Impact of the International Nosocomial Infection Control Consortium (INICC) Multidimensional Hand Hygiene Approach in five intensive care units in three cities of China

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Abstract


Study design: A prospective before-after study from May 2009 to December 2010 in five intensive care units members of the INICC in China.

Methods: The study was divided into two periods: a 3-month baseline period and a follow-up period. A Multidimensional HH Approach was implemented, which included 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. Observations were done for HH compliance in each ICU, during randomly selected 30-min periods.

Results: A total of 2079 opportunities for HH were recorded. Overall HH compliance increased from 51.5% to 80.1% (95% CI 73.2–87.8; P = 0.004). Multivariate analysis indicated that several variables were significantly associated with poor HH compliance: females vs males (64% vs 55%; 95% CI 0.81–0.94; P = 0.0005), nurses vs physicians (64% vs 57%, P = 0.004), among others.

Conclusions: Adherence to HH was increased significantly with the INICC multidimensional approach. Specific programs directed to improve HH in variables found to be predictors of poor HH compliance should be implemented.

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Introduction

The effectiveness of hand hygiene (HH) before patient contact to prevent cross infection was demonstrated back in the XIX Century. Since then, in the scientific literature it has been widely confirmed that improved HH practice reduces health care-associated infection (HAI) rates. HAIs pose a serious threat to patient safety, causing patient mortality and morbidity. Traditionally, most studies of HAIs were from developed countries and in limited-resource countries; this problem had not been systematically addressed until the International Nosocomial Infection Control Consortium (INICC) started analyzing and publishing HAI rates using standardized definitions and methods.

In a recent study by Huang Y et al. conducted at a Chinese teaching hospital, it was reported that, due to deficiencies in learning resources and curricula, there is limited knowledge and practice between Chinese medical students regarding HAIs. In particular, the importance of proper HH procedure to prevent HAI was significantly underestimated, with only 52.9% of the students considering it as the most important preventive measure for infection control. Additionally, it was reported that 58.5% of students did not wash their hands between different procedures on the same patient, and 78.3% did not follow HH practices before and after touching wounds when they used gloves. The authors thus recommended that surveillance and monitoring of practicing health care workers (HCWs) were a priority for effective infection prevention.

Successful interventions to improve HH have been reported from high-income countries and limited-resource countries. From the eighties, investigators have analyzed the effectiveness of interventions to improve HH. In 1997, Larson et al. explicitly referred to a multidimensional approach that considered several interventions in a study conducted in the US. 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, with a reduction in HAI rates. In 2002, the US Centres for Disease Control and Prevention (CDC) published their HH guideline. In 2005, the World Health Organization (WHO) launched the program ‘Clean Care is Safer Care’ to promote HH worldwide, and four years later, in 2009, the WHO published its guidelines including a combination of previously published data, and a new formulation for alcohol hand rub (AHR) products, among several other recommendations.

Adherence to an appropriate hand hygiene method was described as a critical health problem that remains unsolved among the Chinese adult population. There are no previous publications showing HH compliance by HCWs in hospitals from China. The purpose of this INICC study was to establish the baseline HH compliance rate by HCWs before patient contact, analyze risk factors for poor adherence, and implement and evaluate the impact of an INICC Multidimensional HH Approach (IMHHA) in five intensive care units (ICUs), of three hospitals, of three cities of China, which 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. The resources on the ICU setting is focused, a patient care area with the highest HAI rates. The ICU was the priority, therefore, because critically ill patients hospitalized in ICUs are the most susceptible to acquiring severe and life-threatening HAIs.

Methods

Background on INICC

The INICC is an international, non-profit, open, multicentric HAI surveillance network with a methodology based on the U.S. CDC/National Healthcare Safety Network (NHSN). INICC is the first research network established to measure and control HAIs worldwide in hospitals through the analysis of standardized data collected on a voluntary basis by its member hospitals. Gaining new members since its international inception in 2002, INICC comprises a network of nearly 1000 hospitals in 200 cities of 50 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 HAI internationally.

Study setting

This study was conducted in five intensive care units of three hospitals of three cities of China, which were successively incorporated into the study over a period of 2 years. The types of ICUs participating in this study were one medical surgical, one neurosurgical, one respiratory and two surgical ICUs.

Each hospital has an infection control team (ICT) comprised of at least one infection control practitioner (ICP) and one physician. The ICP is the HCW in charge of process surveillance in the ICU, who has at least two years of infection control experience.

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.

Study design

A prospective, before-after multicentric study was conducted from May 2009 to December 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 has a different length of follow-up period because they started to participate in the study at different times; but for all ICUs the length of the baseline period is exactly the same (3 months). For the comparison of compliance rates, the ICUs were aligned for the
amount of study time, independently of the date at which they started to participate in the study.

**INICC Multidimensional HH Approach (IMHHA)**

The IMHHA was implemented at each hospital from the beginning of their participation in INICC. The approach 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 concur for the effective implementation of any ‘multi-dimensional’ approach.

1- 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.

2- 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/or at the foot of patient beds). Sinks with water supply, soap and paper towels were available at the ICUs’ entrances, nursing stations, and common areas of ICUs.

3- Education and training

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

4- Reminders in the workplace

Poster reminders were displayed all around the hospital settings (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 contents of the education and training program.

5- Process surveillance

Process surveillance of HH practices consisted of the registrations of potential opportunities for HH, 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, who had received training sessions by means of a reporting manual, and who was not an observed HCW. To improve data inter-reliability, observers used standardized monitoring processes, following a protocol and completing standardized HH surveillance forms that contained a uniform questionnaire for monitoring HH practices. The ICT member conducted unobtrusive covert observations on health care professionals working 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 three times during a week, lasting 30 minutes each and during all work shifts (morning, afternoon and evening). For this reason, although HCWs had been notified that process surveillance would be conducted some time from the beginning of the study, they were not aware of the schedule of the monitoring period by the member of the ICT. The monitoring included HH compliance before patient contact, and before an aseptic task, because by the time the study in May 2009 was started, the recommendations of the WHO in ‘Your five moments for HH’ had not been disseminated yet. Potential confounders of HH included type of ICU, professional category, sex, work shift, and type of contact.

6- 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, such as sex, HCW professional status, ICU type, contact type, and 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. The performance feedback process started at the third month of participation.

**Training of the infection control team for process surveillance**

The ICT members 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. Internal validation of forms was performed by investigators at the participating centre to ensure 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. Also, ICT members had continuous telephone, email and webinar 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 to ICT members of each participating ICU a report of HH compliance, showing HH compliance by month, by sex, by HCW profession, by ICU, by work shift, and by type of contact.
Statistical methods

Univariate analysis of variables associated with poor hand hygiene, and of impact of hand hygiene 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 all the study, and comparison of HH compliance during the baseline period and during the follow-up period were compared using Fisher’s exact test for dichotomous variables. Relative risk (RR) ratios were calculated for comparisons of analyzed variables associated with HH using EPI Info V6. 95% confidence intervals (CI) were calculated for comparisons of analyzed variables associated with HH using EPI Info V6. P-values <0.05 by two-tailed tests were considered significant.

The list of variables and their values is as follows:

1. **Hand Hygiene compliance**: yes, no (dichotomous variable).
2. **Sex**: male, female (categorical variable).
3. **Type of profession**: ancillary staff, nursing staff, physician (categorical variable).
4. **Type of contact**: non-invasive, invasive (categorical variable).
5. **Type of intensive care unit**: adult, paediatric, newborn (categorical variable).
6. **Work shift**: morning work shift, afternoon work shift; night work shift (categorical variable).
7. **Period of Participation**: months 1–3 of participation, months 4–12 of participation, second year of participation (categorical variable).

Multivariate analysis of variables associated with poor hand hygiene

The aggregated described independent variables of all observed HH opportunities and HH compliance during all the study were compared using logistic regression for dichotomous and continuous variables. Due to the fact that ‘Hand Hygiene compliance’ is a dichotomous variable and the only dependent variable, a generalized linear model such as logistic regression is used. The logistic regression model was applied to consider the effect of all the independent variables (sex, type of profession, type of contact, type of intensive care unit and work shift) on hand hygiene. The regression equation of the model is:

$$ \ln \left( \frac{P}{1-P} \right) = \beta_0 + \beta_1 SE + \beta_2 TP + \beta_3 TC + \beta_4 TI + \beta_5 WS $$

where $P$ is the probability of hand hygiene, $\beta_0$ is the intercept, $\beta_1, \beta_2, \ldots, \beta_5$ are partial regression coefficients, SE is the variable for ‘Sex’, TP is the variable for ‘Type of professional’, TC is the variable for ‘Type of contact’, TI is the variable of ‘type of ICU’, and WS is the variable for ‘Work shift’.

Odds ratio (OR) ratios with 95% CI were calculated for comparisons of analyzed variables associated with HH using PASW Statistics 18. P-values <0.05 by two-tailed tests were considered significant.

Multivariate analysis of impact of INICC hand hygiene multidimensional approach

HH opportunities and HH compliance during baseline and during follow-up were explored for changes in HH compliance rates following an ICU joining INICC. The follow-up period stratified by three-month periods over the first year, and yearly for second year were looked at. The results of a logistic regression model is presented to consider change in HH compliance in INICC participating ICUs over time since the beginning of the HH surveillance.

For the logistical regression over time, the equation is:

$$ \ln \left( \frac{P}{1-P} \right) = \beta_0 + \beta_1 PF + \beta_2 IC $$

where $P$ is the probability of hand hygiene, $\beta_0$ is the intercept, $\beta_1, \beta_2$ are partial regression coefficients, PF is the variable for ‘Period of Participation’, IC is the variable for ‘Participating ICU’.

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 2079 observations and the authors 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 (from 6 months to 16 months), 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 May 2009 through December 2010, a total 2079 opportunities were recorded for HH before patient contact, and before aseptic task in five adult ICUs of three academic teaching hospitals. The baseline period for each ICU was 3 months and their average follow-up period was 8.5 months (range 7–20). ICU characteristics are shown in Table 1.

Predictors of poor hand hygiene compliance

619 procedures in males, and 1660 in females; 1635 in nurses, 397 in physicians, and 47 in ancillary staff were observed; 1633 were prior to non-invasive patient contacts, and 443 prior to invasive procedures; 2079 in adult ICUs; 1810 during the morning, and 269 during the afternoon.

Table 2 shows HH distribution 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 association with poor HH, analyzed with univariate and multivariate statistical methods.

Components of the INICC Multidimensional Hand Hygiene Approach

During the follow-up period, the six components of the IMHHA were applied simultaneously: 66.6% counted on administrative support and available supplies for HH and AHR; 100% educated HCWs (33.3% of them every month, 33.3% every 2 months, and 66.6% every 6 months); 100% posted reminders (100% of them at ICU entrance, 60% in...
common ICU areas); process surveillance was conducted by 100%; 100% provided performance feedback (100% of them every month).

**Impact of the INICC Multidimensional Hand Hygiene Approach on hand hygiene compliance**

Table 5 and Fig. 1 show the results of a logistic regression model to consider change in HH compliance in INICC participating ICUs over the whole study period. Overall HH compliance increased from 51.5% to 80.1% (95% CI 73.2–87.8; \( P = 0.004 \)). Multivariate analysis indicated that the following variables were significantly associated with poor HH compliance: females vs males (64% vs 55%; 95% CI 0.81–0.94; \( P = 0.0005 \)), and nurses vs physicians (64% vs 57%; \( P = 0.004 \)).

**Discussion**

This is the first study that has showed an improvement in HH compliance in China due to the implementation of the IMHHA. The impact of the IMHHA in a diverse ICU population from three cities of China, showing that the six measures of the IMHHA implemented in each ICU were followed by very substantial improvements in HH practices were analyzed.

Baseline HH compliance (51.5%) of HCWs at the study ICUs was similar to that shown in previous studies, whose HH compliance rates ranged from 9% to 75%.3

The results of the multivariate analysis showed that there was higher compliance in females, as also identified in individuals unrelated to health care, such as the findings of Guinan et al. showing higher compliance by female students.33 In a recent study by Tao et al. conducted to describe patterns of hand washing behaviour among Chinese adults, female gender was a factor significantly associated with appropriate hand hygiene practices.30 The influence exerted by gender in HH compliance should be regarded a strong factor that contributes to female HCWs’ higher internal motivation for HH and health care, because of an

<table>
<thead>
<tr>
<th>Data</th>
<th>ICU n (%)</th>
<th>ICU HH observations, n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of ICU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical surgical</td>
<td>1 (20%)</td>
<td>479</td>
</tr>
<tr>
<td>Neurosurgical</td>
<td>1 (20%)</td>
<td>465</td>
</tr>
<tr>
<td>Respiratory</td>
<td>1 (20%)</td>
<td>413</td>
</tr>
<tr>
<td>Surgical</td>
<td>2 (40%)</td>
<td>722</td>
</tr>
<tr>
<td>All ICUs</td>
<td>5 (100%)</td>
<td>2079</td>
</tr>
</tbody>
</table>

ICU, intensive care unit; HH, hand hygiene.

<table>
<thead>
<tr>
<th>ICUs (n)</th>
<th>Baseline period (HH compliance/HH observations)</th>
<th>Intervention period (HH compliance/HH observations)</th>
<th>RR (95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Surgical</td>
<td>1</td>
<td>37% (69/188)</td>
<td>43% (124/291)</td>
<td>1.16 (0.96–1.40)</td>
</tr>
<tr>
<td>Neurosurgical</td>
<td>1</td>
<td>52% (95/184)</td>
<td>63% (177/281)</td>
<td>1.22 (1.01–1.5)</td>
</tr>
<tr>
<td>Respiratory</td>
<td>1</td>
<td>55% (91/165)</td>
<td>73% (181/248)</td>
<td>1.32 (1.01–1.6)</td>
</tr>
<tr>
<td>Surgical</td>
<td>2</td>
<td>64% (111/174)</td>
<td>80% (439/548)</td>
<td>1.26 (1.05–1.5)</td>
</tr>
<tr>
<td>All</td>
<td>5</td>
<td>51% (366/711)</td>
<td>67% (921/1368)</td>
<td>1.31 (1.19–1.43)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Variable</th>
<th>% (# HH/# opportunities)</th>
<th>Comparison</th>
<th>RR</th>
<th>95% CI</th>
<th>P. Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Hospital</td>
<td>Academic</td>
<td>62% (1287/2079)</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>64% (1055/1660)</td>
<td>F vs M</td>
<td>0.87</td>
<td>0.81–0.94</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>55% (232/419)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HCW</td>
<td>Nurses</td>
<td>64% (1039/1635)</td>
<td>Ns vs Ph</td>
<td>0.9</td>
<td>0.83–0.97</td>
</tr>
<tr>
<td></td>
<td>Physicians</td>
<td>57% (225/397)</td>
<td>Ns vs AS</td>
<td>0.8</td>
<td>0.7–0.83</td>
</tr>
<tr>
<td></td>
<td>Ancillary Staff</td>
<td>49% (23/47)</td>
<td>Ph vs AS</td>
<td>0.86</td>
<td>0.73–1.0</td>
</tr>
<tr>
<td></td>
<td>Non-invasive</td>
<td>62% (1010/1633)</td>
<td>Ni vs I</td>
<td>0.996</td>
<td>0.86–1.16</td>
</tr>
<tr>
<td></td>
<td>Invasive</td>
<td>62% (275/443)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work Shift</td>
<td>Morning</td>
<td>64% (1153/1810)</td>
<td>M vs A</td>
<td>0.78</td>
<td>0.73–0.84</td>
</tr>
<tr>
<td></td>
<td>Afternoon</td>
<td>50% (134/269)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HCW, health care worker; ICU, intensive care unit; AS, ancillary staff; F, female; M, male; Ni, non-invasive; I, invasive; Ad, adult; Pe, Paediatric; Nb, newborn; M, morning work shift; A, afternoon work shift; N, night work shift; NS, nursing staff; Ph, physicians; AS, ancillary staff.
unquestioned predisposition for females to be the predominant gender in family health, nursing and related professions. As stated in the scientific literature, this factor needs to be fully acknowledged as a useful parameter for further research and for the design of HH programs. In consonance with this, compliance was higher among nurses, as also shown in a study by Rosenthal et al., in 2005, in which compliance was lower among physicians and ancillary staff compared to nurses.

This approach included administrative support. In 2003 Rosenthal et al. showed that higher HH adherence was associated to administrative support. Supplies availability were also included. In 2000, Bischoff et al. showed that easily accessible dispensers of AHR revealed the more dispensers per bed, the higher HH compliance. Education and training were also included, which were other basic independent interventions identified to foster adequate HH performance. As shown in 1990 by Dubbert et al., educational intervention with routine classes improved HH compliance by 97% over

Table 4 – Hand hygiene compliance by type of variable. Logistic regression, multivariate analysis.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Adjusted OR</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (baseline: female)</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>0.76</td>
<td>0.6–0.98</td>
<td>0.04</td>
</tr>
<tr>
<td>Type of professional (baseline: nurses)</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physicians</td>
<td>0.82</td>
<td>0.63–1.1</td>
<td>0.13</td>
</tr>
<tr>
<td>Ancillary staff</td>
<td>0.57</td>
<td>0.32–1.0</td>
<td>0.06</td>
</tr>
<tr>
<td>Type of contact (baseline: invasive)</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-invasive</td>
<td>0.98</td>
<td>0.8–1.22</td>
<td>0.9</td>
</tr>
<tr>
<td>Type of ICU (baseline: adult)</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work shift (baseline: morning)</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Afternoon</td>
<td>0.54</td>
<td>0.42–0.7</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

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

Table 5 – Hand hygiene improvement by year of participation.

<table>
<thead>
<tr>
<th>Years since joining INICC</th>
<th>HH observations</th>
<th>Number of ICUs included</th>
<th>Number of hospitals included</th>
<th>HH % (95% CI)</th>
<th>Adjusted OR (95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>First 3 months (baseline)</td>
<td>711</td>
<td>5</td>
<td>3</td>
<td>51.5% (47.7–55.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Months 4–12</td>
<td>1228</td>
<td>5</td>
<td>3</td>
<td>65.8% (63.1–68.4)</td>
<td>1.65 (1.36–2.0)</td>
<td>0.0001</td>
</tr>
<tr>
<td>Second year</td>
<td>140</td>
<td>1</td>
<td>1</td>
<td>80.1% (73.2–87.8)</td>
<td>2.44 (1.33–4.5)</td>
<td>0.004</td>
</tr>
</tbody>
</table>

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

Fig. 1 – Hand hygiene improvement by year of participation.
four weeks. Likewise, but within the context of limited-resource countries, Rosenthal et al. showed HCWs' education improved HH adherence, and that compliance increased further if performance feedback was also implemented. Reminders at workplace were also included. In 1989, Conly et al. showed the importance of reminders to raise HCWs' awareness of the relation between correct HH performance and HAI reduction.

2079 opportunities for HH are measured. Every month, the ICT team provided performance feedback to HCWs of each ICU. This is a 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 most rewarding or conscious-raising factor to ensure the IMHHA's effectiveness. From 1998 in Argentina and 2002 internationally, 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 health care to a new level. Multidimensional interventions that focus on standardization of surveillance has resulted in a sustained improvement in HH.

Through the last decade, 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 extremely successful results, by increasing HH compliance, and consequently reducing the rates of HAI and mortality. This study has some limitations. First, the participating hospitals are not representative of China. Second, INICC did not measure ‘Your five moments for HH’ as advised by WHO in May 2009, because the IMHHA started in 1998 in Argentina, and in 2002 internationally; that is, several years before the recommendation of WHO was published and disseminated. This limitation results in limited comparability. As from 2009, INICC included WHO's recommendations in its process surveillance forms and manuals. Third, it should be noted that this is an observational, before-after, methodology, which implies with less strength of evidence than other study designs. Direct observation of adherence typically involves difficulty in assessing inter-observer reliability, especially given the broad scope of this research in terms of facilities. Finally, the quality of HH technique is hard to capture and there might have been a Hawthorne effect. Nevertheless, as reported in the scientific literature, the Hawthorne effect may be a useful tool for sustaining and improving hand hygiene compliance.

Conclusions

As demonstrated, the implementation of the IMHHA—a multimodal intervention focused on six inexpensive, simple, but effective elements—in China, a limited-resource country, improved HH compliance in five intensive care units of three hospitals of three cities of China. Specific programs directed to improve HH in variables found to be predictors of poor HH compliance should be implemented. It is 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, such as HH compliance, and to the correlated reduction of HAIs and their consequences, such as mortality and extra cost. Therefore, the worldwide implementation of the IMHHA was proposed as a promising path to improving patient care.

Author statements

Acknowledgements

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Ethical approval

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

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Competing interests

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

Author contributions

V.D.R. was responsible for study conception and design; software development; data assembly, analysis, and interpretation; epidemiologic analysis; statistical analysis; administrative, technical, and logistical support; and drafting of the manuscript. All authors were involved in provision of study patients, collection of data, critical revision of the manuscript for important intellectual content, and final approval of the manuscript.
Appendix

**PAPER FORM FOR MONITORING HAND HYGIENE COMPLIANCE**

<table>
<thead>
<tr>
<th>Country:</th>
<th>City:</th>
<th>Hospital:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

**Type of Location:**
- Critical care for adult or pediatric patients: Medical Surgical ( ); Medical ( ); Surgical ( ); Coronary ( ); Respiratory ( ); Trauma ( ); Neurosurgical ( ); Cardio-thoracic ( ); Pediatric ( ).
- Neonatal Intensive Care Unit: ( )
- Inpatient Wards: Acute Stroke ( ); Burns ( ); Genitourinary ( ); Gynecology ( ); Labor and Delivery ( ); Medical ( ); Medical Surgical ( ); Neurologic ( ); Neurosurgical ( ); Orthopedic ( ); Post Partum ( ); Other ( ) which one: ____________________________

**Investigator:**

**Observer:**

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Shift: Morning ( ), Afternoon ( ), Evening/Night ( )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

**Observations**

<table>
<thead>
<tr>
<th>1. Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Don’t type year or month. That info is already above)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Type of Contact:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- BPC; 2- BAT; 3- ABF; APC; ACS</td>
</tr>
</tbody>
</table>

| 3. Health Care Professional: RN; NA; STN; SUN; MD; SMD; FMD; PM; RP; OP; TR; TL; PH; NU; SO; RP; HK; MP; AP |

| 4. Name Initials: |

| 5. Gender: |
| M; F |

| 6. Hand Hygiene: |
| Y; N |

| 7. Technique: |
| A; I |

| 8. Used product for hand-rub: |
| A; C; I; NM |

| 9. Used towel: |
| P; C |

**Opportunity for Hand Hygiene**

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
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<tbody>
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</table>

**ABBREVIATIONS:**
- **TYPE OF CONTACT:** 1- BPC: Before Patient Contact; 2- BAT: Before Aseptic Task; 3- ABF: After Body Fluid exposition risk; 4- APC: After Patient Contact; 5- ACS: After contact with patient surroundings.
- **HEALTH CARE PROFESSIONAL:** RN: Registered Nurse; NA: Nursing Assistant; STN: Student of Nursing; SUN: Surgical Nurse; MD: Medical Doctor; SMD: Student of Medicine; FMD: Resident or Fellow of Medicine; PM: Paramedic; RP: Respiratory Physiotherapist; OP: Other Physiotherapist; TR: Technician from Radiology; TL: Technician from Laboratory; PH: Pharmacist; NU: Nutritionist; SO: Stretcher Operator; RP: Relative of the patient; HK: Housekeeper; MP: Maintenance Personal; AP: Administrative personal.
- **GENDER:** M: Male; F: Female.
- **HAND HYGIENE:** Y: Yes; N: No
- **TECHNIQUE:** A: Adequate; I: Inadequate
- **USED PRODUCT FOR HAND-RUB:** A: Alcohol; C: Chlorhex; I: Iodine; NM: Non Medical Soap
- **USED TOWEL:** P: Paper; C: Cloth Towel

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REFERENCES


