International Nosocomial Infection Control Consortium report, data summary for 2002-2007, issued January 2008

Victor D. Rosenthal,[a] Dennis G. Maki,[b] Ajita Mehta,[c] Carlos Álvarez-Moreno,[d] Hakan Leblebicioglu,[e] Francisco Higuera,[f] Luis E. Cuellar,[g] Naoufel Madani,[h] Zan Mitrev,[i] Lourdes Dueñas,[j] Josephine Anne Navoa-Ng,[k] Humberto Guanche Garcell,[l] Lul Raka,[m] Rosalía Fernández Hidalgo,[n] Eduardo A. Medeiros,[o] Souha S. Kanj,[p] Salisu Abubakar,[q] Patricio Nercelles,[r] Ricardo Diez Pratesi,[s] and International Nosocomial Infection Control Consortium Members (see Appendix for rest of the authors), Endorsed by the International Federation of Infection Control

Buenos Aires, Argentina; Madison, Wisconsin; Mumbai, India; Bogota, Colombia; Samsun, Turkey; Mexico City, Mexico; Lima, Peru; Rabat, Morocco; Skopje, Macedonia; San Salvador, El Salvador; Quezon City, Philippines; Havana, Cuba; Prishtina, Kosova; San José, Costa Rica; Sao Paulo, Brazil; Beirut, Lebanon; Kano, Nigeria; Valparaíso, Chile; and Paysandú, Uruguay

We report the results of an International Nosocomial Infection Control Consortium (INICC) surveillance study from 2002 through 2007 in 98 intensive care units (ICUs) in Latin America, Asia, Africa, and Europe. During the 6-year study, using Centers for Disease Control and Prevention (CDC) National Nosocomial Infections Surveillance System (NNIS) definitions for device-associated health care-associated infection, we collected prospective data from 43,114 patients hospitalized in the Consortium's hospital ICUs for an aggregate of 272,279 days. Although device utilization in the INICC ICUs was remarkably similar to that reported from US ICUs in the CDC's National Healthcare Safety Network, rates of device-associated nosocomial infection were markedly higher in the ICUs of the INICC hospitals: the pooled rate of central line–associated bloodstream infections (CLABs) in the INICC ICUs, 9.2 per 1000 CL-days, is nearly 3-fold higher than the 2.4–5.3 per 1000 CL-days reported from comparable US ICUs, and the overall rate of ventilator-associated pneumonia was also far higher, 19.5 vs 1.1–3.6 per 1000 ventilator-days, as was the rate of catheter-associated urinary tract infection, 6.5 versus 3.4–5.2 per 1000 catheter-days. Most strikingly, the frequencies of resistance of *Staphylococcus aureus* isolates to methicillin (MRSA) (80.8% vs 48.1%), Enterobacter species to ceftriaxone (50.8% vs 17.8%), and *Pseudomonas aeruginosa* to fluoroquinolones (52.4% vs 29.1%) were also far higher in the Consortium's ICUs, and the crude unadjusted excess mortalities of device-related infections ranged from 14.3% (CLABs) to 27.5% (ventilator-associated pneumonia). (Am J Infect Control 2008;36:627-37.)

From the Medical College of Buenos Aires and Bernal Medical Center,[a] Buenos Aires, Argentina; University of Wisconsin Medical School,[b] Madison, WI; PD Hinduja National Hospital & Medical Research Centre,[c] Mumbai, India; Pontificia Javeriana University and Simón Bolivar ESE Hospital,[d] Bogota, Colombia; Ondokuz Mayis University Medical School,[e] Samsun, Turkey; Mexico's General Hospital,[f] Mexico City, Mexico; Instituto Nacional de Enfermedades Neoplásicas (INEN),[g] Lima, Peru; Ibn Sina Hospital,[h] Rabat, Morocco; Filip II Special Cardiosurgery Hospital,[i] Skopje, Macedonia; Benjamin Bloom National Children's Hospital,[j] San Salvador, El Salvador; St. Luke's Medical Center,[k] Quezon City, Philippines; Joaquín Albarrán Domínguez Surgical Training Hospital,[l] Havana, Cuba; National Institute for Public Health of Kosova and Medical School,[m] Prishtina University, Prishtina, Kosova; Clínica Bíblica Hospital,[n] San José, Costa Rica; Hospital São Paulo, São Paulo,[o] Brazil; American University of Beirut Medical Center,[p] Beirut, Lebanon; Aminu Kano Teaching Hospital,[q] Kano, Nigeria; Valparaíso University,[r] Valparaíso, Chile; Paysandú Medical Corporation (COMEPA), Paysandú,[s] Uruguay.

Address correspondence to Victor D. Rosenthal, MD, MSc, CIC, International Nosocomial Infection Control Consortium (INICC) (www.INICC.org), Lavalleja 305, Floor 9, Apt A, ZIP 1414, Buenos Aires. Argentina. E-mail: victor_rosenthal@inicc.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; Appendix)[1] between January 2002 and December 2007. 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]).[1] 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 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.[1] The data are collected using standardized Centers for Disease Control and Prevention (CDC) NNIS protocols and definitions.[2-4]

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.[3]

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.[1]

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 an ICU. 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.

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

Table I. Features of the participating INICC hospitals, 2002-2007

	Argentina	Brazil	Chile	Colombia	Costa Rica	Cuba	India	Kosovo	Lebanon	Macedonia	Mexico	Morocco	Nigeria	Peru	Philippines	El Salvador	Turkey	Uruguay	Overall
ICUs, n	15	8	2	17	1	1	15	1	1	1	7	1	1	5	4	2	15	1	98
ICUs, type																			
Coronary	2	0	0	2	0	0	3	0	0	0	0	0	0	0	0	0	0	0	7
Medical	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	2
Medical surgical	9	7	1	10	1	1	7	1	1	0	4	0	0	4	1	0	12	1	60
Neurosurgical	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	2
Surgical cardiothoracic	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	2
Trauma	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2
Surgical	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	4
Pediatric	1	0	1	3	0	0	1	0	0	0	1	0	0	0	1	1	0	0	9
NICU	2	0	0	2	0	0	0	0	0	0	1	0	1	1	1	1	1	0	10
Hospitals, n	10	6	1	11	1	1	10	1	1	1	5	1	1	4	2	1	13	1	71
Academic teaching	1	3	1	3	0	1	4	1	1	0	2	1	1	0	1	1	12	1	34
Public	5	1	0	3	0	0	1	0	0	0	3	0	0	3	0	0	1	0	17
Private community	4	2	0	5	1	0	5	0	0	1	0	0	0	1	1	0	0	0	20

Table 2. Pooled means and key percentiles of the distribution of central line-associated BSI rates, per 1000 central line-days, and central line utilization ratios by type of adult 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	Percentile				
								10th	25th	50th, Median	75th	90th
Coronary ICU	7	8499	51	185	236	23,746	9.94	0.0	0.0	8.3	11.8	12.8
Surgical-cardiothoracic ICU	2	541	4	0	4	2477	1.61	0.0	0.0	0.9	1.7	1.7
Medical ICU	2	2408	23	2	25	2364	10.58	2.1	2.1	7.4	12.7	12.7
Medical-surgical ICU	60	26,155	877	301	1178	132,061	8.92	0.0	3.7	9.7	16.5	34.3
Neurosurgical ICU	2	1200	30	14	44	3362	13.09	0.0	0.0	10.3	13.9	13.9
Pediatric ICU	9	1808	55	55	110	16,012	6.87	0.0	7.9	9.5	19.2	24.4
Surgical ICU	4	1984	108	21	129	7526	17.14	1.3	1.3	18.2	41.6	41.6
Trauma ICU	2	519	9	0	9	853	10.55	9.3	9.3	10.0	10.7	10.7
Overall	88	43,114	1157	578	1735	188,401	9.21	0.0	2.1	9.5	13.5	41.6

Type of ICU	No. of ICUs	Central line-days	Patient days	Pooled mean DUR	Percentile				
					10th	25th	50th, Median	75th	90th
Coronary ICU	7	23,746	40,383	0.59	0.07	0.17	0.51	0.88	1.17
Surgical-cardiothoracic ICU	2	2477	2470	1.00	0.74	0.74	1.00	1.01	1.01
Medical ICU	2	2364	13,399	0.18	0.13	0.13	0.16	0.19	0.19
Medical-surgical ICU	60	132,061	177,009	0.75	0.0	0.41	0.64	0.80	1.10
Neurosurgical ICU	2	3362	8220	0.41	0.02	0.02	0.19	1.06	1.06
Pediatric ICU	9	16,012	11,727	1.37	0.02	0.23	0.50	0.81	0.98
Surgical ICU	4	7526	16,884	0.45	0.0	0.22	0.44	0.65	0.87
Trauma ICU	2	853	2187	0.39	0.37	0.37	0.46	0.56	0.56
Overall	88	188,401	272,279	0.69	0.0	0.39	0.63	0.80	1.17

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

Table 3. Pooled means and key percentiles of the distribution of catheter-associated UTI rates, per 1000 urinary catheter-days, and urinary catheter utilization ratios 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	Percentile				
						10th	25th	50th, Median	75th	90th
Coronary ICU	7	8499	18,722	120	6.41	0.00	0.00	1.9	13.3	16.3
Surgical cardiothoracic ICU	2	541	2344	3	1.28	0.00	0.00	0.0	1.3	1.3
Medical ICU	2	2408	6646	64	9.63	0.00	0.00	5.3	10.5	10.5
Medical surgical ICU	60	26,155	155,722	1030	6.61	0.00	2.50	5.2	8.3	23.8
Neurosurgical ICU	2	1200	3740	31	8.29	0.00	0.00	4.9	13.3	13.3
Pediatric ICU	9	1808	4777	19	3.98	0.00	0.00	0.8	3.3	8.0
Surgical ICU	4	1984	8808	37	4.20	0.30	3.10	12.0	22.9	27.8
Trauma ICU	2	519	1552	8	5.15	4.30	4.30	8.5	12.8	12.8
Overall	88	43,114	202,311	1312	6.49	0.00	0.30	4.2	8.3	27.8

Type of ICU	No. of ICUs	Urinary catheter-days	Patient-days	Pooled mean DUR	Percentile				
					10th	25th	50th, Median	75th	90th
Coronary ICU	7	18,722	40,383	0.46	0.25	0.47	0.61	0.70	0.78
Surgical cardiothoracic ICU	2	2344	2470	0.95	0.87	0.87	0.95	1.00	1.00
Medical ICU	2	6646	13,399	0.50	0.16	0.16	0.39	0.62	0.62
Medical surgical ICU	60	155,722	177,009	0.88	0.10	0.76	0.85	0.93	0.99
Neurosurgical ICU	2	3740	8220	0.45	0.05	0.05	0.61	0.67	0.67
Pediatric ICU	9	4777	11,727	0.41	0.02	0.32	0.39	0.53	0.68
Surgical ICU	4	8808	16,884	0.52	0.31	0.44	0.58	0.72	0.85
Trauma ICU	2	1552	2187	0.71	0.70	0.70	0.75	0.81	0.81
Overall	88	202,311	272,279	0.74	0.02	0.59	0.80	0.90	1.00

CAUTI, catheter-associated urinary tract infections; *DUR*, device use ratio.

report. The identity of all INICC hospitals, cities, and countries is confidential, in accordance with the INICC charter.

RESULTS

Characteristics of 98 ICUs from 18 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 in the INICC program is as follows: mean length of participation ± SD, 15.9 ± 14.3 months, range 1 to 70 months; 10th percentile, 1 month; 25th percentile, 5 months; 50th percentile, 12 months; 75th percentile, 21 months; 90th percentile, 70 months.

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 2002 through December 2007 are summarized (Tables 2-10).

Tables 2, 3, and 4 show DAI rates and DU ratios by infection type (CLAB, CAUTI, VAP, respectively) in adult and pediatric ICUs. Inclusion in these Tables required data from at least 5 ICUs of a given type. The data for adult combined medical/surgical ICUs were not stratified by type or size of hospital. 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.[5] DU also comprises a marker for severity of illness of patients, vis-a-vis patients' susceptibility to HAI.

Tables 5 and 6 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.

Table 7 provides 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. Table 8 provides data on antimicrobial utilization in the INICC ICUs. Table 9 provides data on bacterial resistance of pathogens isolated from patients with DAI in adult and pediatric ICUs and NICUs. Table 10 provides data on hand hygiene compliance before patient contacts in the consortium ICUs. Tables 11 and 12 compare rates of CLAB, CAUTI, and VAP (Table 11)

Table 4. Pooled means and key percentiles of the distribution of ventilator-associated pneumonia rates, per 1000 ventilator-days, and ventilator utilization ratios by type of adult or pediatric ICU

Type of ICU	No. of units	No of patients	Ventilator-days	No. of VAP	Pooled mean VAP rate	Percentile				
						10th	25th	50th, Median	75th	90th
Coronary ICU	7	8499	6585	133	20.20	4.9	7.3	11.2	33.2	39.4
Surgical cardiothoracic ICU	2	541	690	13	18.84	0.0	0.0	0.0	20.2	20.4
Medical ICU	2	2408	3117	127	40.74	6.7	6.7	25.5	44.4	44.4
Medical surgical ICU	60	26,155	90,905	1802	19.82	0.0	9.6	16.5	24.1	51.4
Neurosurgical ICU	2	1200	1962	39	19.88	12.1	12.1	26.0	31.9	31.9
Pediatric ICU	9	1808	7898	62	7.85	1.3	3.0	6.1	14.2	15.5
Surgical ICU	4	1984	5214	94	18.03	5.9	8.5	15.1	21.7	24.4
Trauma ICU	2	519	772	13	16.84	16.2	16.2	18.9	21.7	21.7
Overall	88	43,114	117,143	2283	19.49	0.0	7.5	15.2	23.9	51.4

Type of ICU	No. of units	Patient-days	Ventilator-days	Pooled Mean DUR	Percentile				
					10th	25th	50th, Median	75th	90th
Coronary ICU	7	40,383	6,585	0.16	0.03	0.17	0.27	0.34	0.55
Surgical cardiothoracic ICU	2	2,470	690	0.28	0.13	0.13	0.27	0.86	0.86
Medical ICU	2	13,399	3117	0.23	0.09	0.09	0.19	0.29	0.29
Medical surgical ICU	60	177,009	90,905	0.51	0.05	0.39	0.52	0.63	0.91
Neurosurgical ICU	2	8220	1962	0.24	0.04	0.04	0.30	0.37	0.37
Pediatric ICU	9	11,727	7898	0.67	0.00	0.33	0.40	0.57	0.72
Surgical ICU	4	16,884	5214	0.31	0.03	0.25	0.56	0.69	0.73
Trauma ICU	2	2187	772	0.35	0.34	0.34	0.41	0.48	0.48
Overall	88	272,279	117,143	0.43	0.00	0.30	0.46	0.63	0.91

DUR, device use ratio; *VAP*, ventilator-associated pneumonia.

Table 5. Pooled means and key percentiles of the distribution of central line-associated BSI rates, per 1000 central line-days, and central line utilization ratios for level III NICUs

Birth-weight category (g)	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	Percentile				
								10th	25th	50th, Median	75th	90th
<0.750	6	23	265	1	2	3	11.3	0.0	0.0	0.0	14.9	16.7
0.750-1000	7	66	785	3	10	13	16.6	0.0	8.4	16.5	25.8	27.8
1001-1500	7	177	1302	5	13	18	13.8	0.0	11.0	11.7	34.1	37.0
1501-2500	8	531	2040	12	19	31	15.2	0.0	0.0	13.9	21.8	28.2
>2500	8	526	1338	1	19	20	14.9	0.0	5.4	15.4	31.3	66.7
Overall	9	1323	5730	22	63	85	14.8	0.0	0.0	12.4	25.2	66.7

Birth-weight category (g)	No. of units	Patient-days	Central line-days	Pooled mean DUR	Percentile				
					10th	25th	50th, Median	75th	90th
>0.750	6	334	265	0.79	0.0	0.49	0.83	1.0	1.0
0.750-1000	7	1593	785	0.49	0.0	0.27	0.43	0.84	1.02
1001-1500	7	2970	1302	0.44	0.0	0.17	0.29	0.58	0.58
1501-2500	8	5886	2040	0.35	0.0	0.09	0.24	0.39	0.73
>2500	8	4068	1338	0.33	0.0	0.01	0.21	0.44	0.71
Overall	9	14,851	5730	0.39	0.0	0.12	0.31	0.58	1.02

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

Table 6. Pooled means and key percentiles of the distribution of ventilator-associated pneumonia rates, per 1000 ventilator-days, and ventilator utilization ratios for level III NICUs

Birth-weight category, g	No. of units	No of patients	Ventilator-days	No. of VAP	Pooled mean VAP rate	Percentile				
						10th	25th	50th, Median	75th	90th
<0.750	6	23	221	1	4.52	0.0	0.0	0.0	0.0	8.5
0.750-1000	7	66	607	4	6.59	0.0	0.0	0.0	6.9	20.3
1001-1500	7	177	974	4	4.11	0.0	0.0	0.0	2.1	23.6
1501-2500	8	531	1348	9	6.68	0.0	0.0	0.0	4.2	17.4
>2500	8	526	970	13	13.40	0.0	0.0	0.0	10.8	21.1
Overall	9	1323	4120	31	7.52	0.0	0.0	0.0	4.2	23.6

Birth-weight category, g	No. of units	Patient-days	Ventilator-days	Pooled Mean DUR	Percentile				
					10th	25th	50th, Median	75th	90th
<0.750	6	334	221	0.66	0.0	0.37	0.70	0.78	1.00
0.750-1000	7	1593	607	0.38	0.12	0.18	0.50	0.56	0.62
1001-1500	7	2970	974	0.33	0.0	0.10	0.24	0.30	0.55
1501-2500	8	5886	1348	0.23	0.0	0.05	0.15	0.28	0.30
>2500	8	4068	970	0.24	0.0	0.01	0.16	0.26	0.42
Overall	9	14,851	4120	0.28	0.0	0.11	0.25	0.46	1.00

DUR, device use ratio; *VAP*, ventilator-associated pneumonia.

Table 7. Pooled means and percentiles of the distribution of crude mortality and crude excess mortality* of ICU patients with HAI: adult and pediatric ICUs combined

	No. of patients	No. of deaths	Pooled crude mortality, %	Percentile				
				10th	25th	50th, Median	75th	90th
Crude mortality of patients without HAI	38,412	5883	15.3	0.0	10.5	19.05	28.3	100.0
Crude mortality of patients with CLABI	973	288	29.6	0.0	6.02	33.3	50.0	100.0
Crude excess mortality of patients with CLAB	973	288	14.3	0.0	0.0	9.2	31.1	74.2
Crude mortality rate of patients with CAUTI	583	209	35.8	0.0	0.0	28.5	50.0	100.0
Crude excess mortality of patients with CAUTI	583	209	20.5	0.0	0.0	8.04	22.7	85.8
Crude mortality rate of patients with VAP	1178	504	42.8	0.0	20.0	33.3	60.7	100.0
Crude excess mortality of patients with VAP	1178	504	27.5	0.0	0.0	15.4	39.2	98.6

Pooled means and percentiles of the distribution of crude mortality and crude excess mortality* of infants in NICUs: all birth-weight categories combined

	No. of patients	No. of deaths	Pooled crude mortality, %	Percentile				
				10th	25th	50th, Median	75th	90th
Crude mortality of infants without HAI	1181	169	14.3	0.0	1.8	15.2	37.5	90.9
Crude mortality of infants with CLAB	121	48	39.7	0.0	11.5	43.5	58.3	100.0
Crude excess mortality of infants with CLAB	121	48	25.4	0.0	0.0	13.8	32.2	100.0
Crude mortality of infants with VAP	43	20	46.5	0.0	0.0	44.4	66.7	100.0
Crude excess mortality of infants with VAP	43	20	32.2	0.0	0.0	19.3	36.9	57.8

*Crude excess mortality of DAI equals crude mortality of ICU patients with DAI minus crude mortality of patients without HAI.

and rates of antimicrobial resistance (Table 12) in the INICC and CDC NNIS/NHSN ICUs.

DISCUSSION

Studies done in US hospitals 30 years ago showed that an integrated infection control program that includes surveillance of HAIs can reduce the incidence of infections by as much as 30% and can lead to reduced health care costs.[6] Inspired by the success of the CDC's long-standing NNIS/NHSN network, which has provided invaluable benchmarking data on DAIs and antimicrobial resistance in US hospital ICUs for more than 30 years,[5,7-10] we chose to focus the INICC's

Table 8. DDDs and pooled means and percentiles of the distribution of antimicrobial usage rates, DDDs per 1000 ICU-days: adult and pediatric ICUs

Antimicrobial class	No of DDDs	Pooled mean*	Percentile				
			10th	25th	50th, Median	75th	90th
Penicillin group	1536	5.34	0.00	0.00	0.00	3.14	277.95
Ampicillin group	22,082	76.83	0.00	17.29	51.59	101.20	487.83
Antipseudomonal penicillins	13,563	47.19	0.00	2.33	23.57	105.73	331.96
Antistaphylococcal penicillins	1635	5.69	0.00	0.00	0.00	1.09	263.82
First-generation cephalosporins	15,605	54.29	0.00	2.29	21.44	48.99	478.06
Second-generation cephalosporins	1779	6.19	0.00	0.00	0.28	3.57	228.95
Third-generation cephalosporins	50,609	176.09	7.02	97.80	158.99	324.05	653.16
Carbapenems	25,874	90.02	0.00	51.02	101.45	178.72	905.26
Aztreonam	133	0.46	0.00	0.00	0.00	0.00	146.80
Fluoroquinolones	16,734	58.22	0.00	31.31	61.51	124.40	531.58
Trimethoprim-sulfamethoxazole	3100	10.79	0.00	0.00	3.84	21.11	59.65
Vancomycin	22,866	79.56	0.00	13.19	61.41	131.09	422.89

Defined daily doses and pooled means and percentiles of the distribution of antimicrobial usage rates, DDDs per 1000 ICU-days: NICUs

Antimicrobial class	No of DDDs	Pooled mean*	Percentile				
			10th	25th	50th, Median	75th	90th
Penicillin group	30	2.0	0.00	0.00	0.00	2.90	57.32
Ampicillin group	3795	250.9	0.00	173.55	194.24	357.03	504.60
Antipseudomonal penicillins	118	7.8	0.00	0.00	0.00	1.38	48.61
Antistaphylococcal penicillins	626	41.4	0.00	0.00	0.00	4.60	171.79
First-generation cephalosporins	88	5.8	0.00	0.00	1.16	11.59	57.55
Second-generation cephalosporins	69	4.6	0.00	0.00	0.00	1.94	9.58
Third-generation cephalosporins	2247	148.5	7.29	36.83	119.57	190.77	382.17
Carbapenems	796	52.6	0.00	40.96	51.93	53.48	156.54
Aztreonam	0	0.0	0.00	0.00	0.00	0.00	0.0
Fluoroquinolones	61	4.0	0.00	0.00	0.45	5.52	10.82
Trimethoprim-sulfamethoxazole	6	0.4	0.00	0.00	0.00	0.00	2.92
Vancomycin	1,021	67.5	0.00	0.00	40.33	72.26	110.10

DDD, defined daily doses.
*DDD per 1000 ICU-days.

Table 9. Pooled means and percentiles of the distribution of antimicrobial resistance rates: adult, pediatric ICUs, and NICUs

Resistant bacterial species	No. of units	No. isolates tested	Pooled mean resistant (%)	Percentile				
				10th	25th	50th, Median	75th	90th
Methicillin-resistant *Staphylococcus aureus* (MRSA)	96	1473	80.8	0.0	50.0	80.0	100.0	100.0
Methicillin-resistant coagulase-negative staphylococci	96	307	75.2	0.0	64.0	90.3	100.0	100.0
Vancomycin-resistant enterococcus spp	96	170	9.4	0.0	0.0	0.0	6.3	100.0
Ciprofloxacin/ofloxacin-resistant *Pseudomonas aeruginosa*	96	1262	52.4	0.0	40.0	59.0	75.0	100.0
Imipenem-resistant *P aeruginosa*	96	1947	36.6	0.0	0.0	27.3	52.4	100.0
Ceftazidime-reisistant *P aeruginosa*	96	1928	51.7	0.0	33.3	50.0	72.7	100.0
Piperacillin-resistant *P aeruginosa*	96	1124	50.8	0.0	36.4	58.8	75.0	100.0
Ceftazidime-resistant Enterobacter species	96	294	56.8	0.0	30.0	50.0	80.0	100.0
Carbapenem-resistant Enterobacter species	96	365	8.5	0.0	0.0	0.0	0.0	81.3
Ceftazidime-resistant *Klebsiella pneumoniae*	96	856	68.2	0.0	33.3	72.0	85.7	100.0
imipenem-resistant *K pneumoniae*	96	1001	2.7	0.0	0.0	0.0	2.10	100.0
Ceftazidime-resistant *Escherichia coli*	96	673	53.9	0.0	11.1	47.75	80.0	100.0
Ciprofloxacin/ofloxacin-resistant *E coli*	96	741	42.9	0.0	12.7	44.8	78.9	100.0

Ceph3, third-generation cephalosporin, cefotaxime, or ceftriaxone.

Table 10. Distribution of HH compliance rates by ICU type

Type of ICU	ICUs (n)	Opportunities for HH (n)	HH compliance (n)	Pooled mean compliance (%)	Percentile				
					10th	25th	50th, Median	75th	90th
Coronary ICU	6	12,066	7360	61	27.6	63.8	65.9	76.8	78.3
Medical ICU	4	8609	4564	53	33.8	53.7	75.5	83.8	90.0
Medical-surgical ICU	45	52,966	27,402	52	1.2	29.2	44.1	63.2	99.7
NICU	8	3397	2217	65	33.3	48.7	63.9	79.9	84.2
Neurosurgical ICU	2	2390	1649	69	27.2	27.2	50.6	74.0	74.0
Pediatric ICU	3	1515	851	56	48.2	48.2	61.7	65.8	65.8
Surgical ICU	4	4876	2398	49	5.2	24.3	43.8	67.0	90.0

HH, hand hygiene.

Table 11. 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 2002-2007 Pooled mean (interquartile range, 25%-75%)	US NHSN 2005-2006 Pooled mean (interquartile range, 25%-75%)
Coronary ICU		
CLAB	9.9 (0.0-11.8)	2.8 (0.0-4.2)
CAUTI	6.4 (0.0-13.3)	4.6 (2.8-5.5)
VAP	20.2 (7.3-33.2)	2.8 (0.0-4.5)
Medical-surgical ICU		
CLAB	8.9 (3.7-16.5)	2.4 (0.6-3.1)
CAUTI	6.6 (2.5-8.3)	3.4 (1.9-4.5)
VAP	19.8 (9.6-24.1)	3.6 (1.3-5.1)
Pediatric ICU		
CLAB	6.9 (7.9-19.2)	5.3 (1.1-6.5)
CAU	4.0 (0.0-3.3)	5.2 (0.0-6.0)
VAP	7.9 (3.0-14.2)	2.5 (0.0-2.8)
Newborn ICU (1501-2500 g)		
CLAB	15.2 (0.0-21.8)	4.2 (0.0-4.1)
VAP	6.68 (0.0-4.2)	1.1 (0.0-0.2)

INICC, International Nosocomial Infection Control Consortium; *NHSN*, US National Healthcare Safety Network.

first effort on surveillance of DAI in the ICU[1] because it addresses the health care setting with the most vulnerable patients and the heaviest exposure to invasive devices and highest rates of HAI.

Although device use in the consortium ICUs is similar or slightly lower than that reported from US ICUs in the NHSN system[10] we found that INICC rates of DAI are far higher (Table 11). Moreover, the proportions of *Staphylococcus aureus* isolates resistant to methicillin (MRSA), Enterobacteriaceae resistant to ceftriaxone, and *Pseudomonas aeruginosa* resistant to fluoroquinolones were also much higher in the consortium ICUs than in the NNIS ICUs (Table 12); in contrast, the proportion of enterococcal isolates resistant to vancomycin was considerably lower in the INICC ICUs.

The higher rates of DAI that appear to be representative of ICUs in developing countries[1,11-17] have many plausible explanations. Some have been previously mentioned in prior published reports from developing countries.[18] First, it has to be taken into account that most developing countries lack any legal framework or laws governing the establishment of infection control programs. Nevertheless, in the limited cases where such regulations exist, for example, in the form of national infection control guidelines, compliance is usually variable, at best. Moreover, hospital accreditation is not compulsory. Second, hand hygiene compliance in most health care facilities is also highly variable. Third, the great majority of hospitals in the developing countries receives limited financial or administrative support, which invariably results in very limited funds for infection control.[18,19] Fourth, nurse-to-patient staffing ratios in hospitals in developing countries are typically very low, as compared with hospitals in the developed countries; low nurse-to-patient staffing ratios have been shown to be powerful determinants of high DAI rates in ICUs.[20] These problems are compounded by overcrowding in most hospitals, few experienced nurses, and pressing shortages of other trained health care personnel and supplies.

Surveillance of HAIs—defining the magnitude and nature of the problem—is the first step toward reducing the risk of infection in vulnerable hospitalized patients.

Table 12. Comparison of antimicrobial resistance rates (%) in the ICUs of the International Nosocomial Infection Control Consortium and the US National Nosocomial Infections Surveillance System

Antimicrobial-resistant pathogen	Pooled mean (range) (interquartile range, 25%-75%) INICC 2002-2007	Pooled mean (range) (interquartile range, 25%-75%) US NNIS 1992-2004
Methicillin-resistant *Staphylococcus aureus* (MRSA)	80.8 (50.0-100.0)	52.9 (32.7-603)
Methicillin-resistant coagulase-negative staphylococci	75.2 (64.0-100.0)	76.6 (69.4-83.8)
Vancomycin-resistant enterococcus species	9.4 (0.0-6.3)	13.9 (5-24.3)
Ciprofloxacin/ofloxacin-resistant *Pseudomonas aeruginosa*	52.4 (40.0-75.0)	34.8 (17.4-41.3)
Imipenem-resistant *P aeruginosa*	36.6 (0.0-52.4)	19.1 (8.3-25.5)
Ceftazidime-reisistant *P aeruginosa*	51.7 (33.3-72.7)	13.9 (5-16.9)
Piperacillin-resistant *P aeruginosa*	50.8 (36.4-75.0)	17.50 (7.5-19.5)
Ceph3-resistant Enterobacter species	56.8 (30.8-80.0)	27.70 (17.4-36.4)
Carbapenem-resistant Enterobacter species	8.5 (0.0-0.0)	0.70 (0.0-0.0)
Ceph3-resistant *Klebsiella pneumoniae*	68.2 (33.3-85.7)	6.20 (0.0-8.0)
Ceph3-resistant *Escherichia coli*	53.9 (11.1-80.0)	1.3 (0.0-2.6)
Ciprofloxacin/ofloxacin-resistant *E coli*	42.6 (12.7-78.9)	7.30 (0.0-8.2)

The next step is to implement targeted basic infection control practices that have been shown to prevent HAIs. Increased awareness of the risks of DAI in the Consortium ICUs, which has been enormously enhanced by participation in the INICC,[1] is providing the impetus for instituting positive change: targeted performance feedback programs for hand hygiene and CVC, ventilator, and urinary catheter care have already reduced the incidence of ICU-acquired infections in many consortium hospitals.[21-25] Control of antibiotic resistance will mandate effective nosocomial infection control and more restrictive use of antiinfectives.[26]

If hospitals wish to compare their hospital's rates of HAI and DU ratios with those in this report, they must first collect information from their hospital in accordance with the methods described for the CDC NNIS and the INICC.[1-3,11-17] They should calculate infection rates and DU ratios for the device-associated module. Regarding interpretation of percentiles of infection rates or DU ratios, a high rate or ratio (>90th percentile) does not necessarily define a problem but suggests an area for further investigation. Similarly, a low rate or ratio (<10th percentile) may be the result of suboptimal surveillance. Hospitals should use these data to guide local prevention strategies and other quality improvement efforts aimed at reducing HAI rates as much as possible.

In summary, these data reaffirm that HAIs, especially DAIs in ICU patients, are a huge and largely unrecognized threat to patient safety in the developing world, a far greater threat than in the developed countries. We hope that the activities of the INICC, with efforts to implement simple and inexpensive measures for prevention far more consistently, will lead to wider acceptance of infection control practices and material reductions in DAIs, not only in the member hospitals of the Consortium but in the innumerable other hospitals of the developing world.

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Appendix. International Infection Control Consortium, listed by country alphabetically

Argentina: Sandra Guzmán, Maria del Carmen Alcaraz, Ariel Boglione, Oscar Migone (Bernal Medical Center, Buenos Aires). Juan Carlos Toledo (Colegiales Medical Center, Buenos Aires). Silvia Forciniti, Marcela Gilli, Marta Blasco, Lic. Carmen B. Lezcano (Pedro Fiorito Hospital, Buenos Aires). Daniel Sztokhamer (Estrada Medical Center, Buenos Aires). Beatriz Marta Alicia Di Núbila, Horacio Quevedo, Diana Lanzetta, Leonardo J. Fernández, Adriana Romani, Claudia Migazzi, Clarisa Barolin, Mónica Viegas (Presidente Perón Hospital, Buenos Aires). Luisa C. Soroka, Beatriz Santoro (Evita Hospital, Lanus, Buenos Aires). Carlos Esteban Lastra (Narciso López Hospital, Lanus, Buenos Aires). Luis Pedro Flynn, Diego Rausch, Alejandro Spagnolo (British Medical Center, Rosario). María Laura Frías, Griselda Churruarín (Lanús Private Hospital, Lanús, Buenos Aires). Alicia Kobylarz (Eduardo Oller Solano Pediatric and Maternity Hospital, Buenos Aires).

Brazil: Reinaldo Salomao, Sergio Blecher, Maria Ângela Maretti da Silva, Margarete Vilins, Eni Hilário da Silva (Santa Marcelina Hospital, Sao Paulo). Gorki Grinberg (Porto Alegre General Hospital, Santa Terezinha University, Porto Alegre and Sao Miguel Hospital, Joaçaba). Iselde Buchner Ferreira (Porto Alegre General Hospital, Porto Alegre). Simone Nouer, Rosa Vianna, Ana Lucia Machado, Elaine Gama, Doris Blanquet (Clementino Fraga Filho University Hospital-HUCFF, Rio de Janeiro). Jamile Leda Spessatto, Ricardo Scopel Pasini, Shaline Ferla (Santa Terezinha University Hospital, Porto Alegre). Bruna Boaria Zanandrea, Carolina Rohnkohl, Marcos Regalin (Sao Miguel Hospital, Joaçaba). Daniela Bicudo Angelieri (Hospital Sao Paulo, Sao Paulo).

Colombia: Claudia Linares (San Ignacio University Hospital, Pontificia Javeriana University, Bogota). Laline Osorio (Simón Bolivar ESE Hospital, Bogota). Wilmer Villamil Gómez, Guillermo Ruiz Vergara, Alberto Marrugo Pertuz (Santa María Medical Center, Sucre). Otto Sussmann (Clinica Nueva, and Palermo Private Hospital, Bogotá; Hospital Palermo, Bogota). Beatriz Eugenia

Mojica (Clinica Nueva, Bogota). Narda Olarte, Alberto Valderrama (El Tunal ESE Hospital, Bogota). Julio Garzón Agudelo (Videlmédica Hospital, Bogotá). Catherine Rojas, Humberto Beltran, Jerson Paez (Olaya Policlinic Center, Bogotá). María del Pilar Torres Navarrete (Palermo Private Hospital, Bogotá). María Eugenia Rodríguez Calderón (La Victoria Hospital, Bogotá). Marena Rodríguez Ferrer, Nayide Barahona Guzmán, Guillermo Sarmiento Villa, Alfredo Lagares Guzmán (Simón Bolívar University, Barranquilla).

Costa Rica: Juan Manuel Aragón Calzada, Gabriel Muñoz, Adela Ruiz Argüello (Clínica Bíblica Hospital, San José).

Cuba: Clara Morales Pérez (Joaquín Albarrán Domínguez Surgical Training Hospital, Havana).

El Salvador: Ana Concepción Bran de Casares, Lilian de Jesús Machuca (Benjamin Bloom National Children's Hospital, San Salvador).

India: Anil Karlekar, Pawan Kapoor, Mandakini Pawar, Naresh Trehan (Escorts Heart Institute & Research Centre, New Delhi). Subhash Kumar Todi, Prithwiraj Chakraborty, Sharmila Chatterjee (AMRI Hospitals, Kolkata). Camila Rodrigues, Ashit Hegde, Tanu Singhal (PD Hinduja National Hospital & Medical Research Centre, Mumbai). Murali Chakravarthy, Vivek Jawali, Nirmala Venkatachalam (Wockhardt Hospital & Heart Institute, Bangalore). Nagamani Sen, John Prakash Raj (Christian Medical College, Vellore). Samir Sahu, Damodar Bindhani (Kalinga Hospital, Bhubaneswar). Bala Ramachandran (KK Childs Trust Hospital, Chennai). S. Singh, R. Krishnakumar, Kavitha Ravindran (Amrita Institute of Medical Sciences & Research Center, Kochi). Sheila Nainan Myatra, J. V. Divatia, Rohini Kelkar, Sanjay Biswas, Hemesh Singhal, Sandhya Raut, Nilesh Mahale, Vinay Dhakate, Sulolochana Sampat (Tata Memorial Hospital, Mumbai). Ramachadran Gopinath, Nallagonda Ravindra (Nizam's Institute of Medical Sciences, Hyderabad).

Kosova: Nehat Baftiu, Gazmend Spahija (National Institute for Public Health of Kosova and Medical School, Prishtina University, Prishtina).

Lebanon: Nada Kanj-Sharara, Sidani Nisreen, Lamia Alamaddni Jurdi (American University of Beirut Medical Center, Beirut).

Macedonia: Tanja Anguseva, Vilma Ampova (Filip II Special Cardiosurgery Hospital, Skopje).

México: Martha Sobreyra Oropeza, María de la Paz Herrera Bravo (De la Mujer Hospital, México DF). Guillermo Franco, Javier Ruiz, Pablo Duarte (Mexico's General Hospital, Mexico DF). Héctor Torres Hernández, Amalia Chávez Gómez, Jaime Rivera Morales, Julian Enrique Valero Rodríguez (Irapuato General Hospital, Irapuato). Irma Pérez Serrato, Martha Sánchez López (La Celaya General Hospital, Celaya). Alberto Armas Ruiz, Campuzano, Jorge Mena Brito (La Raza Medical Center, México DF).

Morocco: Rédouane Abouqal, Amine Ali Zeggwagh, Khalid Abidi (Ibn Sina-Medical ICU, Rabat).

Nigeria: A. I. Dutse and Dr. Abdu lG. Habib (Aminu Kanu Teaching Hospital, Kano).

Perú: Rosa Rosales, Luis Isidro Castillo Bravo, María Linares Cáceres (Instituto Nacional de Enfermedades Neoplásicas-INEN, Lima). Eduardo Fernández Maldonado, Manuel Jesús Mayorga Espichan, Yudy Gamio Cárdenas (San Pablo Private Hospital, Lima). Alex Castañeda Sabogal, Luis Camacho Cosavalente, Teodoro Rodríguez, Iliana Paredes Goicochea (Victor Lazarte Echegaray-Essalud Hospital, Trujillo). Teodora Atencio Espinoza, Gerardo Jimenez Luna, Favio Sarmiento López (Pucallpa Regional Hospital, Pucallpa).

Philippines: Imelda Asetre-Luna, Catherine Yu (St. Luke's Medical Center, Quezon City). Regina Berba, Glenn Angelo S. Genuino, Rafael J. Consunji, Jacinto Blas V. Mantaring III (Philippine General Hospital, Manila).

Turkey: Asu Özgültekin, Güldem Turan, Nur Akgün (Haydarpasa Hospital, Istanbul). A. Nevzat Yalcin, Ozge Turhan, Sevim Keskin (Akdeniz University, Antalya). Özay Arıkan Akan, Melek Tulunay, Mehmet Oral, Necmettin Ünal (Ankara University School of Medicine Ibni-Sina Hospital, Ankara). Iftíhar Koksal, Gürdal Yýlmaz, A. C. Senel, Ebru Emel Sözen (Karadeniz Technical University School of Medicine, Trabzon). Nurettin Erben, Ilhan Ozgúnes, Gaye Usluer (Osmanganzi University, Eskisehir). Saban Esen, Fatma Ulger, Canan Aygun, Sukru Küçüködük (Ondokuz Mayis University Medical School, Samsun). Fatma Sirmatel, Mustafa Cengiz, Leyla Yilmaz (Harran University, Faculty of Medicine, Sanliurfa). Yesim Cetinkaya Sardan, Gonul Yildirim, Arzu Topeli (Hacettepe University School of Medicine, Ankara). Emine Alp, Bilgehan Aygen (Erciyes University, Faculty of Medicine, Kayseri). Davut Ozdemir, Nurse Selvi Erdogan (Duzce Medical School, Duzce). Sercan Ulusoy, Bilgin Arda, Feza Bacakoglu (Ege University Medical Faculty, Izmir). Huseyin Turgut, Suzan Sacar, Demet Ökke (Pamukkale University, Denizli). Recep Öztürk, Yalim Dikmen, Gökhan Aygún, (Istanbul University Cerrahpasa Medical School, Istanbul).

Uruguay: Alicia Ottonelli, Gonzalo De León (Paysandú Medical Corporation-COMEPA, Paysandú).