original article

Surgical Site Infections, International Nosocomial Infection Control Consortium Report, Data Summary of 30 Countries, 2005–2010

Victor D. Rosenthal, MD;[1] Rosana Richtmann, MD;[2] Sanjeev Singh, MD;[3] Anucha Apisarnthanarak, MD;[4] Andrzej Kübler, MD;[5] Nguyen Viet-Hung, MD;[6] Fernando M. Ramírez-Wong, MD;[7] Jorge H. Portillo-Gallo, MD;[8] Jessica Toscani, MD;[9] Achilleas Gikas, MD;[10] Lourdes Dueñas, MD;[11] Amani El-Kholy, MD;[12] Sameeh Ghazal, MD;[13] Dale Fisher, MD;[14] Zan Mitrev, MD;[15] May Osman Gamar-Elanbya, MD;[16,17] Souha S. Kanj, MD;[18] Yolanda Arreza-Galapia, MD;[19] Hakan Leblebicioglu, MD;[20] Soňa Hlinková, MD;[21,22] Badaruddin A. Memon, MD;[23] Humberto Guanche-Garcell, MD;[24] Vaidotas Gurskis, MD;[25] Carlos Álvarez-Moreno, MD;[26] Amina Barkat, MD;[27] Nepomuceno Mejía, MD;[28] Magda Rojas-Bonilla, MD;[29] Goran Ristic, MD;[30] Lul Raka, MD;[31] Cheong Yuet-Meng, MD[32] on behalf of the International Nosocomial Infection Control Consortium[a]

objective. To report the results of a surveillance study on surgical site infections (SSIs) conducted by the International Nosocomial Infection Control Consortium (INICC).

design. Cohort prospective multinational multicenter surveillance study.

setting. Eighty-two hospitals of 66 cities in 30 countries (Argentina, Brazil, Colombia, Cuba, Dominican Republic, Egypt, Greece, India, Kosovo, Lebanon, Lithuania, Macedonia, Malaysia, Mexico, Morocco, Pakistan, Panama, Peru, Philippines, Poland, Salvador, Saudi Arabia, Serbia, Singapore, Slovakia, Sudan, Thailand, Turkey, Uruguay, and Vietnam) from 4 continents (America, Asia, Africa, and Europe).

patients. Patients undergoing surgical procedures (SPs) from January 2005 to December 2010.

methods. Data were gathered and recorded from patients hospitalized in INICC member hospitals by using the methods and definitions of the Centers for Disease Control and Prevention National Healthcare Safety Network (CDC-NHSN) for SSI. SPs were classified into 31 types according to *International Classification of Diseases, Ninth Revision*, criteria.

results. We gathered data from of 7,523 SSIs associated with 260,973 SPs. SSI rates were significantly higher for most SPs in INICC hospitals compared with CDC-NSHN data, including the rates of SSI after hip prosthesis (2.6% vs 1.3%; relative risk [RR], 2.06 [95% confidence interval (CI), 1.8–2.4]; $P < .001$), coronary bypass with chest and donor incision (4.5% vs 2.9%; RR, 1.52 [95% CI, 1.4–1.6]; $P < .001$); abdominal hysterectomy (2.7% vs 1.6%; RR, 1.66 [95% CI, 1.4–2.0]; $P < .001$); exploratory abdominal surgery (4.1% vs 2.0%; RR, 2.05 [95% CI, 1.6–2.6]; $P < .001$); ventricular shunt, 12.9% vs 5.6% (RR, 2.3 [95% CI, 1.9–2.6]; $P < .001$), and others.

conclusions. SSI rates were higher for most SPs in INICC hospitals compared with CDC-NSHN data.

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It is increasingly difficult to ignore the burden posed by surgical site infections (SSIs) on patients' safety in terms of pain, suffering, delayed wound healing, increased use of antibiotics, revision surgery, increased length of hospital stay, mortality, and morbidity, which are also reflected in excess healthcare costs.[1] Surveillance programs focused on healthcare-associated infections (HAIs), including SSIs, are essential tools to prevent their incidence and reduce their adverse effects, thereby allowing for the reduction of patients' risk of infection. As is widely shown in the literature from high-income countries, including the United States, the incidence of HAI can be reduced by as much as 30%, and by 55% in the case of SSI, through the implementation of an effective surveillance approach.[2]

Within the scope of developing countries, several reports of the International Nosocomial Infection Control Consortium (INICC) have also shown that, if surveillance and infection control strategies are applied in limited-resource countries, HAIs can also be reduced significantly.[3-5]

According to the World Bank's categorization, 68% of the world countries have low-income and lower-middle-income economies, and they can also be referred to as lower-income or developing countries. Today, lower-income countries comprise more than 75% of the world population.[6] However, far too little attention has been paid to the incidence of SSIs in limited-resource countries, where standard methodological approaches are urgently needed.[7]

INICC is an international nonprofit, charity, open, multicenter, collaborative research network that applies a surveillance methodology that uses the standard definitions used

Affiliations: 1. International Nosocomial Infection Control Consortium, Buenos Aires, Argentina; 2. Hospital Maternidade Santa Joana, São Paulo, Brazil; 3. Amrita Institute of Medical Sciences and Research Center, Kochi , India; 4. Thammasart University Hospital, Pratumthani, Thailand; 5. University

by the US Centers for Disease Control and Prevention National Healthcare Safety Network (formerly the National Nosocomial Infection Surveillance system; CDC-NHSN),[8,9] which has provided researchers worldwide with invaluable benchmarking data on HAIs and antibiotic resistance and served as an inspiration to the INICC program.[10,11]

Initially, the INICC surveillance program was focused on the reduction of device-associated HAIs in the intensive care units of low-income countries, which is a setting in which patient safety is most seriously threatened because of the critical condition of the patients and their exposure to invasive devices.[10,11] At this stage, the systematic surveillance of SSI is also included as a primary focus of the INICC program.

This article will report an analysis of the surveillance data on SSIs associated with surgical procedures (SPs) collected by hospitals from 30 countries participating in the INICC[10,11] from January 2005 to December 2010. These systematic surveillance data will serve as an initial benchmarking tool for SSI rates within hospitals worldwide.

METHODS

Background on INICC

Founded in Argentina in 1998, the INICC was the first multinational research network established to control and reduce HAIs at an international level through the analysis of data collected on a voluntary basis by a pool of hospitals worldwide.[10-12] The goals of the INICC include the following: to develop a dynamic global network of hospitals internationally that conduct surveillance of HAIs by means of standardized definitions and established methodologies, promote implementation of evidence-based infection control practices, and perform 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; and to improve safety and quality of healthcare worldwide through implementation of systematized programs to reduce rates of HAI-associated mortality, excess lengths of stay, excess costs and bacterial resistance.[3-5]

Study Setting and Design

From January 2005 to December 2010, we conducted a cohort prospective multinational multicenter surveillance study of SSIs involving patients who underwent SPs at 82 hospitals in 66 cities in 30 countries (Argentina, Brazil, Colombia, Cuba, Dominican Republic, Egypt, Greece, India, Kosovo, Lebanon, Lithuania, Macedonia, Malaysia, Mexico, Morocco, Pakistan, Panama, Peru, Philippines, Poland, Salvador, Saudi Arabia, Serbia, Singapore, Slovakia, Sudan, Thailand, Turkey, Uruguay, and Vietnam) from 4 continents (America, Asia, Africa, and Europe). The identity of the participating INICC member hospitals, cities, and countries is kept confidential in accordance with the INICC charter. Each hospital's institutional review board agreed to the study protocol.

INICC Surveillance Program

The INICC surveillance program included outcome surveillance of SSI rates,[12] determined according to the standard Centers for Disease Control and Prevention CDC-NHSN definitions for superficial incisional, deep incisional, and organ/space infections, including laboratory and clinical criteria.[8] Infection control professionals (ICPs) were trained for data collection and reporting as part of the first stage of the INICC program on SSI prevention. Surveillance data were prospectively collected by the ICPs at each participating hospital.

On a daily basis, the ICP collected the list of patients who underwent SPs, who were followed up during the 30-day period after surgery to detect early SSIs or for 12 months for prosthesis-associated SSIs. These data were sent to INICC headquarters, where SSI rates were calculated using the number of SPs as denominator and the number of SSIs as numerator.

For analytical purposes, collected data were stratified into 31 specific SPs according the *International Classification of Diseases, Ninth Revision* (*ICD-9*), criteria.[13-16] ICPs reviewed each report of the SPs to find all performed procedures and identify *ICD-9* codes and then reviewed them with the surgeon in charge of the SP. The collected data were validated at the INICC central office in Buenos Aires before their inclusion as reported infections into the INICC database.

Hospital of Wroclaw, Wroclaw, Poland; 6. Bach Mai Hospital, Hanoi, Vietnam; 7. Hospital de Emergencias José Casimiro Ulloa, Lima, Peru; 8. CIMA, Chihuaha, Mexico; 9. Sanatorio Amedrin, Fray Bentos, Uruguay; 10. University Hospital of Heraklion, Heraklion, Greece; 11. Hospital Nacional de Niños Benjamin Bloom, San Salvador, El Salvador; 12. Dar Al Fouad Hospital, Cairo, Egypt; 13. King Fahad Medical City, Riyadh, Saudi Arabia; 14. National University Hospital, Singapore, Republic of Singapore; 15. Filip II Special Hospital for Surgery, Skopje, Macedonia; 16. Bahry Teaching Hospital, Khartoum, Sudan; 17. Khartoum Dental Teaching Hospital, Khartoum, Sudan; 18. American University of Beirut Medical Center, Beirut, Lebanon; 19. National Kidney and Transplant Institute, Quezon City, Philippines; 20. Ondokuz Mayis University Medical School, Samsun, Turkey; 21. Catholic University, Faculty of Medicine, Ružomberok, Slovakia; 22. Military Hospital SNP Ružomberok, Ružomberok, Slovakia; 23. Public Sector Hospital Khairpur, Sindh, Pakistan; 24. Hospital Docente Clínico Quirúrgico "Joaquín Albarrán Domínguez," Havana, Cuba; 25. Lithuanian University of Health Sciences, Kaunas, Lithuania; 26. Pontificia Universidad Javeriana, Hospital Universitario San Ignacio, Bogota, Colombia; 27. Children Hôspital of Rabat, Rabat, Morocco; 28. Hospital General de la Plaza de la Salud, Santo Domingo, Dominican Republic; 29. Hospital de Especialidades Pediátricas "Omar Torrijos Herrera," Panama City, Panama; 30. Mother and Child Health Institute of Serbia, Belgrade, Serbia; 31. National Institute for Public Health of Kosovo and Medical School, Prishtina University, Prishtina, Kosovo; 32. Sunway Medical Centre Berhad and Monash University Sunway Campus, Petaling Jaya, Malaysia; a. Members of the International Nosocomial Infection Control Consortium are listed at the end of the text.

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TABLE 1. Features of the participating International Nosocomial Infection Control Consortium hospitals, 2005–2010, by region

Variable	Latin America	Asia	Africa	Europe	All
Countries	Argentina, Brazil, Colombia, Cuba, Dominican Republic, Mexico, Panama, Peru, El Salvador, Uruguay	India, Lebanon, Malaysia, Pakistan, Philippines, Saudi Arabia, Singapore, Thailand, Vietnam	Egypt, Morocco, Sudan	Greece, Kosovo, Lithuania, Macedonia, Poland, Serbia, Slovakia, Turkey	...
No. of countries	10	9	3	8	30
No. of cities	23	17	3	23	66
No. (%) of hospitals					
Overall	28	22	5	27	82
Academic teaching	9 (32)	10 (45)	4 (80)	22 (81)	47 (55)
Public	9 (32)	4 (18)	0 (0)	3 (11)	16 (20)
Private community	10 (36)	8 (36)	1 (20)	2 (7)	21 (25)
No. of SPs	124,099	68,415	5,706	62,753	260,973
No. of SSIs	2,047	2,580	181	2,715	7,523

NOTE. SP, surgical procedure; SSI, surgical site infection.

Data on the duration of SPs, level of contamination, and infection risk index classification of the American Society of Anaesthesiology (ASA)[17] according to the patient's physical condition were not collected. For this reason, it was not possible to calculate the infection risk index of each SP. Therefore, because our data are not stratified by risk categories, we pooled the different risk categories included in the CDC-NHSN report for 2006–2008[18] to obtain the mean rate of SSIs, and we compared this rate with our results.

SPs

The SPs included in this study are based on those of the *ICD-9* and listed in CDC-NSHN report, as follows: abdominal aortic aneurysm repair (AAA); limb amputation (AMP); appendix surgery (APPY); bile duct, liver, or pancreatic surgery (BILI); breast surgery (BRST); cardiac surgery (CARD); coronary bypass with chest and donor incision (CBGB); gallbladder surgery (CHOL); colon surgery (COLO); craniotomy (CRAN); cesarean delivery (CSEC); spinal fusion (FUSN); open reduction of fracture (FX); gastric surgery (GAST); herniorrhaphy (HER); hip prosthesis (HPRO); heart transplant (HTP); abdominal hysterectomy (HYST); knee prosthesis (KPRO); kidney transplant (KTP); laminectomy (LAM); neck surgery (NECK); kidney surgery (NEPH); prostate surgery (PRST); peripheral vascular bypass surgery (PVBY); rectal surgery (REC); small bowel surgery (SB); spleen surgery (SPLE); thoracic surgery (THOR); thyroid and/or parathyroid surgery (THYR); vaginal hysterectomy (VHYS); ventricular shunt (VSHN); and exploratory abdominal surgery (XLAP).[8]

Statistical Analysis

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

RESULTS

Table 1 shows characteristics of 82 hospitals of 66 cities from 30 countries in Latin America, Asia, Africa, and Europe currently participating in INICC that contributed data for this report. Table 2 shows SSI rates, stratified by SP, including number of procedures, number of SSIs, SSI rate, and percentiles. The SPs with the highest SSI rates were VSHN (12.9%), COLO (9.4%), and BILI (9.2%). The lowest rates were found for THYR (0.3%) and CSEC (0.7%).

Table 3 compares SSI rates for the INICC and CDC NHSN SPs and is quite revealing in several ways. Eighteen (58%) of 31 of the SPs (APPY, CBGB, CARD, CHOL, COLO, CRAN, FUSN, FX, GAST, HPRO, HYST, KPRO, LAM, NEPH, THOR, VHYS, VSHN, and XLAP) were associated with significantly higher rates of SSI in the INICC data than in the CDC-NHSN report. Nine (29%) of 31 of the SPs were associated with similar rates of SSI in the INICC data and in the CDC-NHSN report, whereas only 4 (13%) of 31 of the SPs (CSEC, HER, PVBY, and REC) were associated with significantly lower SSI rates in the INICC data than in the CDC-NHSN report.

As Table 3 also shows, if the percentages of SSI are considered by type of SP, the SPs associated with the highest percentages of SSI are similar for the INICC data and the CDC-NHSN report. Specifically, the 3 SPs associated with the highest percentage of SSI found in the INICC data (VHSN, COLO, and BILI) are within the 5 SPs with the highest percentage of SSI found in the CDC-NHSN report (BILI, REC, PVBY, SB, COLO, and VSHN), ranging from 12.9% to 9.9% in the INICC data and from 9.9% to 5.6% in the CDC-NHSN report, respectively. Interestingly, the results in Table 3 indicate that the risk of infection by type of SP is similar in table 2. Surgical site infections (SSIs) at the participating International Nosocomial Infection Control Consortium (INICC) hospitals, 2005–2010

Code	Procedure name	No. of procedures	No. of INICC SSIs	INICC SSI rate, %	No. of hospitals	10th percentile	25th percentile	50th percentile	75th percentile	90th percentile
AAA	Abdominal aortic aneurysm repair	13	1	7.7	1	...	...	...	...	...
AMP	Limb amputation	4,040	111	2.7	14	...	...	...	...	...
APPY	Appendix surgery	13,668	395	2.9	21	0.12	1.5	2.0	5.3	8.2
BILI	Bile duct, liver or pancreatic surgery	1,262	116	9.2	13	...	...	...	...	...
BRST	Breast surgery	4,148	72	1.7	12	...	...	...	...	...
CBGB	Coronary bypass with chest and donor incision	3,6057	1,615	4.5	35	0.0	1.0	3.2	71	10.8
CARD	Cardiac surgery	14,070	781	5.6	21	0.0	1.2	2.8	6.6	18.9
CHOL	Gallbladder surgery	9,980	247	2.5	21	0.0	0.0	1.4	3.8	5.7
COLO	Colon surgery	4,285	402	9.4	15	...	...	...	...	...
CRAN	Craniotomy	12,501	551	4.4	32	0.0	0.7	3.0	6.0	9.0
CSEC	Cesarean delivery	85,254	606	0.7	18	...	...	...	...	...
FUSN	Spinal fusion	990	32	3.2	9	...	...	...	...	...
FX	Open reduction of fracture	6,642	281	4.2	15	...	...	...	...	...
GAST	Gastric surgery	1,221	67	5.5	8	...	...	...	...	...
HER	Herniorrhaphy	9,843	173	1.8	25	0.0	0.5	12.3	3.1	4.9
HPRO	Hip prosthesis	8,607	225	2.6	38	0.0	0.2	2.1	4.5	5.9
HYST	Abdominal hysterectomy	3,875	106	2.7	20	0.0	0.0	2.1	4.9	10.5
KPRO	Knee prosthesis	9,299	153	1.6	28	0.0	2.4	1.2	4.1	10.3
LAM	Laminectomy	5,352	91	1.7	17	...	...	...	...	...
NECK	Neck surgery	695	26	3.7	11	...	...	...	...	...
NEPH	Kidney surgery	1,575	49	3.1	15	...	...	...	...	...
PRST	Prostate surgery	2,221	47	2.1	15	...	...	...	...	...
PVBY	Peripheral vascular bypass surgery	2,184	54	2.5	7	...	...	...	...	...
REC	Rectal surgery	385	9	2.3	2	...	...	...	...	...
SB	Small bowel surgery	1,921	106	5.5	15	...	...	...	...	...
SPLE	Spleen surgery	287	16	5.6	13	...	...	...	...	...
THOR	Thoracic surgery	7,880	482	6.1	16	...	...	...	...	...
THYR	Thyroid and/or parathyroid surgery	307	1	0.3	4	...	...	...	...	...
VHYS	Vaginal hysterectomy	1,584	31	2.0	10	...	...	...	...	...
VSHN	Ventricular shunt	2,623	338	12.9	18	...	...	...	...	...
XLAP	Exploratory abdominal surgery	8,204	339	4.1	23	0.0	2.2	4.0	6.8	15.7
All		260,973	7,523	2.9						

the INICC and CDC-NHSN, but as revealed by the data presented in Table 2, the incidence of SSI is considerably higher in INICC hospitals.

DISCUSSION

Our study was designed to determine the incidence of SSIs within a wide range of hospitals, mostly from limited-resource economies. A comparison between this study's findings and the data reported by the CDC-NHSN for 2006–2008 showed that, in INICC hospitals, the SSIs (58%) associated with most of the SPs analyzed were much higher than those published for the United States.[18]

Such higher SSI rates may reflect the typical hospital situation in limited-resource countries as a whole,[19] and several reasons have been proposed to explain this fact.[20,21] Among the primary plausible causes, it can be mentioned that, in almost all limited-resource countries, there are still no legally enforceable rules or regulations concerning the implementation of infection control programs, such as national infection control guidelines; in the few cases in which there is a

TABLE 3. Comparison of surgical site infection (SSI) rates in the hospitals of the International Nosocomial Infection Control Consortium (INICC) and the US Centers for Disease Control and Prevention National Healthcare Safety Network (CDC-NHSN)

CODE	Procedure name	INICC 2005–2010, SSI rate, %	CDC-NHSN 2006–2008 SSI rate (pooled risk categories), %	RR	95% CI	P
AAA	Abdominal aortic aneurysm repair	7.7	3.2	2.41	0.33–17.40	.3668
AMP	Limb amputation	2.7	2.3	1.18	0.80–1.74	.4099
APPY	Appendix surgery	2.9	1.4	2.05	1.61–2.59	.0001
BILI	Bile duct, liver or pancreatic surgery	9.2	9.9	0.93	0.70–1.22	.5945
BRST	Breast surgery	1.7	2.3	0.77	0.55–1.06	.1111
CBGB	Coronary bypass with chest and donor incision	4.5	2.9	1.52	1.44–1.61	.0001
CARD	Cardiac surgery	5.6	1.3	4.32	3.81–4.88	.0001
CHOL	Gallbladder surgery	2.5	0.6	3.94	3.10–5.01	.0001
COLO	Colon surgery	9.4	5.6	1.69	1.52–1.87	.0001
CRAN	Craniotomy	4.4	2.6	1.69	1.46–1.96	.0001
CSEC	Cesarean section	0.7	1.8	0.39	0.34–0.43	.0001
FUSN	Spinal fusion	3.2	1.5	2.10	1.48–3.00	.0001
FX	Open reduction of fracture	4.2	1.7	2.44	2.02–2.93	.0001
GAST	Gastric surgery	5.5	2.3	2.41	1.82–3.19	.0001
HER	Herniorrhaphy	1.8	2.3	0.78	0.63–0.96	.0197
HPRO	Hip prosthesis	2.6	1.3	2.06	1.80–2.37	.0001
HYST	Abdominal hysterectomy	2.7	1.6	1.66	1.36–2.03	.0001
KPRO	Knee prosthesis	1.6	0.9	1.84	1.56–2.18	.0001
LAM	Laminectomy	1.7	1.0	1.67	1.33–2.09	.0001
NECK	Neck surgery	3.7	3.5	1.07	0.60–1.91	.8116
NEPH	Kidney surgery	3.1	1.5	2.12	1.07–4.18	.0267
PRST	Prostate surgery	2.1	1.2	1.82	0.97–3.43	.0598
PVBY	Peripheral vascular bypass surgery	2.5	6.7	0.37	0.28–0.49	.0001
REC	Rectal surgery	2.3	7.4	0.32	0.16–0.63	.0005
SB	Small bowel surgery	5.5	6.1	0.91	0.72–1.14	.3937
SPLE	Spleen surgery	5.6	2.3	2.39	0.93–6.10	.0606
THOR	Thoracic surgery	6.1	1.1	5.50	3.59–8.44	.0001
THYR	Thyroid and/or parathyroid surgery	0.3	0.3	1.27	0.13–12.19	.8366
VHYS	Vaginal hysterectomy	2.0	0.9	2.24	1.52–3.28	.0002
VSHN	Ventricular shunt	12.9	5.6	2.30	1.96–2.69	.0001
XLAP	Exploratory abdominal surgery	4.1	2.0	2.05	1.64–2.55	.0001
All		2.9	2.0	1.45	...	...

NOTE. CI, confidence interval; RR, relative risk.

legal framework, adherence to and compliance with the guidelines is irregular, and hospital accreditation is not mandatory.

The association between the rates of device-associated, healthcare-associated infection (DA-HAI) and hospital type (public, academic, and private) and the association between DA-HAI rates and the socioeconomic level of the country (defined as low income, mid-low income, and high income) have recently been analyzed and published by the INICC. This study's findings showed a negative correlation for most types of DA-HAI; that is, a higher socioeconomic level was correlated with a lower infection risk.[22,23]

In most INICC hospitals, lack of official regulations is strongly correlated to the considerable variability found in compliance with hand hygiene recommendations.[19] This situation is further emphasized by the fact that administrative and financial support in most INICC hospitals is insufficient to fund infection control programs[20,21] and invariably results in extremely low nurse-to-patient staffing ratios, which have been shown to be highly associated with high HAI rates, hospital overcrowding, lack of medical supplies, and an insufficient number of experienced nurses or trained healthcare workers.[20,21]

To compare a hospital's SSI rates with the rates identified in this article, it is required that the hospitals concerned start collecting their data by applying definitions of SPs as provided by the *ICD-9*, which are the definitions described by CDC-NHSN, to identify SSIs and then use the methodology described by the CDC-NHSN to calculate SSI rates. Participation in the INICC has played a fundamental role, not only in increasing the awareness of HAI risks in the INICC hospitals, but also in providing an exemplary basis for the institution of infection control practices. In many INICC hospitals, for example, the high incidence of HAI has been reduced by 30%–70% by implementing multidimensional programs that include a bundle of infection control interventions, education, outcome surveillance, process surveillance, feedback of HAI rates, and performance feedback of infection control practices for central-line-associated bloodstream infections, mechanical-ventilation-associated pneumonia, and urinary-catheter-associated urinary tract infections.[3-5]

Because of a limited budget, this study has 3 main limitations. First, we were unable to calculate the risk category of the SPs, because we did not collect the duration of each SP, the level of contamination, or the ASA score. Second, we were not able to collect data on microorganism profile and bacterial resistance. However, since 2012, these data have been collected by INICC member hospitals, thereby enabling the future assessment of the SSI risk index associated with SPs. Third, because of the small sample size for some SPs, these results should be interpreted with caution. In reviewing the literature, no data were found on this topic, and future studies are therefore recommended.

CONCLUSIONS

The data presented here underscore the fact that HAIs, particularly SSIs, pose a grave and often concealed risk to patient safety in the developing world that is greater than that in much of the developed world. As reported in the literature, the association between HAI rates and a country's socioeconomic level and the hospital type indicated a negative correlation. This relationship should be extensively analyzed for SSIs. There is, therefore, a definite need for additional studies on this subject, particularly in developing countries. This information can be used as a benchmarking tool to develop targeted interventions aimed at designing SSI prevention programs and evaluating their impact.

INTERNATIONAL NOSOCOMIAL INFECTION CONTROL CONSORTIUM MEMBERS

Argentina. Sonia Tome (Hospital 4 de Junio, Sáenz Peña).

Brazil. Tatiane Rodrigues, Sandra Regina Baltieri, Fabiana Camolesi, Camila de Almeida Silva (Hospital Maternidade Santa Joana, São Paulo); Erci M. Onzi-Siliprandi, Rodrigo Pires dos Santos (Instituto de Cardiologia do Rio Grande do Sul, Porto Alegre); Tarquino E. G. Sánchez, Roberto Valente, Daniele Apolinário (Hospital Anchieta LTDA, Taguatinga); Marina Moreira, Gabriela Fagundes Stadtlober, Adriana Giunta Cavaglieri (Hospital Universitario de Taubaté, Taubaté).

Colombia. Ana M. Pérez-Fernandez, Ivan Francisco Pinilla-Martínez, Paula Andrea Martínez-Saleg (Clínica Central Del Quindio, Armenia); Yazmín León-Vega, Elkin Lemos Luengas (Clínica del Occidente, Bogotá); Jorge Quintero, Patricia Sierra (IPS Universitaria, Medellín); Edwin Chapeta-Parada, Andrés Eduardo Mindiola-Roche (Hospital San Vicente de Arauca, Arauca); Claudia Linares (Pontificia Universidad Javeriana, Hospital Universitario San Ignacio, Bogotá); David Yepes-Gomez, Bernarda Maria Vergara Gómez, Marcela Gaviria Ruiz (Clínica CES, Medellín).

Cuba. Clara Morales-Pérez (Joaquín Albarrán Domínguez, Havana).

Dominican Republic. Ramona Severino, Margarita Delgado, Yokasta Pérez, Gilda Tolari (Hospital General de la Plaza de la Salud, Santo Domingo); Tatiana Sánchez (Hospital Infantil Dr. Robert Reid Cabral, Santo Domingo).

Egypt. Tarek Marei, Yahia Balbaa, Gamal Sami, Adel El Banna (Dar Al Fouad Hospital, Cairo).

El Salvador. Ana Concepción Bran de Casares, Lilian de Jesús Machuca (Hospital Nacional de Niños Benjamin Bloom, San Salvador).

Greece. Kalliopi Chaniotaki, Constantinos Tsioutis, Dimitris Bampalis (University Hospital of Heraklion, Heraklion).

India. Kavitha Radhakrishnan (Amrita Institute of Medical Sciences and Research Center, Kochi); Murali Chakravarthy, B. N. Gokul, R. Sukanya, P. Leema (Fortis Hospital, Bangalore); Sheila Nainan Myatra, C. S. Pramesh, S.V. Shrikhande, A. Gulia, A. Puri, A. Moiyadi, J. V. Divatia, Rohini Kelkar, Sanjay Biswas, Sandhya Raut, Sulochana Sampat, (Tata Memorial Hospital, Mumbai); Arpita Dwivedy, Suvin Shetty, Sheena Binu (Dr. L. H. Hiranandani Hospital, Mumbai); Iqbal Bagasrawala (Saifee Hospital, Mumbai); Nita Munshi (Ruby Hall Clinic, Pune); Tanu Singhal, Sweta Shah, Reshma Naik, Tanu Singhal (Kokilaben Dhirubhai Ambani Hospital, Mumbai); Bishnu Panigrahi, Bindu Sharma (Max Healthcare, New Delhi); Sanjeev Sood, Neeru Verma (Military Hospital, Jodhpur); Pravin Kumar-Nair, M. B. Shah, Sis Felcy Chacko (Holy Spirit Hospital, Mumbai).

Kosovo. Nehat Baftiu, Gazmend Spahija (University Clinical Center of Kosovo, Prishtina).

Lebanon. Nada Zahreddine, Lamia Alamuddin, Zeina Kanafani, Bassel Molaeb (American University of Beirut Medical Center, Beirut).

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

Macedonia. Tanja Anguseva, Vilma Ampova, Snezana Tufekcievska Guroska, Zaneta Bogoevska-Miteva (Filip II Special Hospital for Surgery, Skopje).

Malaysia. Jegathesan Manikavasagam, Lian Huat Tan, Joelene Lim, (Sunway Medical Centre, Petaling Jaya).

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Morocco. Naima Lamdouar Bouazzaoui, Kabiri Meryem

(Children Hôspital of Rabat, Rabat); Rédouane Abouqal, Naoufel Madani, Amine Ali Zeggwagh, Pr Khalid Abidi, Tarek Dendane (Ibnsina Hospital, Rabat).

Pakistan. Gul Hassan Bhutto (Public Sector Hospital Khairpur, Sindh).

Panama. Kathia Luciani, Carmen Gisela González (Hospital de Especialidades Pediátricas "Omar Torrijos Herrera," Panama City).

Peru. Zoila Rosa Díaz Tavera (Hospital de Emergencias José Casimiro Ulloa, Lima); Eliza Ramirez (ESSALUD- Red Asistencial ANCASH- Hospital III, Chimbote); Teodora Atencio-Espinoza, Favio Sarmiento López (Hospital Regional de Pucallpa, Ucayali); Socorro L. Torres-Zegarra, Nazario Silva Astete, Francisco Campos Guevara, Carlos Bazan Mendoza, Augusto Valencia Ramírez, Javier Soto Pastrana (Hospital Nacional Docente Madre Niño San Bartolomé, Lima).

Philippines. Josephine A. Navoa-Ng, Victoria D Villanueva, María Corazon V. Tolentino (Saint Luke's, Quezon City); Myrna T. Mendoza, Aileen Riego Javier, Lily S. Belmonte (Infection Control Team of National Kidney and Transplant Institute, Quezon City).

Poland. Wieslawa Duszynska, Teresa Kaiser, Barbara Szmaj (University Hospital of Wroclaw, Wroclaw).

Saudi Arabia. Ahmed Hakawi (King Fahad Medical City, Riyadh).

Singapore, Republic of. Paul Anantharajah Tambyah (National University Hospital, Singapore).

Slovakia. Ivan Kubacka (Surgical Clinic, UVN SNP FN, Ružomberok); Anna Lesnakova (Faculty of Health, Catholic University, Ružomberok).

Sudan. Ibrahim M. Sid Ahmed Ali, Asim A.Satti (Bahry Teaching Hospital, Khartoum Dental Teaching Hospital, Khartoum).

Thailand. Silom Jamulitrat (Songklanagarind Hospital, Songkla); Visanu Thamlikitkul (Siriraj Hospital, Mahidol University, Bangkok).

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Address correspondence to Victor D. Rosenthal, MD, MSc, CIC, International Nosocomial Infection Control Consortium, Corrientes Avenue #4580, Floor 12, Apartment D, Buenos Aires 1195, Argentina (victor_rosenthal@inicc.org).

REFERENCES

1. Harrop JS, Styliaras JC, Ooi YC, Radcliff KE, Vaccaro AR, Wu C. Contributing factors to surgical site infections. *J Am Acad Orthop Surg* 2012;20:94–101.
2. Umscheid CA, Mitchell MD, Doshi JA, Agarwal R, Williams K, Brennan PJ. Estimating the proportion of healthcare-associated infections that are reasonably preventable and the related mortality and costs. *Infect Control Hosp Epidemiol* 2011;32:101–114.
3. 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.

4. Tao L, Hu B, Rosenthal VD, Zhang Y, Gao X, He L. Impact of a multidimensional approach on ventilator-associated pneumonia rates in a hospital of Shanghai: Findings of the International Nosocomial Infection Control Consortium. *J Crit Care* 2012;27:440–446.
5. 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.
6. The World Bank. The World Bank list of economies. World Bank, 2008. http://www.worldbank.org/. Accessed May 12, 2010.
7. Aiken AM, Karuri DM, Wanyoro AK, Macleod J. Interventional studies for preventing surgical site infections in sub-Saharan Africa: a systematic review. *Int J Surg* 2012;10:242–249.
8. 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.
9. 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.
10. 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.
11. 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.
12. 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–e12.
13. Williams CA, Hauser KW, Correia JA, Frias JL. Ascertainment of gastroschisis using the ICD-9-CM surgical procedure code. *Birth Defects Res A Clin Mol Teratol* 2005;73:646–648.
14. Stausberg J, Lang H, Obertacke U, Rauhut F. Classifications in routine use: lessons from ICD-9 and ICPM in surgical practice. *J Am Med Inform Assoc* 2001;8:92–100.
15. Estrada JA, Guix J, Puig P, Brull D. Extension of the ICD-9-CM classification of surgical interventions [in Spanish]. *Gac Sanit* 1987;1:83.
16. Tedeschi P, Griffith JR. Classification of hospital patients as "surgical": implications of the shift to ICD-9-CM. *Med Care* 1984;22:189–192.
17. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. Guideline for prevention of surgical site infection, 1999. Hospital Infection Control Practices Advisory Committee. *Infect Control Hosp Epidemiol* 1999;20:250–278; quiz 79–80.
18. Edwards JR, Peterson KD, Mu Y, et al. National Healthcare Safety Network (NHSN) report: data summary for 2006 through 2008, issued December 2009. *Am J Infect Control* 2009;37:783–805.
19. Allegranzi B, Bagheri Nejad S, Combescure C, et al. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. *Lancet* 2011;377:228–241.
20. Lynch P, Rosenthal VD, Borg MA, Eremin SR. Infection control in developing countries. In: Jarvis WR, ed. Bennett and Brachman's hospital infections. Philadelphia: Lipppincott Williams & Wilkins, 2007:255.
21. Rosenthal VD. Health-care-associated infections in developing countries. *Lancet* 2011;377:186–188.
22. 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;39:439–550.
23. Rosenthal VD, Jarvis WR, Jamulitrat S, et al. 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.