International Nosocomial Infection Control Consortium (INICC) report, data summary for 2003-2008, issued June 2009

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We report the results of the International Infection Control Consortium (INICC) surveillance study from January 2003 through December 2008 in 173 intensive care units (ICUs) in Latin America, Asia, Africa, and Europe. During the 6-year study, using Centers for Disease Control and Prevention (CDC) US National Healthcare Safety Network (NHSN; formerly the National Nosocomial Infection Surveillance system [NNIS]) definitions for device-associated health care-associated infection, we collected prospective data from 155,358 patients hospitalized in the consortium's hospital ICUs for an aggregate of 923,624 days. Although device utilization in the developing countries' ICUs was remarkably similar to that reported from US ICUs in the CDC's NHSN, rates of device-associated nosocomial infection were markedly higher in the ICUs of the INICC hospitals: the pooled rate of central venous catheter (CVC)-associated bloodstream infections (BSI) in the INICC ICUs, 7.6 per 1000 CVC-days, is nearly 3-fold higher than the 2.0 per 1000 CVC-days reported from comparable US ICUs, and the overall rate of ventilator-associated pneumonia (VAP) was also far higher, 13.6 versus 3.3 per 1000 ventilator-days, respectively, as was the rate of catheter-associated urinary tract infection (CAUTI), 6.3 versus 3.3 per 1000 catheter-days, respectively. Most strikingly, the frequencies of resistance of *Staphylococcus aureus* isolates to methicillin (MRSA) (84.1% vs 56.8%, respectively), *Klebsiella pneumoniae* to ceftazidime or ceftriaxone (76.1% vs 27.1%, respectively), *Acinetobacter baumannii* to imipenem (46.3% vs 29.2%, respectively), and *Pseudomonas aeruginosa* to piperacillin (78.0% vs 20.2%, respectively) were also far higher in the consortium's ICUs, and the crude unadjusted excess mortalities of device-related infections ranged from 23.6% (CVC-associated bloodstream infections) to 29.3% (VAP).

Key Words: Hospital infection; nosocomial infection; health care-associated infection; INICC; International Nosocomial Infection Consortium; device-associated infection; antibiotic resistance; ventilator-associated pneumonia; catheter-associated urinary tract infection; central line-associated bloodstream infections; bloodstream infection; urinary tract infection; developing countries; limited resources countries; low income countries; network.

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For a list of members of the International Nosocomial Infection Control Consortium, see Appendix 1 available online at www.ajicjournal.org.

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This report is a summary of data on device-associated infections (DAI) within intensive care units (ICUs) collected by hospitals participating in the International Nosocomial Infection Control Consortium (INICC)[1-13] between January 2003 and December 2008.

The INICC is an international nonprofit, open, multicenter, collaborative health care-associated infection control program with a surveillance system based on that of the US National Healthcare Safety Network (NHSN; formerly the National Nosocomial Infection Surveillance system [NNIS]).[3] Founded in Argentina in 1998, the INICC is the first multinational research network established to control and reduce DAI through the analysis of data collected on a voluntary basis by a pool of hospitals worldwide. The INICC has the following goals: Create a dynamic global network of hospitals in the developing world that conducts surveillance of health care-associated infections (HAIs) using standardized definitions and established methodologies, promote implementation of evidence-based infection control practices, and carry out applied infection control research; provide training and surveillance tools to individual hospitals that can allow them to conduct outcome and process surveillance of HAIs, measure their consequences, and assess the impact of infection control practices; to improve the safety and quality of health care worldwide through implementation of systematized programs to reduce rates of HAI, associated mortality, excess lengths of stay, excess costs, and bacterial resistance.

METHODS

The INICC at this time has focused on surveillance and prevention of DAI in adult and pediatric ICUs and high-risk nurseries.[3] The data are collected using standardized CDC NNIS/NHSN protocols and definitions.[14-16]

The INICC has both outcome surveillance and process surveillance components. The modules of the components may be used singly or simultaneously, but, once selected, they must be used for a minimum of 1 calendar month.

All DAIs of the Outcome Surveillance Component, are categorized using standard CDC NNIS definitions that include laboratory and clinical criteria. Both laboratory-confirmed bloodstream infections (BSIs) and clinical sepsis without microbiologic confirmation of BSI are recorded and reported.[15]

Within the Outcome Surveillance Component, data are classified into specific module protocols addressing the following: DAI rates: excess length of stay, evaluation of HAI costs, crude excess mortality, microbiologic profile, bacterial resistance, and antimicrobial-use data. In addition, INICC methodology includes a process for adjudication of and validation of reported HAIs.[3]

Infection control professionals (ICPs) collect data on central line-associated primary bloodstream infections (CLABs), catheter-associated urinary tract infections (CAUTIs), and ventilator-associated pneumonias (VAPs) occurring in patients hospitalized in a specific patient care location, in nearly all hospitals. ICUs are stratified according to the patient population: adult, pediatric, or neonatal units (NICUs).

All NICUs are level III or level II/III units, and ICPs collect data on CLABs and umbilical catheter-associated primary BSIs or VAPs for each of 5 birth-weight categories ($<$750 g, 750-1000 g, 1001-1500 g, 1501-2500 g, $>$2500 g). Corresponding denominator data, patient-days, and specific device-days are also collected.

Small proportion of hospitals, with previous long-lasting experience conducting surveillance of DAIs, sent aggregated data to the INICC. Original and aggregated data were collected to calculate DAI rates. Only original data were collected to calculate mortality and lengh of stay.

The Process Surveillance Component includes the following modules: hand hygiene compliance monitoring in ICUs; central and peripheral vascular catheter care compliance monitoring; urinary catheter care compliance monitoring; monitoring of compliance with measures to prevent VAP; and performance feedback. Data from the Process Surveillance Module on hand hygiene compliance are included in this report. The identity of all INICC hospitals, cities, and countries is confidential, in accordance with the INICC charter.

RESULTS

Characteristics of 173 ICUs from 25 countries in Latin America, Asia, Africa, and Europe currently participating in the INICC that contributed data for this report are shown in Table 1. The participation of hospitals on the INICC Program is as follows: mean length of participation ± SD, 22.9 ± 21.6 months, range 1 to 72 months. One hundred thirty-nine out of 173 (81%) of ICUs collected and sent original data to INICC headquarters, and 34 out of 173 (19%) of ICUs collected and sent aggregated data to INICC headquarters. Original and aggregated data were used to calculate DAI rates. Only original data were used to calculate mortality and lengh of stay.

For the Outcome Surveillance Component, DAI rates, device utilization (DU) ratios, crude excess mortality by specific type of DAI, antimicrobial utilization, and bacterial resistance for January 2003 through December 2008 are summarized (Tables 2-17).

Tables 2-7 show DAI rates and DU ratios by infection type (CLAB, CAUTI, VAP) in adult and pediatric ICUs. The data were not stratified by type or size of hospital.

Table I. Features of the participating INICC hospitals, 2003-2008

	Argentina	Brazil	Chile	Colombia	Costa Rica	Cuba	Greece	India	Jordan	Kosovo	Lebanon	Lithuania	Macedonia	Mexico	Morocco	Pakistan	Panama	Peru	Philippines	Salvador	Thailand	Tunisia	Turkey	Venezuela	Vietnam	Overall
ICUs, n	17	19	5	24	1	2	1	19	4	1	1	3	1	10	2	2	1	10	9	2	5	2	29	1	2	173
ICUs, type																					-					
Coronary	2	-	-	2	-	-	-	3		-	-		-	-	-	-	-	-	1	-	-	-	1	-	-	9
Surgical-cardiothoracic	-	-	1	-	-	-	-	-		-	-		1	-	-	-	-	-	-	-	-	-	2	-	-	4
Medical	1	-	-	-	-	-	-	3	1	-	-		-	-	1	-	-	1	-	-	1	-	3		1	12
Medical-surgical	10	13	2	15	1	1	1	7	1	1	1		-	6	-	2	1	5	1	-	1	-	13	1	-	83
Neurosurgical	-	-	-	-	-	-	-	1		-	-		-	1	-	-	-	-	1	-	-	-	2		-	5
Pediatric	1	4	-	3	-	-	-	1	1	-	-	3	-	2	-	-	-	1	1	-	2	1	1		-	22
Neonatal	2	1	-	4	-	-	-	-	1	-	-		-	1	1	-	-	3	2	-	-	1	4		-	21
Surgical	-	1	2	-	-	-	-	3		-	-		-	-	-	-	-	-	2	-	1	-	3		1	13
Trauma	1	-	-	-	-	1	-	1		-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	3
Burn	-	-	-	-	-	-	-	-		-	-		-	-	-	-	-	-	1	-	-	-	-	-	-	1
Hospitals, n	12	14	3	15	1	2	1	13	1	1	1	3	1	8	2	2	1	7	2	1	2	1	18	1	1	114
Academic, teaching	1	6	2	4		2	1	5	1	1	1	3		1	2	1		1	1	1	2	1	15	0	1	53
Public	7	2	1	2		0		2						7				5			-		2	1		29
Private, community	4	6		9	1	0		6					1	0		1	1	1	1		-		1			32

Device-days consisted of the total number of central line-days, urinary catheter-days, or ventilator-days. The DU ratio constitutes an extrinsic risk factor for HAI.[17] DU also comprises a marker for severity of illness of patients, vis-a-vis, patients' susceptibility to HAI.

Tables 8-11 show DAI rates and DU ratios from the High Risk Nursery Component of the INICC system for CLABs and VAPs. For NICUs, device-days consist of the total number of central line-days, umbilical catheter days, and ventilator-days. The data for neonatal ICUs were stratified by weight.

Tables 12 and 13 provide data on crude ICU mortality in patients hospitalized in each type of unit during the surveillance period, with and without DAI, and crude excess mortality of adult and pediatric patients with CLAB, CAUTI, and VAP and infants in NICUs with CLAB or VAP.

Tables 14 and 15 provide data on crude length of stay of patients hospitalized in each type of unit during the surveillance period with and without DAI and crude excess length of stay of adult and pediatric patients with CLAB, CAUTI, and VAP and infants in NICUs with CLAB or VAP.

Table 16 provides data on bacterial resistance of pathogens isolated from patients with DAI in adult and pediatric ICUs and NICUs. Table 17 provides data on hand hygiene compliance in each type of unit. Tables 18 and 19 compare overall rates of CLAB, CAUTI, and VAP (Table 18)[18] and rates of antimicrobial resistance (Table 19)[19] in the INICC and CDC NHSN ICUs.

DISCUSSION

The effectiveness of implementing an integrated infection control program focused on HAI surveillance was demonstrated approximately 30 years ago, as shown in the many studies conducted in the United States, whose results reported not only that the incidence of HAI can be reduced by as much as 30% but that a related reduction in health care costs was also feasible.[20] For more than 30 years, the CDC's NNIS/NHSN network has provided benchmarking US ICU data on DAIs and antibiotic resistance, which have proven invaluable for researchers,[17-19,21-24] and served as an inspiration to the INICC program. Initially, INICC's surveillance concentrated on DAI surveillance in the ICU, a health care setting with the highest HAI rates and in which patients' safety is most seriously threatened because of their critical condition and exposure to invasive devices.[3]

The rate of device use in INICC ICUs is analogous or even lower to the one reported of US ICUs by the NNIS/NHSN system[18,24]; however, DAI rates identified in INICC ICUs are exceedingly higher than the published US rates (Table 18).[18] Likewise, the antimicrobial

Table 2. Pooled means and 95% CI of the distribution of central line-associated BSI rates, per 1000 central line-days by type of adult and pediatric ICU

Type of ICU	No. of ICUs	No. of patients	No. of CLAB (LCBI)*	No. of CLAB (CSEP)†	No. of CLAB (LCBI + CSEP)	Central line-days	Pooled mean CLAB rate	95% CI
Coronary	9	8845	52	184	236	27,768	8.5	7.5-9.7
Surgical-cardiothoracic	4	1683	18	7	25	6998	3.6	2.3-5.3
Medical	12	11,410	170	10	180	20,034	9.0	7.7-10.4
Medical-surgical	83	85,989	2362	332	2694	362,882	7.4	7.2-7.7
Neurosurgical	5	2996	93	2	95	5367	17.7	14.3-21.6
Pediatric	22	23,047	383	74	457	58,842	7.8	7.1-8.51
Surgical	13	7925	207	22	229	27,313	8.4	7.3-9.54
Trauma	3	2237	28	0	28	8975	3.1	2.07-4.51
Burn	1	191	0	0	0	9	0.0	-
Overall	152	144,323	3313	698	3944	518,188	7.6	7.4-7.9

BSI, bloodstream infection; *CLAB*, central line-associated BSI.
*Laboratory-confirmed BSI.
†Clinical sepsis, without laboratory confirmation.

Table 3. Pooled means and 95% CI of central line utilization ratios by type of adult and pediatric ICU

Type of ICU	No. of ICUs	Central line-days	Patient-days	Pooled mean DUR	95% CI
Coronary	9	27,768	41,289	0.67	0.67-0.68
Surgical-cardiothoracic	4	6998	7495	0.93	0.93-0.94
Medical	12	20,034	53,022	0.38	0.37-0.38
Medical-surgical	83	362,882	495,115	0.73	0.73-0.73
Neurosurgical	5	5367	17,073	0.31	0.31-0.32
Pediatric	22	58,842	129,657	0.45	0.45-0.46
Surgical	13	27,313	42,275	0.65	0.64-0.65
Trauma	3	8975	14,726	0.61	0.60-0.62
Burn	1	9	2156	0.004	0.002-0.01
Overall	152	518,188	802,808	0.65	0.64-0.65

DUR, Device use ratio.

Table 4. Pooled means and 95% CI of the distribution of catheter-associated UTI rates, per 1000 urinary catheter-days by type of adult or pediatric ICU

Type of ICU	No. of ICUs	No. of Patients	Urinary catheter-days	No. of CAUTIs	Pooled mean CAUTI rate	95% CI
Coronary	9	8845	21,595	94	4.4	3.5-5.3
Surgical-cardiothoracic	4	1683	6984	3	0.4	0.1-1.3
Medical	12	11,410	33,318	284	8.5	7.6-9.6
Medical-surgical	83	85,989	403,545	2479	6.1	5.9-6.4
Neurosurgical	5	2996	14,716	204	13.9	12.0-15.9
Pediatric	22	23,047	21,921	96	4.4	3.6-5.4
Surgical	13	7925	29,268	146	5.0	4.2-5.9
Trauma	3	2237	9861	82	8.3	6.6-10.3
Burn	1	191	402	2	5.0	0.6-17.9
Overall	152	144,323	541,610	3390	6.3	6.0-6.5

CAUTI, catheter-associated urinary tract infection.

resistance rates found in INICC ICUs for *Staphylococcus aureus* isolates as resistant to methicillin (MRSA), *enterobacteria* resistant to ceftazidime (extended-spectrum β-lactamase producers), and *Pseudomonas aeruginosa* as resistant to fluoroquinolones were far higher than NHSN ICUs' rates (Table 19).[19] Nonetheless, the rates found in the INICC ICUs for enterococcal isolates as resistant to vancomycin is much lower than NHSN ICUs' rates.[19]

These higher DAI rates may reflect the typical ICU situation in limited-resources countries as a whole,[25,26] and several reasons have been exposed to explain this fact.[27] Among the primary plausible causes, it can be mentioned that, in the majority of the limited-resources

Table 5. Pooled means and 95% CI of urinary catheter utilization ratios by type of adult or pediatric ICU

Type of ICU	No. of ICUs	Urinary catheter-days	Patient-days	Pooled mean DUR	95% CI
Coronary	9	21,595	41,289	0.52	0.52-0.93
Surgical-cardiothoracic	4	6984	7495	0.93	0.93-0.94
Medical	12	33,318	53,022	0.63	0.62-0.63
Medical-surgical	83	375,822	495,115	0.82	0.81-0.82
Neurosurgical	5	14,716	17,073	0.86	0.86-0.87
Pediatric	22	21,921	129,657	0.17	0.17-0.17
Surgical	13	29,268	42,275	0.69	0.69-0.70
Trauma	3	9861	14,726	0.67	0.66-0.68
Burn	1	402	2156	0.19	0.17-0.20
Overall	152	541,610	802,808	0.67	0.67-0.68

DUR, Device use ratio.

Table 6. Pooled means and 95% CI of the distribution of ventilator-associated pneumonia rates, per 1000 ventilator-days by type of adult or pediatric ICU

Type of ICU	No. of ICUs	No. of patients	Ventilator-days	No. of VAP	Pooled mean VAP rate	95% CI
Coronary	9	8845	7905	118	14.9	12.4-17.9
Surgical-cardiothoracic	4	1683	2902	27	9.3	6.1-13.5
Medical	12	11,410	19,300	288	14.9	13.3-16.7
Medical-surgical	83	85,989	275,111	4042	14.7	14.2-15.2
Neurosurgical	5	2996	4473	113	25.3	20.9-30.3
Pediatric	22	23,047	67,914	372	5.5	4.9-6.0
Surgical	13	7925	22,487	248	11.0	9.7-12.5
Trauma	3	2237	6223	322	51.7	46.4-57.6
Burn	1	191	135	3	22.2	4.5-63.7
Overall	152	144,323	406,450	5533	13.6	13.3-14.0

VAP, ventilator-associated pneumonia.

Table 7. Pooled means and 95% CI of ventilator utilization ratios by type of adult or pediatric ICU

Type of ICU	No. of units	Patient-days	Ventilator-days	Pooled mean DUR	95% CI
Coronary	9	41,289	7905	0.19	0.19-0.20
Surgical-cardiothoracic	4	7495	2902	0.39	0.38-0.40
Medical	12	53,022	19,300	0.36	0.36-0.37
Medical-surgical	83	495,115	275,111	0.56	0.55-0.56
Neurosurgical	5	17,073	4473	0.26	0.26-0.27
Pediatric	22	129,657	67,914	0.52	0.52-0.53
Surgical	13	42,275	22,487	0.53	0.53-0.54
Trauma	3	14,726	6223	0.42	0.41-0.43
Burn	1	2156	135	0.06	0.05-0.07
Overall	152	802,808	406,450	0.51	0.51-0.51

DUR: Device use ratio.

countries, there are still no legally enforceable rules or regulations concerning the implementation of infection control programs, such as national infection control guidelines; however, in the few cases in which there is a legal framework, adherence to the rules is most irregular, and hospital accreditation is not mandatory. In most INICC hospitals, this lack of official regulations is strongly correlated to the considerable variability found in the compliance with hand hygiene guidelines. This situation is further emphasized by the fact that administrative and financial support in most INICC hospitals is insufficient to fund infection control programs[28] and invariably results in extremely low nurse-to-patient staffing ratios (which have proved to be highly connected to high DAI rates in ICUs),[3] hospital overcrowding, lack of medical supplies, and in an insufficient number of experienced nurses or trained health care workers.

According to the World Bank, countries are categorized into 4 economic strata based on 2007 gross

Table 8. Pooled means and 95% CI of the distribution of central line-associated BSI rates, per 1000 central line-days for level III NICUs

Birth weight category, kg	No. of units	No of patients	Central line-days	No. of CLAB (LCBI)*	No. of CLAB (CSEP)†	No. of CLAB (LCBI + CSEP)	Pooled mean CLAB rate	95% CI
<0.750	9	47	393	2	3	5	12.7	4.1-29.4
0.750-1.000	15	369	2323	29	8	36	15.5	10.9-21.4
1.001-1.500	15	801	5230	54	29	83	15.9	12.7-19.7
1.501-2.500	16	3206	7437	65	40	103	13.8	11.3-16.8
>2.500	16	4733	5988	39	31	70	11.7	9.1-14.8
Overall	17	9156	21,371	189	111	297	13.9	12.4-15.6

BSI, bloodstreasm infection; *CLAB*, central line-associated BSI; *CLBI*, laboratory-confirmed BSI; *CSEP*, clinical sepsis.
*Laboratory-confirmed BSI.
†Clinical sepsis, without laboratory confirmation.

Table 9. Pooled means and 95% CI of central line utilization ratios for level III NICUs

Birth weight category, kg	No. of units	Patient-days	Central line-days	Pooled mean DUR	95% CI
<0.750	9	1099	393	0.36	0.33-0.39
0.750-1.000	15	5865	2323	0.40	0.38-0.41
1.001-1.500	15	20,532	5230	0.25	0.25-0.26
1.501-2.500	16	37,627	7437	0.20	0.19-0.20
>2.500	16	35,317	5988	0.17	0.17-0.17
Overall	17	100,440	21,371	0.21	0.21-0.22

DUR, Device use ratio.

Table 10. Pooled means and 95% CI of the distribution of ventilator-associated pneumonia rates, per 1000 ventilator-days for level III NICUs

Birth weight category, kg	No. of units	No of patients	Ventilator-days	No. of VAP	Pooled mean VAP rate	95% CI
<0.750	9	47	482	3	6.22	1.25-18.11
0.750-1.000	15	369	1942	15	7.72	4.32-12.72
1.001-1.500	15	801	3053	25	8.19	5.30-12.00
1.501-2.500	16	3206	4252	41	9.64	6.92-13.07
>2.500	16	4733	3639	43	11.82	6.58-12.23
Overall	17	9156	13,368	127	9.50	7.92-11.30

VAP, ventilator-associated pneumonia.

Table 11. Pooled means and 95% CI of ventilator utilization ratios for level III NICUs

Birth weight category, kg	No. of units	Patient-days	Ventilator-days	Pooled mean DUR	95% CI
<0.750	9	1099	482	0.44	0.41-0.47
0.750-1.000	15	5865	1942	0.33	0.32-0.34
1.001-1.500	15	20,532	3053	0.15	0.14-0.15
1.501-2.500	16	37,627	4252	0.11	0.11-0.12
>2.500	16	35,317	3639	0.10	0.10-0.11
Overall	17	100,440	13,368	0.13	0.13-0.14

DUR, Device use ratio.

national income per capita: (1) low income, $935 or less; (2) lower middle income, $936 to $3705; (3) upper middle income, $3706 to $11,455; and (4) high income, $11,456 or more.[29-33] Within this categorization, 144 out of 209 (68%) are low income and lower middle income economies, which can also be referred to as lower income countries, low resources countries, developing economies, or

Table 12. Pooled means and 95% CI of the distribution of crude mortality and crude excess mortality* of ICU patients with HAI, adult and pediatric ICUs combined

	No. of deaths	No. of patients	Pooled crude mortality, %	95% CI
Crude mortality of patients without HAI	7509	52,046	14.4	14.1-14.7
Crude mortality of patients with CLAB	636	1671	38.1	35.7-40.4
Crude excess mortality of patients with CLAB	636	1671	23.6	21.6-25.7
Crude mortality rate of patients with CAUTI	204	620	32.9	29.2-36.8
Crude excess mortality of patients with CAUTI	204	590	18.5	15.1-22.1
Crude mortality rate of patients with VAP	720	1648	43.7	41.2-46.2
Crude excess mortality of patients with VAP	720	1648	29.3	27.1-31.4

BSI, bloodstreasm infection; *CAUTI*, catheter-associated urinary tract infections; *CLAB*, central line-associated BSI; *CLBI*, laboratory-confirmed BSI; *CSEP*, clinical sepsis; *VAP*, ventilator-associated pneumonia.
*Crude excess mortality of DAI = crude mortality of ICU patients with DAI − crude mortality of patients without HAI.

Table 13. Pooled means and 95% CI of the distribution of crude mortality and crude excess mortality*of infants in NICUs, all birth weight categories combined

	No. of deaths	No. of patients	Pooled crude mortality, %	95% CI
Crude mortality of infants without HAI	443	5030	8.8	8.0-9.6
Crude mortality of infants with CLAB	49	142	34.5	26.7-42.9
Crude excess mortality of infants with CLAB	49	142	25.7	18.7-33.3
Crude mortality of infants with VAP	29	107	27.1	18.9-36.6
Crude excess mortality of infants with VAP	29	107	18.3	10.9-27.0

BSI, bloodstreasm infection; *CLAB*, central line-associated BSI; *VAP*, ventilator-associated pneumonia.
*Crude excess mortality of DAI = crude mortality of ICU patients with DAI − crude mortality of patients without HAI.

Table 14. Pooled means and 95% CI of the distribution of the length of stay and crude excess length of stay* of ICU patients with HAI, adult and pediatric ICUs combined.

	LOS, total days	No. of patients	Pooled average LOS, days	95% CI
LOS of patients without HAI	260,038	52,046	5.00	4.96-5.04
LOS of patients with CLAB	22,658	1322	17.14	16.3-18.1
Extra LOS of patients with CLAB	22,658	1322	12.14	11.34-13.1
LOS of patients with CAUTI	9024	622	14.51	13.5-15.7
Extra LOS of patients with CAUTI	9024	622	9.51	8.5-10.7
LOS of patients with VAP	25,521	1638	15.58	14.9-16.3
Extra LOS of patients with VAP	25,521	1638	10.58	9.9-11.3

BSI, bloodstreasm infection; *CAUTI*, catheter-associated urinary tract infections; *CLAB*, central line-associated BSI; LOS, length of stay; *VAP*, ventilator-associated pneumonia.

Table 15. Pooled means and 95% CI of the distribution of the length of stay and crude excess length of stay* of infants in NICUs, all birth weight categories combined

	LOS, total days	No. of patients	Pooled average LOS, days	95% CI
LOS of infants without HAI	58,665	5278	11.12	10.8-11.4
LOS of infants with CLAB	5622	169	33.3	28.7-38.9
Extra LOS of infants with CLAB	5622	169	22.2	17.9-27.5
LOS of infants with VAP	2868	105	27.3	22.6-33.3
Extra LOS of infants with VAP	2868	105	16.2	11.8-21.9

BSI, bloodstreasm infection; *CLAB*, central line-associated BSI; *VAP*, ventilator-associated pneumonia.
*Crude excess LOS of DAI = crude LOS of ICU patients with DAI − crude LOS of patients without HAI.

developing or emerging countries, representing more than 75% of the world population. The relation between DAI rates and the country socioeconomic level (low income, lower middle income, and high income) and between DAI rates and their association to the type of hospital (public, academic, and private) has not been adequatly analyzed and should therefore be further studied.

Table 16. Antimicrobial resistance rates in the ICUs of the International Nosocomial Infection Control Consortium

Pathogen, antimicrobial	No. of pathogenic isolated tested, pooled (CLAB)	Resistance percentage, % (CLAB)	No. of pathogenic isolated tested, pooled (VAP)	Resistance percentage, % (VAP)	No, of pathogenic isolated tested, pooled (CAUTI)	Resistance percentage, % (CAUTI)
Staphylococcus aureus						
OXA	761	84.1	715	77.5	43	74.4
Enterococcus faecalis						
VAN	115	8.7	277	0.72	277	2.9
Pseudomonas aeruginosa						
FQs	963	50.0	963	49.8	188	56.4
PIP or PTZ	703	78.0	1525	35.1	277	37.9
AMK	304	31.0	990	30.4	185	35.1
IMI or MERO	526	44.0	1636	38.6	288	34.7
CPM	30	73.3	118	66.9	30	73.3
Klebsiella pneumoniae						
CTR or TAZ	394	76.1	584	70.4	213	70.0
IMI, MERO, or ETP	444	3.8	632	3.8	237	3.4
Acinetobacter baumannii						
IMI or MERO	605	46.3	1209	52.4	113	38.9
Escherichia coli						
CTR or TAZ	193	53.9	274	67.9	343	41.7
IMI, MERO, or ETP	214	3.7	299	3.0	302	4.6
FQs	181	46.4	142	59.9	300	35.0

AMK, amikacin; *CPM*, cefepime; *CTR*, ceftriaxone; *ETP*, ertapenem; *FQs*, fluoroquinolones (ciprofloxacin, levofloxacin, moxifloxacin, or ofloxacin); *IMI*, imipenem; *MERO*, meropenem; *OXA*, oxacillin; *PIP*, piperacillin; *PTZ*, piperacillin-tazobactam; *TAZ*, ceftazidime; *VAN*, vancomycin.

Table 17. Distribution of hand hygiene compliance rates by ICU type.

Type of ICU	ICUs (n)	Opportunities for HH (n)	HH compliance (n)	Pooled mean compliance (%)	95% CI
Burn	1	1324	1176	88.8	86.9-90.5
Cardio-surgical	2	1405	362	25.8	23.5-28.1
Coronary	5	6950	4109	59.1	57.9-60.3
Medical	3	1546	1150	74.4	72.1-76.6
Medical-surgical	50	61,321	33,116	54.0	53.6-54.4
Neonatal	10	5356	3975	74.2	73.1-75.4
Neuro-surgical	1	3605	2748	76.2	74.8-77.6
Pediatric	4	1988	1164	58.6	56.3-60.7
Surgical	6	6486	3574	55.1	53.8-56.3
Trauma	2	4752	3667	77.2	75.9-78.4
Overall	84	94,733	55,041	58.1	57.8-58.4

HH, hand hygiene.

To reduce the hospitalized patients' risk of infection, HAI surveillance is primary and essential because it effectively describes and addresses the importance and characteristics of the threatening situation created by HAIs. This must be followed by the implementation of practices aimed at HAI prevention and control. Additionally, participation in INICC has played a fundamental role not only in increasing the awareness of DAI risks in the INICC ICUs but also providing an exemplary basis for the institution of infection control practices. In many INICC ICUs, for example, the high incidence of HAI has been reduced by carrying out targeted performance feedback programs for hand hygiene and CVC, ventilator, and urinary catheter care.[29-34] Finally, it is of utmost importance to restrict the administration of anti-infectives to effectively control the increase of antibiotic resistance.

To compare a hospital's HAI rates and DU ratios with the rates identified in this report, it is required that the hospital concerned start by collecting their data by applying the methods and methodology described for CDC NHSN and INICC and then calculate infection rates

Table 18. Comparison of DAI rates, per 1000 device-days, in the ICUs of the International Nosocomial Infection Control Consortium and the US National Healthcare Safety Network

	INICC 2003-2008, Pooled mean (95% CI)	US NHSN 2006-2007, Pooled mean (95% CI)
Coronary ICU		
CLAB	8.5 (7.5-9.7)	2.1 (1.9-2.3)
CAUTI	4.4 (3.5-5.3)	4.4 (4.1-4.8)
VAP	14.9 (12.4-17.9)	2.5 (2.2-2.9)
Medical-surgical ICU		
CLAB	7.4 (7.2-7.7)	2.0 (1.9-2.2)
CAUTI	6.1 (5.9-6.4)	3.3 (3.1-3.5)
VAP	14.7 (14.2-15.2)	3.3 (3.1-3.6)
Pediatric ICU		
CLAB	7.8 (7.1-8.5)	2.9 (2.6-3.2)
CAUTI	4.4 (3.6-5.4)	5.0 (4.4-5.7)
VAP	5.5 (4.9-6.0)	2.1 (1.8-2.4)
Newborn ICU (1501-2500 g)		
CLAB	13.9 (12.4-15.6)	2.4 (1.9-2.9)
VAP	9.50 (7.9-11.3)	1.0 (0.6-0.2)

BSI, bloodstreasm infection; *CAUTI*, catheter-associated urinary tract infections; *CLAB*, central line-associated BSI; *VAP*, ventilator-associated pneumonia.

Table 19. Comparison of antimicrobial resistance rates in the ICUs of the International Nosocomial Infection Control Consortium and the US National Nosocomial Surveillance System

	INICC 2003-2008	US NHSN 2006-2007
Pathogen, antimicrobial	Resistance percentage, % (CLAB)	Resistance percentage, % (CLAB)
Staphylococcus aureus	84.1	
OXA		56.8
Enterococcus faecalis		
VAN	8.7	78.9
Pseudomonas aeruginosa		
FQs	50	30.5
PIP or PTZ	78	20.2
AMK	31	4.3
IMI or MERO	44	23.0
CPM	73	12.6
Klebsiella pneumoniae		
CTR or TAZ	76.1	27.1
IMI, MERO, or ETP	3.8	10.8
Acinetobacter baumannii		
IMI or MERO	46.3	29.2
Escherichia coli		
CTR or TAZ	53.9	8.1
IMI, MERO, or ETP	3.7	0.9
FQs	46.4	30.8

AMK, amikacin; *CPM*, cefepime; *CTR*, ceftriaxone; *ETP*, ertapenem; *FQs*, fluoroquinolones (ciprofloxacin, levofloxacin, moxifloxacin, or ofloxacin); *IMI*, imipenem; *MERO*, meropenem; *OXA*, oxacillin; *PIP*, piperacillin; *PTZ*, piperacillin-tazobactam; *TAZ*, ceftazidime; *VAN*, vancomycin.

and DU ratios for the Device-associated Module. The particular and primary applications of these data are to serve as a guide for the implementation of prevention strategies and other quality improvement efforts locally to help reduce HAI rates at the minimum possible level.

In conclusion, the data presented in this report fortify the fact that HAIs, particularly DAIs in ICU patients in limited-resources countries, pose a grave and many times concealed risk to patient safety, as compared with the developed world. It is INICC's main goal to enhance infection control practices, by facilitating elemental, feasible, and inexpensive tools and resources to tackle this problem effectively and systematically, leading to greater and stricter adherence to infection control programs and guidelines, and to the correlated reduction in DAI and its adverse effects, in the ICUs participating in the INICC, as well as at any other health care facility of the developing world.

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SUPPLEMENTARY DATA

To access Appendix I, visit the online version of the American Journal of Infection Control at www.ajicjournal.org.

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APPENDIX 1

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