Journal of Infection and Public Health (2014) xxx, xxx–xxx

ELSEVIER

http://www.elsevier.com/locate/jiph

The impact of the International Nosocomial Infection Control Consortium (INICC) multicenter, multidimensional hand hygiene approach in two cities of India

Murali Chakravarthy[a], Sheila Nainan Myatra[b], Victor D. Rosenthal[c,*], F.E. Udwadia[d], B.N. Gokul[a], J.V. Divatia[b], Aruna Poojary[d], R. Sukanya[a], Rohini Kelkar[b], Geeta Koppikar[d], Leema Pushparaj[a], Sanjay Biswas[b], Lata Bhandarkar[d], Sandhya Raut[b], Shital Jadhav[d], Sulochana Sampat[b], Neeraj Chavan[d], Shweta Bahirune[d], Shilpa Durgad[d]

[a] *Fortis Hospitals, Bangalore, India*
[b] *Tata Memorial Hospital, Mumbai, India*
[c] *International Nosocomial Infection Control Consortium (INICC), Buenos Aires, Argentina*[1]
[d] *Breach Candy Hospital Trust, Mumbai, India*

Received 30 May 2014; received in revised form 15 July 2014; accepted 24 August 2014

KEYWORDS
Care;
Developing countries;
Hand hygiene;
Hand washing;
Healthcare workers;
India;

Summary The fundamental tool for preventing and controlling healthcare-acquired infections is hand hygiene (HH). Nonetheless, adherence to HH guidelines is often low. Our goal was to assess the effect of the International Nosocomial Infection Control Consortium (INICC) Multidimensional Hand Hygiene Approach (IMHHA) in three intensive care units of three INICC member hospitals in two cities of India and to analyze the predictors of compliance with HH. From August 2004 to July 2011, we carried out an observational, prospective, interventional study to evaluate the implementation of the IMHHA, which included the following elements:

* Corresponding author at: International Nosocomial Infection Control Consortium (INICC), Corrientes Ave. # 4580, Floor 12, Apt D, Buenos Aires 1195, Argentina. Tel.: +54 11 4861 5826; fax: +54 11 4861 5826.
E-mail addresses: victor.rosenthal@inicc.org, V.D. Rosenthal).
[1] URL: www.INICC.org.

http://dx.doi.org/10.1016/j.jiph.2014.08.004

Please cite this article in press as: Chakravarthy M, et al. The impact of the International Nosocomial Infection Control Consortium (INICC) multicenter, multidimensional hand hygiene approach in two cities of India. J Infect Public Health (2014), http://dx.doi.org/10.1016/j.jiph.2014.08.004

Infection control;
Intensive care units;
International Nosocomial Infection Control Consortium;
Multidimensional approach

(1) administrative support, (2) supplies availability, (3) education and training, (4) reminders in the workplace, (5) process surveillance and (6) performance feedback. The practices of health care workers were monitored during randomly selected 30-min periods. We observed 3612 opportunities for HH. Overall adherence to HH increased from 36.9% to 82% (95% CI 79.3—84.5; $P = 0.0001$). Multivariate analysis indicated that certain variables were significantly associated with poor HH adherence: nurses vs. physicians (70.5% vs. 74%; 95% CI 0.62—0.96; $P = 0.018$), ancillary staff vs. physicians (43.6% vs. 74.0%; 95% CI 0.48—0.72; $P < 0.001$), ancillary staff vs. nurses (43.6% vs. 70.5%; 95% CI 0.51—0.75; $P < 0.001$) and private vs. academic hospitals (74.2% vs. 66.3%; 95% CI 0.83—0.97; $P < 0.001$). It is worth noticing that in India, the HH compliance of physicians is higher than in nurses. Adherence to HH was significantly increased by implementing the IMHHA. Programs targeted at improving HH are warranted to identify predictors of poor compliance.

Introduction

Healthcare-associated infection (HAIs) pose serious threats to patient safety, including morbidity and mortality [1]. Within the mainstream literature, the majority of studies on HAIs have been carried in high-income countries [2], whereas this problem has not been studied thoroughly in limited-resource countries. To counteract this, since 2002, the International Nosocomial Infection Control Consortium (INICC) has addressed the burden of HAIs by applying standardized definitions and methods to measure and analyze HAI rates worldwide [3—7].

Over a century ago, it was demonstrated that appropriate hand hygiene (HH) before patient contact was an essential intervention to prevent the transmission of cross-infections by health care workers (HCWs) [8]. It has been widely shown that an increase in the adherence to HH was related to the reduction of bacterial resistance and lower HAI rates [9—11].

Successful interventions to improve HH have been analyzed in studies both from developed and developing countries [10,12—14]. Investigators have assessed the effectiveness of interventions to improve HH since the 1980s [15—17]. Since 1993, Rosenthal et al. have implemented multimodal programs in Argentina combining administrative support, supplies availability, education and training, process surveillance and performance feedback, which produced sustained increases in HH compliance [14], and associated reductions in the rates of HAI [10].

The HH guidelines were published by the US Centers for Disease Control and Prevention (CDC) in 2002 [18], and by the World Health Organization (WHO) in 2005 as part of the ''Clean Care is Safer Care'' campaign [19], and in 2009, by presenting a compilation of previously published data, and a new formulation for alcohol-based hand rub products, among other recommendations [11].

This is the first multisite study conducted in India with the aim of determining the baseline rate of adherence to HH by HCWs before patient contact, analyzing risk factors for poor adherence and assessing the impact of an INICC Multidimensional HH Approach (IMHHA) in 3 hospitals from 2 cities. The IMHHA includes the following components: (1) administrative support, (2) supplies availability, (3) education and training, (4) reminders in the workplace, (5) process surveillance and (6) performance feedback.

Materials and methods

Study design

From August 2004 through July 2011, we carried out an observational, prospective, interventional, before-and-after multisite cohort study, which was divided into two periods: a baseline period and a follow-up period. The baseline period included opportunities registered at each hospital during their first 3 months of participation, and the follow-up period included opportunities documented after the fourth month of participation. Each hospital started to participate in the study at different times, and therefore, they have different lengths of follow-up (from 4 to 36 months); but for all ICUs the length of the baseline period is exactly the same (3 months). For comparing the rate of HH adherence, the ICUs were aligned independently of the date at which they started their participation in the study over the 7-year period.

Please cite this article in press as: Chakravarthy M, et al. The impact of the International Nosocomial Infection Control Consortium (INICC) multicenter, multidimensional hand hygiene approach in two cities of India. J Infect Public Health (2014), http://dx.doi.org/10.1016/j.jiph.2014.08.004

Study setting

This study was conducted in 3 ICUs of 3 INICC member hospitals from 2 cities in India, which were incorporated into the study over the 7-year study period. Each hospital has an infection control team (ICT) with at least one infection control practitioner (ICP) and one physician. The ICT member in charge of process surveillance at each hospital has a minimum of two years of experience in infection control practices and surveillance of HAI rates. Professional categories of HCWs included physicians, nurses, and ancillary staff (paramedical technicians, nurse aides, patient care technicians, laboratory team members, radiology team members, physiotherapists, patient lift teams, and other paramedical personnel.)

Background on INICC

The INICC is an international, non-profit, open, multi-center HAI surveillance network with methodology based on the U.S. CDC/National Healthcare Safety Network (NHSN) [20]. The INICC is the first research network established internationally to measure, control and prevent HAIs in hospitals worldwide through the analysis of standardized data, which are collected on a voluntary basis by its member hospitals. Gaining new members since its international inception in 2002, the INICC is now comprised by nearly 1000 hospitals in 300 cities of 60 countries in Latin America, Asia, Africa, Middle East, and Europe, and has become the only source of aggregate standardized international data on the epidemiology of HAIs worldwide [7].

The INICC Multidimensional Hand Hygiene Approach (IMHHA)

The IMHHA was implemented at the participating ICUs when they began participation in the INICC program. The IMHHA includes 6 elements: (1) administrative support; (2) supplies availability; (3) education and training; (4) reminders in the workplace; (5) process surveillance and (6) performance feedback. For the purposes of analysis, we present the elements of the IMHHA individually. Nevertheless, it is worth noting that for an effective implementation of the approach, the 6 components need to interact simultaneously.

Administrative support

Hospital administrators agreed and committed to supporting the development of the IMHHA, attended infection control meetings on a monthly basis to discuss study findings, and allocated supplies of HH products.

Supplies availability

Supplies were made available by placing alcohol-based hand rub bottles in nursing stations, at the ICUs' and individual patient room entrances, and near the site of patient care (at bedside tables and/or on the feet of patient beds). Soap, paper towels and sink water were supplied at the ICUs' entrances, nursing stations, and common areas in the ICUs.

Education and training

At each ICU, the investigators of the ICT provided 30-min education sessions on HH practices to HCWs in each work shift, at the beginning of the study period and periodically (every month, every 2 months, and every 6 months, in the respective 3 ICUs) during the follow-up period. Sessions included the provision of information about the correct opportunities and techniques for HH.

Reminders in the workplace

Posters reminding employees of HH techniques and opportunities were displayed around the hospital settings (i.e., hospital entrance, corridors, ICT office and entrances, nursing stations, and beside each alcohol-based hand rub bottle). Reminders included simple instructions on HH practice in accordance with the contents of the education and training sessions.

Process surveillance

Process surveillance of HH practices consisted of recording the potential HH opportunities, and the number of HH episodes observed, both with water and soap, or with alcohol-based hand rub products. HCWs' HH practices were directly monitored by a member of the ICT, who had received training sessions from a reporting manual, and who was not an observed HCW [3,11]. To improve the inter-reliability of the data, observers used standardized monitoring processes, following a protocol and completing standardized HH surveillance forms that contained a uniform questionnaire for monitoring HH practices [3]. The ICT member conducted unobtrusive observations (that is, without interference from the observer) at specific time periods selected at random, distributed three times a week, during 30 min each time and during all work shifts (morning, afternoon and evening). HCWs were not aware of the schedule of the monitoring period by the ITC. The monitoring included HH compliance before patient contact, and before an aseptic task, because we started the study in August 2004,

Please cite this article in press as: Chakravarthy M, et al. The impact of the International Nosocomial Infection Control Consortium (INICC) multicenter, multidimensional hand hygiene approach in two cities of India. J Infect Public Health (2014), http://dx.doi.org/10.1016/j.jiph.2014.08.004

and the ''Five moments for HH'' proposed by the WHO was not published until 2009. The potential confounders of HH included the type of ICU, the professional category, sex, the work shift, and the type of contact.

Performance feedback

On a monthly basis, the INICC Headquarters in Buenos Aires prepared and sent each ICU a final month-by-month report on compliance with HH. These reports displayed charts and contained a running tally of HH compliance by HCWs in the ICUs, and compliance comparing several variables, such as sex, HCWs' professional status, ICU type, contact type, and work shift. The results of the reports were reviewed every month at ICT meetings and the charts were posted in the participating ICUs to provide performance feedback to the HCWs working in them [3]. Performance feedback started in the third month of participation in this approach [3].

Training for process surveillance

The ICT investigators were self-trained with a procedure manual designed by the INICC, which specified how to conduct HH process surveillance and how to fill in the forms [3]. ICT members had continuous telephone, email, and webinar access to a support team at the INICC Headquarters.

Data collection and processing

Every month, the ICT members from each participating ICU completed INICC process surveillance HH forms and sent them to the INICC Headquarters in Buenos Aires, where the data were uploaded into a database and analyzed. Next, the members of the ICT at each participating ICU received a report on the HH compliance, showing compliance rates stratified by month, sex, HCWs' professional status, the ICU, the ICU work shift, and the type of contact [3].

Statistical methods

Univariate analysis of variables associated with poor hand hygiene, and the impact of the INICC multidimensional hand hygiene approach

The aggregated independent variables (type of hospital, sex of the HCWs, profession of the HCWs, the type of ICU, and the type of contact) of all of the observed HH opportunities and HH compliance during the study, and the comparison of HH compliance during the baseline period and during the follow-up period were compared using the Fisher's exact test for dichotomous variables and the unmatched Student's *t*-test for continuous variables. 95% confidence intervals (CI) were calculated using Stata 11 (StataCorp LP, 4905 Lakeway Drive, College Station, TX, US). Relative risk (RR) ratios were calculated for comparisons of the analyzed variables associated with HH using EPI Info™ V6 (Centers for Disease Control and Prevention, 1600 Clifton Road Atlanta, GA., US). *P*-values <0.05 by two-tailed tests were considered significant.

Multivariate analysis of the variables associated with poor hand hygiene

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

Multivariate analysis of the impact of the INICC multidimensional hand hygiene approach

HH opportunities and HH compliance during baseline and during follow-up were analyzed for changes in HH compliance rates following an ICU joining the INICC. We looked at the follow-up periods stratified by three-month periods over the first year, and yearly following the second year of participation. We present the results of a logistic regression model to describe the changes in HH compliance in 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 3612 observations, and so 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 at each ICU (from 9 months to 3 years), for each time period only ICUs with follow-up in that time period were included in the baseline period used for calculating the OR of HH compliance for that period.

Results

From August 2004 to July 2011 (7 years), we recorded a total 3612 opportunities for HH before patient contact, and before aseptic task. Characteristics of participating hospitals are shown in Table 1.

Please cite this article in press as: Chakravarthy M, et al. The impact of the International Nosocomial Infection Control Consortium (INICC) multicenter, multidimensional hand hygiene approach in two cities of India. J Infect Public Health (2014), http://dx.doi.org/10.1016/j.jiph.2014.08.004

Table 1 The characteristics of the participating hospitals (from August 2004 to July 2011).

Hospital type	ICU type	Observations of opportunities for HH in ICUs, *n*
Hospital 1 – academic teaching	Medical surgical	2060
Hospital 2 – private	Surgical	310
Hospital 3 – private	Medical surgical	1242
All hospitals		3612

ICU, intensive care unit; HH, hand hygiene.

Table 2 The distribution of hand hygiene compliance by the type of intensive care unit.

	ICUs (*n*)	Baseline period (HH compliance/HH observations)	Intervention period (HH compliance/HH observations)	RR (95% CI)	*P* value
Medical	1	64.9% (72/111)	90.9% (1023/1131)	1.40 (1.1–1.8)	0.0039
Medical surgical	1	40.1% (87/217)	69.4% (1279/1843)	1.73 (1.4–2.2)	0.001
Surgical	1	13.5% (22/163)	19.7% (29/147)	1.46 (0.81–2.7)	0.1811
All	3	36.9% (181/491)	74.8% (2336/3121)	2.0 (1.7–2.4)	0.0001

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

Predictors of poor hand hygiene compliance

We observed 2060 opportunities in academic hospitals and 1552 in private hospitals; 1084 opportunities in males, and 2528 in females; 2154 in nurses, 1194 in physicians, and 264 in ancillary staff; 2127 were prior to non-invasive patient contacts, and 822 were prior to invasive procedures; 1440 during the morning, 1139 during the afternoon, and 1033 during the night shift.

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

In Table 3, we present the HH compliance rates for the whole study period comparing each variable (sex, HCW professional status, type of procedure, type of ICU, and work shift). Their associations with poor HH were analyzed with univariate and multivariate statistical methods as also shown in Table 3.

Components of the INICC multidimensional hand hygiene approach

During the follow-up period, the 6 components of the IMHHA were applied simultaneously in each ICU. All the aspects of the IMHHA were followed by all 3 ICUs, with the exception of the posting of reminders, which were only posted in 2 ICUs, at the ICU entrance and in common ICU areas. All ICUs counted on administrative support and available supplies for HH and alcohol-based hand rub products. Process surveillance was conducted at the 3 ICUs. All HCWs working at the 3 ICUs were provided with performance feedback and attended training sessions at regular intervals: 1 ICU on a monthly basis: 1 ICU every 2 months, and 1 ICU every 6 months.

The impact of the INICC multidimensional hand hygiene approach on hand hygiene compliance

In Table 4, we present the results of a regression model to describe the changes 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 17.2 months (range 4–52).

Discussion

Over the last decade, the INICC has constantly struggled to reduce the burden of HAIs in Latin America, Asia, Africa, Middle East, and Europe, achieving successful results. Through the INICC multimodal programs, compliance with infection control measures and tools has been increased substantially, thereby reducing the HAI rates and their adverse effects, such as mortality, as shown in many scientific publications [10]. Since 2002, in adult ICUs in 15 countries, the INICC has reduced the rate of central line-associated bloodstream infection by 54% [21], of catheter-associated urinary tract infection by 37% [22], of ventilator-associated pneumonia by 56% [23], and of mortality by 58% [21]. In pediatric ICUs from 5 countries, the INICC

Please cite this article in press as: Chakravarthy M, et al. The impact of the International Nosocomial Infection Control Consortium (INICC) multicenter, multidimensional hand hygiene approach in two cities of India. J Infect Public Health (2014), http://dx.doi.org/10.1016/j.jiph.2014.08.004

Table 3 Hand hygiene compliance by type of variable using univariate analysis, logistic regression, and multivariate analysis.

Variable	% (# HH/# opportunities)	Comparison	RR	95% CI	P value	Adjusted OR	95% CI	P value
Type of hospital (baseline: private)								
Private	74.2% (1151/1552)					1		
Academic	66.3% (1366/2060)	Ac vs. Pr	0.89	0.83–0.97	0.0052	0.49	0.42–0.60	0.001
Sex (baseline female)								
Female	71.2% (1801/2528)	F vs. M	0.93	0.85–1.01	0.0858	1		
Male	66.1% (716/1084)					0.86	0.70–1.07	0.186
Type of professional (baseline: physicians)								
Physicians	74.0% (883/1194)	Ph vs. AS	0.59	0.48–0.72	0.0001	1		
Nurses	70.5% (1519/2154)	Ns vs. Ph	0.95	0.88–1.04	0.2616	0.77	0.62–0.96	0.018
Ancillary staff	43.6% (115/264)	Ns vs. AS	0.62	0.51–0.75	0.0001	0.23	0.16–0.31	0.001
Type of contact (baseline: invasive)								
Invasive	82.8% (681/822)	NI vs. I	0.95	0.87–1.04	0.2935	1		
Non-invasive	79.0% (1680/2127)					1.02	0.82–1.3	0.850
Work shift (baseline: night)								
Afternoon	71.6% (815/1139)	M vs. A	0.94	0.85–1.03	0.1892	1.0		
Morning	67.2% (968/1440)	M vs. N	0.95	0.86–1.05	0.2574	0.96	0.79–1.20	0.723
Night	71.1% (734/1033)	A vs. N	0.99	0.90–1.10	0.8910	0.92	0.74–1.1	0.447

ICU, intensive care unit; OR, odds ratio; CI, confidence interval; AS, ancillary staff; F, female; M, male; Ni, non-invasive; I, invasive; M, morning work shift; A, afternoon work shift; N, night work shift; NS, nursing staff; Ph, physicians; AS, ancillary staff

has reduced the rate of central line-associated bloodstream infection by 52% [24], of catheter-associated urinary tract infection by 57% [25], of ventilator-associated pneumonia by 31% [26], and of mortality by 31% [24]. In neonatal ICUs in 10 countries, the INICC has reduced the rate of ventilator-associated pneumonia by 33% [27].

The baseline percentage of adherence to HH by HCWs at our ICUs (37%) was within the wide and variable range of percentages of compliance with HH reported in previous studies, which vary from 9% to 75% [11]. This is the first study that has showed an increase in HH compliance in India as a result of the implementation of the IMHHA.

However, there are some limitations in our study that need to be addressed before describing and explaining our findings. We did not measure the opportunities as specified in 2009 by the WHO in, ''My five moments for HH,'' because the INICC started the IMHHA in 1998 in Argentina and in 2002 internationally; that is, several years before these WHO recommendations were published. However, since 2009, the INICC has included the WHO's ''My five moments for HH'' in its process surveillance forms and manuals [3,10,11,14]. It should be noted also that, due to our limited budget, we did not include more details about the HH techniques [28]. In addition, as we applied an observational, before–after method, the evidence may have less strength and accuracy than other study designs. Directly observing adherence typically involves a Hawthorne effect, and represents only a sample of all opportunities and we cannot overtly assure inter-observer reliability. Finally, an analysis of the compliance by the intensity of education would be very useful for future infection control interventions.

The evaluation of the impact of the IMHHA in the ICU populations from 2 cities of India showed that the 6 measures of the IMHHA were followed by important improvements in HH practices. The results of the multivariate analysis showed that there was higher compliance in private hospitals than in public and academic ones. The relationship between the type of hospital and HH compliance has not been assessed in the literature [29]. Nevertheless, there is published evidence that in limited-resource countries, such as India, ICUs in the private sector can influence the outcome of such programs due to the wider availability of resources and greater administrative support, in contrast to public ICUs that experience overcrowding and understaffing, which have been shown to hinder HCWs' efforts to perform HH [30,31]. Adherence to HH was not statistically significantly different by the HCWs' sex, which is in contrast with the findings of Guinan

Please cite this article in press as: Chakravarthy M, et al. The impact of the International Nosocomial Infection Control Consortium (INICC) multicenter, multidimensional hand hygiene approach in two cities of India. J Infect Public Health (2014), http://dx.doi.org/10.1016/j.jiph.2014.08.004

Table 4 Hand hygiene improvement by year of participation from July 2004 to July 2011.

Years since joining INICC	HH observations	Number of ICUs Included	HH % (95% CI)	Adjusted OR (95% CI)	*P* value
First 3 months (baseline)	491	3	36.9% (32.5–41.3)	1.0	
Months 4–6	437	3	44.4% (39.7–49.2)	1.04 (0.77–1.4)	0.803
Months 7–9	413	3	60.3% (55.4–65.1)	1.91 (1.4–2.6)	0.001
Months 10–12	381	2	65.1% (60.1–69.9)	1.78 (1.3–2.5)	0.001
2nd year	1211	2	89.8% (88.1–91.5)	9.9 (7.3–13.3)	0.001
3rd year	679	2	82.0% (79.3–84.5)	7.3 (5.3–9.9)	0.001

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

et al., were higher adherence to HH was found in females not related to health care [32]; as well as in relation to the type of contact and work shift, which also contrasts with the previous findings, such as in the study by Lipsett et al., which showed that lower HH compliance was found in low-risk situations [33]. In regard to the type of professional, compliance was lower among ancillary staff, which is consistent with the findings of Rosenthal et al. in 2005 in which compliance was lower among ancillary staff compared to nurses [10]. The most surprising outcome found by this research is that in India, the HH compliance of physicians is higher than nurses: nurses vs. physicians (70.5% vs. 74%; 95% CI 0.62–0.96; $P = 0.018$), which is in contrast with previous findings in the mainstream literature [34,35]. This can be explained by the strongest commitment to preventing and controlling HAIs in India by doctors, and the lack of emphasis on hand hygiene importance in the nursing curricula [36]. We found greater compliance among physicians, which is the opposite of the findings from other studies [37–39].

We think that the impact of the IMHHA is directly related to its components. Regarding administrative support, there is published evidence that higher HH adherence was associated to the support of administrative authorities, as shown by Rosenthal et al. [14] The IMHHA included supplies availability. In 2000, Bischoff et al. [40] showed that easily accessible dispensers of alcohol-based hand rub products revealed that the more dispensers per bed, the higher adherence to HH. The IMHHA also included education and training sessions, which were other basic independent interventions identified to foster adequate HH performance. As described by Dubbert et al., the regularity of educational sessions improved HH compliance by 97% over four weeks [41]. Likewise, but within the context of limited-resource countries, Rosenthal et al. showed that educating HCWs increased

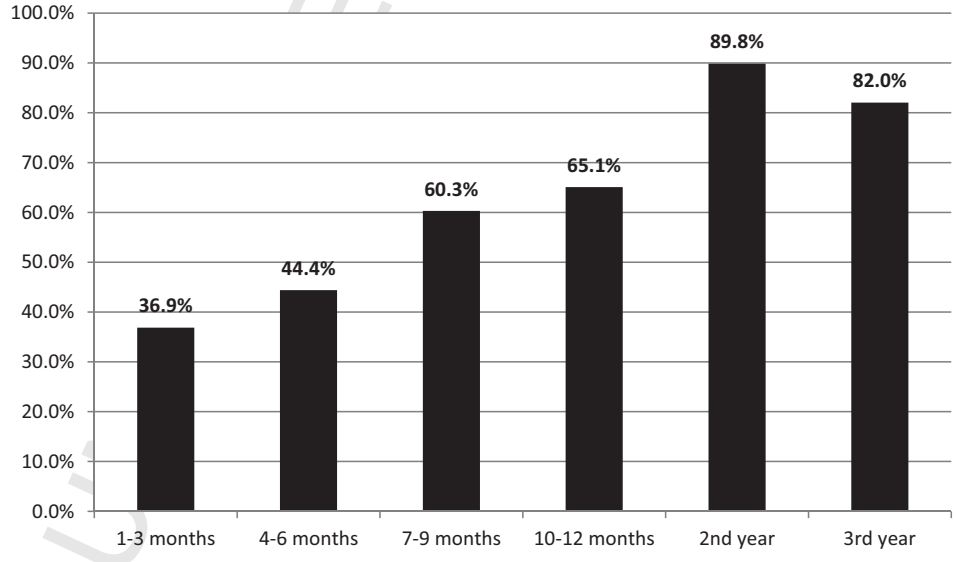

Figure 1 Hand hygiene improvement by year of participation.

Please cite this article in press as: Chakravarthy M, et al. The impact of the International Nosocomial Infection Control Consortium (INICC) multicenter, multidimensional hand hygiene approach in two cities of India. J Infect Public Health (2014), http://dx.doi.org/10.1016/j.jiph.2014.08.004

adherence to HH and that compliance percentages could be further improved if performance feedback was also provided to HCWs [14]. The IMHHA also included reminders at the workplace, which has been highlighted as an important tool to raise HCWs' awareness of the relation between correct HH performance and the reduction of HAIs [42]. The ICT team provided performance feedback to the HCWs in each ICU on a monthly basis. This is the most motivating aspect of the IMHHA for HCWs. Knowing the outcome of their efforts reflected by the measurement of their practices and HAI incidence can be a rewarding or consciousness-raising factor to ensure the IMHHA's effectiveness [43]. From 1998 in Argentina, and 2002 internationally, the INICC has introduced process surveillance and performance feedback to measure and improve quality in healthcare by monitoring and providing constant feedback to HCWs not only of outcome data — that is, the HAI rates — but also by informing the HCWs about the results of the process surveillance—rates of HH compliance and other basic but highly effective, evidence-based infection control practices — and we show that combining education with surveillance feedback can substantially reduce the risk of HAIs in ICUs [3—7,10,14] (Fig. 1).

Conclusions

The primary goal of the INICC is to promote infection control practices by providing free resourceful tools to address the burden posed by HAIs effectively, thereby leading to greater and steady adherence to infection control programs and guidelines. As demonstrated, the IMHHA improved HH compliance in India, and as shown in other INICC publications, thus contributing to the reduction of HAIs and the consequences attributable to them [10,44,45].

Funding

The funding for the activities carried out at the INICC headquarters were provided by the corresponding author, Victor D. Rosenthal, and the Foundation to Fight against Nosocomial Infections.

Competing interests

None declared.

Ethical approval

Every hospital's Institutional Review Board agreed to the study protocol, and patient confidentiality was protected by codifying the recorded information, and making it only identifiable to the infection control team.

Acknowledgments

The authors thank the many health care professionals at each member hospital who assisted with the conduct of surveillance in their hospital, including the surveillance nurses, clinical microbiology laboratory personnel, and the physicians and nurses providing care for the patients during the study; without their cooperation and generous assistance this INICC would not be possible; Mariano Vilar and Débora López Burgardt, who work at the INICC headquarters in Buenos Aires, for their hard work and commitment to achieving the INICC goals; the INICC Country Coordinators and Secretaries (Altaf Ahmed, Carlos A. Álvarez-Moreno, Anucha Apisarnthanarak, Luis E. Cuéllar, Bijie Hu, Namita Jaggi, Hakan Leblebicioglu, Montri Luxsuwong, Eduardo A. Medeiros, Yatin Mehta, Ziad Memish, and Lul Raka); and the INICC Advisory Board (Carla J. Alvarado, Nicholas Graves, William R. Jarvis, Patricia Lynch, Dennis Maki, Gerald McDonnell, Toshihiro Mitsuda, Cat Murphy, Russell N. Olmsted, Didier Pittet, William Rutala, Syed Sattar, and Wing Hong Seto), who have so generously supported this unique international infection control network.

References

[1] Jarvis WR. Selected aspects of the socioeconomic impact of nosocomial infections: morbidity, mortality, cost, and prevention. Infect Control Hosp Epidemiol 1996;17(8):552—7.

[2] Safdar N, Crnich CJ, Maki DG. Nosocomial infections in the intensive care unit associated with invasive medical devices. Curr Infect Dis Rep 2001;3(6):487—95.

[3] Rosenthal VD, Maki DG, Graves N. The International Nosocomial Infection Control Consortium (INICC): goals and objectives, description of surveillance methods, and operational activities. Am J Infect Control 2008;36(November (9)):e1—12.

[4] Rosenthal VD, Maki DG, Salomao R, Moreno CA, Mehta Y, Higuera F, et al. Device-associated nosocomial infections in 55 intensive care units of 8 developing countries. Ann Intern Med 2006;145(October (8)):582—91.

[5] Rosenthal VD, Maki DG, Mehta A, Alvarez-Moreno C, Leblebicioglu H, Higuera F, et al. International Nosocomial Infection Control Consortium report, data summary for 2002—2007, issued January 2008. Am J Infect Control 2008;36(November (9)):627—37.

Please cite this article in press as: Chakravarthy M, et al. The impact of the International Nosocomial Infection Control Consortium (INICC) multicenter, multidimensional hand hygiene approach in two cities of India. J Infect Public Health (2014), http://dx.doi.org/10.1016/j.jiph.2014.08.004

[6] Rosenthal VD, Maki DG, Jamulitrat S, Medeiros EA, Todi SK, Gomez DY, et al. International Nosocomial Infection Control Consortium (INICC) report, data summary for 2003–2008, issued June 2009. Am J Infect Control 2010;38(March (2)):95–104, e2.

[7] Rosenthal VD, Bijie H, Maki DG, Mehta Y, Apisarnthanarak A, Medeiros EA, et al. International Nosocomial Infection Control Consortium (INICC) report, data summary of 36 countries, for 2004–2009. Am J Infect Control 2012;40(June (5)):396–407.

[8] Raju TN. Ignac Semmelweis and the etiology of fetal and neonatal sepsis. J Perinatol 1999;19(4):307–10.

[9] Simmons B, Bryant J, Neiman K, Spencer L, Arheart K. The role of handwashing in prevention of endemic intensive care unit infections. Infect Control Hosp Epidemiol 1990;11(November (11)):589–94.

[10] Rosenthal VD, Guzman S, Safdar N. Reduction in nosocomial infection with improved hand hygiene in intensive care units of a tertiary care hospital in Argentina. Am J Infect Control 2005;33(September (7)):392–7.

[11] Pittet D, Allegranzi B, Boyce J. The World Health Organization Guidelines on Hand Hygiene in Health Care and their consensus recommendations. Infect Control Hosp Epidemiol 2009;30(July (7)):611–22.

[12] Lam BC, Lee J, Lau YL. Hand hygiene practices in a neonatal intensive care unit: a multimodal intervention and impact on nosocomial infection. Pediatrics 2004;114(November (5)):e565–71.

[13] Allegranzi B, Sax H, Bengaly L, Richet H, Minta DK, Chraiti MN, et al. Successful implementation of the World Health Organization hand hygiene improvement strategy in a referral hospital in Mali, Africa. Infect Control Hospital Epidemiol 2010;31(February (2)):133–41.

[14] Rosenthal VD, McCormick RD, Guzman S, Villamayor C, Orellano PW. Effect of education and performance feedback on handwashing: the benefit of administrative support in Argentinean hospitals. Am J Infect Control 2003;31(April (2)):85–92.

[15] Preston GA, Larson EL, Stamm WE. The effect of private isolation rooms on patient care practices, colonization and infection in an intensive care unit. Am J Med 1981;70(March (3)):641–5.

[16] Conly JM, Hill S, Ross J, Lertzman J, Louie TJ. Handwashing practices in an intensive care unit: the effects of an educational program and its relationship to infection rates. Am J Infect Control 1989;17(December (6)):330–9.

[17] Mayer JA, Dubbert PM, Miller M, Burkett PA, Chapman SW. Increasing handwashing in an intensive care unit. Infect Control 1986;7(May (5)):259–62.

[18] Boyce JM, Pittet D. Guideline for Hand Hygiene in Health-Care Settings. Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Society for Healthcare Epidemiology of America/Association for Professionals in Infection Control/Infectious Diseases Society of America. MMWR Recommend Rep 2002;51(October (RR-16)):1–45, quiz CE1-4.

[19] WHO launches global patient safety challenge; issues guidelines on hand hygiene in health, care. Indian J Med Sci 2005;59(October (10)):461–3.

[20] Horan TC, Andrus M, Dudeck MA. CDC/NHSN surveillance definition of health care-associated infection and criteria for specific types of infections in the acute care setting. Am J Infect Control 2008;36(June (5)):309–32.

[21] Rosenthal VD, Maki DG, Rodrigues C, Alvarez-Moreno C, Leblebicioglu H, Sobreyra-Oropeza M, et al. Impact of International Nosocomial Infection Control Consortium (INICC) strategy on central line-associated bloodstream infection rates in the intensive care units of 15 developing countries. Infect Control Hosp Epidemiol 2010;31(December (12)):1264–72.

[22] Rosenthal VD, Todi SK, Alvarez-Moreno C, Pawar M, Karlekar A, Zeggwagh AA, et al. Impact of a multidimensional infection control strategy on catheter-associated urinary tract infection rates in the adult intensive care units of 15 developing countries: findings of the International Nosocomial Infection Control Consortium (INICC). Infection 2012.

[23] Rosenthal VD, Rodrigues C, Alvarez-Moreno C, Madani N, Mitrev Z, Ye G, et al. Effectiveness of a multidimensional approach for prevention of ventilator-associated pneumonia in adult intensive care units from 14 developing countries of four continents: findings of the International Nosocomial Infection Control Consortium. Crit Care Med 2012;40(December (12)):3121–8.

[24] Rosenthal VD, Ramachandran B, Villamil-Gomez W, Armas-Ruiz A, Navoa-Ng JA, Matta-Cortes L, et al. Impact of a multidimensional infection control strategy on central line-associated bloodstream infection rates in pediatric intensive care units of five developing countries: findings of the International Nosocomial Infection Control Consortium (INICC). Infection 2012;40(August (4)):415–23.

[25] Rosenthal VD, Ramachandran B, Duenas L, Alvarez-Moreno C, Navoa-Ng JA, Armas-Ruiz A, et al. Findings of the International Nosocomial Infection Control Consortium (INICC), Part I: effectiveness of a multidimensional infection control approach on catheter-associated urinary tract infection rates in pediatric intensive care units of 6 developing countries. Infect Control Hosp Epidemiol 2012;33(July (7)):696–703.

[26] Rosenthal VD, Alvarez-Moreno C, Villamil-Gomez W, Singh S, Ramachandran B, Navoa-Ng JA, et al. Effectiveness of a multidimensional approach to reduce ventilator-associated pneumonia in pediatric intensive care units of 5 developing countries: International Nosocomial Infection Control Consortium findings. Am J Infect Control 2012;40(August (6)):497–501.

[27] Rosenthal VD, Rodriguez-Calderon ME, Rodriguez-Ferrer M, Singhal T, Pawar M, Sobreyra-Oropeza M, et al. Findings of the International Nosocomial Infection Control Consortium (INICC), Part II: impact of a multidimensional strategy to reduce ventilator-associated pneumonia in neonatal intensive care units in 10 developing countries. Infect Control Hosp Epidemiol 2012;33(July (7)):704–10.

[28] Mehta A, Rosenthal VD, Mehta Y, Chakravarthy M, Todi SK, Sen N, et al. Device-associated nosocomial infection rates in intensive care units of seven Indian cities. Findings of the International Nosocomial Infection Control Consortium (INICC). J Hosp Infect 2007;67(October (2)):168–74.

[29] Haley RW, Bregman DA. The role of understaffing and overcrowding in recurrent outbreaks of staphylococcal infection in a neonatal special-care unit. J Infect Dis 1982;145(June (6)):875–85.

[30] Al-Wazzan B, Salmeen Y, Al-Amiri E, Abul A, Bouhaimed M, Al-Taiar A. Hand hygiene practices among nursing staff in public secondary care hospitals in Kuwait: self-report and direct observation. Med Princ Pract 2011;20(4):326–31.

[31] De Wandel D, Maes L, Labeau S, Vereecken C, Blot S. Behavioral determinants of hand hygiene compliance in intensive care units. Am J Crit Care 2010;19(May (3)):230–9.

[32] Guinan ME, McGuckin-Guinan M, Sevareid A. Who washes hands after using the bathroom? Am J Infect Control 1997;25(5):424–5.

Please cite this article in press as: Chakravarthy M, et al. The impact of the International Nosocomial Infection Control Consortium (INICC) multicenter, multidimensional hand hygiene approach in two cities of India. J Infect Public Health (2014), http://dx.doi.org/10.1016/j.jiph.2014.08.004