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Major article

International Nosocomial Infection Control Consortiu (INICC) report, data summary of 43 countries for 2007-2012. Device-associated module

Víctor Daniel Rosenthal MD, MSc, CIC [a,*], Dennis George Maki MD [b], Yatin Mehta MD [c], Hakan Leblebicioglu MD [d], Ziad Ahmed Memish MD [e], Haifaa Hassan Al-Mousa MD [f], Hanan Balkhy MD [g], Bijie Hu MD [h], Carlos Alvarez-Moreno MD [i], Eduardo Alexandrino Medeiros MD [j], Anucha Apisarnthanarak MD [k], Lul Raka MD [l], Luis E. Cuellar MD [m], Altaf Ahmed MD [n], Josephine Anne Navoa-Ng MD [o], Amani Ali El-Kholy MD [p], Souha Sami Kanj MD [q], Ider Bat-Erdene MD [r], Wieslawa Duszynska MD [s], Nguyen Van Truong MD [t], Leonardo N. Pazmino MD [u], Lucy Chai See-Lum MD [v], Rosalia Fernández-Hidalgo RN [w], Gabriela Di-Silvestre MD [x], Farid Zand MD [y], Sona Hlinkova MD [z], Vladislav Belskiy MD [aa], Hussain Al-Rahma MD [bb], Marco Tulio Luque-Torres MD [cc], Nesil Bayraktar MD [dd], Zan Mitrev MD [ee], Vaidotas Gurskis MD [ff], Dale Fisher MD [gg], Ilham Bulos Abu-Khader MD [hh], Kamal Berechid MD [ii], Arnaldo Rodríguez-Sánchez MD [jj], Florin George Horhat MD [kk], Osiel Requejo-Pino MD [ll], Nassya Hadjieva MD [mm], Nejla Ben-Jaballah MD [nn], Elías García-Mayorca MD [oo], Luis Kushner-Dávalos MD [pp], Srdjan Pasic MD [qq], Luis E. Pedrozo-Ortiz MD [rr], Eleni Apostolopoulou MD [ss], Nepomuceno Mejía MD [tt], May Osman Gamar-Elanbya MD [uu], Kushlani Jayatilleke MD [vv], Miriam de Lourdes-Dueñas MD [ww], Guadalupe Aguirre-Avalos MD [xx]

[a] *International Nosocomial Infection Control Consortium, Buenos Aires, Argentina*
[b] *University of Wisconsin, Madison, WI*
[c] *Medanta The Medicity, New Delhi, India*
[d] *Ondokuz Mayis University, Samsun, Turkey*
[e] *Ministry of Health, Riyadh, Kingdom of Saudi Arabia*
[f] *Ministry of Health, City of Kuwait, Kuwait*
[g] *King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia*
[h] *Zhongshan Hospital, Fudan University, Shanghai, China*
[i] *Universidad Nacional de Colombia, Clínica Universitaria Colombia, Bogotá, Colombia*
[j] *Hospital Sao Paulo, Sao Paulo, Brazil*
[k] *Thammasat University Hospital, Pratumthani, Thailand*
[l] *National Institute for Public Health of Kosova and Medical School, Prishtina University, Prishtina, Kosova*
[m] *Instituto Nacional de Enfermedades Neoplásicas, Lima, Peru*
[n] *The Indus Hospital, Karachi, Pakistan*
[o] *St Luke's Medical Center, Manila, Philippines*
[p] *Children Hospital Cairo University Abu el Reesh, Cairo, Egypt*
[q] *American University of Beirut Medical Center, Beirut, Lebanon*
[r] *Central State Hospital 1, Ulaanbaatar, Mongolia*
[s] *Wroclaw University Hospital, Wroclaw, Poland*
[t] *Hung Vuong Hospital, Ho Chi Minh, Vietnam*
[u] *Hospital Eugenio Espejo, Hospital de los Valles, Quito, Ecuador*
[v] *University Malaya Medical Centre, Kuala Lumpur, Malaysia*
[w] *Hospital Clínica Bíblica, San Jose, Costa Rica*

[*] Address correspondence to Victor Daniel Rosenthal, MD, MSc, CIC, International Nosocomial Infection Control Consortium, Corrientes Ave #4580, Fl 12, Apt D, Buenos Aires, 1195, Argentina.
E-mail address: victor_rosenthal@inicc.org (V.D. Rosenthal).

For a list of all the members of the International Nosocomial Infection Control Consortium and all the coauthors of this study, see the Appendix.

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[x] Hospital de Clínicas Caracas, Caracas, Venezuela
[y] Nemazee Hospital, Shiraz University of Medical Sciences, Shiraz, Iran
[z] Faculty of Health Central Military Hospital Ruzomberok, Catholic University in Ruzomberok, Ružomberok, Slovakia
[aa] Privolzhskiy District Medical Center, Nizhniy Novgorod, Russia
[bb] Dubai Hospital, Dubai, United Arab Emirates
[cc] Hospital de especialidades del Instituto Hondureño de Seguridad Social, Tegucigalpa, Honduras
[dd] Burhan Nalbantoğlu Devlet Hastanesi, Nicosia, Cyprus
[ee] Special Hospital for Surgical Diseases Filip Vtori, Skopje, Macedonia
[ff] Hospital of Lithuanian University of Health Sciences Kauno Klinikos, Kaunas, Lithuania
[gg] National University Hospital, Singapore, Republic of Singapore
[hh] Jordan University Hospital, Amman, Jordan
[ii] Ibn Sina, Rabat, Morocco
[jj] Hospital Episcopal San Lucas Guayama, Guayama, Puerto Rico
[kk] University of Medicine and Pharmacy "Victor Babes" Clinical County Hospital, Timisoara, Romania
[ll] Hospital Universitario Gral. Calixto García, Havana, Cuba
[mm] University Hospital "Queen Giovanna-ISUL", Sofia, Bulgaria
[nn] Hôpital d'Enfants, Tunis, Tunisia
[oo] Hospital Santo Tomás, Panama, Panama
[pp] Caja de Salud de la Banca Privada Reg. La Paz, La Paz, Bolivia
[qq] Institute for Mother Child Health Care "Vukan Čupić", Belgrade, Serbia
[rr] Hospital Regional Salto, Salto, Uruguay
[ss] Sotiria, Athens, Greece
[tt] Hospital General de la Plaza de la Salud, Santo Domingo, Dominican Republic
[uu] Royal Care International Hospital, Khartoum, Sudan
[vv] Sri Jayewardenepura General Hospital, Nugegoda, Sri Lanka
[ww] Hospital Nacional de Niños Benjamin Bloom, San Salvador, El Salvador
[xx] Hospital Civil de Guadalajara Fray Antonio Alcalde, Unidad de Terapia Intensiva de Adultos, Guadalajara, Mexico

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Central line–associated bloodstream infections
Bloodstream infection
Urinary tract infection
Developing countries
Limited resources countries
Low income countries
Network

We report the results of an International Nosocomial Infection Control Consortium (INICC) surveillance study from January 2007-December 2012 in 503 intensive care units (ICUs) in Latin America, Asia, Africa, and Europe. During the 6-year study using the Centers for Disease Control and Prevention's (CDC) U.S. National Healthcare Safety Network (NHSN) definitions for device-associated health care–associated infection (DA-HAI), we collected prospective data from 605,310 patients hospitalized in the INICC's ICUs for an aggregate of 3,338,396 days. Although device utilization in the INICC's ICUs was similar to that reported from ICUs in the U.S. in the CDC's NHSN, rates of device-associated nosocomial infection were higher in the ICUs of the INICC hospitals: the pooled rate of central line–associated bloodstream infection in the INICC's ICUs, 4.9 per 1,000 central line days, is nearly 5-fold higher than the 0.9 per 1,000 central line days reported from comparable U.S. ICUs. The overall rate of ventilator-associated pneumonia was also higher (16.8 vs 1.1 per 1,000 ventilator days) as was the rate of catheter-associated urinary tract infection (5.5 vs 1.3 per 1,000 catheter days). Frequencies of resistance of *Pseudomonas* isolates to amikacin (42.8% vs 10%) and imipenem (42.4% vs 26.1%) and *Klebsiella pneumoniae* isolates to ceftazidime (71.2% vs 28.8%) and imipenem (19.6% vs 12.8%) were also higher in the INICC's ICUs compared with the ICUs of the CDC's NHSN.

This report is a summary of device-associated (DA) module data collected by hospitals participating in the International Nosocomial Infection Control Consortium (INICC) for events occurring from January 2007-December 2012 and reported to the INICC by December 31, 2013. This report updates previously published DA module data from the INICC and provides contemporary, comparative rates.[1-5]

The INICC is an international nonprofit, open, multicenter, collaborative health care–associated infection control program with a surveillance system based on that of the U.S. Center for Diseases Control and Prevention's (CDC) National Healthcare Safety Network (NHSN). Founded in Argentina in 1998, the INICC is the first multinational surveillance and research network established to measure, control, and reduce health care–associated infections (HAIs) through the analysis of data collected on a voluntary basis by a pool of hospitals worldwide. The INICC has the following goals: to create a dynamic global network of hospitals worldwide, which conduct surveillance on HAIs using standardized definitions and established methodologies, promote implementation of evidence-based infection control practices, and carry out applied infection control research; to provide training and surveillance tools to individual hospitals, which can allow them to conduct outcome and process surveillance of HAIs, measure their consequences, and assess the impact of infection control practices[6-22]; and to improve the safety and quality of health care worldwide through the implementation of systematized programs to reduce rates of HAI, associated mortality, excess lengths of stay (LOSs), excess costs, antibiotic use, and bacterial resistance.[23-32] In 2013, the INICC switched to an online database platform, which is currently in use in 300 cities in 62 countries for data collection, data analysis, and report generation.

METHODS

Study setting and design

From January 2007-December 2012, we conducted a cohort prospective multicenter surveillance study of device-associated

health care–acquired infections (DA-HAIs) in 503 intensive care units (ICUs) in 43 countries from Latin America, Asia, Africa, and Europe currently participating in the INICC. The mean length of participation of hospitals in the INICC program ± SD is 19.5 ± 17.7 months (range, 1-72 months).

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

INICC's surveillance program

The INICC has focused on surveillance and prevention of DA-HAIs in adult ICUs, pediatric ICUs, high-risk nurseries, general wards, and surveillance of surgical site infections (SSIs).[1-5] The data are collected using standardized protocols from the CDC's NHSN and definitions that include laboratory and clinical criteria.[33,34]

The INICC has both outcome surveillance and process surveillance components. The modules of the components may be used singly or simultaneously. However, once selected, they must be used for a minimum of 1 calendar month.[34]

Within the outcome surveillance component, data are classified into specific module protocols addressing the following: HAI rates, excess LOS, evaluation of HAI costs, crude excess mortality, microbiological profile, bacterial resistance, and antimicrobial use data. Antimicrobial use, HAI cost, and SSI rates were not included in this report.

There were 263 hospitals with previous experience in surveillance of DA-HAIs who sent detailed data by patient (49%) and aggregated data (51%) to the INICC. Detailed data by patient and aggregated data were used to calculate DA-HAI rates. Only detailed data by patient were used to calculate mortality and LOS.

In addition, the methodology of the INICC includes a process for adjudication and validation of reported HAIs.[34]

Infection control professionals collect data on central line–associated primary bloodstream infections (CLABSIs), catheter-associated urinary tract infections (CAUTIs), ventilator-associated pneumonias (VAPs), and SSIs occurring in patients hospitalized in a specific patient care location in nearly all hospitals. For surveillance of DA-HAIs, ICUs are stratified according to the patient population: different types of adult ICUs, pediatric ICUs, or neonatal intensive care units (NICUs).

All NICUs are level III or level II and III units, and infection control professionals collect data on CLABSIs and umbilical catheter-associated primary bloodstream infections or VAPs for each of 5 birth-weight categories (<750, 750-1,000, 1,001-1,500, 1,501-2,500, >2,500 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 vascular catheter care compliance monitoring, urinary catheter care compliance monitoring, monitoring of compliance with measures to prevent VAP, monitoring of compliance with measures to prevent SSI, and performance feedback. Data from the process surveillance compliance are not included in this report.

Data analysis

Data for ICUs were not stratified by type or size of hospital. For NICUs, device days consist of the total number of central line days, umbilical catheter days, and ventilator days. The data for NICUs were stratified by weight. Device days consisted of the total number of central line days, urinary catheter days, or ventilator days. Crude excess mortality of HAI equals the crude mortality of ICU patients with HAI minus the crude mortality of patients without HAI. Crude excess LOS of HAI equals the crude LOS of ICU patients with HAI minus the crude LOS of patients without HAI.

Table 1
International Nosocomial Infection Control Consortium facilities contributing data used in this report

Details	Africa	America	Asia	Europe	Overall
ICUs, type					
Medical	1	5	54	9	69
Medical cardiac	0	8	21	4	33
Medical and surgical	5	64	61	21	151
Neurologic	0	0	4	2	6
Neurosurgical	0	2	21	3	26
Pediatric	2	22	24	9	57
Respiratory	1	3	17	3	24
Surgical	1	5	46	8	60
Surgical cardiothoracic	0	0	28	3	31
Trauma	0	1	7	0	8
Neonatal	3	17	12	6	38
Total ICUs, n (%)	13 (3)	127 (25)	295 (59)	68 (14)	503 (100)
Hospitals, n (%)					
Academic teaching	6 (6)	24 (23)	46 (44)	29 (28)	105 (100)
Public	2 (2)	31 (37)	47 (57)	3 (4)	83 (100)
Private community	1 (1)	32 (43)	40 (53)	2 (3)	75 (100)
Total hospitals, n (%)	9 (3)	87 (33)	133 (51)	34 (13)	263 (100)

ICU, intensive care unit.

Comparisons of the percentile distribution were made if there were at least 20 locations contributing to the strata. SPSS version 16.0 (SPSS Inc, Chicago, IL) and EpiInfo 6.04b (Centers for Disease Control and Prevention, Atlanta, GA) were used to conduct data analysis. Relative risk ratios, 95% confidence intervals (CIs), and *P* values were determined for primary and secondary outcomes.

RESULTS

Characteristics of 503 ICUs that contributed data for this report are shown in Table 1. For the outcome surveillance component, DA-HAI rates, device utilization (DU) ratios, crude excess mortality by specific type of DA-HAI, and bacterial resistance for January 2007-December 2012 are summarized in Tables 2-15. Tables 2-7 show DA-HAI rates and DU ratios by infection type (CLABSI, CAUTI, VAP) in adult and pediatric ICUs. Tables 8-11 show DA-HAI rates and DU ratios from the high-risk nursery component of the INICC system for CLABSIs and VAP. The overall rate of CLABSI per 1,000 central line days in the adult and pediatric ICUs was 4.78 (95% CI, 4.7-4.9) and 5.17 (95% CI, 4.5-5.9) in the NICUs. The overall rate of VAP per 1,000 mechanical ventilator days was 14.7 (95% CI, 14.5-14.9) in the adult and pediatric ICUs and 9.54 (95% CI, 8.5-10.7) in the NICUs. The overall CAUTI rate per 1,000 catheter days was 5.30 (95% CI, 5.2-5.4) in the adult and pediatric ICUs. (Tables 2, 4, 6, 8, 10). Table 12 provides data on crude ICU mortality and crude LOS in patients hospitalized in each type of unit during the surveillance period, with and without DA-HAI, and crude excess mortality and crude excess LOS of adult and pediatric patients with CLABSI, CAUTI, and VAP and infants in NICUs with CLABSI or VAP. Table 13 provides data on bacterial resistance of pathogens isolated from patients with DA-HAI in adult and pediatric ICUs and NICUs and compares these rates with the ICUs of the CDC's NHSN. Table 14 compares overall rates of CLABSI, CAUTI, and VAP in the INICC's ICUs and the ICUs of the CDC's NHSN. Table 15 compares the results of the 5 different biennial INICC reports published from 2006-2014.

DISCUSSION

The effectiveness of implementing an integrated infection control program focused on HAI surveillance was demonstrated around 30 years ago as shown in the many studies conducted in the U.S., whose results reported not only that the incidence of HAI can

Table 2
Pooled means, 95% CIs, and key percentiles of the distribution of laboratory-confirmed CLABSI rates by type of location in adult and pediatric ICUs for the device-associated module, 2007-2012

Type of ICU	No. of ICUs	No. of patients	No. of CLABSI	CL days	Pooled mean CLABSI rate	95% CI	Percentile				
							10%	25%	50%	75%	90%
Medical	69	84,642	1,043	225,427	4.63	4.4-4.9	0.0	0.0	2.55	7.27	18.04
Medical cardiac	33	42,054	312	89,998	3.47	3.1-3.9	0.0	0.0	1.97	3.97	8.26
Medical and surgical	151	285,654	3,990	809,754	4.93	4.8-5.1	0.0	0.86	3.31	7.90	17.01
Neurologic	6	6,060	85	13,329	6.38	5.1-7.9	NA	NA	NA	NA	NA
Neurosurgical	26	12,217	111	31,893	3.48	2.9-4.2	0.0	0.0	0.0	1.86	7.32
Pediatric	57	41,474	776	127,825	6.07	5.7-6.5	0.0	0.7	4.99	10.67	25.4
Respiratory	24	5,779	225	38,843	5.79	5.1-6.6	0.0	0.0	2.51	8.78	19.5
Surgical	60	75,041	1,214	212,885	5.70	5.4-6.0	0.0	0.0	2.41	6.81	18.02
Surgical cardiothoracic	31	31,468	87	85,554	1.02	0.8-1.3	0.0	0.0	0.0	1.10	3.2
Trauma	8	4,648	44	15,393	2.86	2.1-3.8	NA	NA	NA	NA	NA
Pooled	465	589,037	7,887	1,650,901	4.78	4.7-4.9	0.0	0.0	2.46	6.77	15.6

CI, confidence interval; *CL*, central line; *CLABSI*, central line–associated bloodstream infection; *ICU*, intensive care unit; *NA*, not applicable.

Table 3
Pooled means, 95% CIs, and key percentiles of the distribution of CL utilization ratios by type of location in adult and pediatric ICUs for the device-associated module, 2007-2012

Type of ICU	No. of ICUs	CL days	Patient days	Pooled mean DUR	95% CI	Percentile				
						10%	25%	50%	75%	90%
Medical	69	225,427	481,037	0.47	0.47-0.47	0.23	0.33	0.53	0.79	1.00
Medical cardiac	33	89,998	154,625	0.58	0.58-0.58	0.11	0.35	0.55	0.85	1.00
Medical and surgical	151	809,754	1,488,318	0.54	0.54-0.54	0.21	0.42	0.59	0.83	1.00
Neurologic	6	13,329	41,254	0.32	0.32-0.33	NA	NA	NA	NA	NA
Neurosurgical	26	31,893	76,423	0.42	0.41-0.42	0.18	0.39	0.50	0.88	1.00
Pediatric	57	127,825	254,549	0.50	0.50-0.50	0.11	0.25	0.42	0.66	0.89
Respiratory	24	38,843	70,331	0.55	0.55-0.56	0.26	0.49	0.63	0.93	1.00
Surgical	60	212,885	422,365	0.50	0.50-0.51	0.34	0.42	0.61	0.76	0.91
Surgical cardiothoracic	31	85,554	122,525	0.70	0.70-0.70	0.34	0.45	0.73	0.93	1.00
Trauma	8	15,393	25,672	0.60	0.59-0.61	NA	NA	NA	NA	NA
Pooled	465	1,650,901	3,137,099	0.53	0.53-0.53	0.21	0.38	0.56	0.81	1.00

CI, confidence interval; *CL*, central line; *DUR*, device use ratio; *ICU*, intensive care unit; *NA*, not applicable.

Table 4
Pooled means, 95% CIs, and key percentiles of the distribution of CAUTI rates by type of location in adult and pediatric ICUs for the device-associated module, 2007-2012

Type of ICU	No. of ICUs	No. of patients	No. of CAUTIs	UC days	Pooled mean CAUTI rate	95% CI	Percentile				
							10%	25%	50%	75%	90%
Medical	69	84,642	1,530	342,724	4.46	4.2-4.7	0.00	0.00	2.07	7.19	14.00
Medical cardiac	33	42,054	506	86,410	5.86	5.4-6.4	0.00	0.00	0.64	3.35	10.96
Medical and surgical	151	285,654	4,914	921,015	5.34	5.2-5.5	0.00	1.11	3.08	7.74	14.29
Neurologic	6	6,060	583	36,463	15.99	14.7-17.3	NA	NA	NA	NA	NA
Neurosurgical	26	12,217	422	59,480	7.09	6.4-7.8	0.00	0.00	0.00	5.16	14.90
Pediatric	57	41,474	447	79,832	5.60	5.1-6.1	0.00	0.00	2.28	6.83	11.97
Respiratory	24	5,779	369	39,556	9.33	8.4-10.3	0.00	0.00	7.15	18.15	22.99
Surgical	60	75,041	1,333	283,415	4.70	4.5-5.0	0.00	0.00	2.04	5.88	11.54
Surgical cardiothoracic	31	31,468	103	79,865	1.29	1.1-1.6	0.00	0.00	0.00	0.64	4.4
Trauma	8	4,648	115	18,890	6.09	5.0-7.3	NA	NA	NA	NA	NA
Pooled	465	589,037	10,322	1,947,650	5.30	5.2-5.4	0.00	0.00	2.29	6.86	13.9

CAUTI, catheter-associated urinary tract infection; *CI*, confidence interval; *ICU*, intensive care unit; *NA*, not applicable; *UC*, urinary catheter.

be reduced by as much as 30% but that a related reduction in health care costs was also feasible.[35] For >30 years, the CDC's National Nosocomial Infections Surveillance System and NHSN network has provided benchmarking U.S. ICU data on DA-HAIs and antibiotic resistance, which have proven invaluable for researchers[36] and served as an inspiration to the INICC program. Initially, the INICC's surveillance concentrated on DA-HAI surveillance in the ICU: a health care setting with the highest DA-HAI rates in which patients' safety is most seriously threatened because of their critical condition and exposure to invasive devices; however, since 2006, it also focuses on SSI surveillance.[34]

The DU ratio constitutes an extrinsic risk factor for DA-HAI[37] and is also a marker for the severity of illness of patients and vis-à-vis patients' susceptibility to DA-HAI.[37] However, our findings show that although the rate of device use in the INICC's ICUs is analogous or even lower to the one reported in the ICUs of the CDC's NHSN system, DA-HAI rates identified in the INICC's ICUs are higher than the published U.S. rates (Table 14).[38] Likewise, the antimicrobial resistance rates found in the INICC's ICUs for *Staphylococcus aureus* isolates resistant to methicillin; *Enterococcus faecalis* resistant to vancomycin; *Klebsiella pneumoniae* resistant to ceftriaxone, ceftazidime, imipenem, and meropenem; *Pseudomonas aeruginosa* resistant to piperacillin and tazobactam, amikacin, and cefepime; and *Escherichia coli* resistant to ceftriaxone, ceftazidime, imipenem, meropenem, and ertapenem were higher than the NHSN's rates (Table 13).[39] Nonetheless, the rates found in the INICC's ICUs for

Table 5
Pooled means, 95% CIs, and key percentiles of the distribution of UC utilization ratios by type of location in adult and pediatric ICUs for the device-associated module, 2007-2012

Type of ICU	No. of ICUs	UC days	Patient days	Pooled mean DUR	95% CI	Percentile				
						10%	25%	50%	75%	90%
Medical	69	342,724	481,037	0.71	0.71-0.72	0.31	0.49	0.74	0.90	0.98
Medical cardiac	33	86,410	154,625	0.56	0.56-0.56	0.23	0.44	0.64	0.74	0.96
Medical and surgical	151	921,015	1,488,318	0.62	0.62-0.62	0.35	0.54	0.73	0.90	0.99
Neurologic	6	36,463	41,254	0.88	0.88-0.89	NA	NA	NA	NA	NA
Neurosurgical	26	59,480	76,423	0.78	0.78-0.78	0.34	0.61	0.85	0.97	1.00
Pediatric	57	79,832	254,549	0.31	0.31-0.32	0.07	0.15	0.32	0.48	0.61
Respiratory	24	39,556	70,331	0.56	0.56-0.57	0.22	0.52	0.66	0.87	0.96
Surgical	60	283,415	422,365	0.67	0.67-0.67	0.37	0.68	0.82	0.93	1.00
Surgical cardiothoracic	31	79,865	122,525	0.65	0.65-0.65	0.38	0.52	0.77	0.93	1.00
Trauma	8	18,890	25,672	0.74	0.73-0.74	NA	NA	NA	NA	NA
Pooled	465	1,947,650	3,137,099	0.62	0.62-0.62	0.24	0.47	0.72	0.90	0.99

CI, confidence interval; *DUR*, device use ratio; *ICU*, intensive care unit; *NA*, not applicable; *UC*, urinary catheter.

Table 6
Pooled means, 95% CIs, and key percentiles of the distribution of VAP rates by type of location in adult and pediatric ICUs for the device-associated module, 2007-2012

Type of ICU	No. of ICUs	No. of patients	No. of VAP	Ventilator days	Pooled mean VAP rate	95% CI	Percentile				
							10%	25%	50%	75%	90%
Medical	69	84,642	2,794	225,750	12.4	11.9-12.8	0.00	3.24	10.16	27.9	38.52
Medical cardiac	33	42,054	519	45,276	11.5	10.5-12.5	0.00	0.00	7.39	13.68	26.72
Medical and surgical	151	285,654	8,832	536,024	16.5	16.1-16.8	0.00	5.93	12.23	24.94	39.27
Neurologic	6	6,060	193	9,674	20.0	17.2-23.0	NA	NA	NA	NA	NA
Neurosurgical	26	12,217	472	22,683	20.8	19.0-22.8	0.00	0.00	4.66	25.63	119.8
Pediatric	57	41,474	1,060	134,560	7.9	7.4-8.4	0.00	1.23	6.06	13.43	20.74
Respiratory	24	5,779	773	33,895	22.8	21.2-24.5	0.00	0.00	16.33	35.23	62.99
Surgical	60	75,041	2,156	138,034	15.6	15.0-16.3	0.00	3.47	15.19	30.43	44.16
Surgical cardiothoracic	31	31,468	410	38,414	10.7	9.7-11.8	0.00	0.00	2.03	32.84	52.41
Trauma	8	4,648	396	13,371	29.6	26.8-32.7	NA	NA	NA	NA	NA
Pooled	465	589,037	17,605	1,197,681	14.7	14.5-14.9	0.00	2.48	10.67	23.74	40.01

CI, confidence interval; *ICU*, intensive care unit; *NA*, not applicable; *VAP*, ventilator-associated pneumonia.

Table 7
Pooled means, 95% CIs, and key percentiles of the distribution of ventilator utilization ratios by type of location in adult and pediatric ICUs for the device-associated module, 2007-2012

Type of ICU	No. of ICUs	Ventilator days	Patient days	Pooled mean DUR	95% CI	Percentile				
						10%	25%	50%	75%	90%
Medical	69	225,750	481,037	0.47	0.47-0.47	0.08	0.21	0.42	0.69	0.94
Medical cardiac	33	45,276	154,625	0.29	0.29-0.30	0.05	0.14	0.32	0.43	0.51
Medical and surgical	151	536,024	1,488,318	0.36	0.36-0.36	0.14	0.27	0.45	0.62	0.80
Neurologic	6	9,674	41,254	0.23	0.23-0.24	NA	NA	NA	NA	NA
Neurosurgical	26	22,683	76,423	0.30	0.29-0.30	0.02	0.15	0.30	0.49	0.76
Pediatric	57	134,560	254,549	0.53	0.53-0.53	0.10	0.30	0.47	0.61	0.74
Respiratory	24	33,895	70,331	0.48	0.48-0.49	0.14	0.35	0.45	0.73	0.84
Surgical	60	138,034	422,365	0.33	0.33-0.33	0.05	0.13	0.34	0.52	0.71
Surgical cardiothoracic	31	38,414	122,525	0.31	0.31-0.32	0.00	0.05	0.22	0.46	0.64
Trauma	8	13,371	25,672	0.52	0.51-0.53	NA	NA	NA	NA	NA
Pooled	465	1,197,681	3,137,099	0.38	0.38-0.38	0.21	0.38	0.57	0.82	1.00

CI, confidence interval; *DUR*, device use ratio; *ICU*, intensive care unit; *NA*, not applicable.

Table 8
Pooled means, 95% CIs, and key percentiles of the distribution of CLABSI rates for level III neonatal ICUs for the device-associated module, 2007-2012

Birth weight category, kg	No. of ICUs	No. of patients	No. of CLABSI	Central line days	Pooled mean CLABSI rate	95% CI	Percentile				
							10%	25%	50%	75%	90%
<0.750	17	268	7	1,744	4.01	1.6-8.3	0.0	0.0	0.0	8.3	33.3
0.750-1.000	31	1,295	60	8,493	7.06	5.4-9.1	0.0	0.0	0.0	8.9	23.0
1.001-1.500	36	2,408	65	12,435	5.23	4.0-6.7	0.0	0.0	0.0	11.3	28.5
1.501-2.500	37	5,849	67	13,923	4.81	3.7-6.1	0.0	0.0	3.8	11.6	35.9
>2.500	37	6,453	45	10,563	4.26	3.1-5.7	0.0	0.0	0.0	8.0	17.7
Pooled	38	16,273	244	47,158	5.17	4.5-5.9	0.0	0.0	0.0	9.5	25.0

CI, confidence interval; *CLASBI*, central line–associated bloodstream infection; *ICU*, intensive care unit.

Acinetobacter baumannii resistance to imipenem and meropenem are similar to the rates of the ICUs of the NHSN.[39]

Such higher DA-HAI rates, in comparison with the U.S. CDC-NHSN report, may reflect the typical hospital situation in other countries worldwide as a whole.[40] Several reasons have been exposed to explain this fact.[41,42] Among the primary plausible causes, in some countries, there are still no legally enforceable regulations for the implementation of infection control programs (eg, national infection

Table 9
Pooled means, 95% CIs, and key percentiles of the distribution of CL utilization ratios for level III neonatal ICUs for the device-associated module, 2007-2012

						Percentile				
Birth weight category, kg	No. of ICUs	CL days	Patient days	Pooled mean DUR	95% CI	10%	25%	50%	75%	90%
<0.750	17	1,744	4,496	0.39	0.37-0.40	0.00	0.00	0.33	0.81	1.02
0.750-1.000	31	8,493	23,847	0.36	0.35-0.36	0.00	0.09	0.38	0.66	1.00
1.001-1.500	36	12,435	46,880	0.27	0.26-0.27	0.00	0.05	0.21	0.43	0.94
1.501-2.500	37	13,923	67,030	0.21	0.20-0.21	0.00	0.05	0.13	0.46	0.84
>2.500	37	10,563	59,044	0.18	0.18-0.18	0.01	0.07	0.13	0.43	0.74
Pooled	38	47,158	201,297	0.23	0.23-0.24	0.00	0.05	0.17	0.55	0.93

CI, confidence interval; *CL*, central line; *DUR*, device use ratio; *ICU*, intensive care unit.

Table 10
Pooled means, 95% CIs, and key percentiles of the distribution of VAP rates for level III neonatal ICUs for the device-associated module, 2007-2012

							Percentile				
Birth weight category, kg	No. of ICUs	No. of patients	No. of VAP	Ventilator days	Pooled mean VAP rate	95% CI	10%	25%	50%	75%	90%
<0.750	17	268	10	2,057	4.86	2.3-8.9	0.0	0.0	0.0	2.1	11.1
0.750-1.000	31	1,295	56	6,398	8.75	6.6-11.4	0.0	0.0	1.2	14.6	30.0
1.001-1.500	36	2,408	47	5,523	8.51	6.3-11.3	0.0	0.0	0.0	9.5	20.9
1.501-2.500	37	5,849	74	6,915	10.70	8.4-13.4	0.0	0.0	0.0	7.2	23.1
>2.500	37	6,453	95	8,681	10.94	8.9-13.4	0.0	0.0	0.0	8.8	20.0
Pooled	38	16,273	282	29,574	9.54	8.5-10.7	0.0	0.0	0.0	9.3	19.0

CI, confidence interval; *ICU*, intensive care unit; *VAP*, ventilator-associated pneumonia.

Table 11
Pooled means, 95% CIs, and key percentiles of the distribution of ventilator utilization ratios for level III neonatal ICUs for the device-associated module, 2007-2012

						Percentile				
Birth weight category, kg	No. of ICUs	Ventilator days	Patient days	Pooled mean DUR	95% CI	10%	25%	50%	75%	90%
<0.750	17	2,057	4,496	0.46	0.44-0.47	0.00	0.09	0.47	0.77	1.00
0.750-1.000	31	6,398	23,847	0.27	0.26-0.27	0.00	0.08	0.22	0.49	0.90
1.001-1.500	36	5,523	46,880	0.12	0.11-0.12	0.00	0.07	0.12	0.21	0.38
1.501-2.500	37	6,915	67,030	0.10	0.10-0.11	0.00	0.03	0.10	0.23	0.48
>2.500	37	8,681	59,044	0.15	0.14-0.15	0.01	0.06	0.11	0.32	0.37
Pooled	38	29,574	201,297	0.15	0.15-0.15	0.00	0.06	0.13	0.36	0.63

CI, confidence interval; *DUR*, device use ratio; *ICU*, intensive care unit.

Table 12
Pooled means of the distribution of crude mortality, crude excess mortality, LOS, and crude excess LOS of ICU patients with and without DA-HAI in adult and pediatric ICUs combined and infants in level III neonatal ICUs for the device-associated module, 2007-2012

ICU Patients	No. of deaths	No. of patients	Pooled crude mortality, %	Pooled crude extra mortality, %, RR (95% CI), *P* value	LOS, total days	Pooled average LOS, days, (95% CI)	Pooled average extra LOS, days
Adult and pediatric patients without DA-HAI	10,237	129,518	7.9	NA	790,579	6.10, (6.07-6.13)	NA
Infants at level III neonatal ICUs without DA-HAI	464	7,447	6.2	NA	80,080	10.75, (10.53-10.99)	NA
Adult and pediatric patients with CLABSI	301	1,209	24.9	17.0, 3.15 (2.8-3.5), .001	23,543	19.47, (18.44-20.59)	13.37
Infants at level III neonatal ICUs with CLABSI	9	51	17.6	11.4, 2.83 (1.46-5.48), .012	1,184	23.22, (17.78-31.03)	12.46
Adult and pediatric patients with VAP	821	3,513	23.4	15.5, 2.96 (2.7-3.2), .001	69,066	19.66, (19.04-20.31)	13.56
Infants at level III neonatal ICUs with VAP	35	178	19.7	13.4, 3.16 (2.24-4.45), .001	6,378	35.83, (31.01-41.67)	25.08
Adult and pediatric patients with CAUTI	160	1,202	13.3	5.4, 1.68 (1.4-1.9), .001	24,384	20.29, (19.23-21.46)	14.18

CAUTI, catheter-associated urinary tract infection; *CI*, confidence interval; *CLABSI*, central line–associated bloodstream infection; *DA-HAI*, device-associated health care–associated infection; *LOS*, length of stay; *NA*, not applicable; *RR*, relative risk; *VAP*, ventilator-associated pneumonia.

control guidelines); however, if there is a legal framework, adherence to and compliance with the guidelines can be irregular, and hospital accreditation is not mandatory in some countries. It is especially risky in cases with extremely low nurse-to-patient staffing ratios, which have proved to be highly connected to high HAI rates, hospital overcrowding, lack of medical supplies, and in an insufficient number of experienced nurses or trained health care workers.[41,42] Of the hospitals that participated in this study, 29% are private institutions that enjoy accreditation and sufficient administrative and financial support to fund infection control programs (eg, INICC's multidimensional approach).[43-53]

There has recently been much progress in health care in most countries, where new technologies have been introduced and official regulations support infection control programs.[43-53] This

Table 13
Antimicrobial resistance rates in the ICUs of the INICC Consortium and comparison of antimicrobial resistance rates (%) in the ICUs of the INICC with the U.S. NHSN

Pathogen, antimicrobial	No. of pathogenic isolates tested at INICC's ICUs, pooled (VAP)	Resistance percentage at INICC's ICUs, % (VAP)	No, of pathogenic isolates tested at INICC's ICUs, pooled (CAUTI)	Resistance percentage at INICC's ICUs, % (CAUTI)	No, of pathogenic isolates tested at INICC's ICUs, pooled (CLABSI)	Resistance percentage at INICC's ICUs, % (CLABSI)	Resistance percentage at CDC's NHSN ICUs, % (CLABSI)
Staphylococcus aureus							
OXA	266	62.0	11	36.4	196	61.2	54.6
Enterococcus faecalis							
VAN	49	6.1	91	9.9	123	12.2	9.5
Pseudomonas aeruginosa							
FQs	1,132	41.9	148	49.3	264	37.5	30.5
PIP or TZP	1,903	35.8	246	37.0	525	33.5	17.4
AMK	1,233	36.2	153	43.8	290	42.8	10.0
IPM or MEM	1,925	42.8	278	33.5	472	42.4	26.1
FEP	252	59.1	31	58.1	45	51.1	26.1
Klebsiella pneumoniae							
CRO or CAZ	1,023	62.6	269	68.4	514	71.2	28.8
IPM, MEM, or ETP	1,190	17.2	346	13.9	638	19.6	12.8
Acinetobacter baumannii							
IPM or MEM	1,963	77.1	127	67.7	526	66.3	62.6
Escherichia coli							
CRO or CAZ	504	61.5	505	63.0	305	65.9	19.0
IPM, MEM, or ETP	615	7.5	647	5.1	342	8.5	1.9
FQs	391	64.5	373	70.0	215	69.3	41.8

AMK, amikacin; *CAUTI*, catheter-associated urinary tract infection; *CAZ*, ceftazidime; *CDC*, Centers for Disease Control and Prevention; *CLABSI*, central line–associated bloodstream infection; *CRO*, ceftriaxone; *ETP*, ertapenem; *FEP*, cefepime; *FQ*, fluoroquinolone (ciprofloxacin, levofloxacin, moxifloxacin, ofloxacin); *ICU*, intensive care unit; *INICC*, International Nosocomial Infection Control Consortium; *IPM*, imipenem; *MEM*, meropenem; *NHSN*, National Healthcare Safety Network; *OXA*, oxacillin; *PIP*, piperacillin; *TZP*, piperacillin and tazobactam; *VAN*, vancomycin; *VAP*, ventilator-associated pneumonia.

new trend in health care already had a positive impact on DA-HAI and SSI rates in several countries. There is a significant trend toward the reduction of CLABSI, CAUTI, and VAP rates and bacterial resistance in comparing the INICC's reports from 2006, 2008, 2010, and 2012 with this report as shown in Tables 13 and 14. However, this trend has not yet been seen in the cases of pediatric ICUs.

According to the World Bank, countries are categorized into 4 economic strata based on 2012 gross national income per capita: low income (≤$1,035), lower middle income ($1,036-$4,085), upper middle income ($4,086-$12,615), and high income (≥$12,616).[54] Within this categorization, 144 out of 209 (68%) countries are low income and lower middle income economies (which can also be referred to as lower income countries, low resource countries, developing economies, or developing or emerging countries), which represent >75% of the world population. The relation between the HAI rates and their association to the type of hospital (public, academic, private) and the relation between HAI rates and the country's socioeconomic level (defined as low income, mid-low income, high income) have been analyzed and published by the INICC.[55,56] Such studies' findings showed that a country's higher socioeconomic level was correlated with a lower infection risk.[55,56] The results of one such study showed that in pediatric ICUs, lower middle income countries had statistically significantly higher CLABSI, CAUTI, and VAP rates than upper middle income countries (12.2 vs 5.5 CLABSIs, 5.9 vs 0.6 CAUTIs, 9.0 vs 0.5 VAPs per 1,000 device days.), and hand hygiene compliance rates were higher in public than academic or private hospitals (65.2% vs 54.8% [$P < .001$] vs 13.3% [$P < .01$]).[56] Similarly, in NICU patients, CLABSI rates were significantly higher in low income countries than in lower middle income countries or upper middle income countries (37.0 vs 11.9 [$P < .02$] vs 17.6 [$P < .05$]) CLABSIs per 1,000 catheter days, respectively.[55] VAP rates in NICU patients were significantly higher in lower middle income countries than upper middle income countries (3.8 vs 6.7 per 1,000 device days). When examined by hospital type, overall crude mortality for NICU patients without DA-HAIs was significantly higher in academic and public hospitals than in private hospitals (5.8% vs 12.5%; $P < .001$). In contrast, NICU patient mortality among those with DA-HAIs was not different regardless of hospital type or the country's socioeconomic level.[55]

Table 14
Comparison of device-associated health care–associated infection rates per 1,000 device days in the ICUs of the INICC (2007-2012) and the U.S. NHSN (2012)

DA-HAI per Type of ICU	INICC 2007-2012 pooled mean (95% CI)	U.S. NHSN 2012 pooled mean (95% CI)
Medical cardiac ICU		
CLABSI	3.5 (3.1-3.9)	1.1 (1.0-1.1)
CAUTI	5.9 (5.4-6.4)	2.2 (2.0-2.3)
VAP	11.5 (10.5-12.5)	1.0 (0.8-1.1)
Medical and surgical ICU		
CLABSI	4.9 (4.8-5.1)	0.9 (0.9-1.0)
CAUTI	5.3 (5.2-5.8)	1.2 (1.2-1.3)
VAP	16.5 (16.1-16.8)	1.1 (1.0-1.2)
Pediatric ICU		
CLABSI	6.1 (5.7-6.5)	1.4 (1.3-1.6)
CAUTI	5.6 (5.1-6.1)	2.7 (2.5-3.0)
VAP	7.9 (7.4-8.4)	0.8 (0.6-0.9)
Newborn ICU (1,501-2,500 g)		
CLABSI	4.8 (3.7-6.1)	0.6 (0.5-0.8)
VAP	10.7 (8.4-13.4)	0.2 (0.1-0.5)

CAUTI, catheter-associated urinary tract infection; *CI*, confidence interval; *CLABSI*, central line–associated bloodstream infection; *DA-HAI*, device-associated healthcare-associated infection; *ICU*, intensive care unit; *INICC*, International Nosocomial Infection Control Consortium; *NHSN*, National Healthcare Safety Network; *VAP*, ventilator-associated pneumonia.

In order 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 the INICC has played a fundamental role, not only in increasing the awareness of risks of HAI in the INICC's ICUs and SSI, but also in providing an exemplary basis for the institution of infection control practices. In many INICC's ICUs, the high incidence of DA-HAI has been reduced by carrying out a multidimensional approach, including

Table 15
Comparison of device-associated health care–associated infection rates per 1,000 device days in the ICUs of the INICC as published in the 2006, 2008, 2010, 2012, and 2014 reports

Details	INICC 2002-2005 (published in 2006) pooled mean (95% CI)	INICC 2002-2007 (published in 2008) pooled mean (95% CI)	INICC 2003-2008 (published in 2010) pooled mean (95% CI)	INICC 2004-2009 (published in 2012) pooled mean (95% CI)	INICC 2007-2012 (this report) pooled mean (95% CI)
No. of countries	8	18	25	36	43
Participating countries	Argentina, Brazil, Colombia, India, Mexico, Morocco, Peru, Turkey	Argentina, Brazil, Chile, Colombia, Costa Rica, Cuba, India, Kosovo, Lebanon, Macedonia, Mexico, Morocco, Nigeria, Peru, Philippines, El Salvador, Turkey, Uruguay	Argentina, Brazil, China, Colombia, Costa Rica, Cuba, Greece, India, Jordan, Kosovo, Lebanon, Lithuania, Macedonia, Mexico, Morocco, Pakistan, Panama, Peru, Philippines, El Salvador, Thailand, Tunisia, Turkey, Venezuela, Uruguay	Argentina, Brazil, Bulgaria, China, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Egypt, Greece, India, Jordan, Kosovo, Lebanon, Lithuania, Macedonia, Malaysia, Mexico, Morocco, Pakistan, Panama, Peru, Philippines, Puerto Rico, El Salvador, Saudi Arabia, Singapore, Sri Lanka, Sudan, Thailand, Tunisia, Turkey, Venezuela, Vietnam, Uruguay	Argentina, Bolivia, Brazil, Bulgaria, China, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Egypt, Greece, India, Iran, Jordan, Kosovo, Lebanon, Lithuania, Macedonia, Malaysia, Mexico, Morocco, Pakistan, Panama, Peru, Philippines, Poland, Puerto Rico, Romania, El Salvador, Saudi Arabia, Serbia, Singapore, Slovakia, Sri Lanka, Sudan, Thailand, Tunisia, Turkey, United Arab Emirates, Uruguay, Venezuela, Vietnam
No. of ICUs	55	98	173	422	503
Medical cardiac ICU					
CLABSI	NA	9.9 (8.7-11.3)	8.5 (7.5-9.7)	6.2 (5.6-6.9)	3.5 (3.1-3.9)
CAUTI	NA	6.4 (5.3-7.7)	4.4 (3.5-5.3)	3.7 (3.2-4.3)	5.9 (5.4-6.4)
VAP	NA	20.2 (17.0-23.9)	14.9 (12.4-17.9)	10.8 (9.5-12.3)	11.5 (10.5-12.5)
Medical and surgical ICU					
CLABSI	NA	8.9 (8.4-9.4)	7.4 (7.2-7.7)	6.8 (6.6-7.1)	4.9 (4.8-5.1)
CAUTI	NA	6.6 (6.2-7.0)	6.1 (5.9-6.4)	7.1 (6.9-7.4)	5.3 (5.2-5.8)
VAP	NA	19.8 (14.2-27.1)	14.7 (14.2-15.2)	18.4 (17.9-18.8)	16.5 (16.1-16.8)
Pediatric ICU					
CLABSI	NA	6.9 (5.6-8.3)	7.8 (7.1-8.5)	4.6 (3.7-5.6)	6.1 (5.7-6.5)
CAUTI	NA	4.0 (2.4-6.2)	4.4 (3.6-5.4)	4.7 (4.1-5.5)	5.6 (5.1-6.1)
VAP	NA	7.9 (6.0-10.1)	5.5 (4.9-6.0)	6.5 (5.9-7.1)	7.9 (7.4-8.4)
Newborn ICU (1,501-2,500 g)					
CLABSI	NA	15.2 (10.3-21.5)	13.9 (12.4-15.6)	11.9 (10.2-13.9)	4.8 (3.7-6.1)
VAP	NA	6.68 (3.0-12.7)	9.50 (7.9-11.3)	10.1 (7.9-12.8)	10.7 (8.4-13.4)
Overall	NA				
CLABSI	12.5 (11.7-13.3)	9.2 (8.8-9.7)	7.6 (7.4-7.9)	6.8 (6.7-7.0)	4.8 (4.7-4.9)
CAUTI	8.9 (8.3-9.5)	6.5 (6.1-6.9)	6.3 (6.0-6.5)	6.3 (6.2-6.5)	5.3 (5.2-5.4)
VAP	24.1 (22.8-25.5)	19.5 (18.7-20.3)	13.6 (13.3-14.0)	15.8 (15.5-16.1)	14.7 (14.5-14.9)

CAUTI, catheter-associated urinary tract infections; *CI*, confidence interval; *CLABSI*, central line-associated bloodstream infection; *ICU*, intensive care unit; *INICC*, International Nosocomial Infection Control Consortium; *NA*, not applicable; *VAP*, ventilator-associated pneumonia.

a bundle of infection control interventions; education; outcome surveillance of CLABSI, VAP, CAUTI, and SSI; process surveillance for hand hygiene, central line, ventilator, and urinary catheter care; feedback of HAI rates; and performance feedback.[23-31,43-53] Finally, control of antibiotic resistance mandates more restrictive use of antiinfectives in addition to effective nosocomial infection control.

During the last 4 decades, the CDC's NHSN has been the only source available to provide a basis for comparison of infection rates with hospitals worldwide. Comparing the hospital rates of the CDC in the U.S. with those of hospitals from Western Europe and Oceania is considered valid because of their similar socioeconomic conditions. In contrast, the comparison between the hospital rates of the CDC and those of hospitals with limited resources (or with sufficient available resources but without enough experience in the field of infection control) may not be adequate. On the one hand, U.S. hospitals enjoy >50 years of unrivaled experience in infection control and surveillance, sufficient human and medical supply resources availability, and a comprehensive legal framework backing infection control programs, including mandatory surveillance and hospital accreditation policies. Such background can easily result in significantly lower HAI rates for the CDC's hospitals and hospitals from high income countries in contrast with hospitals from developing economies or with insufficient resources and experience in infection control. Within this context, the INICC emerged 15 years ago as an alternative valid and fair benchmarking tool for HAI rates in hospitals worldwide because of their shared socioeconomic hospital backgrounds.

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

The particular and primary application of these data is to serve as a guide for the implementation of prevention strategies and other quality improvement efforts locally to help reduce DA-HAI rates at the minimum possible level.

Finally, it is to be highlighted that although DA-HAIs in our ICU patients continue to be higher than the rates reported in NSHN reports, representing the developed world, we have verified a significant trend toward the reduction of DA-HAI rates in the adult ICUs of the INICC. Therefore, it is the INICC's main goal to continue enhancing infection control practices worldwide by facilitating basic 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 a correlated reduction in DA-HAI and its adverse effects in every health care facility.

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APPENDIX WITH REMAINING AUTHORS

Argentina

Diego Marcelo Maurizi, Adriana Montanini, and Maria Laura Spadaro (Hospital Municipal De Agudos Dr Leonidas Lucero, Bahia Blanca, Argentina); Lorenzo Santiago Marcos, Priscila Botta, Florencia Maria Jerez, Maria Constanza Chavez, Lucia Ramasco, Maria Isabel Colqui, Maria Silvia Olivieri, Ana Silvia Rearte, Gladys Edith Correa, Paola Deolinda Juarez, Paola Fabiana Gallardo, Miriam Patricia Brito, Gabriel Horacio Mendez, Julia Rosa Valdez, and Lorena Paola Cardena (Hospital Del Nino Jesus De Tucuman, Tucuman, Argentina); Jose Maria Harystoy and Gustavo Jorge Chaparro (Instituto Medico Platense Sa, La Plata, Argentina); Claudia Gabriela Rodriguez and Rodolfo Toomey (Instituto Medico Adrogue, Adrogue, Argentina); Maria Caridi (Centro Gallego De Buenos Aires, Buenos Aires, Argentina); Monica Viegas (Hospital Interzonal General De Agudos Presidente Peron, Avellaneda, Argentina); Marisa Liliana Bernan (Hgza San Roque De Gonnet, La Plata, Argentina); Adriana Romani (Clinica Modelo Imagmed Sociedad Anónima, Lanus, Argentina); and Claudia Beatriz Dominguez (Obra Social De Empleados Publicos-Sanatorio Fleming, Mendoza, Argentina).

Bolivia

Luis Kushner Davalos (Caja De Salud De La Banca Privada Reg, La Paz, Bolivia).

Brazil

Rosana Richtmann, Camila Almeida Silva, and Tatiane T. Rodrigues (Hospital E Maternidade Santa Joana, Sao Paulo, Brazil); Amaury Mielle Filho, Ernandi Dagoberto Seerig Palme, Aline Besen, Caroline Lazzarini, and Caroline Batista Cardoso (Hospital Santa Catarina, Blumenau, Brazil); Francisco Kennedy Azevedo, Ana Paula Fontes Pinheiro, and Aparecida Camacho (Hospital Jardim Cuiaba, Cuiaba, Brazil); Braulio Matias De Carvalho, Maria Jose Monteiro De Assis, Ana Paula Vasconcelos Carneiro, Maria Lilian Maciel Canuto, Keyla Harten Pinto Coelho, Tamiris Moreira, Agamenon Alves Oliveira, Marcela Maria Sousa Colares, Marcia Maria De Paula Bessa, Tereza De Jesus Pinheiro Gomes Bandeira, Renata Amaral De Moraes, Danilo Amâncio Campos, and Tânia Mara Lima De Barros Araújo (Hospital De Messejana, Fortaleza, Brazil); Maria Tereza Freitas Tenório, Simone Amorim, Manuela Amaral, Julianne Da Luz Lima, Lindalva Pino Da Silva Neta, Caphiane Batista, Fabio Jorge De Lima Silva, Maria C. Ferreira De Souza, and Katia Arruda Guimaraes (Santa Casa De Misericordia De Maceio, Maceio, Brazil); Julia Marcia Maluf Lopes (Hospital Infantil Joao Paulo II-Fhemig, Belo Horizonte, Brazil); Karina M. Nogueira Napoles, Lorena Luiza Silva Neto Avelar, and Lilian Aguiar Vieira (Santo Ivo, Belo Horizonte, Brazil); Luis Gustavo De Oliveira Cardo (Hospital De Clinicas Unicamp, Campinas, Brazil); Christianne F.V. Takeda, Glaydson A. Ponte, and Fco Eduardo Aguiar Leitão (Hospital Antonio Prudente, Fortaleza, Brazil); Ricardo De Souza Kuchenbecker and Rodrigo Pires Dos Santos (Hospital De Clinicas De Porto Alegre, Porto Alegre, Brazil); Erci Maria Onzi Siliprandi (Instituto De Cardiologia Do Rio Grande Do Sul, Porto Alegre, Brazil); Luiz Fernando Baqueiro Freitas (Hospital Santa Lydia, Ribeirao Preto, Brazil); Ianick Souto Martins (Hospital Do Cancer Instituo Nacional Do Cancer, Rio De Janeiro, Brazil); Daiane Casi (Hospital Samaritano, Sao Paulo, Brazil); Maria Angela Maretti Da Silva, Sergio Blecher, Margarete Villins, and Reinaldo Salomao (Hospital Santa Marcelina, Sao Paulo, Brazil); Solange Regina Oliveira Castro, Daniela V. Da Silva Escudero, and Mariana Andrade Oliveira Reis (Hospital Sao Paulo Escola Paulista De Medicina Unifesp, Sao Paulo, Brazil); Marcelo Mendonca, Valter Furlan, and Antonio Claudio do Amaral Baruzzi (Totalcor, Sao Paulo, Brazil); Tarquino Eristidesg Sanchez (Hospital Anchieta Ltda, Taguatinga, Brazil); Marina Moreira (Hospital Universitario De Taubate, Taubate, Brazil); and Wania Vasconcelos de Freitas and Leonardo Passos de Souza (Hospital Casa de Portugal, Rio de Janeiro, Brazil).

Bulgaria

Velmira Angelova Velinova, Nassya Hadjieva, Michael M. Petrov, Dimitar Georgiev Karadimov, Emil D. Kostadinov, and Violeta Jivkova Dicheva (Queen Giovanna Isul, Sofia, Bulgaria).

China

Chaohua Wang, Xiuqin Guo, Xihua Geng, Shufang Wang, Jinzhi Zhang, Ling Zhu, Shufang Zhuo, and Chunli Guo (Dong E People's Hospital, Shandong, China); Tao Lili (The First Hospital Shanxi Medical University, Tai Yuan, China); Li Ruisheng (Beijing Chao Yang Hospital, Beijing, China); Liu Kun (Beijing Chao-Yang Hospital, Capital Medical University, Beijing, China); Xuesong Yang (Peking University Third Hospital, Beijing, China); Li Yimin, Mao Pu, Li Changan, Yiang Shumei, Wu Kangxiong, and Lin Meiyi (The First Affiliated Hospital of Guangzhou Medical Univertiy, Guang Zhou, China); Guxiang Ye (Yangpu Hospital, Shanghai, China); Xu Ziqin (The Third People's Hospital of Wenzhou, Wenzhou, China); Suo Yao (The Second Affiliated Hospital of Xian Jiaotong University, Medical College, Xi'an, China); and Song Liqiang (Xijing Hospital, Fourth Military Medical University, Xi'an, China).

Colombia

Luis Marino Cañas Giraldo, Elsa Margarita Trujillo Ramirez, and Paola Andrea Rios (Clinica Privada, Cali, Colombia); Juan Carlos Torres Millan (Uci Valle De San Nicolas, Antioquia, Colombia); Edwin Giovanny Chapeta Parada, Andres Eduardo Mindiola Rochel, and Andres H. Corchuelo Martinez (Hospital San Vicente De Arauca, Arauca, Colombia); Ana Marãa Perez Fernandez (Clinica Central Del Quindio, Armenia, Colombia); Nayide Barahona Guzman, Alfredo Lagares Guzman, and Marena Rodriguez Ferrer (Universidad Simon Bolivar, Barranquilla, Colombia); Yazmin Leon Vega (Clinica Del Occidente, Bogota, Colombia); Heidi Johanna Munoz (Clinica Reina Sofia, Bogota, Colombia); Germán Camacho Moreno and Sandra Liliana Romero Torres (Hospital De La Misericordia, Bogota, Colombia); Herlidia Taboada Hernandez (Hospital De San Jose, Bogota, Colombia); Ismael A. Valderrama Marquez (Hospital El Tunal Ese, Bogota, Colombia); Claudia Linares (Pontificia Universidad Javeriana Hospital Universitario San Ignacio, Bogota, Colombia); Monica Espinosa Valencia, Lusayda Sanchez Corrales, Sandra Milena Bonilla, Jorge Ivan Marin Uribe (Clinica De La Presentacion, Manizales, Colombia); David Yepes Gomez (Clinica Ces, Medellin, Colombia); Javier Ospina Martinez and Luz Dary Burgos Florez (Clinica Zayma Ltda, Monteria, Colombia); Johanna Osorio and Dagoberto Santofimio (Hospital Universitario De Neiva, Neiva, Colombia); Lorena Matta Cortes (Corporacion Comfenalco Valle Universidad Libre, Santiago De Cali, Colombia); and Wilmer Villamil-Gomez (Hospital Universitario De Sincelejo, Sincelejo, Colombia; Clinica Santa Maria, Sucre; Sociedad Cardiovascular Del Caribe Colombiano Ltda, Sucre, Colombia).

Costa Rica

Gabriel Munoz Gutierrez and Adela Arguello Ruiz (Hospital Clinica Biblica, San Jose, Costa Rica); and Carlos Gonzalez Fuentes,

Antonio Solano Chinchilla, Ivar Calvo Hernandez, and Olber Chavarria Ugalde (Hospital La Catolica, San Jose, Costa Rica).

Cuba

Humberto Guanche Garcell and Clara Morales Perez (Hospital Clinico Quirurgico Joaquin Albarran, La Habana, Cuba; Hospital Universitario Gral. Calixto Garcia, La Habana, Cuba).

Cyprus

Selin Bardak and Sumru Ozkan (Bndh, Nicosia, Cyprus).

Dominican Republic

Nepomuceno Mejia, Adrian M. Puello Guerrero Glenny Mirabal, Margarita Delgado, Ramona Severino, Eliesel Lacerda, and Gilda Tolari (Hospital General De La Plaza De La Salud, Santo Domingo, Dominican Republic).

Ecuador

María Marcela Bovera, Diego Barahona Pinto, Pedro Fernández González, Gasdali Santacruz, Nelly Alquinga, Celso Zaruma, Nelson Remache, and Diego Morocho (Hospital De Los Valles, Quito, Ecuador); Mario Arboleda, Mario Cadena Zapata, Maria Fernanda Garcia, Fabricio Picoita, Jorge Velez, and Marcia Valle (Hospital Eugenio Espejo, Quito, Ecuador); and Estuardo Salgado Yepez, Diego Morocho Tutillo, Ricardo Arteaga Mora, Andrea Peña Padilla, Mayra Chango, Karina Cabezas, Shirley Tenorio López, Ana Lucía Bonilla Escudero, Gladys Tatiana Sánchez, Hugo Alberto Gonzalez Flores, and Maria Fernanda Garcia (Clinica La Merced, Quito, Ecuador).

Egypt

Islam Abdullorziz Ghazi (Benha Children's Hospital, Benha, Egypt); Mohamed Hassan and Ghada A. Ismail (Ain Shams University Hospitals, Cairo, Egypt); Reham Hamed, Mona Mohiedden Abdel-Halim, May Abd El-Fattah, Doaa Abdel-Aziz, and Zeinab Salah Seliem (Children Hospital Cairo University Abu El Reesh, Cairo, Egypt); and Rasha Hamed Elsherif, Reham Ali Dewdar, Abeer Ahmed Mohmed, and Lamiaa Abdel-Fatteh Ahmed (Kasr Alainy, Cairo, Egypt).

El Salvador

Lilian De Jesus Machuca and Concepcion Bran De Casares (Hospital Nacional De Ninos Benjamin Bloom, San Salvador, El Salvador).

Greece

Prokopis Kithreotis, Maria Daganou, and Dimitrios Veldekis (Sotiria, Athens, Greece); and Maria Kartsonaki and Achilleas Gikas (University General Hospital of Heraklion, Heraklion, Greece).

Honduras

Marco Tulio Luque Torres, Denis Padgett, and Doris Maribel Rivera (Hospital De Especialidades Del Instituto Hondureno De Seguridad Social Ihss, Tegucigalpa, Honduras).

India

Namita Jaggi (Artemis Health Institute, New Delhi, India); Camilla Rodrigues (PD Hinduja National Hospital & Medical Research Centre, Mumbai, India); Bhagyesh Shah, Keyur Parikh, Jigar Patel, and Riya Thakkar (Care Institute of Medical Sciences Hospital, Ahmedabad, India); Murali Chakravarthy, B.N. Gokul, R. Sukanya, Leema Pushparaj, Thejas Vini and Sukanya Rangaswamy (Fortis Hospitals, Bangalore, India); Saroj Kumar Patnaik, Vempati Venkateshwar, Biju John, and Shamsher Dalal (Command Hospital Air Force, Bangalore, India); Suneeta Sahu, Samir Sahu, Banambar Ray, Sudhiranjan Misra, Nisith Mohanty, Biraj Mohan Mishra, Prafulla Sahoo, and Naresh Parmar (Apollo Hospital Bhubaneswar, Bhubaneswar, India); Sanghamitra Mishra, Basanta Kumar Pati, Santosh Singh, Bhabani Shankar Pati, Aparajita Panda, Swarna Banergee, Dipankar Padhihari, and Soumya Samal (Institute of Medical Sciences and State University of Medicine Hospital, Siksha 'O' Anusandhan University, Bhubaneswar, India); Samir Sahu (Kalinga Hospital, Bhubaneswar, India); Karthikeya Varma (Malabar Institute of Medical Sciences Ltd, Calicut, India); Velu Pandi Suresh Kumar and Ram Gopalakrishnan (Apollo Children Hospital, Chennai, India); Nagarajan Ramakrishnan, Babu Kuruvilla Abraham, Senthilkumar Rajagopal, Ramesh Venkatraman, Ashwin Kumar Mani, Dedeepiya Devaprasad, and Lakshmi Ranganathan (Apollo Hospitals, Chennai, India); Thara Francis and Kotturathu Mammen Cherain (Frontier Lifeline Hospital, Chennai, India); Bala Ramachandran and Ravikumar Krupanandan (Kanchi Kamakoti Childs Trust Hospital, Chennai, India); S. Muralidharan, Murali Karpagam, Baby Padmini, and S. Saranya (G. Kuppusamy Naidu Memorial Hospital, Coimbatore, India); Siva Kumar (Kovai Medical Center and Hospital, Coimbatore, India); Nirav Pandya, Rajesh Kakkar, and Tenzin Zompa (Max Super Specialty Hospital Dehradun, Dehradun, India); Narinder Saini (Pushpanjali Crosslay Hospital, Ghaziabad, India); Srinivas Samavedam and Ganshyam Jagathkar (Care Hospital Banjara Hills, Hyderabad, India); Suhas Nirkhiwale, G.S. Gehlot, and Shefali Bhattacharya (Greater Kailash Hospital, Indore, India); Sanjeev Sood (Military Hospital, Jodhpur, India); Suman Singh (Shree Krishna Hospital, Karamsad, India); Sanjeev Singh (Amrita Institute of Medical Sciences & Research Center, Kochi, India); Subhash Kumar Todi, Mahuya Bhattacharyya, Arpita Bhakta, and Susmita Basu (Advanced Medicare Research Institute, Kolkata, India); Anuradha Agarwal and Manoj Agarwal (Belle Vue Clinic, Kolkata, India); Mohit Kharbanda, Sankar Sengupta, and Anirban Karmakar (Desun Hospital, Kolkata, India); Debkishore Gupta, Ajoy Krishna Sarkar, Rimita Dey, and Chandramouli Bhattacharya (Peerless Hospitex Hospital & Research Center, Kolkata, India); Mammen Chandy, V.R. Ramanan, Aseem Mahajan, Manas Roy, and Sanjay Bhattacharya (Tata Medical Center, Kolkata, India); Saswati Sinha, Indranil Roy, Umesh Gupta, Sujoy Mukherjee, Mrinmoy Bej, Purnima Mukherjee, and Sumana Baidya (The Calcutta Medical Research Institute, Kolkata, India); Afzal Azim (Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, India); Asmita Sagar Sakle, Jehangir Soli Sorabjee, and Mrunalini Subhash Potdar (Bombay Hospital and Medical Research Centre, Mumbai, India); Vaibhavi R. Subhedar (Bombay Hospital Indore, Mumbai, India); F.E. Udwadia (Breach Candy Hospital Trust, Mumbai, India); Hena Francis, Arpita Dwivedy, Sheena Binu, and Suvin Shetty (Dr L H Hiranandani Hospital, Mumbai, India); Pravin Kumar Nair, Devendra K. Khanna, Felcy Chacko, and Seelas Blessymole (Holy Spirit Hospital, Mumbai, India); Preeti Rajeev Mehta (Kem Hospital, Mumbai, India); Tanu Singhal, Sweta Shah, Vatsal Kothari, and Reshma Naik (Kokilaben Dhirubhai Ambani Hospital and Research Institute, Mumbai, India); Mayur Harshadrai Patel, Deepesh Gokulchand Aggarwal, Burhanuddin Qutbuddin Jawadwala, Niketa Kaul Pawar, Shoeb Nizamuddin Kardekar, and Abizer Nuruddin Manked (Saifee Hospital, Mumbai, India); S.N. Myatra, J.V. Divatia, R. Kelkar, S.K. Biswas, V. Raut, and S. Sampat (Tata Memorial Hospital, Mumbai, India); Alka Thool (Wockhardt Nagpur, Nagpur, India); Anil Karlekar (Escorts Heart Institute & Research Centre, New Delhi, India); Sumi Nandwani, Sudhir Gupta, Sanjay Singhal, and Madhu Gupta (ESIC Post Graduate Institute of Medical Science, Basaidarapur, New Delhi, India); Purva

Mathur and Subodh Kumar (Jai Prakash Narayan Apex Trauma Center, All India Institute of Medical Sciences, New Delhi, India); Kavita Sandhu, Arnab Dasgupta, Abhijeet Raha, Padmalatha Raman, Ashoo Wadhera, Binesh Badyal, Sarika Juneja, and Bikas Mishra (Max Superspecialty Hospital, Saket, New Delhi, India); Sunil Sharma (Medanta The Medicity, New Delhi, India); Megha Mehrotra (Primus Super Specialty Hospital, New Delhi, India); Jayant Shelgaonkar (Aditya Birla Memorial Hospital, Pune, India); Vikram Padbidri, Rohini Dhawale, and Sheena Mary Sibin (Jehangir Hospital, Pune, India); Dileep Mane, Hanamant Kashinath Sale, Mohammad Mukhit Abdul Gaffar Kazi, Supriya Chabukswar, Anju Mathew, Dipti Gaikwad, and Amol Harshe (Noble Hospital Pune, Pune, India); Gita Nadimpalli, Sunil Bhamare, Soniya Thorat, Omnarayan Sarda, and Pattabhiramarao Nadimpalli (Rao Nursing Home, Pune, India); Angelina Mendonca, Sujata Malik, Asmita Kamble, Nilakshi Kumari, Sohini Arora, and Nita Munshi (Ruby Hall Clinic, Pune, India); Deepa Ganesh Divekar, Maithili Satish Kavathekar, Anuja Kedar Kulkarni, Maithili Satish Kavathekar, and Madhupriya Vijay Suryawanshi (Sahyadri Specialty Hospital, Pune, India); Madhavi Latha Bommala and Anil Bilolikar (Krishna Institute of Medical Sciences, Secunderabad, India); Kashmira Limaye Joshi, Charulata Pamnani, Harvinder Wasan, Sonali Khamkar, and Leena Steephen (Jupiter Hospital, Thane, India); Arjun Rajalakshmi, Anzar Thair, and Aisha Mubarak (Kerala Institute of Med Sciences Thiruvananthapuram, Thiruvananthapuram, India); Swathy Sathish, Suresh Kumar, H. Sunil, Sujith Sujith, and Dinesh (Kerala Institute of Med Sciences Trivandrum, Trivandrum, India); Nagamani Sen (Christian Medical College, Vellore, India); and Alka Thool and Nitin Shinde (Wockhardt Hospital, Nagpur, India).

Iran

Masoud Alebouyeh, Somayeh Jahani-Sherafat, Mohammad Reza Zali, Mohammad Reza Sarbazi, Nahid Mansouri, Elahe Tajeddin, and Maryam Razaghi (Taleghani Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran); Simasadat Seyedjavadi, Elahe Tajeddin, Marjan Rashidan, and Maryam Razaghi (Shohadaye Tajrish Hospital, Shahid Modares Hospital, Emam Hosein Hospital, Mofid Hospital, Loghman Hakim Hospital, Tehran, Iran); Mansoor Masjedi, Behzad Maghsudi, Golnar Sabetian, Anahita Sanaei, and Atefeh Yousefipour (Nemazee Hospital Shiraz University of Medical Sciences, Shiraz, Iran); and Masoud Alebouyeh (Shohadaye Tajrish, Tehran, Iran).

Kingdom of Saudi Arabia

Abdullah Mufareh Assiri, Elaine Mari Furukawa-Cinquini, Areej Dhafer Alshehri, and Alysia Faye Giani (Ministry of Health of Kingdom of Saudi Arabia, Riyadh, Kingdom of Saudi Arabia); Nadia Lynette Demaisip, Elizabeth Laungayan Cortez, Analen Fabros Cabato, Jerlie Mae Gonzales Celiz, Ibrahim A.M. Al-Zaydani Asiri, Yassir Khidir Mohammed, Mohammed Abdullah Al Raey, Ali Omer Abdul Aziz, Saeed Ali Al Darani, and Misbah Rehman Aziz (Aseer Central Hospital Abha, Abha, Kingdom of Saudi Arabia); Roaa Hasan Basri, Duaa Khalil Al-Awadi, and Syed Zahid Bukhari (Hera General Hospital Mekkah, Mekkah, Kingdom of Saudi Arabia); Rosita Gasmin Aromin and Evangelina Balon Ubalde (King Khalid Hospital Najran, Najran, Kingdom of Saudi Arabia); Apsia Musa Molano, Hessa Abdullah Al Enizy, Celia Flores Baldonado, Fatima Mohammad Al Adwani, and Arlu Marie Casuyon Pahilanga (King Khaled Hospital Tabuk, Tabuk, Kingdom of Saudi Arabia); Avigail M. Tan, Sonia Joseph, Deepa Sasidharan Nair, Nabeela Abdullah Al-Abdullah, Grace Sindayen, Annalyn Amor Malificio, and Diaa Abdullah Mohammed (King Abdulaziz Specialist Hospital Taif, Taif, Kingdom of Saudi Arabia); Hanan Mesfer Al Ghamdi, Ameurfina Curioso Silo, and Marianina Brenda V. Valisto (Security Forces Hospital, Dammam, Kingdom of Saudi Arabia); and Nektarios Foteinakis, Sameeh Salem Ghazal, Mercy V. Joseph, and Ahmed Hakawi (King Fahad Medical City, Riyadh, Kingdom of Saudi Arabia).

Kosovo

Antigona Hasani and Ismet Jusufi (American Hospital, Prishtina, Kosovo); and Gazmend Spahija, Nehat Baftiu, and Agreta Gecaj-Gashi (University Clinical Center of Kosovo, Public-University, Prishtina, Kosovo).

Kuwait

Nasser Yehia Aly, Mohammad El-Dossoky Noweir, Suga Thomas Varghese, Ruby Jose Ramapurath, Amna Mostafa Mohamed, Sneha Mary George, Anu Kurian, and Amani Fouad Sayed (Farwaniya Hospital, Kuwait City, Kuwait); and Mona Foda Salama, Abeer Aly Omar, Flavie Maria Rebello, and Dennis Malungcot Narciso (Mubarak Al Kabir, Kuwait City, Kuwait).

Lebanon

Nada Kara Zahreddine, Zeina Kanafani, Tala Kardas, Bassel Molaeb, and Lamia Jurdi (American University of Beirut Medical Center, Beirut, Lebanon); and Anwar Al Souheil, Mohamad Ftouni, Hasan Ayash, and Tahsine Mahfouz (Sheikh Ragheb Harb Hospital, Nabatieh, Lebanon).

Lithuania

Tomas Kondratas, Dovile Grinkeviciute, Rimantas Kevalas, Greta Gailiene, and Algirdas Dagys (Lithuanian University of Health Sciences, Kaunas, Lithuania).

Macedonia

Milena Petrovska and Katja Popovska (Institute for Microbiology Med Faculty, Skopje, Macedonia); and Zaneta Bogoevska-Miteva, Katerina Jankovska, Snezana Tufekcievska Guroska, and Tanja Anguseva (Special Hospital for Surgical Diseases Filip Vtori, Skopje, Macedonia).

Malaysia

Wan Nurbayah Wan Yusoff, Anis Shiham Zainal Abidin, Chin Seng Gan, and Hasimah Zainol (University Malaya Medical Centre Pediatric Intensive Care, Kuala Lumpur, Malaysia); Vineya Rai, Wong Kang Kwong, Mohd Shahnaz Hasan, Sasheela Sri La Sri Ponnampala, and Jeyaganesh Veerakumaran (University Malaya Medical Centre Adult Intensive Care, Kuala Lumpur, Malaysia); Ojan Assadian (Prince Court Medical Center, Kuala Lumpur, Malaysia); and Doan Mai Phuong, Nguyen Gia Binh, Kerinjeet Kaur, Joelene Lim, Lian-Huat Tan, Jegathesan Manikavasagam, and Yuet-Meng Cheong (Sunway Medical Centre, Petaling Jaya, Malaysia).

Mexico

Hilario Coronado Magaña, Julio Cesar Mijangos Méndez, and Federico Corona Jiménez (Hospital Civil De Guadalajara Fray Antonio Alcalde, Unidad De Terapia Intensiva De Adultos, Guadalajara, Mexico); Sergio Esparza-Ahumada, Rayo Morfin-Otero, Eduardo Rodriguez-Noriega, Susana Gutierrez-Martinez, Hector Raul Perez-Gomez, Gerardo León-Garnica, and Christian Mendoza-Mujica (Hospital Civil De Guadalajara Fray Antonio Alcalde, Comite De Infecciones, Guadalajara, Mexico); Martha Cecilia Culebro Burguet (Hospital De Especialidades Pediatricas De Chiapas, Chiapas,

Mexico); Jorge Horacio Portillo-Gallo, Fernando Aguilera Almazán, Gaspar Iglesias Miramontes, Maria del Rosario Vázquez Olivas, Alicia Sanchez Chávez, and Yolcey Angulo Espinoza (Hospital Cima Chihuahua, Chihuahua, Mexico); Veronica Alejandra Gaona-Flores and Enrique Alcalá Martínez (Hospital de Infectologia, Centro Médico Nacional La Raza, Mexico DF, Mexico); Maria De Jesus Herver (Hospital General La Villa, Mexico Df, Mexico); Lauro Armenta Gallegos (Hospital Gral De Sonora "Dr Ernesto Ramos Bours", Mexico Df, Mexico); Raúl Vizzuett Martínez, Alma Olivia Aguilar Lucio, Juan José Rodríguez Zepeda, and Salvador Mendoza Domínguez (recently deceased) (Hospital Regional "Lic. Adolfo Lopez Mateos" Instituto de Seguridad de Servicios Sociales de los Trabajadores del Estado, City of Mexico, Mexico); Martha Yolanda Martínez-Marroquín, Araceli Martínez Martínez, Marco Montell Garcia, Elena León Sánchez, María Guadalupe Gómez Flores, and Verónica Tlazola Rivera (Centro Médico "Lic. Adolfo Lopez Mateos" Instituto de Salud del Estado de México, Toluca, Estado de Mexico, Mexico); Gabriel Arteaga Troncoso, Fernando Martin Guerra Infante, Iyari Morales Mendez, Marcela Lopez Hurtado, and Rafael Galvan Contreras (Instituto Nacional De Perinatologia, Mexico Df, Mexico); Maria G. Miranda Novales, Irma Zamudio Lugo, and Claudia J. Gomez Gonzalez (Unidad Médica de Alta Especialidad Hospital de Pediatría, Centro Médico Nacional Siglo XXI, Instituto Mexicano del Seguro Social, Mexico DF, Mexico); Juan Jacobo Ayala Gaytan, Mary Cruz Alemán Bocanegra, and Claudia Elena Guajardo Lara (Hospital San Jose-TECsalud, Monterrey, Nuevo Leon, Mexico); Alfredo Daniel Bernal Mendez, Jayro Ulises Bermejo, German Delgadillo, and Martina Rodriguez (Clinica Hospital San Jose De Navojoa, Navojoa, Mexico); Antonio Cerero Gudino and Miguel Angel Altuzar Figueroa (Hospital General De Zona No. 1 Oaxaca, Demetrio Mayoral Pardo, Oaxaca De Juarez, Mexico); Jose Alberto Denicia Caleco, Edgar Enrique Leyva Medellin, Arturo Salamanca Meneses, Carla Cosio Moran, Rufino Ruiz Rendon, Lucio Alberto Aguilar Angel, Marisol Sanchez Vargas, Angel Orlando Flores Alvarado, Roberto Carlos Mares Morales, and Luis Carlos Fernandez Alvarez (Hospital General De La Zona Norte Bicentenario De La Independencia, Puebla, Mexico); Hector Armando Rincon Leon, Karla Reyna Navarro Fuentes, Yuri Mariela Perez Hernandez, and Gabriela Martinez Falcon (Hospital Regional De Alta Especialidad Ciudad Salud, Tapachula, Mexico); Angel Gonzalez Vargas, Marco A. Trujillo Juarez, Antonio Martinez Mulia, and Paulina Alma Ulloa Camacho (Hospital General Dr Nicolas San Juan, Toluca De Lerdo, Mexico); Martha Y. Martinez-Marroquin, Marco Montell Garcia, Araceli Martinez Martinez, Elena Leon Sanchez, and Guadalupe Gomez Flores (Centro Medico Lic Adolfo Lopez Mateos, Toluca, Estado De Mexico, Mexico); and Marisela del Rocío González Martínez, Jesús Alfonso Galindo Olmeda, Georgina Olivarez, Enrique Barbachano Rodriguez, María Magdalena Gutierrez Castillo, María Guadalupe Villa González, Isaura Beatriz Sauceda Castañeda, and Jaime Martínez Rodriguez (Hospital de Especialidades UMAE 71 IMSS, Torreón, México).

Mongolia

Otgon Baatar and Byambadorj Batkhuu (Central State Hospital 1, Ulaanbaatar, Mongolia).

Morocco

Kabiri Meryem and Barkat Amina (Children Hospital of Rabat, Rabat, Morocco); and Rédouane Abouqal, Amine Ali Zeggwagh, Tarek Dendane, Khalid Abidi, and Naoufel Madani (Ibn Sina Hospital, Rabat, Morocco).

Pakistan

Syed Faisal Mahmood (Aga Khan University Medical College, Karachi, Pakistan); Badaruddin A. Memon and Gul Hassan Bhutto (Shah Abdul Latif University, Public Sector Hospital Khairpur Mir S Sindh, Khairpur, Pakistan); Nadeem Paul, Azra Parveen, Aun Raza, Amjad Mahboob, Summiya Nizamuddin, Faisal Sultan, Hammad Nazeer, and Ashraf Ali Khan (Shaukat Khanum Meorial Cancer Hospital and Research Center, Lahore, Pakistan); and Arifa Hafeez (The Indus Hospital, Karachi, Pakistan).

Panama

Lydia Lara (Santo Tomas, Panama, Panama); Trudell Mapp (Clinica Hospital San Fernando, Panama, Panama); Balkys Alvarez (Hospital Caja Del Seguro Social, Panama, Panama); Magda Ivonne Rojas-Bonilla (Hospital De Especialidades Pediatricas "Omar Torrijos Herrera", Panama, Panama); and Elizabeth Castano and Daisy A. De Moros (Hospital Del Nino, Panama, Panama).

Peru

Roberto Espinoza Atarama, Maria Elena Calisto Pazos, Alfredo Paucar, Marlene Tasayco Ramos, and Jenny Jurado (Edgardo Rebagliati Martins, Lima, Peru); Dafne Moreno (Hospital Almanzor Aguinaga Asenjo, Chiclayo, Peru); Marãa E. Cruz Saldarriaga (Hospital Nacional Adolfo Guevara Velasco, Cusco, Peru); Eliza Ramirez and Carlos Enrique La Hoz Vergara (Hospital Iv Essalud, Huancayo, Peru); Walter Enrique Prudencio Leon, Luis Isidro Castillo Bravo, Katya Fernanda Aibar Yaranga, Janet E. Pichilingue Chagray, and Vanessa A. Marquez Mondalgo (Clinica Anglo Americana, Lima, Peru); Socorro Torres Zegarra, Nazario Silva Astete, Francisco Campos Guevara, and Javier Soto Pastrana (Hospital Nacional Docente Madre Niño San Bartolomé, Lima, Peru); Walter Enrique Prudencio Leon, Carlos F. Linares Calderon, Manuel Jesus Mayorga Espichan, Luis Martin Santivanez Monge, and Maria V. Changano Rodriguez (Hospital Central De La Fuerza Aerea Del Peru, Lima, Peru); Zoila Rosa Diaz Tavera and Fernando Martin Ramirez Wong (Hospital De Emergencias Jose Casimiro Ulloa, Lima, Peru); Selene Manga Chavez (Hospital Nacional Cayetano Heredia De Lima, Lima, Peru); Zoila Rosa Diaz Tavera and Fernando Martin Ramirez Wong (Hospital Nacional Maria Auxiliadora, Lima, Peru); and Teodora Atencio-Espinoza (Hospital Regional De Pucallpa, Pucallpa, Peru).

Philippines

Victoria D. Villanueva, Maria Teresa Blanco-Abuy, Arnefelina S. Tamayo, Lailane D. Bergosa, Cristina Mari Jean P. Llames, Marilou F. Trajano, Suzette A. Bunsay, and Jessica C. Amor (St Lukes Medical Center Quezon City, Manila, Philippines); Regina Berba (Philippine General Hospital, Manila, Philippines); Maria Carmen Sg Buenaflor and Ever Labro (Philippine Heart Center, Manila, Philippines); and Myrna T. Mendoza, Ofelia P. Javellana, Lilibeth G. Salvio, Rhoda Gay Rayco, and Vanessa Bermudez (Cardinal Santos Medical Center, San Juan, Philippines).

Poland

Andrzej Kubler, Marzena Zielinska, Magdalena Kosmider-Zurawska, Barbara Barteczko-Grajek, Ewa Szewczyk, and Barbara Dragan (Wroclaw University Hospital, Wroclaw, Poland); and Malgorzata Anna Mikaszewska-Sokolewicz and Tomasz Lazowski (1st Clinic of Anaesthesia and Intensive Care Hospital of Medical University in Warsaw, Warsaw, Poland).

Puerto Rico

Elsie Cancel (San Jorge Children's Hospital-Asociacion Epidemiologos De Puerto Rico, Guaynabo, Puerto Rico).

Romania

Monica Sorina Licker, Liliana Alina Dragomirescu, Victor Dumitrascu, Dorel Sandesc, Ovidiu Bedreag, Marius Papurica, and Delia Muntean (University of Medicine and Pharmacy "Victor Babes" Clinical County Hospital, Timisoara, Romania).

Russia

Igor Kotkov, Vladimir Kretov, Vladimir Shalapuda, Alexander Molkov, Sergey Puzanov, Ivan Utkin, Alexander Tchekulaev, and Valentina Tulupova (Privolzhskiy District Medical Center, Nizhniy Novgorod, Russia).

Serbia

Ljubica Nikolic, Goran Ristic, Jelena Eremija, Jelena Kojovic, Dragana Lekic, and Sladjana Vasiljevic (Mother and Child Health Care Institute Dr Vukan Cupic Medical Faculty University of Belgrade, Belgrade, Serbia).

Slovakia

Anna Lesnakova, Alzbeta Marcekova, and Katarina Furova (Catholic University in Ruzomberok, Faculty of Health Central Military Hospital Ruzomberok, Ruzomberok, Slovakia).

Sudan

May Osman Gamar Elanbya, Malik Abdo Ali, and Shobhana Kumari Kadankunnel (Royal Care International Hospital, Khartoum, Sudan).

Thailand

Suwara Somabutr, Rungratchanee Pimathai, Suthinee Wanitanukool, Montri Luxsuwong, Namphon Supa, and Pornpheth Prasan (Bangpakok 9 International Hospital, Bangkok, Thailand); Visanu Thamlikitkul (Siriraj Hospital, Mahidol University, Bangkok, Thailand); and Silom Jamulitrat, Nonglak Suwalak, and Parichart Phainuphong (Songklanagarind Hospital, Hat Yai, Thailand).

Tunisia

Bouziri Asma, Borgi Aida, Bel Hadj Sarra, and Khaldi Ammar (Children Hospital Bechir Hamza of Tunis, Tunis, Tunisia).

Turkey

Gunay Tuncer Ertem, Cemal Bulut, Cigdem Ataman Hatipoglu, Fatma Sebnem Erdinc, and Ali Pekcan Demiroz (Ankara Training and Research Hospital, Ankara, Turkey); Menekse Ozcelik, Basak Ceyda Meco, Mehmet Oral, Necmettin Unal, and Cigdem Yildirim Guclu (Ankara University School of Medicine Department of Medicine, Anaesthesiology, and Intensive Care Medicine, Ankara, Turkey); Tanıl Kendirli, Erdal İnce, Ergin Çiftçi, Ayhan Yaman, Çağlar Ödek, Adem Karbuz, and Bilge Aldemir Kocabaş (Ankara University School of Medicine, Division of Pediatric Intensive Care Unit, Ankara, Turkey); Nilgün Altın, Salih Cesur (Etlik İhtisas Training and Education Hospital, Ankara); Begum Atasay, Omer Erdeve, Hasan Akduman, Dilek Kahvecioglu, Ufuk Cakir, Duran Yildiz, Atila Kilic, and Saadet Arsan (Ankara University School of Medicine Department of Neonatal Intensive Care Unit, Ankara, Turkey); Dilek Arman (Gazi University Medical School, Ankara, Turkey); Serhat Unal, Yasemin Gelebek, and Humeyra Zengin (Hacettepe University Hospital, Ankara, Turkey); Suha Sen, Hatice Cabadak, and Ayse Erbay (Turkiye Yuksek Ihtisas Education and Research Hospital, Ankara, Turkey); Ata Nevzat Yalcin, Ozge Turhan, Melike Cengiz, Oguz Dursun, Perihan Gunasan, Sehnaz Kaya, and Atilla Ramazanoglu (Akdeniz University School of Medicine, Antalya, Turkey); Cemal Ustun, Aliye Yasayacak, Hayrettin Akdeniz, and Fatma Sirmatel (Medical Faculty of Abant Izzet Baysal University, Bolu, Turkey); Ali Metin Otkun, Suzan Sacar, and Alper Sener (Onsekiz Mart University Hospital, Canakkale, Turkey); Huseyn Turgut, Hulya Sungurtekin, Dogaç Ugurcan, Ceyda Necan, and Cansu Yilmaz (Pamukkale University, Denizli, Turkey); Davut Ozdemir, Mehmet Faruk Geyik, Nevin Ince, Ayse Danis, and Selvi Yener Erdogan (Duzce University Training and Research Hospital, Duzce, Turkey); Nurettin Erben, Gaye Usluer, and Ilhan Ozgunes (Eskisehir Osmangazi University, Eskisehir, Turkey); Cengiz Uzun (German Hospital, Istanbul, Turkey); Oral Oncul, Levent Gorenek, Hakan Erdem, and Orhan Baylan (Gulhane Military Medical Academy Haydarpasa Training Hospital, Istanbul, Turkey); Asu Ozgultekin, Asuman Inan, and Sibel Bolukcu (Haydarpasa Numune Training and Research Hospital, Istanbul, Turkey); Gunes Senol (Dr Suat Seren Chest Diseases and Chest Surgery Training Hospital, Izmir, Turkey); Halil Ozdemir, Zeynel Gokmen, and Sonay Incesoy Ozdemir (Konya Training and Research Hospital, Konya, Turkey); Ali Kaya, Gulden Ersoz, Necdet Kuyucu, Sevim Karacorlu, and Zeynep Kaya (Mersin University School of Medicine, Mersin, Turkey); Ertugrul Guclu, Gulsume Kaya, and Oguz Karabay (Sakarya University Training and Research Hospital, Sakarya, Turkey); Saban Esen, Canan Aygun, Fatma Ulger, Ahmet Dilek, Hava Yilmaz, and Mustafa Sunbul (Ondokuz Mayis University, Samsun, Turkey); Aynur Engin, Mehmet Bakir, and Nazif Elaldi (Cumhuriyet University School of Medicine, Sivas, Turkey); Iftihar Koksal (Karadeniz Technical University School of Medicine, Trabzon, Turkey); Dincer Yildizdas and Ozden Ozgur Horoz (Balcali Hospital, Adana, Turkey); and Ayşe Willke, Meliha Meriç Koç, and Emel Azak (Kocaeli University, Medical Faculty, Department of İnfectious Diseases and Clinical Microbiology, Kocaeli, Turkey).

United Arab Emirates

Naheed Elahi, Philip Annamma, and Ashraf El Houfi (Dubai Hospital, Dubai, United Arab Emirates).

Uruguay

Maria Catalina Pirez Garcia (Centro Hospitalario Pereira Rosell Bluar, Montevideo, Uruguay).

Venezuela

Hector Vidal, Fernando Perez, Gabriel D. Empaire, Yvis Ruiz, Dulce Hernandez, Dayana Aponte, Evelyn Salinas, and Claudia Diaz (Hospital De Clinicas Caracas, Caracas, Venezuela); and María Eugenia Guzmán Siritt, Zenaida Durán Gil De Añez, Luis Montes Bravo, Nelva Orozco, and Eugenia Mejías (Hospital Militar Dr Carlos Arvelo, Caracas, Venezuela).

Vietnam

Nguyen Viet Hung, Nguyen Quoc Anh, Ngo Quy Chau, Truong Anh Thu, Doan Mai Phuong, Nguyen Gia Binh, and Le Thi Diem Tuyet (Bach Mai, Hanoi, Vietnam); Dang Thi Van Trang, Vo Thi Hong Thoa, Nguyen Phuc Tien, and Le Thi Anh Thu (Cho Ray Hospital, Ho Chi Minh, Vietnam); and Phan Thi Hang, Tran Thi My Hanh, Tran Thi Thuy Hang, and Dinh Pham Phuong Anh (Hung Vuong Hospital, Ho Chi Minh, Vietnam).