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Impact of the International Nosocomial Infection Control Consortium (INICC) multidimensional hand hygiene approach in three cities of Colombia☆

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SUMMARY

Objective: To assess the feasibility and effectiveness of the International Nosocomial Infection Control Consortium (INICC) multidimensional hand hygiene (HH) approach in Colombia, and analyze predictors of poor HH compliance.
Methods: An observational, prospective, interventional, before-and-after study was conducted from May 2003 through September 2010 in 10 intensive care units (ICUs) of six hospitals in three cities. The study was divided into two periods: a baseline and a follow-up period. Observations for HH compliance were done in each ICU during randomly selected 30-min periods. The multidimensional HH approach included: (1) administrative support, (2) supplies availability, (3) education and training, (4) reminders in the workplace, (5) process surveillance, and (6) performance feedback.
Results: A total of 13 187 opportunities for HH were observed. Overall HH compliance increased from 50% to 77% (relative risk 1.55, 95% confidence interval 1.43–1.68; $p = 0.0001$). Multivariate and univariate analyses showed that several variables were significantly associated with poor HH compliance: males vs. females (67% vs. 77%; $p = 0.0001$), physicians vs. nurses (59% vs. 78%; $p < 0.0001$), and adult vs. pediatric ICUs (76% vs. 42%; $p < 0.001$), among others.
Conclusions: Adherence to HH was increased by 55% with the INICC approach. Programs targeted at improving HH in variables found to be predictors of poor compliance should be implemented.

1. Introduction

Back in the nineteenth century, when Semmelweis studied the relationship between improved hand antisepsis and reduced mortality from puerperal sepsis,[1] it was shown that appropriate hand hygiene (HH) before patient contact was a fundamental tool for the prevention of infection. Since then, several studies have reported that improved HH practice is associated with a reduction

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in the rates of healthcare-associated infection (HAI) and antimicrobial resistance.[2–4]

HAIs pose a threat to patient safety, including morbidity and mortality.[5] Traditionally, most studies focusing on HAIs have been conducted in developed countries;[6] in developing countries, this public health problem had not been systematically studied until the International Nosocomial Infection Control Consortium (INICC) began to measure and analyze HAI rates with standardized definitions and methods.[7–11]

HH practice plays a crucial role in preventing cross-transmission of HAIs, and successful interventions to improve HH have been reported in the mainstream literature from developed[12] and developing nations.[3,13,14] Since the 1980s, investigators have analyzed the effectiveness of several interventions to improve HH, such as the use of monitoring and performance feedback as published by Mayer et al. in 1986;[15] the impact of supplies availability as published by Preston et al. in 1981;[16] administrative support as published by Larson et al. in 1997;[17] the effectiveness of education as published by Dubbert et al. in 1990,[18] and by Dorsey et al. in 1996;[19] the use of reminders and posters in the workplace as published by Conly et al. in 1989;[20] and the introduction of alcohol-based hand rub (AHR) as published by Graham in 1990.[21] In a study conducted in the USA in 1997, Larson et al. explicitly referred to a multidimensional approach that considered several interventions.[17] Likewise, Rosenthal et al. have implemented programs in Argentina since 1993, 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, HH guidelines were published by the US Centers for Disease Control and Prevention (CDC).[22] With a view to promoting HH from a global angle, in 2005 the World Health Organization (WHO) launched the program "Clean Care is Safer Care",[23] and in 2009 the WHO published its guidelines presenting a compilation of previously published data, and a new formulation for AHR products, among several other recommendations.[4]

There are no previous publications showing HH compliance in the hospitals of Colombia. The aim of this study was to establish the baseline HH compliance rate of healthcare workers (HCWs) before patient contact in 10 intensive care units (ICUs) of six hospitals in three cities of Colombia, to analyze risk factors for poor adherence, and to evaluate the impact of implementing the INICC multidimensional HH approach (IMHHA). The IMHHA includes the following elements: (1) administrative support, (2) supplies availability, (3) education and training, (4) reminders in the workplace, (5) process surveillance, and (6) performance feedback.

2. Methods

2.1. The INICC

The INICC is an open, non-profit, HAI surveillance multicenter network that applies methods based on the US CDC/National Healthcare Safety Network (NHSN).[24] The INICC was established to measure and control HAIs in hospitals worldwide through the analysis of standardized data collected on a voluntary basis by its member hospitals and fosters the use of evidence-based preventive measures. Since its international inception in 2002, the INICC has increasingly gained new members and now comprises nearly 1000 hospitals in 200 cities of 50 countries in Latin America, Asia, Africa, the Middle East, and Europe; it has become the only source of aggregate standardized international data on the epidemiology of HAIs internationally.[11]

2.2. Study setting

This study was conducted in 10 ICUs of six hospitals in three cities of Colombia, which were successively incorporated into the study over a period of 8 years.

Each hospital has an infection control team (ICT) with at least one infection control practitioner (ICP) and one physician, but the number of members varies depending on the ICU. The ICT member in charge of process surveillance at each hospital has at least 2 years of experience in monitoring 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 boards at each hospital.

2.3. Study design

An observational, prospective, cohort, interventional, before-and-after multicenter study was conducted from May 2003 through September 2010. The study was divided into two periods: a baseline 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; however the length of the baseline period was exactly the same (3 months) for all ICUs. For comparison of the compliance rates, the ICUs were aligned independently of the date at which they started to participate in the study.

2.4. INICC multidimensional HH approach (IMHHA)

The IMHHA is implemented at each hospital from the beginning of their participation in the INICC. This includes the following six components: (1) administrative support, (2) supplies availability, (3) education and training, (4) reminders in the workplace, (5) process surveillance, and (6) performance feedback. Although the components are presented individually, they are interactive elements that must occur together for the effective implementation of any 'multidimensional' approach.

2.4.1. Administrative support

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

2.4.2. Supplies availability

During the study period, AHR bottles were available at the ICU entrances, nursing stations, and near the site of patient care (individual patient room entrances, at bedside tables, and/or at the foot of the patient's bed). Sinks with a water supply, soap, and paper towels were available at the ICU entrances, nursing stations, and common areas of the ICUs.

2.4.3. Education and training

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

Table 1
Characteristics of the participating hospitals and intensive care units

	n (%)	HH baseline observations, *n*	HH intervention observations, *n*	HH overall observations, *n*
Type of ICU				
Coronary	1 (10%)	132	1383	1515
Medical surgical	5 (50%)	553	9148	9701
Newborn	2 (20%)	381	1142	1523
Neurosurgical	1 (10%)	127	76	203
Pediatric	1 (10%)	101	144	245
All ICUs	10	1294	11 893	13 187
Type of hospital				
Private	4 (67%)	752	10 772	11 524
Public	2 (33%)	542	1121	1663
All hospitals	6 (100%)	1294	11 893	13 187

HH, hand hygiene; ICU, intensive care unit.

2.4.4. Reminders in the workplace

Poster reminders were displayed all around the hospital setting (i.e., 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 content of the education and training program.

2.4.5. 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. HCW HH practice was monitored directly by an observer, a member of the ICT, following a standardized protocol and completion of HH process surveillance INICC forms.[7] Observations were conducted unobtrusively at specific time periods distributed across three work shifts (morning, afternoon, and evening). HCWs were not aware of the schedule of the monitoring period. The monitoring included HH compliance before patient contact and before an aseptic task, because at the time we started the study in May 2003, the "Five Moments for Hand Hygiene" proposed by the WHO had not been published; they were published in 2009. Potential confounders of HH included sex, type of ICU, professional category, work shift, and type of contact.

2.4.6. Performance feedback

Every month, the INICC Headquarters team prepares and sends a final month-by-month report on compliance with HH to each participating ICU. These charts contain a running tally of HH compliance by HCWs of the ICUs, and compliance comparing several variables, such as sex, HCW professional status, ICU type, contact type, and work shift. These 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 in this approach.[7]

2.5. Training of the infection control team 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 HH process surveillance and how to fill in the INICC forms.[7] ICT members had continuous telephone, e-mail, and webinar access to a support team at the INICC Headquarters.

2.6. Data collection and processing

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

2.7. Statistical methods

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

The aggregated independent variables (sex and profession of HCWs, type of ICU, type of contact, etc.) of all observed HH opportunities and HH compliance during the whole study, and a

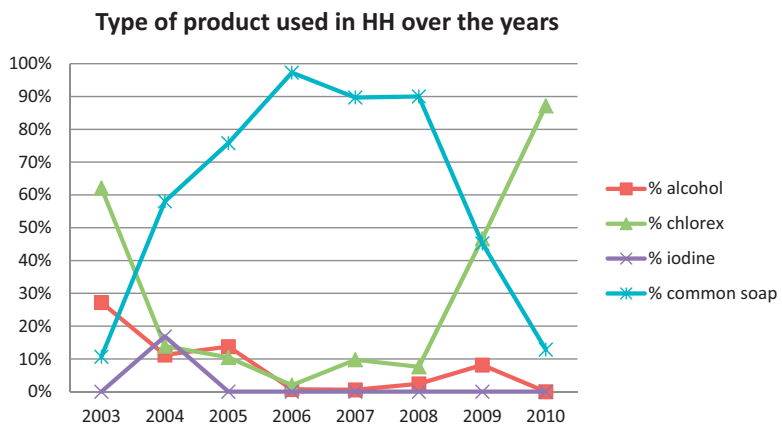

Figure 1. Types of product used in hand hygiene over the years of participation.

Table 2
Distribution of hand hygiene compliance by type of intensive care unit

ICU type	Number of ICUs	Baseline period (HH compliance/HH observations)	Intervention period (HH compliance/HH observations)	RR (95% CI)	*p*-Value
Coronary	1	22.7% (30/132)	25.5% (352/1383)	1.12 (0.77–1.63)	0.5514
Medical surgical	5	62.0% (343/553)	85.7% (7839/9148)	1.38 (1.24–1.54)	0.0001
Newborn	1	57.2% (218/381)	79.2% (904/1142)	1.38 (1.19–1.60)	0.0001
Neurosurgical	1	29.1% (37/127)	44.7% (34/76)	1.54 (0.96–2.45)	0.0688
Pediatric	1	17.8% (18/101)	59.7% (86/144)	3.35 (2.02–5.57)	0.0001
All	9	49.9% (646/1294)	77.5% (9215/11 893)	1.55 (1.43–1.68)	0.0001

ICU, intensive care unit; HH, hand hygiene; RR, relative risk; CI, confidence interval.

comparison of HH compliance during the baseline period and during the follow-up period, were compared using Fisher's exact test for dichotomous variables and the unmatched Student's *t*-test for continuous variables. Relative risk (RR) ratios were calculated for comparisons of analyzed variables associated with HH using EPI Info v. 6. Confidence intervals (95% CI) were calculated using VCStat (Castiglia). *p*-Values of <0.05 by two-tailed tests were considered significant.

2.7.2. Multivariate analysis of variables associated with poor HH

The aggregated independent variables described for all observed HH opportunities and HH compliance during the whole study were compared using logistic regression for dichotomous and continuous variables. Odds ratios (OR) with 95% CI were calculated for comparisons of analyzed variables associated with HH using PASW Statistics 18 (SPSS Inc.). *p*-Values of <0.05 by two-tailed tests were considered significant.

2.7.3. Multivariate analysis of the impact of the INICC multidimensional HH approach (IMHHA)

HH opportunities and HH compliance during baseline and during follow-up were explored for changes in HH compliance rates following an ICU joining the INICC. We present the results of a logistic regression model to consider the change in HH compliance in INICC participating ICUs over time since the beginning of the HH surveillance. ORs are presented, comparing each time period since the start of the surveillance with the baseline of 3 months. Because of the different lengths of follow-up at each ICU, for each time period only ICUs with follow-up during that time period were included in the baseline period used for calculating the OR of HH compliance for that period.

3. Results

From May 2003 to September 2010, we recorded a total 13 187 opportunities for HH before patient contact and before an aseptic task. Characteristics of the hospitals and ICUs participating in the study from May 2003 to September 2010 are shown in Table 1.

The distribution of use of HH products over the study period is shown in Figure 1.

3.1. Predictors of poor HH compliance

We observed 11 524 procedures in private hospitals and 1663 in public hospitals; 10 446 procedures in females and 2741 in males; 6656 in nurses, 1908 in physicians, and 4623 in ancillary staff; 8956 were prior to non-invasive patient contacts and 3939 prior to invasive procedures; 11 419 in adult ICUs, 245 in pediatric ICUs (PICUs), and 1523 in neonatal ICUs (NICUs); 6816 during the morning, 4058 during the afternoon, and 2313 during the night shift.

Table 2 shows the distribution of HH compliance among the different ICU types in the baseline and intervention periods.

Tables 3 and 4 show HH compliance according to each variable (type of hospital, sex, profession of HCW, type of procedure, type of unit, and work shift), and the association with poor HH, analyzed with univariate and multivariate statistical methods.

3.2. Components of the INICC multidimensional HH approach (IMHHA)

During the follow-up period, the six components of the IMHHA were applied simultaneously: 100% counted on administrative

Table 3
Hand hygiene compliance by type of variable: univariate analysis

Data	Variable	% (number of HH/number opportunities)	Comparison	RR	95% CI	*p*-Value
Sex	Female	77% (8024/10 446)	F vs. M	0.87	0.83–0.92	0.0001
	Male	67% (1837/2741)				
HCW	Nurses	78% (5198/6656)	Ns vs. Ph	0.76	0.71–0.81	0.0001
	Physicians	59% (1127/1908)	Ns vs. AS	0.98	0.94–1.02	0.3399
	Ancillary staff	76% (3536/4623)	Ph vs. AS	0.77	0.72–0.83	0.0001
Procedure	Non-invasive	71% (6360/8956)	NI vs. I	0.84	0.88–0.87	0.0001
	Invasive	85% (3337/3939)				
ICU	Adult	76% (8635/11 419)	Ad vs. Pe	0.56	0.46–0.68	0.0001
	Newborn	74% (1112/1523)	Ad vs. Nb	0.97	0.92–1.04	0.4105
	Pediatric	42% (104/245)	Nb vs. Pe	0.58	0.47–0.70	0.0001
Work shift	Morning	78% (5299/6816)	M vs. A	0.94	0.89–0.98	0.0036
	Afternoon	73% (2951/4058)	M vs. N	0.90	0.85–0.95	0.0001
	Night	70% (1611/2313)	A vs. N	0.96	0.90–1.02	0.1636
Type of hospital	Public	78% (1299/1663)	Pu vs. Pr	0.95	0.90–1.01	0.0926
	Private	74% (8562/11 524)				

HH, hand hygiene; RR, relative risk; CI, confidence interval; HCW, healthcare worker; ICU, intensive care unit.

Table 4
Hand hygiene compliance by type of variable: logistic regression, multivariate analysis

Variable	Adjusted OR (95% CI)	*p*-Value
Type of hospital (baseline: Public)	1	
Private	0.65 (0.54–0.80)	0.001
Sex (baseline: Female)	1	
Male	0.88 (0.79–0.98)	0.024
Type of professional (baseline: Nurses)	1	
Physicians	0.41 (0.36–0.47)	0.001
Ancillary staff	0.92 (0.84–1.01)	0.092
Type of contact (baseline: Invasive)	1	
Non-invasive	0.42 (0.38–0.47)	0.001
Type of ICU (baseline: Adult)	1	
Adult ICU	0.56 (0.46–0.69)	0.001
Pediatric ICU	0.28 (0.22–0.37)	0.001
Work shift (baseline: Morning)	1	
Afternoon	0.77 (0.71–0.85)	0.001
Night	0.70 (0.63–0.78)	0.001

OR, odds ratio; CI, confidence interval; ICU, intensive care unit.

support and available supplies for HH and AHR; 100% educated HCWs (14.3% of them every month, 57.1% every 2 months, 14.3% every 3 months, and 14.3% every 6 months); 100% posted reminders (100% of them at ICU entrances, 100% in common ICU areas, 36.4% beside each bed); process surveillance was conducted by 100%; 100% provided performance feedback (14.3% of them every month, 28.6% every 2 months, 28.6% every 3 months).

3.3. Impact of the INICC multidimensional HH approach (IMHHA) on HH compliance

The baseline period of the INICC ICUs was 3 months and their average follow-up period was 42.0 months (range 4–84 months). The results of a logistic regression model to consider the change in HH compliance in INICC participating ICUs over the whole study period are presented in Table 5 and Figure 2.

4. Discussion

This is the first study to show an improvement in HH compliance in Colombia due to the implementation of the IMHHA. We analyzed the impact of the IMHHA in a diverse ICU population in three cities of Colombia, showing that the six measures of the IMHHA implemented in each ICU were followed by a 55% increase in the adherence to proper HH practices.

Baseline HH compliance (50%) of HCWs in the INICC ICUs was similar to that shown in previous studies, although HH compliance rates have ranged from 9% to 75% in different studies.[4]

The results of the multivariate analysis showed that there was higher compliance in females, which has also been identified in individuals unrelated to healthcare: Guinan et al. showed higher HH compliance by female students.[25] In consonance with this, compliance was also higher among nurses than physicians, as also shown in a study by Rosenthal et al. in 2005.[3] We also showed the highest HH compliance was in the adult ICUs. Our findings show that the type of contact influenced HH performance: non-invasive contact was associated with lower compliance than invasive contact. This finding is in agreement with Lipsett and Swoboda, who suggested that low-risk situations were predictors for lower compliance.[26]

Our approach included administrative support; in 2003 Rosenthal et al. showed that higher HH adherence was associated with administrative support.[14] It also included supplies availability, which was shown to improve HH compliance.[14] The IMHHA also included education and training, which are other basic independent interventions identified as fostering adequate HH performance. As shown in 1990 by Dubbert et al.,[18] educational interventions with routine classes improved HH compliance by 97% over 4 weeks. Likewise, but within the context of resource-limited countries, Rosenthal et al.[14] showed HCW education improved HH adherence and that compliance increased further if performance feedback was also implemented. We also included reminders in the workplace. In 1989, Conly et al.[20] showed the importance of reminders to raise HCW awareness of the relationship between correct HH performance and the reduction of HAI.

We measured 13 187 opportunities for HH. On a monthly basis, the ICT team provided performance feedback to the HCWs of each ICU. This is a highly motivating aspect of the IMHHA for HCWs. Knowing the outcome of their efforts reflected by the measurement of their practices and the incidence of HAIs can be a most rewarding or awareness-raising factor and ensures the effectiveness of the IMHHA.[27,28] Since 1998 in Argentina,[3,14] and 2002 internationally,[7–11] the INICC has introduced outcome and process surveillance and feedback on outcomes and performance, combined with training and education, as a means to improve quality in healthcare to a new level.[3,14]

Through the last decade, the INICC has undertaken a global effort in 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 central line-associated bloodstream infection (CLAB) by 54%,[29] of catheter-associated urinary tract infection (CAUTI) by 37%,[30] of ventilator-associated pneumonia (VAP) by 56%,[31] and of mortality by 58%.[29] In PICUs in five countries, the INICC have reduced the rate of CLAB by 52%,[32] of CAUTI by 57%,[33] of VAP by 31%,[34] and of mortality by 31%.[32] In NICUs in 10 countries, the INICC has reduced the rate of VAP by 33%.[35]

This study has several limitations. First, we did not measure the "Five Moments for Hand Hygiene" as recently described by the WHO in 2009. This is because the INICC started the IMHHA in 1998 in Argentina,[3,14] which was launched internationally in 2002,[7] i.e., several years before the WHO published its recommendations in 2009. However, since 2009, the INICC has included the WHO recommendations in its process surveillance forms and manuals.[4] Additionally, it should be noted that this study applied an observational, before-and-after methodology, which implies less strength of evidence than other study designs. A Hawthorne effect

Table 5
Hand hygiene improvement by year of participation

Years since joining INICC	HH observations	Number of ICUs included	Number of hospitals included	HH % (95% CI)	Adjusted OR (95% CI)	*p*-Value
First 3 months (baseline)	1294	10	6	49.9% (0.47–0.52)	1.0	
Months 4–6	823	10	6	57.8% (0.54–0.61)	1.04 (0.84–1.31)	0.694
Months 7–9	761	8	5	68.6% (0.65–0.72)	2.45 (1.9–3.2)	0.001
Months 10–12	767	8	5	67.9% (0.65–0.71)	2.83 (2.2–3.7)	0.001
Second and third year	9542	5	4	80.7% (0.80–0.81)	4.70 (3.6–6.2)	0.0001

INICC, International Nosocomial Infection Control Consortium; HH, hand hygiene; ICU, intensive care unit; CI, confidence interval; OR, odds ratio.

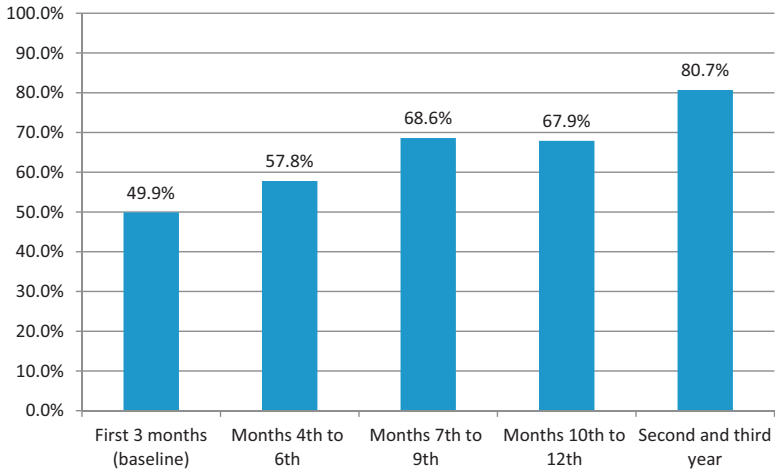

Figure 2. Hand hygiene improvement by year of participation.

is typical in direct observations of adherence. In addition, direct observations represent only a sample of all opportunities and there are inherent weaknesses including assuring inter-observer reliability. Finally, capturing the quality of the HH technique is highly complex, 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 have focused on these topics in relation to HH.

In conclusion, we found that the IMHHA improved HH compliance in 10 ICUs of six hospitals in three cities of Colombia. It is the primary objective of the INICC to foster infection control practices by freely facilitating elemental and inexpensive resource tools to tackle this problem effectively and systematically, leading to greater and steady adherence to infection control programs and guidelines, such as HH compliance, and to the correlated reduction in HAIs and their consequences, such as extra mortality and costs.

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Ethical approval: Every hospital's institutional review board agreed to the study protocol. Patient confidentiality was protected by codifying the recorded information, making it only identifiable to the infection control team.

Conflict of interest: All authors report no conflicts of interest related to this article.

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