable (type of hospital, sex, profession of HCW, type of procedure, type of unit, and work shift) and association with poor HH, analyzed with univariate and multivariate statistical methods, respectively.

Components of the IMHHA

During the follow-up period, the 6 components of the IMHHA were applied simultaneously: 100% counted on administrative support and available supplies for HH and AHR; 100% educated HCWs (50% of them every month, 25% every 2 months, and 25% every year); 100% posted reminders (100% of them at ICU entrance, 100% in common ICU areas); process surveillance was conducted by 100%; and 75% provided performance feedback (50% of them every month, and 25% every 2 months).

Table 2
HH compliance by type of variable

Variable	% (no. of HH/no. of opportunities)	Comparison	Univariate analysis: Relative risk	95% CI	P value	Multivariate analysis: Adjusted OR	95% CI	OR P value
Type of hospital								
Academic	42 (911/2,159)	Academic vs private	.94	0.87-1.01	.041	1.0		
Private	40 (1,061/2,678)					0.9	0.8-1.0	.07
Sex								
Female	38 (1,451/3,769)	Female vs male	.80	0.7-0.9	.0001	0.72	0.62-0.84	.0001
Male	49 (521/1,068)					1.0		
HCWs								
Nurses	55 (406/738)	Nurses vs physicians	.86	0.76-0.98	.02	1.0		
Physicians	48 (272/572)	Nurses vs ancillary staff	.70	0.6-0.76	.0001	0.64	0.51-0.8	.0001
Ancillary staff	37 (1,294/3,527)	Physicians vs ancillary staff	.77	0.7-0.9	.0005	0.5	0.4-0.6	.0001
Procedure								
Noninvasive	41 (1,491/3,653)	Noninvasive vs invasive	.99	0.94-1.1	.90	1.0		
Invasive	41 (481/1,184)					0.99	0.94-1.1	.90
Work shift								
Morning	48 (764/1,604)	Morning work shift vs afternoon work shift	.76	0.7-0.83	.0001	1.0		
Afternoon	36 (570/1,579)	Morning work shift vs night work shift	.81	0.74-0.9	.0001	0.65	0.6-0.75	.0001
Night	39 (638/1,654)	Afternoon work shift vs night work shift	.94	0.85-1.0	.16	0.73	0.63-0.84	.0001

CI, confidence interval; *HCW*, health care worker; *HH*, hand hygiene; *OR*, odds ratio.

Table 3
HH improvement by year of participation

Years since joining the INICC	HH observations	No. of ICUs included	No. of hospitals included	HH (%)	Adjusted OR (95% CI)	P value
First 3 months (baseline)	1,594	4	4	27	1.0	NA
Second 3 months	1,001	4	4	36	1.23 (1.0-1.5)	.03
Third 3 months	767	2	2	43	1.5 (0.2-1.8)	.002
Fourth 3 months	730	2	2	57	2.6 (2.0-3.3)	.0001
Second year	745	2	2	58	2.9 (2.3-3.6)	.0001

CI, confidence interval; *HH*, hand hygiene; *ICU*, intensive care unit; *INICC*, International Nosocomial Infection Control Consortium; *NA*, not applicable; *OR*, odds ratio.

Impact of the IMHHA on HH compliance

In Table 3 we present the results of a logistic regression model to consider change in HH compliance in the INICC participating ICUs over the whole study period. The baseline period of the INICC ICUs was 3 months, and their average follow-up period was 9.7 months (range, 4-21 months).

Use of HH products over time

Common soap for HH was at 31% in 2004; it rose to 72% in 2005. It was gradually reduced to 0% by 2007. AHR use started in 2007, with a sharp rise to 100% in 2008 (Fig 1).

DISCUSSION

Baseline HH compliance (27%) of HCWs at the INICC ICUs was similar to that shown in previous studies, where HH compliance rates ranged from 9%-75%.[4] In a study by Hofer et al,[25] conducted in a Brazilian hospital, it was reported that appropriate performance HH was observed in only 35% of opportunities for HH.

In this study, we have shown that implementing the previously described 6 measures of the IMHHA in each ICU was followed by very substantial improvements in HH practices in 4 ICUs from 4 hospitals in Brazil.

One unanticipated finding was that there was higher compliance in men than women, which is contrary to other findings unrelated to health care, such as the findings of Guinan et al[26] showing higher compliance by female students. Compliance was higher among nurses as shown in a study by Rosenthal et al,[3] in which compliance was lower among physicians and ancillary staff than nurses. Morning and afternoon shifts were significantly associated with lower HH compliance than night shift. This can be explained by the fact that during day shifts, ICUs are more crowded and busy than night shifts. In 1982, Haley et al[27] showed that overcrowding and understaffing hindered HCWs' efforts to perform HH. In regard to noninvasive and invasive procedures, we did not find any difference in HH compliance; this differs with the findings of Lipsett et al,[28] who showed that lower HH compliance was found in low-risk situations.

Use of HH products changed, showing an increase in AHR use and a reduction in common soap use, which could be related to increasingly wider promotion of AHR by the WHO, which was included in the IMHHA, and therefore support by hospital administrators.[4]

Our approach included administrative support. Rosenthal et al[14] showed that higher HH adherence was associated with administrative support. Additionally, ICUs had availability of supplies. Bischoff et al[29] showed that easily accessible dispensers of AHR revealed the more dispensers per bed, the higher HH compliance. In addition, we included education and training, which were other basic independent interventions identified to foster adequate HH performance. As shown by Santana et al,[20] alcohol-based hand gel and an educational program on HH improved adherence among HCWs in an ICU of a Brazilian hospital.[30] Likewise, Rosenthal et al[14] showed HCWs' education improved HH adherence and compliance increased further if performance feedback was also implemented. We also included reminders at the workplace. Conly et al[16] showed the importance of reminders to raise HCWs' awareness of the relation between correct HH performance and HAI reduction.

We measured 4,837 opportunities for HH. Every month, the ICT team provided performance feedback to HCWs of each ICU. This is the most motivating aspect of the IMHHA for HCWs. Awareness of the outcome of their efforts reflected by the measurement of their

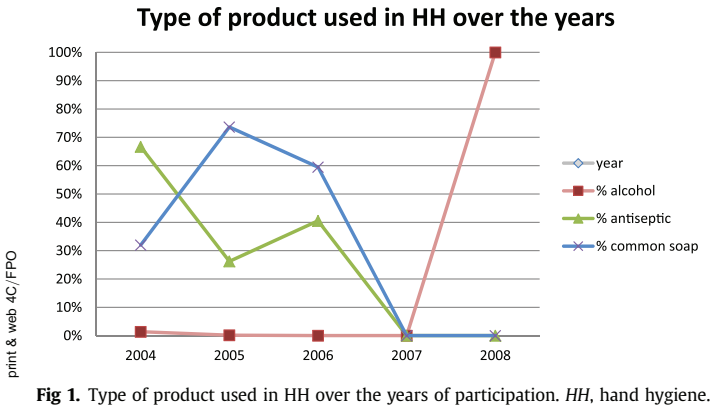

Fig 1. Type of product used in HH over the years of participation. *HH*, hand hygiene.

practices and HAI incidence is a conscious-raising factor to ensure the IMHHA's effectiveness. From 1998 in Argentina,[3,14] and 2002 internationally,[7-11] the INICC has introduced process surveillance and performance feedback as a means to improve quality in health care to a new level, monitoring and providing continuous feedback not only of outcome data (rates of HAI) but also of the results of process surveillance (rates of HH compliance and other simple but highly effective, evidence-based infection control practices) and shown that combining education with feedback of surveillance can bring quantum reductions in the risk of life-threatening HAIs in ICUs.[3,14]

Through the last decade, the INICC has undertaken a global effort in Latin America, Asia, Africa, the Middle East, and Europe to respond to the burden of HAIs and has achieved successful results by increasing HH compliance, improving compliance with other infection control interventions, as described in several INICC publications, and consequently reducing the rates of HAI and mortality. Since 2002, in adult ICUs in 15 countries, the INICC has reduced the rate of CLAB by 54%,[31] catheter-associated urinary tract infection by 37%,[32] ventilator-associated pneumonia (VAP) by 56%,[33] and mortality by 58%.[31] In pediatric ICUs in 5 countries, the INICC has reduced the rate of CLAB by 52%,[34] catheter-associated urinary tract infection by 57%,[35] VAP by 31%,[36] and mortality by 31%.[34] In neonatal ICUs in 10 countries, the INICC has reduced the rate of VAP by 33%.[37]

This study has some limitations. First, we did not measure My 5 Moments for HH as described recently by the WHO in 2009. This is because the INICC program started the IMHHA in 1998 in Argentina[3,14] and in 2002 internationally,[7] that is, several years before the WHO published its recommendation in 2009. However, since 2009, the INICC has included the WHO's My 5 Moments for HH in its process surveillance forms and manuals.[4] Additionally, it should be noted that this study applied an observational, before-after methodology, which implies less strength of evidence than other study designs. A Hawthorne effect is typical of direct observations of adherence. In addition, direct observations represent only a sample of all opportunities and there are inherent weaknesses, including assuring interobserver reliability. Finally, is it highly complex to capture the quality of HH techniques, and we were not able to include many details in this study (eg, information regarding HAI and mortality rates) because there are several INICC publications that focus on these topics in relation to HH.

CONCLUSIONS

As demonstrated, the IMHHA improved HH compliance in 4 ICUs in 4 hospitals in 3 cities in Brazil, probably contributing to the HAI rates and mortality rates.[31-37] It is the INICC's primary objective to foster infection control practices by freely facilitating elemental and inexpensive resourceful tools to tackle this problem effectively and systematically, leading to greater and steady adherence to infection control programs and guidelines (eg, HH compliance) and to the correlated reduction of HAIs and their consequences (eg, mortality, extra cost).

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