Impacts of INICC Multidimensional Hand Hygiene Approach in ICUs in Four Cities in Argentina

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We evaluated the impact of the International Nosocomial Infection Control Consortium multidimensional approach to hand hygiene in 11 intensive care units in 4 cities in Argentina and analyzed predictors of poor hand hygiene compliance. We had a baseline period and a follow-up period. We observed 21,100 hand hygiene opportunities. Hand hygiene compliance increased from 28.3% to 64.8% (P = .0001). Males versus females (56.8% vs 66.4%; P < .001) and physicians versus nurses (46.6% vs 67.8%: P < .001) were significantly associated with poor hand hygiene compliance.

Key words: hand hygiene, hand washing, infection control, infection prevention, intensive care unit

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MORE THAN a century ago, when the relationship between improved hand antisepsis and reduced mortality from puerperal sepsis was being studied by Semmelweis, it was shown that appropriate hand hygiene before patient contact was a fundamental tool for infection prevention. Different studies have reported that an improved hand hygiene practice was associated with the reduction of rates of health care-associated infections (HAIs). The threat to patient safety posed by HAIs includes morbidity and mortality.

Most studies addressing HAIs have been conducted in high-income countries, whereas in developing countries, this problem had not been sufficiently studied until the International Nosocomial Infection Control Consortium (INICC) began to apply standardized definitions and methods to measure and analyze HAI rates.

Hand hygiene plays a critical role in preventing cross transmission of HAIs, and successful interventions to improve hand hygiene have been reported both from developed and developing nations. As mentioned by the INICC in a recent study, it was only in 2002 that the Centers for Disease Control and Prevention published its hand hygiene guideline, and only in 2005 that the World Health Organization (WHO) launched the program “Clean Care Is Safer Care” and in 2009 presented a compilation of previous publications with a new formulation for alcohol-based hand rub (AHR) products, among other recommendations.

The INICC has undertaken a global effort in America, Asia, Africa, Middle East, and Europe to respond to the burden of HAIs through the last decade and has achieved successful results by improving compliance with other infection control practices and hand hygiene compliance and consequently reducing the rates of HAIs and mortality. Since 2002, in adult intensive care units (ICUs) in 15 countries, the INICC has reduced the rate of central line-associated bloodstream infection by 54%, of catheter-associated urinary tract infection by 37%, of ventilator-associated pneumonia by 56%, and of mortality by 58%. In pediatric ICUs in 5 countries, the INICC has reduced the rate of central line-associated bloodstream infection by 52%, of catheter-associated urinary tract infection by 57%, of ventilator-associated pneumonia by 31%, and of mortality by 31%. In neonatal ICUs in 10 countries, the INICC has reduced the rate of ventilator-associated pneumonia by 33%.

The main issues addressed in this study were to (a) determine the baseline hand hygiene adherence rate by health care workers (HCWs) before patient contact, (b) analyze risk factors for poor adherence, and (c) evaluate the impact of the INICC Multidimensional Hand Hygiene Approach (IMHHA) to improve compliance in 11 ICUs of 8 hospitals in 4 cities of Argentina. We focused our resources on the ICU setting because critically ill patients hospitalized in ICUs are the most susceptible to acquiring severe and life-threatening HAIs.

The IMHHA, as presented by the INICC in a previous publication, includes the following components: (1) administrative support; (2) supplies availability; (3) training and education; (4) reminders in the workplace; (5) process surveillance; and (6) performance feedback.

MATERIALS AND METHODS

Background on the INICC

The INICC is a nonprofit, open, multi-centered organization established as an HAI
surveillance network that applies a methodology based on the US Centers for Disease Control and Prevention/National Healthcare Safety Network. It is the first research network that aims to measure and control HAIs worldwide through the analysis of standardized data collected on a voluntary basis by its member hospitals. At present, there are more than 1000 hospitals in 300 cities of 66 countries contributing to form a unique source of international, aggregate, standardized, epidemiological data on HAIs from Latin America, Asia, Africa, Middle East, and Europe.

Study setting

The 11 ICUs were enrolled into the study during different periods through 9 years and 7 months. The types of ICUs participating in this study were 1 newborn, 2 coronary, and 8 medical-surgical ICUs. Each hospital had an infection control team (ICT), with at least 1 infection control practitioner and 1 physician, but this number of members was variable depending on the ICU. The ICT member in charge of process surveillance at each hospital had at least 2 years of experience in monitoring of HAI rates and infection control practices. Professional categories of HCWs included nurses, physicians, and ancillary staff (including paramedical technicians, nurse aides, laboratory team members, radiology team members, physiotherapists, patient care technicians, paramedical personnel, and patient lift teams). The study protocol was approved by the institutional review board at each hospital.

Study design

From April 1999 to November 2008, we conducted an observational, prospective, cohort, interventional, before-and-after multicentered study, which was divided into a baseline period and a follow-up period. The baseline period for hand hygiene compliance comprised the documentation of hand hygiene opportunities at each ICU during its first 3 months of participation in the study, and the follow-up included the surveillance as from the fourth month of participation. The lengths of the follow-up periods are different for each ICU, because they were enrolled in the study at different times, but the length of the baseline period was the same (3 months) for all ICUs. For the comparison of compliance rates, the ICUs were aligned for the duration of study time, independently of the date at which they started to participate in the study.

INICC MULTIDIMENSIONAL HAND HYGIENE APPROACH

The IMHHA was implemented at each ICU from its enrollment in the INICC. Although the 6 components are presented individually, they are interactive components that must concur for the effective implementation of any “multidimensional” approach.

1. Administrative support: Hospital administrators of the participating hospitals committed to the study, attended infection control meetings to discuss study findings, and allocated supply of hand hygiene products.

2. Supplies availability: During the study period, AHR bottles were available at the participating ICUs’ entrances, nursing stations, and near the site of patient care (individual patient room entrances, at bedside tables, and/or on the foot of patient beds). Sinks with water supply, soap, and paper towels were available at ICUs’ entrances, nursing stations, and common areas of ICUs.

3. Training and education: In the study’s ICUs, members of the ICT provided 30-minute education sessions to HCWs in each work shift, at the beginning of the study period, and periodically during the follow-up period, at regular times (every month, every 2 months, and every 6 months, depending on the ICU). Education included basic information on indications of hand hygiene and adequate procedures and technique for hand hygiene.

4. Reminders in the workplace: Posters reminders were displayed around the hospital’s settings (eg, nursing stations, hospital entrance, corridors, ICT office,
ICU entrances, beside each sink, and each AHR bottle). Reminders included simple instructions on hand hygiene performance.

5. Process surveillance: Process surveillance of hand hygiene practices included the registrations of potential opportunities for hand hygiene, and the actual number of hand hygiene episodes, either with water and soap or AHR. Healthcare workers' hand hygiene practice was directly monitored by a member of the ICT who had received training by means of a reporting manual and was not an observed HCW. To improve data interreliability, observers used standardized monitoring processes, following a protocol and completing standardized hand hygiene surveillance forms that contained a uniform questionnaire for monitoring hand hygiene practices. The ICT member conducted unobtrusive covert observations on HCWs in the ICU, that is, without interference from the observer and without being aware that they were being observed. These observations were done at specific time periods selected at random, distributed 3 times a week, during 30 minutes each time and during all work shifts (morning, afternoon, and evening). Infection control practitioners were in charge of surveillance of HAIs, invasive device utilization (vascular catheters, urinary catheters, mechanical ventilators, etc), positive cultures, and other surveillance activities. Surveillance of hand hygiene was just one of many surveillance activities. Health care workers working at the observed units were aware that ICT members were conducting surveillance of many process and outcomes, but they never knew when ICT members were conducting specifically surveillance of hand hygiene or any other kind of surveillance. For this reason, although HCWs had been notified that hand hygiene process surveillance would be conducted some time as from the beginning of the study, they were not aware of the schedule of the monitoring period by the ICT member. The monitoring included hand hygiene compliance before patient contact and before an aseptic task, because by the time we started the study in April 1999, the recommendations of the WHO in “My 5 Moments for Hand Hygiene” had not been published yet.

6. Performance feedback: A final monthly report on compliance with hand hygiene was prepared by the INICC headquarters team and sent to each participating ICU on a monthly basis. These charts contained a running tally of hand hygiene compliance by HCWs of the ICUs and compliance comparing several variables, such as gender, professional category, ICU type, contact type, and work shift. The charts were reviewed at monthly ICT meetings and also posted in the ICUs to give performance feedback to the HCWs. The performance feedback process started in the third month of participation in this approach.

Training for process surveillance
The ICT investigators were self-trained with a procedure manual sent from the INICC headquarters in Buenos Aires, specifying how to carry out the hand hygiene process surveillance and how to complete the INICC forms. Internal validation of forms was performed by investigators at the participating center to ensure that relevant information was accurately recorded for each case. External validation was performed at INICC headquarters with consistency analyses of the database to ensure matching of data entered.

Data collection, processing, and analysis
Completed INICC process surveillance forms of hand hygiene 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 to ICT members of each ICU a report of hand hygiene compliance.
The aggregated independent variables (gender of HCWs, profession of HCWs, type of ICU, type of contact, etc.) of all observed hand hygiene opportunities and compliance during the study, and comparison of hand hygiene compliance during the baseline period and follow-up period, were compared using the Fisher exact test for dichotomous variables and the unmatched Student t test for continuous variables. Relative risk (RR) ratios were calculated for comparisons of analyzed variables associated with hand hygiene using EPI Info V6. Ninety-five percent confidence intervals (CIs) were calculated using VCStat (Castiglia, Argentina). P values of less than .05 by 2-tailed tests were considered significant.

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

Hand hygiene opportunities and compliance during the baseline and follow-up periods were explored for changes in compliance rates following an ICU joining the INICC. We examined at the follow-up period stratified by 3-month periods over the first year and yearly for second to seventh years. The result of a logistic regression model is presented to consider change in hand hygiene compliance in the participating ICUs over time since the beginning of 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 around 21 100 observations, and so we were able to adjust for the effect of each ICU on hand hygiene compliance as a categorical variable in the analysis. Because of the different length of follow-up of each ICU (from 3 months to 9 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 hand hygiene compliance for baseline.

**RESULTS**

We recorded a total of 21 100 opportunities for hand hygiene before patient contact and before aseptic task. The characteristics of the participating ICUs and hospitals are shown in Supplemental Digital Content, Table 1 (available at: http://links.lww.com/JNCQ/A183).

**Predictors of poor hand hygiene compliance**

We observed 20 099 procedures in private hospitals and 1001 in public hospitals; 6384 in males and 14 716 in females; 17 197 in nurses, 2218 in physicians, and 1685 in ancillary staff; 14 692 prior to noninvasive patient contacts and 6401 prior to invasive procedures; 20 888 in adult ICUs and 212 in neonatal ICUs; and 7795 during the morning shift, 7715 during the afternoon shift, and 5590 during the night shift.

Hand hygiene compliance distribution among the different ICU types in the baseline and intervention periods are shown in Supplemental Digital Content, Table 2 (available at: http://links.lww.com/JNCQ/A184). In the coronary ICUs, hand hygiene compliance increased from 25.7% to 66.2% (RR = 2.57; 95% CI, 2.31-2.85; P = .0001), and in the medical-surgical ICUs, hand hygiene compliance increased from 24.4% to 65.3% (RR = 2.68; 95% CI, 2.48-2.89; P = .0001).

Hand hygiene compliance according to each variable (type of hospital, gender, profession of HCW, type of procedure, type of unit, and work shift) and association with poor hand hygiene were analyzed with univariate and multivariate statistical methods, as shown in Supplemental Digital Content, Table 3 (available at: http://links.lww.com/JNCQ/A186). The following variables were significantly associated with poor hand hygiene compliance: males versus females (56.8% vs 66.4%; 95% CI, 0.83-0.88; P < .001), and physicians versus nurses (46.6% vs 67.8%; 95% CI, 0.67-0.7; P < .001).
Components and impact of the IMHHA

During the follow-up period, the 6 components of the IMHHA were applied simultaneously: 85.7% of the ICUs had administrative support and available supplies for hand hygiene and AHR; 100% HCWs attended education (85.7% of them every month, and 14.32% every 3 months); 100% posted reminders (54.5% of them at ICU entrance, 54.5% in common ICU areas, 54.5% beside each bed); process surveillance was conducted by 100%; and 100% provided performance feedback (85.7% of them every month and 14.3% every 3 months).

The baseline period of the INICC ICUs was 3 months, and the average follow-up period was 36 months (range, 6-84). In the Figure, we present the results of a logistic regression model to consider change in hand hygiene compliance in INICC participating ICUs over the whole study period. Overall, hand hygiene compliance increased from 28.3% to 64.8% (95% CI, 62.2-67.2; \( P = .0001 \)).

Use of hand hygiene products

Use of aqueous chlorhexidine for hand hygiene was 96% in 1999, with a gradual reduction to 29% by 2005, rising to 80% by 2006, and a final reduction to 31% in 2008. The use of AHR started in 2001, with variations from 12% to 70% from 2001 to 2005, decreasing to 0% in 2007, and with a sudden rise to 49% by 2008 (see Supplemental Digital Content, Figure, available at: http://links.lww.com/JNCQ/A185).

DISCUSSION

In this study in Argentina, we have shown that implementing the 6 measures of the IMHHA in each ICU was followed by substantial and sustained improvements in hand hygiene practices. Baseline hand hygiene compliance (20%) of HCWs at INICC ICUs was similar to that shown in previous studies, although in different studies, hand hygiene compliance rates ranged from 9% to 75%.\(^4\)

The multivariate analysis showed that there was higher compliance in private hospitals than in public and academic ones. The relation of type of hospital and hand hygiene compliance has not been analyzed in the literature; however, there is published evidence\(^30\) that, in developing countries, being in the private sector can influence the outcome of programs in terms of wider availability of resources and greater administrative support, in contrast to a situation of ICU overcrowding and understaffing that is shown to hinder HCWs’ efforts to perform hand hygiene. Findings also indicated that adequate adherence to hand hygiene was higher in females, similar to studies unrelated to health care, such as the findings of Guinan et al,\(^31\) showing higher compliance by female students.

Compliance was higher among nurses, as also shown in a study by Rosenthal et al,\(^3\) in which compliance was lower among physicians and ancillary staff than among nurses. Morning and afternoon shifts were significantly associated with lower hand hygiene compliance than night shift. This may be explained by the fact that during day shifts, ICUs are more crowded and busy than during night shifts. In an early study, Haley and Bregman\(^30\) showed that overcrowding and understaffing hindered HCWs’ efforts to perform hand hygiene. We also showed the highest hand hygiene compliance was in neonatal ICUs, consistent with the Watanakunakorn et al\(^32\) findings of remarkable variations by unit, with compliance being 56% in ICUs compared with 23% in non-ICUs. We also showed that type of contact influenced hand hygiene performance: superficial contacts were associated with lower compliance. Lipsett and Swoboda\(^33\) showed that lower hand hygiene compliance was found in low-risk situations.

Use of hand hygiene products changed over the study period, showing an increase in AHR use and a reduction in chlorhexidine use, which could be related to increasingly wider promotion of AHR by the WHO.\(^4\)

Our approach included administrative support. In 2003, Rosenthal et al\(^18\) showed that higher hand hygiene compliance was associated to administrative support. We also included supply availability. Bischoff et al\(^13\) found that the more AHR dispensers per
bed, the higher hand hygiene compliance. We also included education sessions, which were other basic independent interventions identified to foster adequate hand hygiene practices. In a study by Dubbert et al, educational intervention with routine classes improved hand hygiene compliance by 97% over 4 weeks. Likewise, but within the context of limited-resource countries, Rosenthal et al. found that HCWs’ education improved hand hygiene performance and compliance was increased further if performance feedback was also implemented. We also included reminders at workplace. In an early study, Conly et al showed the importance of reminders to raise HCWs’ awareness of the relation between correct hand hygiene performance and HAI reduction.

We recorded 21,100 opportunities for hand hygiene. Every month, the ICT team provided performance feedback to HCWs of each ICU. Health care workers’ knowledge of the outcome of their efforts reflected by the measurement of their practices, and HAI incidence can be a most rewarding or conscious-raising factor to ensure the IMHHA’s effectiveness. Continuous feedback provided to industrial workers on the results of monitoring the quality of the final product to improve its quality dates from the epochal contributions of Deming. From 1998 in Argentina and 2002 internationally, the INICC has adopted process surveillance and performance feedback as powerful tools to improve quality in health care, monitoring and providing continuous feedback not only on outcome data—HAI rates—but also on the results of process surveillance—rates of hand hygiene compliance and other simple but highly effective, evidence-based infection control practices, and has shown that combining education with feedback about surveillance can bring great reductions in the risk of life-threatening HAIs in ICUs.

Finally, a number of limitations need to be considered. First, we did not measure “My 5 Moments for Hand Hygiene” as recommended by the WHO in 2009. This is because the INICC program started the IMHHA in 1998 in Argentina and in 2002 internationally, several years before the WHO published its recommendation in 2009. However, since 2009, the INICC has included the WHO’s hand hygiene recommendations in its process surveillance forms and manuals. Second, this study applied an observational, before-after methodology, which implies less strength and quality of evidence than other study designs.
Third, direct observation of adherence typically involves difficulty in ensuring interobserver reliability, because the quality of hand hygiene technique is hard to capture and there might have been a Hawthorne effect implied in direct observation techniques. Nevertheless, as reported in the literature, the Hawthorne effect may be a useful tool for sustaining and improving hand hygiene compliance. Finally, it is highly complex to capture the quality of hand hygiene technique, and we were not able to include many details in this study, such as information regarding HAI and mortality rates, since there are several INICC publications that focus on these topics in relation to hand hygiene.

**CONCLUSIONS**

As shown in this study, the IMHHA improved hand hygiene compliance in 11 ICUs of 8 hospitals in 4 cities of Argentina. Therefore, an implication of our findings is that the implementation of the IMHHA should be considered worldwide, as a promising path to improving patient care. It is the INICC's primary goal to foster infection control practices by freely providing HCWs with simple and resourceful tools to address this problem and lead to steady adherence to infection control programs and guidelines, such as hand hygiene compliance, and to the prevention of HAIs and their consequences.

**REFERENCES**

INICC Multidimensional Approach to Hand Hygiene in ICUs in Argentina


