American Journal of Infection Control 000 (2021) 1–8

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major Article

International Nosocomial Infection Control Consortium (INICC) report, data summary of 45 countries for 2013-2018, Adult and Pediatric Units, Device-associated Module

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Funding: The funding for design, development, maintenance, technical support, data validation, and report generation of ISOS, and the activities carried out at INICC headquarters, were provided by the corresponding author, Victor D. Rosenthal and the INICC Foundation.

Author Contributions: All authors were involved in provision of study patients, critical revision of the manuscript for important intellectual content, and final approval of the manuscript. V.D.R. was responsible for study conception and design, drafting of the manuscript, software development, technical support, report generation, data validation, data assembly, data interpretation, epidemiologic and statistical analysis.

Conflicts of interest: All authors report no conflicts of interest related to this article. Every hospital's Institutional Review Board agreed to the study protocol, and patient confidentiality was protected by codifying the recorded information, making it only identifiable to the infection control team.

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https://doi.org/10.1016/j.ajic.2021.04.077

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Key Words:
Hospital infection
Nosocomial infection
Health care-associated infection
Device-associated infection
Bacterial resistance
Limited resources countries

Background: We report the results of INICC surveillance study from 2013 to 2018, in 664 intensive care units (ICUs) in 133 cities, of 45 countries, from Latin-America, Europe, Africa, Eastern-Mediterranean, Southeast-Asia, and Western-Pacific.

Methods: Prospective data from patients hospitalized in ICUs were collected through INICC Surveillance Online System. CDC-NHSN definitions for device-associated healthcare-associated infection (DA-HAI) were applied.

Results: We collected data from 428,847 patients, for an aggregate of 2,815,402 bed-days, 1,468,216 central line (CL)-days, 1,053,330 mechanical ventilator (MV)-days, 1,740,776 urinary catheter (UC)-days. We found 7,785 CL-associated bloodstream infections (CLAB), 12,085 ventilator-associated events (VAE), and 5,509 UC-associated urinary tract infections (CAUTI). Pooled DA-HAI rates were 5.91% and 9.01 DA-HAIs/1,000 bed-days. Pooled CLAB rate was 5.30/1,000 CL-days; VAE rate was 11.47/1,000 MV-days, and CAUTI rate was 3.16/1,000 UC-days. *P aeruginosa* was non-susceptible (NS) to imipenem in 52.72% of cases; to colistin in 10.38%; to ceftazidime in 50%; to ciprofloxacin in 40.28%; and to amikacin in 34.05%. *Klebsiella spp* was NS to imipenem in 49.16%; to ceftazidime in 78.01%; to ciprofloxacin in 66.26%; and to amikacin in 42.45%. *coagulase-negative Staphylococci* and *S aureus* were NS to oxacillin in 91.44% and 56.03%, respectively. *Enterococcus spp* was NS to vancomycin in 42.31% of the cases.

Conclusions: DA-HAI rates and bacterial resistance are high and continuous efforts are needed to reduce them.

The International Nosocomial Infection Control Consortium (INICC) is the first and biggest multinational healthcare-associated infection (HAI) research network established in 2002 for the surveillance and prevention of HAIs worldwide.[1] Its main goal includes the promotion of evidence-based infection prevention practices to reduce the incidence of HAIs and their associated mortality, bacterial resistance, excess length of stay (LOS) and costs.[2]

Over forty years ago, the US Centers for Disease Control and Prevention (CDC) published the first HAI rates report,[3] using standardized methods and definitions.[4,5]

INICC HAI rates reports have adopted CDC's definitions and criteria,[5,6] and obtained accurate, valid and comparative HAI rates from hospitals worldwide. According to standard CDC/NSHN methods,[5,6] HAI numerators and denominators are device days collected from all patients as pooled data, without specifying each patient's characteristics or the number of device days related to such patient. INICC surveillance is conducted through an online platform, the INICC Surveillance Online System (ISOS), which includes CDC methods, and adding the collection of specific data per patient from *all* patients, both with and without HAI, as well as their particular HAI risk factors, such as invasive devices, temperature, blood pressure, results of cultures, antibiotic therapy, LOS, costs, and mortality. Data of all patients admitted to the intensive care unit (ICU), whether infected or non-infected, allows their matching by several characteristics, serving to the purposes of estimating other adverse events associated to HAIs, such as excess LOS, mortality, cost, as well as the cost-effectiveness of interventions.[1,2] In addition, these data increase awareness among infection prevention professionals and sensitivity to detect HAIs, thus avoiding underreporting.[1,2]

This is a summary of the device-associated module data of events occurring from January 1st 2013 to December 31st 2018, and provides data on device-associated HAI rates (DA-HAI), device utilization ratio (DUR), bacterial resistance, LOS and mortality of patients with and without DA-HAI in adult and pediatric ICUs, which updates comparative rates previously published in 2006, 2008, 2010, 2012, 2014, 2016 and 2019.[7-13]

METHODS

The device-associated module data were collected using the ISOS platform,[2] which applies the latest CDC/NHSN criteria and reported methods for calculation of HAI rates and DUR ratios, and DA-HAI definitions that include laboratory and clinical criteria.[5,6]

Definitions of HAI used during surveillance were those published by CDC in 2008,[5] and their subsequent updates through 2017.[14]

Corresponding denominator data, patient days and specific device days were collected and validated. Detailed data by patient and aggregated data were used to calculate central line-associated bloodstream infections (CLAB), ventilator-associated events (VAE), and catheter-associated urinary tract infection (CAUTI) rates, DU ratio, microbiological profile, and bacterial resistance. LOS and mortality were calculated.

The INICC methods include validation of reported DA-HAIs, through which daily data collection of invasive devices are checked, for denominators, and the fulfillment of CDC/NHSN criteria of DA-HAIs in each case of DA-HAI are checked for numerators.[1,2]

Infection preventionists (IPs) collected data on DA-HAIs occurring in all patients admitted to the ICU.

Data of adult and pediatric ICUs were stratified by ICU type.

Data analysis

SPSS 16.0 (SPSS Inc. an IBM company, Chicago, Illinois) ISOS® (Buenos Aires, Argentina),[2] and EpiInfo® version 6.04b (CDC, Atlanta, GA) were used for data analysis. Relative risk (RR) ratios, 95% confidence intervals (CIs) and P-values were determined for primary and secondary outcomes. Data for ICUs were not stratified by type or size of hospital.

RESULTS

From January 1, 2013 to December 31, 2018, we conducted a cohort, prospective, multicenter surveillance study of DA-HAIs in 664 ICUs in 45 countries (Argentina, Bahrain, Brazil, Bulgaria, China, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Egypt, Greece, India, Iran, Jordan, Kingdom of Saudi Arabia, Kosovo, Kuwait, Lebanon, Lithuania, Macedonia, Malaysia, Mexico, Mongolia, Morocco, Nepal, Pakistan, Palestine, Panama, Papua New Guinea, Peru, Philippines, Poland, Romania, Russia, Serbia, Singapore, Slovakia, Sri Lanka, Thailand, Tunisia, Turkey, United Arab Emirates, Venezuela, and Vietnam) from Latin America, Africa, Europe, Eastern Mediterranean, South East Asia, and Western Pacific WHO regions, currently participating in INICC.

Out of all 224 hospitals, 53 (23.6%) were academic, 85 (37.9%) were public and the remaining 87 (38.8%) were private.

Out of all 664 ICUs, 31 (4.6%) were surgical cardiothoracic; 57 (8.5%) were medical cardiac; 120 (18.0%) were medical; 201 (30.2%) were medical surgical; 42 (6.3%) were neuro surgical; 23 (3.4%) were neurologic; 9 (1.3%) were oncology; 73 (10.9%) were pediatric; 23 (3.4%) were respiratory, 64 (9.6%) were surgical; and 21 (3.1%) were trauma.

The identity of patients and hospitals are kept confidential.

The length of participation of hospitals in INICC ranged from 3 to 72 months (mean, 10, SD 17.2).

Table 1 shows DA-HAI rates by infection type of adult and pediatric patients with CLAB, CAUTI, and VAE.

Table 2 shows DURs from adult, and pediatric ICUs.

Table 3 provides data on crude ICU mortality and crude LOS in adult and pediatric patients hospitalized during the surveillance period, without DA-HAI and with CLAB, CAUTI, and VAE.

Table 4 provides data on bacterial resistance of pathogens isolated from patients with DA-HAI in adult and pediatric ICUs.

Table 5 show bacterial resistance found in INICC ICUs compared with US CDC NHSN ICUs.

DISCUSSION

Although device use in INICC ICUs was similar to that reported from CDC-NHSN ICUs, DA-HAI rates were higher in the INICC ICUs. In the INICC ICUs, the pooled central line-associated bloodstream infection rate was higher (5.30 vs 0.8 per 1,000 central line-days); the ventilator-associated events rate was also higher (11.47 vs 6.96 per 1,000 ventilator-days,) as was the rate of catheter-associated urinary tract infection (3.16 vs 0.91 per 1,000 catheter-days).[15]

In the INICC network, all CLs used by patients are measured. If the patient has 2 CLs simultaneously, both CLs are measured, and both are computed. In consequence, in the cardiothoracic surgery unit, the DUR of CL appears to be larger than 1, since there is a higher number of CL-days than bed-days. This network has adopted this small modification, as it has been shown that when a patient has 2 CLs simultaneously rather than 1 CL, the risk of CLAB increases.[16,17]

As shown in Table 3, the acquisition of 1 HAI increases mortality approximately 2 to 3 times. However, if the patient presents 3 HAIs simultaneously, mortality increases more significantly, reaching over 63%. The length of stay is also increased 3 times when HAI is present. Nevertheless, this investigation has not specifically analyzed whether this prolongation of stay was before or after acquiring HAI, therefore, it cannot be confirmed whether it is the cause or the consequence. Other publications pairing patients for similar characteristics have shown that HAI effectively increases both mortality and length of stay.[18-20]

As shown in Table 5, whereas the resistance rates found in the INICC ICUs for *Acinetobacter spp* to imipenem, *Enterobacter spp* to imipenem and to cefepime, *Pseudomonas aeruginosa* to piperacillin tazobactam, to imipenem, to ceftazidime, to ciprofloxacin and to amikacin were higher to the percentages found by CDC's NHSN. Resistance rates found in *Staphylococcus aureus* to oxacillin, and *Enterococcus faecalis* to vancomycin was similar in INICC and CDC NHSN; and resistance rate found in *Enterococcus faecium* to vancomycin was higher in CDC NHSN compared to INICC.[21]

Such higher DA-HAI rates and bacterial resistance in INICC data, compared to the US CDC's NHSN report, may be representative of the burden of DA-HAIs in other countries, particularly in resource-limited ones. There are different underlying reasons that can explain this adverse situation,[22,23] such as lower rates of compliance with the guidelines, low nurse-to-patient staffing ratios, over-crowding in ICUs, insufficient medical supplies, outdated technology, and lack of trained and experienced healthcare workers.[22,23]

In addition, HAI rates have also been connected to the type of hospital ownership (Public, Academic, and Private), and the country socioeconomic level.[24,25] Moreover, it has been reported in the literature that there is a correlation between a lower infection risk and a higher country socio-economic level.[24,25]

Benchmarks have long played a key role in aiding researchers to have standardized, comparable surveillance measures, and so benchmarking US CDC NHSN ICU data on DA-HAIs with international data has served as a fundamental tool for prevention of HAIs worldwide.[2] The INICC started conducting prospective, standardized HAI surveillance in 1998,[1,2] and was inspired in the former National Nosocomial Infections Surveillance (NNIS) system,[3] and thereafter, in the United States. CDC's NHSN reporting methods to provide unbiased, reliable, and comparable benchmarking data.[15,21]

The similar socio-economic condition of the participating hospitals from Africa, Latin America, Eastern Mediterranean, Europe, South East Asia, and Western Pacific allows for an adequate comparison and benchmarking tool for HAI rates with analogous socio-economic situations. In those hospitals with limited-resources or insufficient availability of experienced IPs, the comparison with US CDC-NHSN's ICUs may not be valid. [9-11] Through the publication of the different INICC reports since 2006,[7-13] we have observed that, despite INICC ICUs have higher DA-HAI rates in comparison with US CDC-NHSN's ICUs, there has been a trend towards their reduction through the implementation of the INICC Multidimensional Approach (IMA) and the INICC Surveillance Online System (ISOS), which includes: bundles of DA-HAI prevention practice interventions; education; outcome surveillance of CLAB, VAE, CAUTI and SSI rates, process surveillance for hand hygiene practice, insertion and maintenance of central and peripheral lines, and mechanical ventilator, urinary catheter and surgical site care; and feedback on DA-HAI rates and performance.[26-42]

Table 1
Pooled means, 95% confidence intervals of the distribution of central line-associated BSI rates, ventilator-associated event rates, and urinary catheter-associated UTI rates, by type of location, in adult and pediatric intensive care units, DA module, 2013-2018

Central line-associated BSI rate							
Type of ICU	N° of ICUs	No of patients	No of CLABs	Central line days	Pooled mean	95% CI	
Surgical cardiothoracic	31	17,667	132	62,265	2.12	1.77	2.51
Medical cardiac	57	30,773	120	45,656	2.63	2.17	3.14
Medical	120	34,660	790	120,049	6.58	6.13	7.05
Medical/Surgical	201	251,361	4,140	929,319	4.45	4.32	4.59
Neuro surgical	42	10,603	102	34,390	2.97	2.41	3.60
Neurologic	23	13,989	157	17,529	8.96	7.61	10.47
Oncology	9	1,999	61	6,835	8.92	6.82	11.46
Pediatric	73	38,899	1,716	153,084	11.21	10.69	11.75
Respiratory	23	2,980	55	19,501	2.82	2.12	3.67
Surgical	64	24,870	437	74,614	5.86	5.32	6.43
Trauma	21	1,046	75	4,974	15.08	11.86	18.90
Pooled ICUs	664	372,588	7,785	1,468,216	5.30	5.18	5.42

Ventilator-associated events rate							
Type of ICU	N° of ICUs	No ofpatients	No. ofVAEs	Ventilatordays	Pooled mean	95% CI	
Surgical cardiothoracic	31	17,667	180	23,948	7.52	6.45	8.69
Medical cardiac	57	30,773	237	22,407	10.58	9.27	12.01
Medical	120	34,660	1,036	85,257	12.15	11.42	12.91
Medical/Surgical	201	251,361	7,524	676,116	11.13	10.88	11.38
Neuro surgical	42	10,603	296	25,001	11.84	10.53	13.27
Neurologic	23	13,989	189	17,472	10.82	9.33	12.47
Oncology	9	1,999	25	4,076	6.13	3.96	9.05
Pediatric	73	38,899	1,959	125,502	15.61	14.93	16.32
Respiratory	23	2,980	126	16,372	7.70	6.41	9.16
Surgical	64	24,870	380	52,518	7.24	6.52	8.00
Trauma	21	1,046	133	4,661	28.53	23.89	33.82
Pooled ICUs	664	372,588	12,085	1,053,330	11.47	11.27	11.68

Urinary catheter-associated UTI rate							
Type of ICU	N° of ICUs	No ofpatients	No. ofCAUTIs	Urinary catheter days	Pooledmean	95% CI	
Surgical cardiothoracic	31	17,667	75	44,312	1.69	1.33	2.12
Medical cardiac	57	30,773	153	42,653	3.59	3.04	4.20
Medical	120	34,660	542	147,914	3.66	3.36	3.98
Medical/Surgical	201	251,361	3,507	1,182,771	2.97	2.86	3.06
Neuro Surgical	42	10,603	284	62,131	4.57	4.05	5.13
Neurologic	23	13,989	171	36,043	4.74	4.06	5.51
Oncology	9	1,999	21	8,928	2.35	1.45	3.59
Pediatric	73	38,899	360	87,359	4.12	3.70	4.56
Respiratory	23	2,980	108	23,362	4.62	3.79	5.58
Surgical	64	24,870	253	97,110	2.61	2.29	2.94
Trauma	21	1,046	35	8,193	4.27	2.97	5.94
Pooled ICUs	664	372,588	5,509	1,740,776	3.16	3.08	3.24

BSI, bloodstream infection; CAUTI, catheter-associated urinary tract infection; CI, confidence interval; CL, central line; CLAB, central-line associated bloodstream infection; DA, device-associated; ICU, intensive care unit; NICU, Neonatal intensive care unit; VAE, ventilator-associated event.

INICC's main objective is to tackle the HAI burden effectively and systematically worldwide by facilitating education, training, and basic and cost-effective tools and resources.[1,2]

Study limitations

Firstly, the purpose of this report is to obtain updated data on epidemiology of HAIs in worldwide. However, it does not provide insights regarding the impact of INICC interventions, such as the implementation of IMA and ISOS.[1,2] The impact of the adoption of such resources is published in prospective, interventional studies at hospitals that have participated in INICC during a considerable amount of years.[26-42] Another factor that prevents determining INICC involvement in the effectiveness in reducing HAIs and bacterial resistance is that hospitals are added to this network on a daily basis, and these hospitals have no previous experience in surveillance and prevention of HAIs, and consequently, their HAIs rates and bacterial resistance frequently are extremely high when they join this network. This is a cohort study, and therefore, new hospitals with the aforementioned characteristics have been added weekly over the last 20 years.

Furthermore, this study is not representative of all hospitals in the world, nor of all hospitals in a given country or continent, as it is a surveillance system to which hospitals that wish to participate join voluntarily. It is likely that the hospitals that decide to participate are those that have a better quality program, and surveillance and prevention of HAIs. Therefore, it is also likely that the rates of HAI and antimicrobial resistance of bacteria shown in this study are lower than the actual rates found worldwide.

Moreover, considering that the quality of microbiology laboratories depends on the resources of each institution, it is likely that the data does not have a homogeneous quality.

Table 2
Pooled means, 95% confidence intervals of the distribution of central line utilization ratios, ventilator utilization ratios, and of urinary catheter utilization ratios, by type of location, in adult and pediatric intensive care units, DA module, 2013-2018

Central line utilization ratio						
Type of ICU	N° of ICUs	Patient days	Central line days	Pooled mean	95% CI	
Surgical cardiothoracic	31	61,513	62,265	1.012	1.000	1.020
Medical cardiac	57	145,134	45,656	0.315	0.311	0.317
Medical	120	214,869	120,049	0.559	0.555	0.561
Medical/Surgical	201	1,768,918	929,319	0.525	0.524	0.526
Neuro surgical	42	107,282	3,439	0.032	0.030	0.033
Neurologic	23	88,772	17,529	0.197	0.194	0.200
Oncology	9	10,233	6,835	0.668	0.652	0.684
Pediatric	73	265,054	153,084	0.578	0.574	0.580
Respiratory	23	26,427	19,501	0.738	0.727	0.748
Surgical	64	116,934	74,614	0.638	0.633	0.642
Trauma	21	10,266	4,974	0.485	0.471	0.498
Pooled ICUs	664	2,815,402	1,437,265	0.511	0.519	0.523
Ventilator utilization ratio						
Type of ICU	N° of ICUs	Patient days	Ventilator days	Pooled mean	95% CI	
Surgical cardiothoracic	31	61,513	23,948	0.389	0.384	0.394
Medical cardiac	57	145,134	22,407	0.154	0.152	0.156
Medical	120	214,869	85,257	0.397	0.394	0.399
Medical/Surgical	201	1,768,918	676,116	0.382	0.381	0.383
Neuro surgical	42	107,282	25,001	0.233	0.230	0.235
Neurologic	23	88,772	17,472	0.197	0.193	0.199
Oncology	9	10,233	4,076	0.398	0.386	0.410
Pediatric	73	265,054	125,502	0.473	0.470	0.476
Respiratory	23	26,427	16,372	0.620	0.610	0.629
Surgical	64	116,934	52,518	0.449	0.445	0.453
Trauma	21	10,266	4,661	0.454	0.441	0.467
Pooled ICUs	664	2,815,402	1,053,330	0.374	0.372	0.376
Urinary catheter utilization ratio						
Type of ICU	N° of ICUs	Patient days	Urinary catheter days	Pooled mean	95% CI	
Surgical cardiothoracic	31	61,513	44,312	0.720	0.713	0.727
Medical cardiac	57	145,134	42,653	0.294	0.291	0.296
Medical	120	214,869	147,914	0.688	0.684	0.691
Medical/Surgical	201	1,768,918	1,182,771	0.669	0.665	0.673
Neuro surgical	42	107,282	62,131	0.579	0.574	0.583
Neurologic	23	88,772	36,043	0.406	0.401	0.410
Oncology	9	10,233	8,928	0.872	0.854	0.890
Pediatric	73	265,054	87,359	0.330	0.327	0.331
Respiratory	23	26,427	23,362	0.884	0.872	0.895
Surgical	64	116,934	9,711	0.083	0.081	0.084
Trauma	21	10,266	8,193	0.798	0.780	0.815
Pooled ICUs	664	2,815,402	1,653,377	0.587	0.581	0.592

CI, confidence interval; ICU, intensive care unit.

Table 3
Pooled means of the distribution of crude mortality and length of stay of intensive care unit patients with device-associated health care-associated infections in adult and pediatric intensive care units combined, DA module, 2013-2018

	No. ofPatients, n	No. ofDeaths, n	Pooled crudeMortality, % (95% CI)	LOS,Total Days, n	Pooled crudeAverage LOS, days, (95% CI)
Patients without DA-HAI	172,916	29,608	17.12 % (16.93-17.32)	1,395,908	8.07 (8.01-8.10)
Patients with CAUTI	1,844	556	30.15 % (27.70-32.77)	39,061	21.18 (20.97-21.39)
Patients with VAE	5,432	2,299	42.32 % (40.61-44.09)	117,355	21.60 (21.48-21.72)
Patients with CLAB	2,595	1,251	48.21 % (45.57-50.96)	53,493	20.61 (20.44-20.78)
Patients with VAE + CAUTI	628	271	43.15 % (38.17-48.61)	23,054	36.71 (36.23-37.18)
Patients with CLAB + CAUTI	361	170	47.09 % (40.28-54.73)	12,976	35.94 (35.32-36.56)
Patients with CLAB + VAE	1042	528	50.67 % (46.44-55.18)	31,925	30.64 (30.30-30.96)
Patients with CLAB + VAE + CAUTI	413	262	63.44 % (55.99-71.60)	19,994	48.41 (47.74-49.08)

CAUTI, catheter-associated urinary tract infection; CI, confidence interval; CLAB, central line-associated bloodstream infection; DA, device-associated; DA-HAI, device-associated healthcare-associated infection; LOS, length of stay; RR, relative risk; VAE, ventilator-associated event.

Finally, as mentioned in the discussion, in order to accurately determine the attributable extra mortality and extra length of due HAIs, patients with similar characteristics should be paired, and this pairing is not present in this report. For this reason, attributable extra mortality and length of stay are instead referred to as 'crude extra stay' and 'crude extra mortality.

Table 4
Percentage of pathogens reported from adult and pediatric healthcare-associated infections in intensive care units of acute-care hospitals, that tested non-susceptible to selected antimicrobial agents, 2013-2018

Pathogen	*No. of tested, n*	Non Susceptible to Selected Antimicrobial Agents, (%)									
		TZP	IPM	CST	CRO	CAZ	FEP	CIP	AMK	OXA	VAN
Acinetobacter spp	3,814	93.45	91.54	3.27	97.08	93.17	94.25	93.54	83.06	-	-
Burkholderia cepacia	110	91.67	88.46	80.95	88.89	19.30	71.43	76.92	86.67	-	-
Citrobacter freundii	99	36.07	17.65	14.29	70.00	56.86	40.38	50.00	26.09	-	-
Enterobacter spp	600	35.64	20.54	12.17	39.69	53.03	31.73	24.10	17.72	-	-
Escherichia coli	1,477	42.86	17.36	6.38	73.81	68.29	65.78	61.54	16.67	-	-
Klebsiella spp	3,286	64.62	49.16	13.68	74.17	78.01	76.48	66.26	45.25	-	-
Proteus spp	330	16.05	17.39	79.59	43.24	45.60	46.05	48.68	22.22	-	-
Pseudomonas aeruginosa	2,556	49.13	52.72	10.38	90.86	50.00	51.27	40.28	34.05	-	-
Serratia spp	264	30.33	24.11	91.18	38.46	38.89	41.41	22.39	16.47	-	-
Stenotrophomonas maltophilia	332	65.63	91.84	36.67	100.00	56.76	77.27	42.31	67.31		
coagulase-negative Staphylococci	723	-	-	-	80.36	70.00	73.33	75.60	36.26	91.44	1.50
Staphylococcus aureus	1,199	-	-	-	69.17	62.16	60.00	48.47	40.16	56.03	3.55
Enteroccocus spp	194	63.16	-	-	-	-	-	87.23	84.09	100.00	42.31
Enterococcus faecalis	288	50.00	-	-	-	-	-	61.31	50.00	100.00	8.59
Enterococcus faecium	195	100.00	-	-	-	-	-	86.76	66.67	100.00	29.20

AMK, amikacin; CAZ, ceftazidime; CIP, ciprofloxacin; CRO, ceftriaxone; CST, colistin; FEP, cefepime; IPM, imipenem; OXA, oxacillin; NS, non susceptible; TZP, piperacillin-tazobactam; VAN, vancomycin.

Table 5
Benchmark INICC data vs US CDC NHSN data**,** of percentage of pathogens reported from adult and pediatric healthcare-associated infections in intensive care units of acute-care hospitals, that tested non-susceptible to selected antimicrobial agents

Pathogen	Antimicrobial	INICC, 2013-2018, NS (%)	CDC NHSN, 2015-2017, NS (%)
Acinetobacter spp	IPM	91.54	43.2
Enterobacter spp	IPM	20.54	6.2
	FEP	31.73	11.4
Pseudomonas aeruginosa	TZP	49.13	15.0
	IPM	52.72	20.7
	CAZ	50.00	20.3
	CIP	40.28	26.2
	AMK	34.05	14.4
Staphylococcus aureus	OXA	56.03	48.4
Enterococcus faecalis	VAN	8.59	7.2
Enterococcus faecium	VAN	29.20	82.1

AMK, amikacin; CAZ, ceftazidime; CIP, ciprofloxacin; FEP, cefepime; IPM, imipenem; NS, non susceptible; OXA, oxacillin; TZP, piperacillin-tazobactam; VAN, vancomycin.

ACKNOWLEDGMENTS

The authors thank the many healthcare professionals who assisted with the conduct of surveillance in their hospital, the INICC Advisory Board, Country Directors and Secretaries (Safaa Abdul Aziz AlKhawaja, Amani Ali El-Kholy, Vineya Rai, Souha S. Kanj, Yatin Mehta, Sheila Nainan Myatra, Bijie Hu, Lul Raka, Najiba M Abdulrazzaq, Nguyen Viet Hung, Wing Hong Seto, Anucha Apisarnthanarak, Toshihiro Mitsuda, Syed Sattar, William Rutala, William R. Jarvis, Russell N. Olmsted, Carla J. Alvarado, Dennis Maki, Nicholas Graves, and Patricia Lynch), who have so generously supported this unique international infection control network.

References

1. Rosenthal VD, Maki DG, Graves N. The International Nosocomial Infection Control Consortium (INICC): goals and objectives, description of surveillance methods, and operational activities. *Am J Infect Control*. 2008;36:e1–12.
2. Rosenthal VD. International Nosocomial Infection Control Consortium (INICC) resources: INICC multidimensional approach and INICC surveillance online system. *Am J Infect Control*. 2016;44:e81–e90.
3. Reported nosocomial infections, NNIS hospitals, 1975. *Natl Nosocomial Infect Study Rep*. 1977:1–7.
4. *CDC/NHSN surveillance definition of health care-associated infection and criteria for specific types of infections in the acute care setting*. 2019.. Available at: http://www.cdc.gov/nhsn/. Accessed April 30, 2019.
5. Horan TC, Andrus M, Dudeck MA. CDC/NHSN surveillance definition of health care-associated infection and criteria for specific types of infections in the acute care setting. *Am J Infect Control*. 2008;36:309–332.
6. Emori TG, Culver DH, Horan TC, et al. National nosocomial infections surveillance system (NNIS): description of surveillance methods. *Am J Infect Control*. 1991;19:19–35.
7. Rosenthal VD, Maki DG, Salomao R, et al. Device-associated nosocomial infections in 55 intensive care units of 8 developing countries. *Ann Intern Med*. 2006;145:582–591.
8. Rosenthal VD, Maki DG, Mehta A, et al. International Nosocomial Infection Control Consortium report, data summary for 2002-2007, issued January 2008. *Am J Infect Control*. 2008;36:627–637.
9. Rosenthal VD, Maki DG, Jamulitrat S, et al. International Nosocomial Infection Control Consortium (INICC) report, data summary for 2003-2008, issued June 2009. *Am J Infect Control*. 2010;38:95-104 e2.
10. Rosenthal VD, Bijie H, Maki DG, et al. International Nosocomial Infection Control Consortium (INICC) report, data summary of 36 countries, for 2004-2009. *Am J Infect Control*. 2012;40:396–407.
11. Rosenthal VD, Maki DG, Mehta Y, et al. International Nosocomial Infection Control Consortium (INICC) report, data summary of 43 countries for 2007-2012. Device-associated module. *Am J Infect Control*. 2014;42:942–956.
12. Rosenthal VD, Al-Abdely HM, El-Kholy AA, et al. International Nosocomial Infection Control Consortium report, data summary of 50 countries for 2010-2015: Device-associated module. *Am J Infect Control*. 2016;44:1495–1504.
13. Rosenthal VD, Bat-Erdene I, Gupta D, et al. International Nosocomial Infection Control Consortium (INICC) report, data summary of 45 countries for 2012-2017: Device-associated module. *Am J Infect Control*. 2019.
14. Wright MO, Allen-Bridson K, Hebden JN, et al. Assessment of the accuracy and consistency in the application of standardized surveillance definitions: A summary of the American Journal of Infection Control and National Healthcare Safety Network case studies, 2010-2016. *Am J Infect Control*. 2017;45:607–611.

15. CDC-NHSN. The 2019 National and State Healthcare-Associated Infections (HAI) Progress Report. Available at: https://www.cdc.gov/nhsn/datastat/index.html. Accessed February 17, 2021.
16. Couk J, Chernetsky Tejedor S, Steinberg JP, Robichaux C, Jacob JT. Impact of multiple concurrent central lines on central-line-associated bloodstream infection rates. *Infect Control Hosp Epidemiol*. 2019;40:1019–1023.
17. Dube WC, Jacob JT, Zheng Z, et al. Comparison of rates of central line-associated bloodstream infections in patients with 1 vs 2 central venous catheters. *JAMA Netw Open*. 2020;3: e200396.
18. Rosenthal VD, Guzman S, Migone O, Crnich CJ. The attributable cost, length of hospital stay, and mortality of central line-associated bloodstream infection in intensive care departments in Argentina: a prospective, matched analysis. *Am J Infect Control*. 2003;31:475–480.
19. Higuera F, Rangel-Frausto M, Rosenthal VD, et al. The attributable cost, and length of hospital stay of central line associated blood stream infection in intensive care units in mexico. a prospective, Matched Analysis. In: *Proceedings and Abstracts of the 15th Annual Scientific Meeting of the Society for Healthcare Epidemiology of America*. 2005 April 9-12; Los Angeles, California, United States of America; 2005104.
20. Rosenthal VD, Guzman S, Migone O, Safdar N. The attributable cost and length of hospital stay because of nosocomial pneumonia in intensive care units in 3 hospitals in Argentina: a prospective, matched analysis. *Am J Infect Control*. 2005;33:157–161.
21. Weiner-Lastinger LM, Abner S, Edwards JR, et al. Antimicrobial-resistant pathogens associated with adult healthcare-associated infections: Summary of data reported to the National Healthcare Safety Network, 2015-2017. *Infect Control Hosp Epidemiol*. 2020;41:1–18.
22. Lynch P, Rosenthal VD, Borg MA, Eremin SR. Infection Control in Developing Countries. Jarvis WR, ed. Infection Control in Developing Countries. *Bennett and Brachman's hospital infections*. 2007:255.
23. Rosenthal VD. Health-care-associated infections in developing countries. *Lancet*. 2011;377:186–188.
24. Rosenthal VD, Lynch P, Jarvis WR, et al. Socioeconomic impact on device-associated infections in limited-resource neonatal intensive care units: findings of the INICC. *Infection*. 2011;39:439–450.
25. Rosenthal VD, Jarvis WR, Jamulitrat S, et al. International Nosocomial Infection Control Members. Socioeconomic impact on device-associated infections in pediatric intensive care units of 16 limited-resource countries: International Nosocomial Infection Control Consortium findings. *Pediatr Crit Care Med*. 2012;13:399—406.
26. Rosenthal VD, Desse J, Maurizi DM, et al. Impact of the International Nosocomial Infection Control Consortium's multidimensional approach on rates of ventilator-associated pneumonia in 14 intensive care units in 11 hospitals of 5 cities within Argentina. *Am J Infect Control*. 2018;6553:31290–31297.
27. Rosenthal VD, Desse J, Maurizi DM, et al. Impact of the International Nosocomial Infection Control Consortium (INICC)'s Multidimensional approach on rates of central line-associated bloodstream infection in 14 intensive care units in 11 hospitals of 5 cities in Argentina. *Infect Control Hosp Epidemiol*. 2018;12:1–7.
28. Al-Abdely HM, Khidir Mohammed Y, Rosenthal VD, et al. Impact of the International Nosocomial Infection Control Consortium (INICC)'s multidimensional approach on rates of ventilator-associated pneumonia in intensive care units in 22 hospitals of 14 cities of the Kingdom of Saudi Arabia. *J Infect Public Health*. 2018;11:677–684.
29. Al-Mousa HH, Omar AA, Rosenthal VD, et al. Impact of the International Nosocomial Infection Control Consortium (INICC) multidimensional approach on rates of ventilator-associated pneumonia in intensive care units of two hospitals in Kuwait. *J Infect Prev*. 2018;19:168–176.
30. Al-Abdely HM, Alshehri AD, Rosenthal VD. Prospective multicenter Study in Intensive Care Units in 5 cities from Kingdom of Saudi Arabia: impact of the International Nosocomial Infection Control Consortium (INICC) multidimensional approach on rates of central line associated bloodstream infection. *J Infect Prev*. 2017;18:25–34.
31. Rosenthal VD, Duenas L, Sobreyra-Oropeza M, et al. Findings of the International Nosocomial Infection Control Consortium (INICC), part III: effectiveness of a multidimensional infection control approach to reduce central line-associated bloodstream infections in the neonatal intensive care units of 4 developing countries. *Infect Control Hosp Epidemiol*. 2013;34:229–237.
32. Mehta Y, Jaggi N, Rosenthal VD, et al. Effectiveness of a multidimensional approach for prevention of ventilator-associated pneumonia in 21 adult intensive-care units from 10 cities in India: findings of the International Nosocomial Infection Control Consortium (INICC). *Epidemiol Infect*. 2013;141:2483–2491.
33. Leblebicioglu H, Yalcin AN, Rosenthal VD, et al. Effectiveness of a multidimensional approach for prevention of ventilator-associated pneumonia in 11 adult intensive care units from 10 cities of Turkey: findings of the International Nosocomial Infection Control Consortium (INICC). *Infection*. 2013;41:447–456.
34. Leblebicioglu H, Ozturk R, Rosenthal VD, et al. Impact of a multidimensional infection control approach on central line-associated bloodstream infections rates in adult intensive care units of 8 cities of Turkey: findings of the International Nosocomial Infection Control Consortium (INICC). *Ann Clin Microbiol Antimicrob*. 2013;12:10.
35. Leblebicioglu H, Ersoz G, Rosenthal VD, et al. Impact of a multidimensional infection control approach on catheter-associated urinary tract infection rates in adult intensive care units in 10 cities of Turkey: International Nosocomial Infection Control Consortium findings (INICC). *Am J Infect Control*. 2013;41:885–891.
36. Jaggi N, Rodrigues C, Rosenthal VD, et al. Impact of an international nosocomial infection control consortium multidimensional approach on central line-associated bloodstream infection rates in adult intensive care units in eight cities in India. *Int J Infect Dis*. 2013;17:e1218–e1224.
37. Rosenthal VD, Todi SK, Alvarez-Moreno C, et al. Impact of a multidimensional infection control strategy on catheter-associated urinary tract infection rates in the adult intensive care units of 15 developing countries: findings of the International Nosocomial Infection Control Consortium (INICC). *Infection*. 2012;40: 517–526.
38. Rosenthal VD, Rodriguez-Calderon ME, Rodriguez-Ferrer M, et al. Findings of the International Nosocomial Infection Control Consortium (INICC), Part II: Impact of a multidimensional strategy to reduce ventilator-associated pneumonia in neonatal intensive care units in 10 developing countries. *Infect Control Hosp Epidemiol*. 2012;33:704–710.
39. Rosenthal VD, Rodrigues C, Alvarez-Moreno C, et al. Effectiveness of a multidimensional approach for prevention of ventilator-associated pneumonia in adult intensive care units from 14 developing countries of four continents: findings of the International Nosocomial Infection Control Consortium. *Crit Care Med*. 2012;40:3121–3128.
40. Rosenthal VD, Ramachandran B, Villamil-Gomez W, et al. Impact of a multidimensional infection control strategy on central line-associated bloodstream infection rates in pediatric intensive care units of five developing countries: findings of the International Nosocomial Infection Control Consortium (INICC). *Infection*. 2012;40:415–423.
41. Rosenthal VD, Ramachandran B, Duenas L, et al. Findings of the International Nosocomial Infection Control Consortium (INICC), Part I: Effectiveness of a multidimensional infection control approach on catheter-associated urinary tract infection rates in pediatric intensive care units of 6 developing countries. *Infect Control Hosp Epidemiol*. 2012;33:696–703.
42. Rosenthal VD, Maki DG, Rodrigues C, et al. Impact of International Nosocomial Infection Control Consortium (INICC) strategy on central line-associated bloodstream infection rates in the intensive care units of 15 developing countries. *Infect Control Hosp Epidemiol*. 2010;31:1264–1272.