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Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major articles

International Nosocomial Infection Control Consortium (INICC) resources: INICC multidimensional approach and INICC surveillance online system

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Key Words:

nosocomial infection
 health care-associated infection
 device-associated infection
 antibiotic resistance
 ventilator-associated pneumonia
 catheter-associated urinary tract infection
 central line-associated bloodstream infections
 limited-resources countries
 low-income countries
 network

Background: The International Nosocomial Infection Control Consortium (INICC) is an international, non-profit, multicentric health care-associated infection (HAI) cohort surveillance network with a methodology based on the U.S. Centers for Disease Control and Prevention's National Healthcare Safety Network (CDC-NHSN). The INICC was founded in 1998 to promote evidence-based infection control in limited-resource countries through the analysis of surveillance data collected by their affiliated hospitals. The INICC is comprised of >3,000-affiliated infection control professionals from 1,000 hospitals in 67 countries and is the only source of aggregate standardized international data on HAI epidemiology. Having published reports on device-associated (DA) HAI (HAI) and surgical site infections (SSIs) from 43 countries and several reports per individual country, the INICC showed DA HAI and SSI rates in limited-resources countries are 3-5 times higher than in high-income countries.

Methods: The INICC developed the INICC Multidimensional Approach (IMA) for HAI prevention with 6 components, bundles with 7-13 elements, and the INICC Surveillance Online System (ISOS) with 15 modules.

Resources: In this article the IMA, the ISOS for outcome surveillance of HAIs and process surveillance of bundles to prevent HAIs, and the use of surveillance data feedback are described.

Comments: Remarkable features of the IMA and ISOS are INICC's applying of the latest published CDC-NHSN HAI definitions, including their updates and revisions in 2008, 2013, 2015 and 2016; INICC's informatics system to check accuracy of fulfillment of CDC-NHSN HAI criteria; and INICC's system to check compliance with each bundle element.

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Founded in 1998, the International Nosocomial Infection Control Consortium (INICC) is an altruistic, nonprofit, open, multicentric health care-associated infection (HAI) surveillance network, which is comprised of an international board of 30 members from high-income and limited-resources countries and >3,000 affiliated infection control professionals (ICPs) from 1,000 hospitals in 500 cities of 67 countries from the following 6 World Health Organization regions: Africa, Americas, Eastern Mediterranean, Europe, South East Asia, and Western Pacific.

The INICC is focused on the surveillance and prevention of device-associated (DA) HAIs (eg, central line-associated bloodstream infection [CLAB], pneumonia [PNEU], and urinary tract infection [UTI]) in adult, pediatric, and neonatal intensive care units (ICUs), step-down units, and inpatient wards and surgical site infections (SSIs) on the assessment of compliance with hand hygiene (HH), bundles, improving antimicrobial consumption, and reducing bacterial resistance, length of stay (LOS), mortality, costs, and needlestick injuries.

With methodology based on the U.S. Centers for Disease Control and Prevention's National Healthcare Safety Network (CDC-NHSN),¹ the INICC has promoted evidence-based infection control by providing hospitals internationally and, particularly, in limited-resource countries with free training and access to free online surveillance tools. Since 1998, INICC surveillance has been fundamental to increase the knowledge on the incidence of DA-HAIs, device utilization, extra LOS, extra cost, extra mortality, microorganism profile, and bacterial resistance internationally.²⁻⁶ This was done through the publications of 5 pooled multinational biannual

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Conflicts of Interest: None to report.

Funding/Support: Support for the activities carried out at International Nosocomial Infection Control Consortium Headquarters was provided by Dr. Rosenthal and Foundation to Fight against Nosocomial Infections.

reports,^{2-4,6,7} starting in 2006.² This was also done at the national level in many studies, with a report being published for the first time in 2003 with data from Argentina,⁸ and reports being published later on with data from other countries.⁹⁻²⁹ As the only source of aggregate standardized international data on the epidemiology of HAIs, the INICC has acknowledged that DA HAIs rates in limited-resources countries are 3-5 times higher than in western countries.³

The burden posed by SSIs on patients' safety internationally and, particularly, in limited-resource countries has also been shown by the INICC to be higher than in western countries,³⁰ with pooled data of 30 countries³¹ and data occurring at a national level.³²⁻³⁸

Additionally, the INICC has conducted studies that analyzed the relationship between DA HAI rates and a country's socioeconomic condition according to the World Bank criteria (upper-middle income, lower-middle income, and low income) and type of hospital (public, academic, and private).^{39,40} Such study findings showed that a higher socioeconomic level and being a private institution were variables correlated with a lower DA HAI risk.^{39,40}

Cost, LOS, and mortality attributable to DA HAI have also been determined by the INICC internationally through prospective, matched analyses of CLAB and PNEU.⁴¹⁻⁴³ For LOS and mortality, the INICC applied a new multistate model, including specific censoring to ensure the estimation of the independent effect of each DA HAI, and not the combined effects of multiple DA HAIs.^{7,44-46}

To reduce the incidence of these higher rates internationally and, particularly, in limited-resource countries, the INICC adopted the INICC Multidimensional Approach (IMA) to prevent and control HAIs. The IMA consists of the simultaneous implementation of 6 components, 4 of which are conducted using an online platform, called the INICC Surveillance Online System (ISOS).

On the one hand, the ISOS enables ICPs to conduct online prospective, active, surveillance cohort studies designed to collect specific data per patient from all patients, both those with and those without HAI. This allows for the identification of risk factors of HAIs (eg, age, sex, severity illness score, invasive devices utilization, and several surrogates of HAIs) and the validation of HAIs, thereby ensuring that the latest published CDC-NHSN criteria are met in each DA HAI diagnosis, so as to avoid under-reporting and inconsistent selections caused by oversight. On the other hand, the ISOS has tools to assess compliance with each bundle element through the online process surveillance.

The successful application of the IMA and ISOS resulted in significant reductions in the rates of CLAB, ventilator-associated pneumonia (VAP), and catheter-associated urinary tract infection (CAUTI) in pooled multinational studies in the ICUs^{31,47-53} of many countries and also at the national level.⁵⁴⁻⁶⁶

In most limited-resource countries, there are laws mandating the implementation of HAI prevention programs, and hospital accreditation is becoming very common. However, among the many causes influencing these higher HAI rates in limited-resource countries are the variable levels of adherence to bundles, constraints on funds and resources for infection control, low nurse-to-patient staffing ratios, and high proportions of inexperienced nurses, all of which have been shown to have association with increased risk of DA HAIs and SSIs.⁶⁷ Finally, the use of outdated technology has also been reported to be another factor (ie, vented intravenous infusion systems containers and 3-way stopcocks are used near-universally in limited-resource countries rather than closed intravenous systems or split septum, which are the standard of care in most developed countries).^{7,68-75}

The improvement of adherence to HH has been long considered the cornerstone of HAI prevention. Since 1998, the INICC has been applying the INICC Multidimensional Hand Hygiene Approach (IMHHA), published for the first time in 2003 in a study from Argentina.⁷⁶ It includes the following 6 components: (1) administrative support, (2) supplies availability, (3) training and education,

(4) reminders in the workplace, (5) process surveillance, and (6) performance feedback. The results of the implementation of the IMHHA were published in a pooled multinational study conducted in 19 countries⁷⁷ and also at a national level.^{76,78-85}

Advancing our understanding of the epidemiology, prevention, and control of HAI is a continuous concern within the many thousands of hospitals and billions of patients worldwide. The lack of enough knowledge regarding HAI in limited-resource settings led the INICC to the conceptualization and development of the IMA and ISOS.

The importance of this article lies in the presentation of a clear and comprehensive description of the INICC's resources, the IMA and the ISOS, with methods and tools for HAI surveillance, applying the latest published CDC-NHSN HAI definitions, including their updates and revisions in 2008, 2013, 2015 and 2016 and the INICC's validation informatics system to check the accuracy of fulfillment of CDC-NHSN HAI criteria and a system to check compliance with each bundle element. In this way, the INICC's resources and methods are useful to accurately measure HAIs, prevent HAIs, and reduce their rates and consequences.

CHARACTERISTICS OF PARTICIPATING HOSPITALS

The hospitals participating in the INICC provide in-patient services to adult, children, and newborns requiring acute care. They also provide services to patients admitted to inpatient wards and step-down units and patients undergoing surgical procedures of any type. They may be of any size and ownership, affiliated or unaffiliated with a medical school. Although participation is voluntary and free, hospitals are in charge of applying for INICC membership. They should have both adequate personnel and support for infection control and approval from hospital administration to participate in the INICC.³

METHODOLOGY, APPROACH, AND RESOURCES

Through the IMA and ISOS, the INICC applies 2 kinds of surveillance: outcome surveillance and process surveillance.

IMA

The INICC developed the IMA, a system to measure and reduce HAI rates, mortality, LOS, costs, bacterial resistance, and antibiotic consumption that is comprised of the simultaneous implementation of 6 components⁸⁶: (1) bundles, (2) education and training, (3) online outcome surveillance of HAI rates and their adverse consequences, (4) online process surveillance to evaluate compliance with bundles, (5) online feedback of HAI rates and their adverse consequences, and (6) online performance feedback. As part of the IMA, the INICC uses an online platform called ISOS, which includes components 3, 4, 5, and 6 of the IMA (Fig 1).

BUNDLES

The INICC bundles of interventions for HAI prevention were designed as adaptation of the bundles and recommendations and guidelines published by the Institute for Healthcare Improvement (IHI),⁸⁷ Centers for Disease Control and Prevention,⁸⁸ Society for Health Care Epidemiology of America, Infectious Diseases Society of America,⁸⁹ Association for Professionals of Infection Control,⁹⁰ and Joint Commission International.⁹¹

To describe the INICC process and define key elements of a bundle, by way of example, we subsequently present the CLAB prevention bundle herein.

According to a study published by the INICC in 2010,⁴⁷ in 15 limited-resource countries from regions of Africa, Americas, Eastern Mediterranean Europe, South East Asia, and Western Pacific, standard

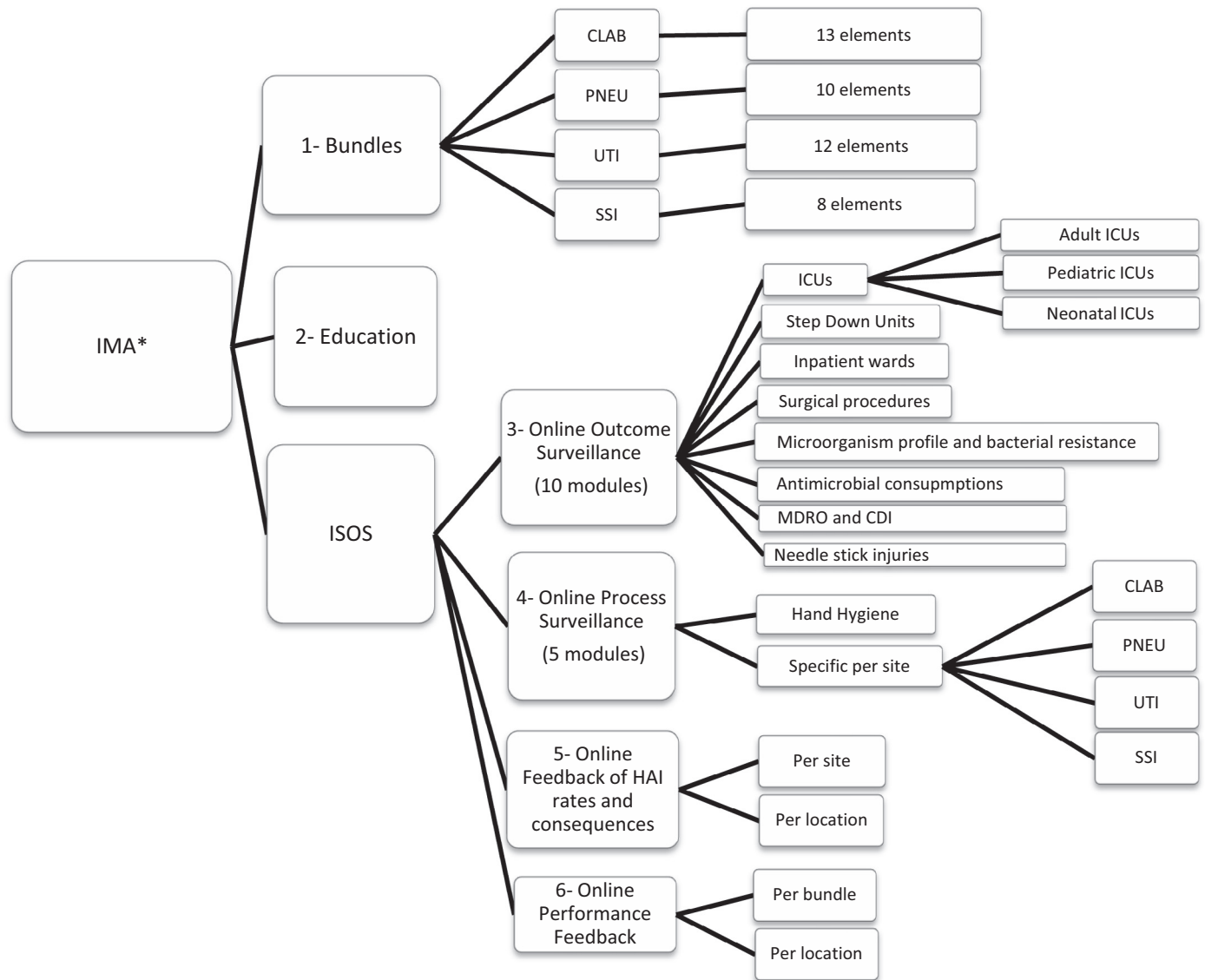


Fig 1. INICC IMA and INICC Surveillance Online System. *CDI*, *Clostridium difficile* infection; *CLAB*, central line-associated bloodstream infection; *HAI*, health care-associated infection; *ICU*, intensive care unit; *IMA*, INICC Multidimensional Approach; *INICC*, International Nosocomial Infection Control Consortium; *MDRO*, multidrug-resistant organism; *PNEU*, pneumonia; *SSI*, surgical site infection; *UTI*, urinary tract infection. *The IMA consists of the 6 components as identified with numbers 1–6, including (1) bundles to prevent HAIs; (2) education and training; (3) online outcome surveillance of HAI rates, device usage, patient characteristics, and adverse consequences (eg extra length of stay, extra mortality); (4) online process surveillance of hand hygiene and compliance with bundles to prevent HAIs; (5) online feedback of HAI rates and adverse consequences; and (6) online performance feedback of compliance with bundles.

practices to prevent CLAB are significantly different from the ones applied in most high-income countries. This study conducted by the INICC has shown compliance rates with 13 different elements—practices and supplies—used to prevent CLABs.

According to this study, in limited-resource countries, it is not standardized to use many of the following 8 elements, which are standard in most high-income countries, especially in the United States: (1) date on administration set; (2) sterile gauze or sterile transparent dressing and in optimal condition; (3) chlorhexidine-impregnated dressing; (4) split septum as intravenous connector; (5) single-use flushing; (6) collapsible nonvented closed system bag as intravenous fluid container; (7) daily bath with 2% chlorhexidine-impregnated wash cloth; and (8) use of antimicrobial impregnated catheter.

Having these 8 elements as standards in most high-income countries, and adding a bundle with 5 elements proposed by the IHI (HH,

maximal barriers during insertion, skin antisepsis with chlorhexidine, avoid femoral vein, and remove line when is not needed), resulted in a significant CLAB reduction in the United States.

By contrast, the INICC bundle for limited-resource countries includes 13 elements, the same 5 elements of the IHI bundle plus the 8 aforementioned elements that the INICC found are not standard in limited-resource countries.

EDUCATION AND TRAINING

For effective implementation of an infection control program, education of health care workers (HCWs) is a crucial tool. Education to HCWs includes information about surveillance and infection control measures based on the aforementioned guidelines and recommendations. The INICC team trains the hospital epidemiologists and ICs, conducts webinars, and also provides tutorial movies and

printed tutorials with screenshots of the ISOS as tools for training on how to conduct surveillance and upload surveillance data. Hospital epidemiologists and ICPs have continuous access to a support team in the INICC Headquarters in Buenos Aires, which responds to all inquiries within 24 hours.

ISOS MODULES

The ISOS has 15 modules. Ten modules are for outcome surveillance, and 5 modules are for process surveillance.

Full reports with tables and graphs of each module (available online, printed, in PDF files, or in row data as a Microsoft Excel file [Microsoft, Redmond, WA]) are generated in a range of 1-5 seconds (Table 1).

The time needed to upload the data into the system for ISOS's main module, which is cohort DA HAI surveillance in ICUs, is 25 seconds per patient on the day of admission to the unit, 20 seconds per day every day from admission to discharge to upload device usage, 10 seconds the day of discharge, 45 seconds if the patient

has a positive culture, and 20 seconds if the patient acquires an HAI, for a total of 30 minutes per day for a full ICU with 20 beds.

OUTCOME SURVEILLANCE

Outcome surveillance is the measurement of patient characteristics (eg, age, sex, severity illness score), HAI rates, device utilization ratios, and HAI consequences (eg, extra mortality, extra LOS, extra cost, microorganism profile, bacterial resistance).

The results of HAI outcome surveillance allow ICPs to define the magnitude of the problem, identify HAI risk factors (eg, devices with the highest risk), and provide the framework for plans to reduce infection risk, including the evaluation of the cost-effectiveness of specific interventions.⁶⁹

The INICC Outcome Surveillance Online System has the following 10 modules: (1) cohort surveillance of HAIs in adult and pediatric ICUs; (2) cohort surveillance of HAIs in neonatal ICUs; (3) cohort surveillance of HAIs in inpatient wards and step-down units;

Table 1
Modules of the INICC Surveillance Online System

Surveillance module	Data to be collected and reports of each module presented as tables and charts
Cohort HAI surveillance in adult, pediatric, and neonatal patients in ICUs, step-down units, and inpatient wards	Patient characteristics; proportion of device-associated infections; HAIs per 1,000 bed days; percentage of HAIs; HAIs per 1,000 devices days; number of patients; number of bed days; number of HAIs; HAIs per 1,000 device days; device utilization ratio; benchmark against CDC-NHSN, INICC, and each country, stratified by type of ICU; microorganism profile of HAIs; attributable extra length of stay; attributable extra mortality.
Aggregated HAI surveillance in ICU for adult, pediatric, and neonatal patients	HAIs per 1,000 bed days; percentage of HAIs; HAIs per 1,000 device days; number of patients; number of bed days; number of HAIs; HAIs per 1,000 device days; device utilization ratio; benchmark against CDC-NHSN and INICC stratified by type of ICU.
Microbiology for adult and pediatric patients	Type and number of units reporting; number of cultures with each type of HAI as a source; type and number of surgical procedures; source of cultures; number of pathogenic isolates reported; number of pathogenic isolates tested; resistance percentage; number of pathogenic isolates reported from each kind of surgical procedure; resistance percentage of each kind of surgical procedure.
Multidrug-resistant organisms and <i>Clostridium difficile</i> infections	Type of sample; microorganism profile; sources from environment samples; source from health care workers samples; source from patients with HAI; source from patients with colonization during outbreak; source of patients with colonization as a routine sample at admission.
Monitoring HH	Reports include compliance of HH per month stratified by (1) My 5 Moments for Hand Hygiene of the WHO (before contact with patient per month; before aseptic task per month; after body fluid exposition risk per month; after patient contact per month; and after contact with patient surrounding); (2) by HCW category; (3) HCW sex; (4) technique; (5) work shift; (6) used product; (7) used towel; and (8) other.
Monitoring bundle for BSI	Reports include compliance per month of (1) hand hygiene; (2) insertion of a CL using maximal barrier; (3) skin antiseptics with chlorhexidine; (4) avoid femoral access; (5) evaluation of the need of the CL; (6) date on administration set; (7) sterile gauze or sterile transparent dressing and in optimal condition; (8) chlorhexidine-impregnated dressing; (9) split septum as IV connector; (10) single-use flushing; (11) collapsible nonvented closed system bag as IV fluid container; (12) daily bath with 2% chlorhexidine-impregnated wash cloth; and (13) use of antimicrobial-impregnated catheter.
Monitoring bundle for UTI	Reports include compliance per month of (1) hand hygiene; (2) insertion of a UC using maximal barrier; (3) single-use lubricant; (4) evaluation of catheter necessity; (5) presence of securement of the UC; (6) sterile closed drainage system and UC never disconnected; (7) catheter above the leg avoiding urinary reflux; (8) urinary collecting bag below the level of the bladder, hanging beside the bed; (9) urinary collecting bag with <75% of capacity full; and (10) catheter indication.
Monitoring bundle for PNEU	Reports include compliance per month of (1) hand hygiene; (2) maintenance of semi-recumbent position of the head (30-45°); (3) evaluation of readiness to wean; (4) comprehensive oral care with antiseptic solution; (5) absence of gastric overdistention; (6) subglottic suctioning; (7) endotracheal cuff above 20 cm of water; (8) absence of tubing condensate; and (9) orotracheal intubation over nasotracheal intubation.
Surgical procedures: outcome surveillance	Number of patients; age; height; weight; sex; malnutrition rate; overweight rate; diabetes rate; smokers; remote site infection; prosthesis implant; trauma. Wound Classification: clean; clean contaminated; contaminated; and dirty. Proportion of each surgical procedure according to ICD-9, ICD-10, and CDC-NHSN; inpatient stay; type (emergency/programmed); average duration; number of SSIs; SSI rate; microorganisms; SSI rate stratified by surgical procedure; benchmark against CDC-NHSN, INICC, and each country, stratified by type of surgical procedure.
Surgical procedures: process surveillance	Reports include compliance per month of (1) aseptic technique; (2) presurgical bath and product used; (3) avoid hair removal, and if necessary, use clipper; (4) presurgical skin preparation with chlorhexidine; (5) monitoring of presurgical antibiotic prophylaxis and drug used; (6) maintain glucose level; and (7) maintain normothermia.
Antimicrobial consumption	Defined daily dose of this antibiotic per 1,000 bed days.
Needlestick injuries	Date of injury by month; time of day when the injury occurred; job category, sex, age, and dominant hand of injured worker; number of injuries per month; place where the injury occurred; home employing department where the injury occurred; when did the injury happened; activity performed when the injury occurred; original purpose of using the sharp item; identification of the source; if injury was to the hand, did the sharp item penetrate gloves?; which device caused the injury; kind of glass object associated with the injury; kind of needle associated with the injury; kind of surgical device associated with the injury; level of contamination of the sharp item; if the injured worker was the original user of the sharp item; if the protective mechanism was activated.

BSI, bloodstream infection; CDC-NHSN, Centers for Disease Control and Prevention's National Healthcare Safety Network; CL, central line; HAI, health care-associated infection; HCW, health care worker; HH, hand hygiene; ICU, intensive care unit; INICC, International Nosocomial Infection Control Consortium; IV, intravenous; PNEU, pneumonia; SSI, surgical site infection; UC, urinary catheter; UTI, urinary tract infection; WHO, World Health Organization.

(4) cohort surveillance of surgical procedures and SSIs; (5) aggregated surveillance of HAIs in adult and pediatric ICUs; (6) aggregated surveillance of HAIs in neonatal ICUs; (7) microorganism profile and bacterial resistance; (8) laboratory-based surveillance of multidrug resistant organisms (MDROs) and *Clostridium difficile* infections (CDIs); (9) antimicrobial consumption; and (10) surveillance of needlestick injuries.

Outcome surveillance: Cohort surveillance of HAIs in adult, pediatric, and neonatal ICUs, inpatient wards, and step-down units

The INICC applies CDC-NHSN methodology and definitions, that is, numerators (number of each type of DA HAI) and denominators (device days collected from all patients).

However, the INICC also collects other additional specific data per patient, from all patients, both those with and those without HAIs, including age, sex, underlying diseases, severity illness score, vital signs, use of antibiotics, LOS, mortality, and others.

Through the ISOS, data are prospectively registered from all patients whose stay in the hospital is >24 hours. The ICP at each hospital is responsible for extracting patients' data from medical records, charts, patient inspection, and laboratory results, including radiographs, other imaging tests, and all cultures done.

The ISOS is designed to continuously prompt the ICPs to suspect HAIs because it provides a panoramic view of what is happening each day to every patient in the ICU in terms of their risk factors (eg, exposure to invasive devices) and provides key surrogates of HAIs (eg, high temperature, low blood pressure, results of cultures, antibiotic therapy, LOS, mortality). This approach is especially useful in cases in which no cultures have been done or culture results are equivocal or negative (eg, clinical PNEU) and may not be otherwise recognized as an HAI, or when ICPs lack enough experience and therefore sensitivity to detect HAIs.⁹²

Furthermore, by collecting data on all patients, it is possible to easily match patients with and without HAI by characteristics (eg, age, sex, underlying diseases, service, admission diagnosis, severity of illness score, time of year, and several others) in order to calculate attributable extra LOS, costs, mortality, and risk factors for HAI.^{12,21,41}

HAIs are categorized by site, using the standard last CDC-NHSN definitions.¹ The INICC has always applied the latest HAI criteria published by the CDC-NHSN and has incorporated every update and revision made to them. At the beginning, the INICC applied the definitions published in 1988,⁹³ then those published in 2008,⁹⁴ 2013,⁶² 2015, and currently those published in 2016.¹

Validation of each case is checked, and the recorded signs and symptoms of infection and the results of cultures, laboratory and radiographic studies, and other tests are scrutinized to assure that the latest U.S. NHSN criteria for HAIs are met.¹ All patients are followed over time to determine the occurrence of HAI, death, LOS, and cost.

Denominator data include the number of patients, total patient days in the unit, and number of days of exposure to invasive devices—central lines (CLs), urinary catheters (UCs), and mechanical ventilators (MVs)—for ICUs and the number of surgical procedures for surgical components. Calculation of site-specific infection rates is based on methods of the CDC-NHSN.¹

Hospitals also have the option to collect additional data of special interest for their own use. Severity of illness scores, such as Acute Physiology and Chronic Health Evaluation II, are optional items to be recorded for each patient at ICU admission.

This module has the following 5 mandatory tabs: (1) patient characteristics (eg, age, sex), (2) invasive devices usage, (3) culture results, (4) HAI results, and (5) patient discharge. The options for invasive devices are as follows: CL (20 options), peripheral catheter (2

options), UC (3 options), respiratory support device (5 options), and other (10 types).

This module has the following optional tabs: (1) underlying diseases, (2) diagnosis made during this hospitalization, (3) artificial nutrition, (4) daily vital signs, (5) antibiotic used, and (6) other. The options for locations are critical care unit (22 options), emergency room, hemodialysis unit, inpatient long-term care unit, inpatient ward (20 options) operating room, outpatient department, and step-down unit (3 options).

Hospitals with >1 location may carry out surveillance in any or all locations, but in the selected location, every patient is monitored for HAI, including all HAIs included in the latest CDC-NHSN publication of criteria in 2016.¹ For patients hospitalized in neonatal ICUs, denominator data are stratified for each of the classic 5 birth weight categories included in the CDC-NHSN reports.

LOS is recorded for each infected and uninfected patient, and the timing of the onset of HAI is also recorded. The effect of HAI on LOS has been estimated by matching patients in the same ICU during the surveillance period by age, sex, severity illness score, and other variables.^{42,43}

The crude excess mortality is defined as the difference between the overall case fatality of patients hospitalized in the ICU during the surveillance period with an HAI and the case fatality of patients hospitalized in the ICU during that period who did not acquire an HAI.^{39,46}

Aggregated surveillance of HAIs in adult, pediatric, and neonatal ICUs

This module is not a cohort surveillance system. This type of surveillance applies the CDC-NHSN method without any additions.¹ Aggregated surveillance data can be reported on CLAB, PNEU, or UTI that occurs in patients staying in a patient care location, such as an ICU, specialty care area, or inpatient ward, and can be used by facilities to guide local prevention strategies and prioritize prevention efforts in those patient care areas with the highest DA HAI incidence or device utilization ratio.⁹⁵ It includes the following denominators of the ICU: number of patients, number of DA HAIs, number of bed days, and number of device days (ie, CL days, MV days, UC days).

Outcome surveillance: Microorganism profile and bacterial resistance in adult, pediatric, and neonatal ICUs

The ISOS includes surveillance of the microorganism profile and susceptibilities to antimicrobials that are confirmed from CLABs, UTIs, PNEU, and SSIs.⁹⁶

Laboratory-based surveillance of MDROs and CDIs

Surveillance of MDROs and CDIs aids in the assessment of variations and trends in the occurrence of MDROs, CDIs, and related infections. The ISOS provides a reporting mechanism to analyze MDRO and CDI data and provide infection incidence rates for the MDRO being monitored, with the aim of communicating to ICPs the effect of targeted preventive interventions. MDROs that are monitored with the ISOS include the following: methicillin-resistant *Staphylococcus aureus* (option with methicillin-susceptible *S aureus*), vancomycin-resistant *Enterococcus* spp, multidrug-resistant *Klebsiella* spp, and multidrug-resistant *Acinetobacter* spp.

Antimicrobial consumption

The ISOS module for antimicrobial consumption is based on the method of defined daily dose reported to the number of days of hospital stay. The defined daily dose provides a determined unit of

measurement, which is independent of dosage form, allowing the assessment of trends in drug consumption.

Surveillance of needlestick injuries

The ISOS module for surveillance of needlestick and sharp injuries includes collection of comprehensive data included in the following 6 tabs: (1) injured person personal data, (2) moment of the injury, (3) setting of the injury, (4) characteristics of the injury, (5) characteristics of the device, and (6) costs and other consequences.

PROCESS SURVEILLANCE

HCWs are aware that bundle elements are the most adequate practices for effective infection control; however, their actual application may not be consistent in routine patient care. Process surveillance serves as a means to ensure that all bundle interventions are carried out consistently for all patients and at all times.

It consists of a standardized collection of data on the regular supervision of a series of routine infection control practices and use of supplies in the health care facility. These practices include the monitoring of compliance of HH^{76,78,79} and specific measures to prevent PNEU,⁵⁸ CLAB,^{54,55} UTI,⁶³ and SSI.

Process surveillance is conducted by an ICP who directly monitors HCWs' practices and supplies utilization, by following a standardized protocol and conducting specific surveillance at regular intervals. HCWs are not aware of the actual schedule of the monitoring, to avoid or minimize the observer effect.⁸⁶

Process surveillance: Monitoring compliance with HH

Since 1998, the INICC has been applying the IMHHA, which includes the following 6 components: (1) administrative support, (2) supplies availability, (3) training and education, (4) reminders in the workplace, (5) process surveillance and (6) performance feedback. It has had successful results, as published in a pooled international study conducted in 19 countries⁷⁷ and at a national level.^{76,78-85}

HH compliance by HCWs is monitored by the ICP through randomly selected 1-hour observations 3 times a week, during all working shifts, and includes all HCWs according to a specific sequence set forth in the INICC protocol.^{76,78} All kinds of HCWs are observed during this surveillance.

Although the HCWs are aware that HH practices will be monitored, they are not informed when these observations are taking place. The ICP records the opportunities for HH according to the My 5 Moments for Hand Hygiene proposed by the World Health Organization.⁹⁷ HH process surveillance data are recorded on an online form of the ISOS using a smart phone, a tablet, or any other device with Internet access.

Process surveillance: Monitoring compliance with a bundle to prevent bloodstream infections, UTIs, PNEU, and SSIs

Bundles to prevent CLABs, UTIs, PNEU, and SSIs consist in groups of established evidence-based medicine interventions, which are implemented in patients with these specific risks. Compliance with those 4 bundles is monitored and recorded once, twice, or more times per week through standardized process surveillance using 4 different modules of the ISOS.

Specific process surveillance modules were designed for monitoring compliance with bundles to prevent DA HAIs, which include elements for insertion and maintenance (CLAB [13 elements], UTI [10 elements], PNEU [9 elements], and SSI [7 elements]).

FEEDBACK OF HAI RATES AND ADVERSE CONSEQUENCES

The goal of measuring HAIs and consequences through outcome surveillance is directly related to the need of communicating those rates to HCWs, who are expected to cause meaningful changes. This communication process entails providing HCWs with feedback of the incidence of HAI rates, benchmarks with standards, and adverse consequences. The concept of using feedback of outcome surveillance is an effective control measure in hospitals with limited resources, as analyzed by the INICC since 1998 and published since 2003.⁵⁴

HCWs receive this feedback at monthly meetings, by means of the review of reports generated through the ISOS,⁸⁶ which contains charts and tables with a running record of the monthly data, as described in [Table 1](#).

PERFORMANCE FEEDBACK

Providing feedback to HCWs to assess performance levels is an important motivating aspect of the IMA. Knowing the outcome of their efforts reflected by the measurement of their practices and the incidence of HAIs can be a most rewarding or conscious-raising factor for HCWs, which is crucial to ensure the effectiveness of the IMA.

The ICPs retrieve those tables and charts from the ISOS, with monthly reports showing bar charts with HH compliance; CL and UC care compliance; and measures to prevent PNEU and SSIs (see [Table 1](#) for contents of the reports). The data are reviewed at monthly meetings of ICU staff and are also posted in a prominent hospital location.^{76,78}

PROACTIVE PROSPECTIVE VALIDATION OF HEALTH CARE-ACQUIRED INFECTIONS

There was a strong linear trend relating increasing sensitivity to numbers of years of ICP surveillance experience ($P < .001$). For ICPs with <4 years of experience, satisfactory sensitivity ($\geq 80\%$) was reached in only 1 of 10 ICP years of observation. For ICPs with ≥ 4 years' experience, satisfactory sensitivity was achieved for 14 of 18 person years ($P = .001$).⁹² In 1995, Ehrenkranz et al showed that sensitivity of ICPs to detect HAI in U.S. hospitals during the first 3 years was very low, but it rose significantly to 80% after the fourth year. For that reason, it is necessary to apply methods to increase sensitivity, especially during the first 3 years.⁹²

Validation of HAIs is an essential feature of the ISOS to maximize the sensitivity and accuracy of surveillance data. Each HAI reported by an ICP is validated (ie, scrutinized to be certain that all CDC-NHSN criteria are fulfilled to justify its recording as an HAI). The validation process also includes data reported for putatively uninfected patients to permit detection of unreported but true HAIs. To do that, the INICC Informatics System shows an online message to the ICP asking them to check CDC-NHSN criteria for that putative HAI ([Fig 2](#)).

COST-EFFECTIVENESS ANALYSIS

The cost-effectiveness of the IMA and the use of the ISOS for HAI prevention has been demonstrated in different studies in the mainstream scientific literature.^{31,50,51,69} Studies in limited-resources countries have also shown that although HAI prevention programs require ongoing investments, reductions in costs were significantly higher.⁹⁸

The methods of the INICC cost-effectiveness analyses include the estimation of effectiveness by modeling life years, quality-adjusted life years, health care expenditures with and without HAIs, and incremental cost-effectiveness ratios of the IMA and ISOS for HAI

Your patient has a positive culture of a respiratory sample taken after 3rd day of admission. We suspect PNU2 – Pneumonia with Common Bacterial or Filamentous Fungal Pathogens. Please tick here to confirm if your patient ALSO has other criteria for PNU2 – Pneumonia with Common Bacterial or Filamentous Fungal Pathogens

Date of Event: Today |

Checked

Please tick just here above this yellow message, if you confirm presence of this HAI

Lvl1: PNEU

Lvl2: PNU 2- Pneumonia With Common Bacterial Or Filamentous Fungal Pathogens And Specific Laboratory Findings

Criteria: Hold down "Control", or "Command" on a Mac, to select more than one.

Criteria for PNU2 – Pneumonia with Common Bacterial or Filamentous Fungal Pathogens are the following: positive culture of a respiratory sample; AND ALSO infiltrate, or consolidation, or cavitation on Thorax X ray; AND ALSO fever, or altered mental status, or leucocytosis, or leucopenia; AND ALSO new onset of purulent sputum, or change in character of sputum, or Increased respiratory secretions, or increased suctioning requirements, or new onset or worsening cough, or dyspnea, or tachypnea, or rales, or bronchial breath sounds

Fig 2. Validation of health care–associated infections with the INICC Informatics System in the INICC Surveillance Online System. *INICC*, International Nosocomial Infection Control Consortium; *PNEU*, pneumonia.

prevention.⁹⁸ The cost-effectiveness analysis considers a health care payer perspective. Both costs and quality-adjusted life years are estimated for each patient of this trial using the aforementioned parameters and the mean calculated for each group (standard and test care).

DISCUSSION

HAIs surveillance has been standardized by the U.S. CDC-NHSN by providing simple unambiguous definitions.¹ Targeted surveillance and calculation of DA HAI rates per 1,000 device days allows benchmarking with other similar hospitals and detection of unique institutional problems in need of redress.⁹⁹

HAIs are a major cause of patient morbidity and mortality, and DA HAIs pose the greatest threat to hospital safety in the ICU, particularly in developing countries, as communicated for the first time in a multinational report published by the INICC in 2006.²

The methods applied by the INICC are based on those of the CDC-NHSN in terms of definitions and criteria, but they were modified by the INICC by adding data per patient (eg, age, sex, use of devices) and the IMA. Process surveillance was proposed and has been used by INICC hospitals since 1998, and its results were published in *AJIC* in 2003.⁵⁴

According to standard CDC-NSHN methods, numerators and denominators are collected from all patients as pooled data, without determining the number of device days and characteristics per patient. By contrast, through the INICC cohort study, specific data per patient are collected from all patients, both those with and those without HAI, risk factors of HAIs (eg, invasive devices), and surrogates of HAIs. This approach is useful to increase sensitivity of ICPs to detect HAIs. Furthermore, by collecting data on all patients in the ICU, it is possible to match patients with and without HAI by several characteristics to estimate extra LOS, mortality, and cost. If other surveillance systems also use CDC-NSHN methods and HAI definitions, then the INICC is comparable with them as well.

The INICC's surveillance system has some limitations. First, we do not yet consider the data as adequate to represent any single entire country; however, with data now being collected by >2,000 ICPs in >1,000 hospitals in 500 cities of 67 countries in the Americas, Asia, Africa, Middle East, and Eastern Europe, we think our

findings are becoming representative of the developing world. The magnitude of the HAI burden is nevertheless likely to be underestimated because the INICC participants in general represent the best hospitals in their countries, hospitals with the greatest resources and commitment to patient safety in regards to control of HAIs, and hospitals with the necessary time and resources for implementing the IMA and using the ISOS. Second, we must rely on the member hospitals' laboratories to identify infecting pathogens and delineate bacterial resistance patterns, which have varying levels of expertise and resource availability; however, similar concerns can be raised about any multi-institutional surveillance program or study. Finally, the frequency of culturing and the use of other diagnostic tests are beyond the control of infection control programs; in hospitals where culturing and other laboratory testing are infrequent and suspected infections are treated empirically, the capacity of the surveillance program to detect most HAIs is likely to be low.

The IMA and ISOS have been successfully applied in hospital settings of limited-resource countries, and there is evidence of the effectiveness of audit and feedback methods in achieving significant reductions in DA HAI rates since 2002. By way of example, in adult ICUs, the rate of CLAB was reduced by 54%,⁴⁷ the rate of CAUTI was reduced by 50%,⁵² and the rate of PNEU was reduced by 40%.⁴⁹ In pediatric ICUs, the rate of CLAB was reduced by 47%,⁴⁸ the rate of CAUTI was reduced by 54%,⁵³ and the rate of VAP was reduced by 31%.⁵¹ In neonatal ICUs, the rate of CLAB was reduced by 55%³¹ and the rate of VAP was reduced by 29%.⁵¹

We are confident that knowledge of the magnitude of the problem of DA HAIs in the INICC member hospitals provides a powerful impetus for instituting needed changes, and we have already seen ample evidence of improvement: process surveillance and targeted performance feedback programs for HH and CL, MV, and UC care have already translated to documentation of major reductions in the incidence of ICU-acquired infections in individual member hospitals.⁵⁴⁻⁶⁶ INICC data are used by national health care planners in the member countries to develop strategies and target resources for HAI prevention.

It is clear that HAIs are a huge and largely underestimated threat to patient safety, particularly in hospitals of developing countries, a far greater threat than in high-income ones, which we think rivals

the huge burden of childhood diarrhea, tuberculosis, and malaria. It is our hope that the successes of the INICC, combined with our ongoing efforts to more consistently implement simple and inexpensive measures for prevention, will lead to wider acceptance of infection control practices and continued reductions in HAI rates and their adverse effects, not only in the hospitals of the INICC, but in hospitals of limited-resource countries as well.

Acknowledgments

I thank the many health care professionals at each member hospital who assisted with surveillance in their hospital: Mariano Vilar and Débora López Burgardt, who work at INICC Headquarters in Buenos Aires; the INICC Country Directors and Secretaries (Haifaa Hassan Al-Mousa, Hail Alabdaley, Areej Alshehri, Altaf Ahmed, Carlos A. Álvarez-Moreno, Anucha Apisarntanarak, Bijie Hu, Hakan Leblebicioglu, Yatin Mehta, Toshihiro Mitsuda, and Lul Raka); and the INICC Advisory Board (Carla J. Alvarado, Nicholas Graves, William R. Jarvis, Patricia Lynch, Dennis Maki, 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.

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