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Major article

Surgical site infection rates in 16 cities in Turkey: findings of the International Nosocomial Infection Control Consortium (INICC)

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Background: Surgical site infections (SSIs) are a threat to patient safety; however, there were no available data on SSI rates stratified by surgical procedure (SP) in Turkey.
Methods: Between January 2005 and December 2011, a cohort prospective surveillance study on SSIs was conducted by the International Nosocomial Infection Control Consortium (INICC) in 20 hospitals in 16

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Surgical wound infection
Developing countries

Turkish cities. Data from hospitalized patients were registered using the Centers for Disease Control and Prevention (CDC) National Healthcare Safety Network (NHSN) methods and definitions for SSIs. Surgical procedures (SPs) were classified into 22 types according to International Classification of Diseases, Ninth Revision criteria.

Results: We recorded 1879 SSIs, associated with 41,563 SPs (4.3%; 95% confidence interval, 43-4.7). Among the results, the SSI rate per type of SP compared with rates reported by the INICC and CDC NHSN were 11.9% for ventricular shunt (vs 12.9% vs 5.6%); 5.3% for craniotomy (vs 4.4% vs 2.6%); 4.9% for coronary bypass with chest and donor incision (vs 4.5 vs 2.9); 3.5% for hip prosthesis (vs 2.6% vs 1.3%), and 3.0% for cesarean section (vs 0.7% vs 1.8%).

Conclusions: In most of the 22 types of SP analyzed, our SSI rates were higher than the CDC NHSN rates and similar to the INICC rates. This study advances the knowledge of SSI epidemiology in Turkey, allowing the implementation of targeted interventions.

It is difficult to ignore the burden posed by surgical site infections (SSIs) on patient safety in Turkey in terms of pain, suffering, delayed wound healing, increased antibiotic use, revision surgery, increased length of hospital stay, and increased morbidity and mortality, which are also reflected in excessive health care costs.[1] Nevertheless, as far as we know, the incidence of SSIs in Turkey has not been systematically studied to date. Thus, for Turkey, there no data on global SSI rates or SSI rates stratified by surgical procedure (SP) according to International Classification of Diseases, Ninth Revision (ICD-9) criteria,[2-5] which would provide a basis for international benchmarking.[6]

According to the World Bank's classification of national economies based on 2012 gross national income per capita, low-income and lower middle-income economies represent more than 75% of the world's population.[7] The incidence of SSIs in limited-resource economies has not been studied systematically, however, and standard methodological approaches are infrequently introduced in infection control programs in such countries.[8,9]

Surveillance programs focused on health care–associated infections (HAIs), including surgical site infections (SSIs), are essential tools for preventing their occurrence and reducing their adverse effects, thereby reducing patients' risk of infection. As widely shown in the literature from high-income countries, including the United States, the HAI rate can be reduced by as much as 30%, and by as much as 55% in the case of SSIs, through the implementation of an effective surveillance approach.[10]

Within the scope of developing countries, several reports of the International Nosocomial Infection Control Consortium (INICC) have also shown that application of surveillance and infection control strategies can significantly reduce HAI rates in limited-resource countries.[11-13] The first joint effort to provide data on the epidemiology of SSIs was initiated by the INICC in 2005 and continues to the present day, to providing the big picture of SSI rates in limited-resource countries.[14] The objective of the present study was to provide a comprehensive analysis of each of these countries.

As noted in a 2011 World Health Organization report, limited-resource countries like Turkey only have published data on SSI rates stratified by level of wound contamination.[15] This multicenter study, conducted between January 2005 and December 2011 at 20 hospitals in 16 cities of Turkey, is the first to report an analysis on the SSIs rates associated with 22 types of surgical procedures (SPs) stratified according to the ICD-9 and the Centers for Disease Control and Prevention (CDC) National Healthcare Safety Network (NHSN), which will allow us to introduce targeted interventions.

METHODS

Background on the INICC

The INICC is an open, nonprofit, HAI surveillance network that applies methods based on US CDC NHSN guidelines.[16] The INICC was established to measure and control HAIs worldwide in hospitals through the analysis of standardized data collected on a voluntary basis by its member hospitals, fostering the use of evidence-based preventive measures. Since its international inception in 2002, the INICC has steadily grown and now composes nearly 1000 hospitals in 300 cities of 60 countries in Latin America, Asia, Africa, the Middle East, and Europe, and is currently the sole source of aggregate standardized international data on the epidemiology of HAIs.[14]

Study setting and design

Between January 2005 and December 2011, we conducted a cohort prospective multicenter surveillance study of SSIs on patients undergoing SPs in 20 medium-sized hospitals of 16 cities in Turkey. Sixteen of the 20 hospitals (80%) participating in this study are academic teaching hospitals, 3 (15%) are public hospitals, and 1 (5%) is a private community hospital.

Each participating hospital's Institutional Review Board approved the study protocol. Patient confidentiality was protected by codifying the recorded information, making it identifiable only to the infection control team.

INICC surveillance program

As part of the INICC program on SSI prevention, infection control professionals (ICPs) at each participating hospital were trained in conducting outcome surveillance of SSI rates,[16] according to the standard CDC NHSN definitions for superficial incisional, deep incisional, and organ/space SSIs, including laboratory and clinical criteria.[14]

Data collection

SSI rates were calculated using the number of SPs as the denominator and the number of SSIs as the numerator. The ICP recorded these SSI rates, as well as data by type of SP, which were collected from the SP book of the operating theater at each participating hospital. The collected data included the names of the patients who underwent SPs; these patients were followed up during the 30 postsurgical days to detect early SSIs, or for 12 months for prosthesis-related SSIs. Microbiological data were collected.

Table 1
SSIs in participating Turkish hospitals by type of procedure

Code	Procedure	Procedures, n	SSIs, n	Turkey SSI rate, % (95% CI)	Hospitals, n
1. AMP	Limb amputation	494	47	9.5 (7.1-12.5)	5
2. CBGB	Coronary bypass with chest and donor incision	4040	198	4.9 (4.3-5.6)	13
3. CARD	Cardiac surgery	1228	33	2.7 (1.9-3.8)	8
4. CHOL	Gallbladder surgery	3353	44	1.3 (1.0-1.8)	7
5. COLO	Colon surgery	2378	271	11.4 (10.1-12.7)	6
6. CRAN	Craniotomy	3122	166	5.3 (4.6-6.2)	10
7. CSEC	Cesarean section	197	6	3.0 (1.1-6.5)	2
8. FUSN	Spinal fusion	371	8	2.2 (0.9-4.2)	4
9. FX	Open reduction of fracture	2592	130	5.0 (4.2-5.9)	7
10. GAST	Gastric surgery	468	20	4.3 (2.6-6.5)	2
11. HPRO	Hip prosthesis	2766	96	3.5 (2.8-4.2)	16
12. HYST	Abdominal hysterectomy	2025	62	3.1 (2.4-3.9)	8
13. KPRO	Knee prosthesis	1876	64	3.4 (2.6-4.3)	13
14. LAM	Laminectomy	4211	56	1.3 (1.0-1.7)	8
15. NECK	Neck surgery	175	13	7.4 (4.0-12.4)	4
16. NEPH	Kidney surgery	351	10	2.8 (1.4-5.2)	6
17. PRST	Prostate surgery	1470	27	1.8 (1.2-2.7)	6
18. SPLE	Spleen surgery	139	7	5.0 (2.0-10.1)	5
19. THOR	Thoracic surgery	6137	408	6.6 (6.0-7.3)	7
20. VHYS	Vaginal hysterectomy	239	4	1.7 (0.5-4.2)	4
21. VSHN	Ventricular shunt	1213	138	11.4 (9.6-13.3)	12
22. XLAP	Exploratory abdominal surgery	2718	71	2.6 (2.0-3.3)	10
All		41,563	1879	4.3 (4.3-4.7)	20

CI, confidence interval.

For analytical purposes, collected data were stratified into 22 SPs according to ICD-9 criteria.[2-5] ICPs reviewed each SP report to identify all SPs performed and note the ICD-9 codes. The collected data were validated at the INICC's central office in Buenos Aires before their inclusion into the INICC database as reported SSIs. The validation process included revision of age, sex, and length of stay, among other data revised for consistency.

Data on the duration of SPs, level of contamination, and infection risk index classification of the American Society of Anesthesiology[18] according to the patient's physical condition were not collected at this first step. As a result, we were not able to calculate the infection risk index of each SP, and thus we pooled the different risk categories included in the CDC NHSN reports for 2006-2008[19] to obtain the mean SSI rate, and compared this rate with our results.

SPs

The 22 SPs included in this study are those described in the ICD-9 and listed in CDC NSHN report, as follows: limb amputation (AMP), coronary bypass with chest and donor incision (CBGB), cardiac surgery (CARD), gallbladder surgery (CHOL), colon surgery (COLO), craniotomy (CRAN), cesarean section (CSEC), spinal fusion (FUSN), open reduction of fracture (FX), gastric surgery (GAST), hip prosthesis (HPRO), abdominal hysterectomy (HYST), knee prosthesis (KPRO), laminectomy (LAM), neck surgery (NECK), kidney surgery (NEPH), prostate surgery (PRST), spleen surgery (SPLE), thoracic surgery (THOR), vaginal hysterectomy (VHYS), ventricular shunt (VSHN), and exploratory abdominal surgery (XLAP).[16]

Statistical analysis

Data analyses were performed using EpiInfo 6.04b (Centers for Disease Control and Prevention, Atlanta, GA) and SPSS 16.0 (SPSS, Chicago, IL). Relative risk ratios, 95% confidence intervals, and *P* values were determined for all primary and secondary outcomes. *P* values $<.05$ are reported as statistically significant. Our initial assumption was that the SSI rate would be higher in this study than in the INICC and CDC NHSN reports. To compare incidence densities of SSI, we considered as the data of this study "exposed" and the events of the INICC and CDC benchmarks "nonexposed."

RESULTS

Table 1 presents SSI rates, stratified by SP, including number of SPs, number of SSIs, and SSI rate with 95% confidence intervals. The SPs with the highest SSI rates were VSHN (11.9%) and COLO (11.4%). Table 2 compares SSI rates in the present study with those in the INICC reports for 2005-2010 and in the CDC NHSN reports for 2007-2009.

Compared with the CDC NHSN rates, our SSI rates were significantly higher in 19 of the 22 analyzed SP types (86%) (AMP, CBGB, CARD, CHOL, COLO, CRAN, CSEC, FUSN, FX, GAST, HPRO, HYST, KPRO, NECK, NEPH, SPLE, THOR, VHYS, and VSHN), but similar in the other 3 SPs (14%) (LAM, PROST, and XLAP). Compared with the INICC rates, our SSI rates were significantly higher in 4 of the 22 analyzed SPs (18%) (AMP, CSEC, KPRO, and NECK), similar in 17 (77%) (CBGB, CHOL, COLO, CRAN, FUSN, FX, GAST, HPRO, HYST, LAM, NEPH, PRST, SPLE, THOR, VHYS, VSHN, and XLAP), and lower in 1 (5%) (CARD).

DISCUSSION

The present study was designed to determine the incidence of SSIs in 20 hospitals in 16 cities in Turkey, a limited-resource economy. In this study, we found higher SSI rates for AMP, COLO, CRAN, HPRO, KPRO, and NECK compared with those reported by the INICC and CDC NHSN. Our SSI rates for CBGB, FX, GAST, HYST, LAM, and VSHN were higher than those of the CDC NHSN, but similar to those of the INICC. Our SSI rates for CARD and CHOL were lower than those of the INICC, but higher than those of the CDC NHSN. Our SSI rate for CSEC was higher than that of the INCC, but similar to that of the CDC NHSN. Our SSI rate for XLAP was lower than that of the INICC, but similar to that of the CDC NHSN. Finally, our SSI rates for FUSN, NEPH, PRST, SPLE, THOR, and VHYS were not statistically significantly different from the INICC and CDC-NHSN rates.[9,19]

Table 2
SSI rates in the participating Turkish hospitals compared with the hospitals of the INICC and CDC NHSN

Code	Procedure name	Turkey 2005-2011, SSI rate, %	INICC 2005-2010, SSI rate, %	Turkey vs INICC, RR (95% CI), *P* value	CDC NHSN 2007-2009 SSI rate (pooled risk categories), %	Turkey vs CDC NHSN, RR (95% CI), *P* value
1. AMP	Limb amputation	9.5	2.7	3.5 (2.5-4.9), .001	2.3	4.08 (2.6-6.4), .001
2. CBGB	Coronary bypass with chest and donor incision	4.9	4.5	1.1 (0.9-1.3), .231	2.9	1.67 (1.4-1.9), .001
3. CARD	Cardiac surgery	2.7	5.6	0.48 (0.3-0.7), .001	1.3	2.09 (1.5-3.0), .001
4. CHOL	Gallbladder surgery	1.3	2.5	0.53 (0.4-0.7), .001	0.6	2.09 (1.5-3.0), .001
5. COLO	Colon surgery	11.4	9.4	1.21 (1.0-1.4), .013	5.6	2.05 (1.8-2.3), .001
6. CRAN	Craniotomy	5.3	4.4	1.21 (1.0-1.4), .033	2.6	2.04 (1.7-2.5), .001
7. CSEC	Cesarean section	3.0	0.7	4.28 (1.9-9.6), .001	1.8	1.66 (0.7-3.7), .214
8. FUSN	Spinal fusion	2.2	3.2	0.67 (0.3-1.4), .303	1.5	1.40 (0.7-2.8), .338
9. FX	Open reduction of fracture	5.0	4.2	1.19 (1.0-4.5), .108	1.7	2.89 (2.3-3.6), .001
10. GAST	Gastric surgery	4.3	5.5	0.78 (0.5-1.3), .325	2.3	1.88 (1.2-3.0), .006
11. HPRO	Hip prosthesis	3.5	2.6	1.33 (1.0-1.7), .020	1.3	2.74 (2.2-3.4), .001
12. HYST	Abdominal hysterectomy	3.1	2.7	1.12 (0.8-1.5), .480	1.6	1.86 (1.4-2.4), .001
13. KPRO	Knee prosthesis	3.4	1.6	2.07 (1.6-2.8), .001	0.9	3.82 (3.0-4.9), .001
14. LAM	Laminectomy	1.3	1.7	0.78 (0.6-1.1), .147	1.0	1.30 (1.0-1.7), .062
15. NECK	Neck surgery	7.4	3.7	1.99 (1.0-3.9), .039	3.5	2.13 (1.1-4.2), .028
16. NEPH	Kidney surgery	2.8	3.1	0.92 (0.5-1.8), .800	1.5	1.94 (0.8-4.7), .131
17. PRST	Prostate surgery	1.8	2.1	0.87 (0.5-1.4), .557	1.2	1.58 (0.8-3.1), .182
18. SPLE	Spleen surgery	5.0	5.6	0.90 (0.4-2.2), .822	2.3	2.16 (0.7-6.4), .167
19. THOR	Thoracic surgery	6.6	6.1	1.09 (0.9-1.2), .215	1.1	5.98 (3.9-9.2), .001
20. VHYS	Vaginal hysterectomy	1.7	2.0	0.86 (0.3-2.4), .768	0.9	1.91 (0.7-5.2), .191
21. VSHN	Ventricular shunt	11.4	12.9	0.88 (0.7-1.1), .217	5.6	2.03 (1.7-2.5), .001
22. XLAP	Exploratory abdominal surgery	2.6	4.1	0.63 (0.5-0.8), .001	2.0	1.29 (0.9-1.7), .095

RR, relative risk.

For decades, the CDC was the sole available source of data for comparing infection rates among hospitals worldwide. Comparing the CDC hospital SSI rates with those of Western Europe and Oceania is considered valid, owing to their similar socioeconomic conditions. In contrast, the comparison of rates of the CDC and those of hospitals with limited resources—or with sufficient available resources but insufficient experience in the field of infection control—should take into consideration the aforementioned disadvantages in terms of socioeconomic factors. On one hand, US hospitals have more than 50 years of unrivaled experience in infection control and surveillance, sufficient human and medical supply resources, and a comprehensive legal framework backing infection control programs and including mandatory surveillance and hospital accreditation policies. The higher SSI rates found in our study compared with the CDC rates are also influenced by such factors. The relationship between HAI rate and type of hospital (public, academic, or private), and the relationship between HAI rate and national socioeconomic level (low income, mid-low income, or high income) were recently analyzed by the INICC.[20,21] A higher national socioeconomic level was correlated with a lower infection risk.[20,21] Within this context, INICC reports can serve as an alternative valid benchmarking tool for HAI rates in hospitals worldwide, owing to their shared socioeconomic background.

Our higher SSI rates compared with those of the CDC NHSN may reflect the typical hospital situation in limited-resources economies.[22] Among the primary plausible causes, as in most limited-resources countries, are hospital accreditation and regulations for the implementation of infection control programs, which focus on national infection control guidelines; however, in the cases where there are regulations, compliance with these guidelines is highly variable.[23,24] Nonetheless, there has been much recent progress in health care in some developing countries, such as Turkey, where new technologies have been introduced and official regulations support infection control programs. This new trend in health care is expected to have a positive impact in hospitals 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 insufficient numbers of experienced nurses and trained health care workers.[23,24]

Through their participation in INICC, health care professionals have increased the awareness of HAI risks in the INICC hospitals, and also have set an example for the systematic institution of infection control practices. The incidence of HAI in INICC hospitals has been reduced by as much as 30%-70% through the implementation of multidimensional strategies for HAI prevention that include infection control bundles, education, outcome surveillance, process surveillance, feedback on HAI rates, and performance feedback on infection control practices for central line–associated bloodstream infections, mechanical ventilator–associated pneumonia, and urinary catheter–associated urinary tract infections.[11-13]

For valid comparisons of a hospital's SSI rates with the rates from INICC hospitals, the hospital needs to start collecting data by applying the CDC NHSN definitions to identify SSIs, the ICD-9 definitions of SPs, and the methodology for calculating SSI rates described by CDC NHSN.

Study limitations

Owing to a lack of 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, and the ASA score. Furthermore, we applied a 30-day follow-up, although a 90-day follow-up is the standard of care for many procedures. Second, we were not able to collect data to differentiate superficial, deep, and organ/space SSIs; collect data on microorganism profiles and bacterial resistance; or implement any other kind of postdischarge surveillance, such as phone calls, visits, or letters to patients. However, since 2012, these data have been collected by INICC member hospitals, thereby enabling future assessment of SSI risk index associated with SPs. Third, given the small sample size of cases in some SPs, these results should be interpreted with caution. Our review of the literature found no systematic data on SSI global rates or SSI rates stratified by SP. For this reason, it is worth mentioning that despite the aforementioned limitations, this study provides substantial and useful data, which is a first step in advancing our understanding of the SSI rate in Turkey.

CONCLUSION

Compared with data reported by the INICC for 2005-2010,[9] our present findings show similar SSI rates in 77% of the analyzed SPs. In contrast, our SSI rates were significantly higher than those reported by the CDC NHSN for 2006-2008[19] in 86% of the analyzed SPs. This study provides important advancements in the knowledge of SSI epidemiology in Turkey and will enable the introduction of targeted interventions. Furthermore, it demonstrates that the INICC is a valuable international benchmarking tool, whose participating hospitals have unrivaled infection control experience and resources.

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