Evaluation of the surveillance of surgical site infections within the Dutch PREZIES network

Manniën, J.

5

Comparison of the national surgical site infection surveillance data between the Netherlands and Germany: PREZIES versus KISS

Judith Manniën, Susan van den Hof, Christian Brandt, Michael Behnke,
Jan Wille, Petra Gastmeier
Journal of Hospital Infection 2007;66:224-231

ABSTRACT

As there has been increasing interest in comparing surgical site infection (SSI) rates between countries increases, we compared the SSI surveillance data for the Netherlands ('PREZIES') and Germany ('KISS'). Both surveillance systems have comparable protocols with many similar risk factors, including SSI definitions developed by the Centers for Disease Control and Prevention and optional postdischarge surveillance. Nine surgical procedure categories from several specialties were included, the reporting of which were similar for PREZIES and KISS with respect to content and with enough data for proper comparison. Differences for the SSI data were found between PREZIES and KISS for duration of surgery, wound contamination class, American Society of Anesthesiologists physical status classification and the postoperative duration of hospitalization. A significantly higher superficial SSI rate was found for seven surgical procedures according to PREZIES and a higher deep SSI rate for five procedures. When considering only deep SSI during hospitalization, the differences in SSI rates were much smaller. Differences in intensity of postdischarge surveillance led to 34% of SSI being detected after discharge for PREZIES and 21% for KISS. In conclusion, even though similar infection surveillance protocols were used in the Netherlands and Germany, differences occurred in the implementation. Comparison between countries are most reliable if only deep SSI during hospitalization are taken into account, since these SSI are not affected by postdischarge surveillance and the diagnostic sensitivity for deep SSI is probably more alike between countries than for superficial SSI.

INTRODUCTION

Surgical site infections (SSI) occur frequently in hospitals and have severe consequences. In recent decades, national SSI surveillance networks have been set up in many countries to monitor SSI incidence and variation between hospitals. The first nosocomial infection surveillance network, the NNIS system, was established in the USA in the 1970s.[1] Since then, many other countries have set up similar national surveillance systems using the infection definitions developed by the Centers for Disease Control and Prevention.

There is an increasing interest in comparing SSI data, not only between hospitals within a country, but also between countries. However, comparison between countries is more difficult, because the healthcare system and practices, types of hospitals, patient mix and reason for participation in a national surveillance system are likely to vary.[2]

In the Netherlands since 1996 ('PREZIES') and in Germany since 1997 ('KISS') SSI data have been recorded within a national nosocomial infection surveillance system.[3,4] These are neighbouring countries in Western Europe. The Netherlands has a population of 16 million with 100 hospitals, whereas Germany is much larger with 83 million inhabitants and 2200 hospitals. An earlier study showed that the surveillance practices in PREZIES and KISS are comparable; their protocols are based on the American NNIS protocol using the definitions developed by the Centers for Disease Control and Prevention,[5] participation is voluntary and confidential, the project is funded by the Ministry of Health and the network is coordinated centrally by a multidisciplinary team.[2] Other than this, the actual SSI data have not yet been compared in detail, apart from some surgical procedures by the European "Hospital In Europe Link for Infection Control through Surveillance" project (The Surveillance of Surgical Site Infections, Protocol Version 9.1. September 2004). In the current study, all aspects of the SSI surveillance data have been observed by comparing patient and hospital characteristics and SSI rates for several surgical procedures between PREZIES and KISS.

METHODS

Surveillance design

PREZIES aims for 100% participation. At this moment, the PREZIES SSI database contains data from 67 (68%) of the Dutch hospitals. KISS included 300 (14%) hospitals for participation. Those hospitals produce reference data for all German hospitals that register according to the same protocol but do not send in data, and therefore do not officially participate.

Both surveillance systems perform validation checks on submitted data. Both systems check the logical sequence of dates, and gender in certain procedures (e.g., caesarean section, hysterectomy, prostatectomy). The internet-based registration system in KISS, available since 2004, makes stricter validation checks during data-entry possible. Furthermore, the PREZIES team undertakes one-day visits to all participating hospitals every three years, to validate the process of the surveillance and the use of the SSI criteria.[6] KISS does not perform validation visits to participating hospitals, due to the large number of hospitals and the size of the country.

In both surveillance systems, postdischarge surveillance is voluntary. In PREZIES, a standard method is recommended and described in the protocol.[7] Currently 60% of the participating hospitals use the recommended method. In KISS, the methods used for postdischarge surveillance are not recorded. In this study, all registered SSIs were included, regardless of whether they developed during hospitalization or after discharge.
In PREZIES, hospitals receive a procedure-specific feedback report every time they send in data. In KISS, hospitals can generate a feedback report per procedure category by themselves at any time, using the internet-based registration system. National reference data are generated once a year for PREZIES and twice a year in KISS.

Surgical procedure categories

The SSI surveillance in KISS is concentrated in 27 operative procedure categories and separate procedure codes are not registered. In PREZIES, the Dutch procedure-specific financial codes are used. We matched the Dutch codes rigorously to the KISS categories where possible. Furthermore, only procedure categories with enough data for proper comparison were included in the current study, i.e. at least 1000 procedures and 50 SSI. As a result, the analyses for this study are performed on nine surgical procedure categories within several specialties: appendectomy, colon resection, abdominal hysterectomy, Caesarean section, mastectomy, arterial reconstruction of lower extremities, hip arthroplasty, knee arthroplasty, and femur fraction. These procedures are described in detail in Table 1. All PREZIES data up to 2004 were included because the data of

Table 1. Description of the surgical procedure categories.

Procedure	Description
Appendectomy	(Endoscopic) appendectomy, not in combination with another procedure.
Colon resection	Total or partial (endoscopic) colectomy, excluding rectum extirpation.
Abdominal hysterectomy	(Endoscopic) subtotal, total, or radical (=with lymphadenectomy) abdominal hysterectomy.
Caesarean section	Classical or supracervical and corporal Caesarean section, possibly in combination with another gynaecological procedure.
Mastectomy	Procedures regarding the mamma, e.g. lumpectomy, segment resection, partial excision with axillary lymphadenectomy, (extensive, supraradical, or subcutane) mastectomy possibly with axillary lympadenectomy and possibly with resection of muscles, plastic mamma reduction or reconstruction.
Arterial reconstruction of the lower extremities	Various procedures, e.g. aneurysm procedures, revascularisation, artery implants, bypasses which bridge the groin, embolectomy, thrombectomy, endarterectomy, resection and interposition of (parts of) blood vessels or aorta. Excluded: percutaneous-transluminal procedure; procedure on intracranial and intraspinal vessels; coronary arteries; shunts; venous excision or stripping.
Hip arthroplasty	Total or partial hip arthroplasty because of arthrosis or fracture. Excluded: revision, removal or reimplantation of hip arthroplasty; arthroplasty because of necrosis of head of femur; arthroplasty because of a tumor.
Knee arthroplasty	Knee arthroplasty. Excluded: revision, removal or reimplantation of knee arthroplasty; replacement of the patella.
Femur fraction	Closed or open reposition of a fracture in the area of the collum or proximal femur. Excluded: procedures with synthetic joint or bone replacement.

2005 were not yet available at the time of analyses. Only data from 2004-2005 were included for KISS, because the procedures included in KISS were modified from January 2004 thus becoming comparable to the PREZIES data.

Risk factors

In both countries, data are collected on gender, date of surgery, the American Society of Anesthesiologists physical status score for the severity of any underlying disease,[8] wound contamination class,[9] duration of surgery, date of infection, type of SSI, and type of hospital (university or other). In PREZIES, deep incisional and organ-space SSI are evaluated under the umbrella term 'deep SSI', because in practice it is often difficult to distinguish deep SSIs from organ-space SSIs. For the current analyses, we also combined deep incisional and organ-space SSI in the KISS data. Regarding the duration of surgery, KISS and PREZIES use their own procedure-specific 75th percentile in minutes. However, for the calculation of the NNIS risk index in the current analyses, we used the 75th percentile of duration of surgery in minutes of the combined data of PREZIES and KISS.[10]

Complementary variables recorded in PREZIES were: whether a non-human implant was left in place, elective or emergency surgery and date of admission. Additional variables registered in KISS were: whether an SSI occurs before or after discharge and whether a postdischarge SSI led to readmission. PREZIES uses the infection date and the date of discharge to assess whether a recorded SSI developed before or after the patient's discharge. The date of discharge was included in the protocol of KISS as an optional variable not until mid-2005.

Statistical analyses

Differences between PREZIES and KISS in the distribution of continuous variables were tested by using the Wilcoxon test. The Chi-squared test was used for binary variables, grouped ordinal variables, and the SSI rate. The increase in SSI rate with increasing NNIS score was tested by using the Cochrane-Armitage trend test. The *P*-values of all tests of significance were two-tailed, and $P < 0.05$ was considered statistically significant. All statistical analyses were performed using SAS for Windows, release 9.1 (SAS Institute Inc., Cary, NC, USA).

RESULTS

In Table 2, patient characteristics are compared between PREZIES and KISS, according to surgical procedure category. Mainly hip and knee arthroplasties were registered for both systems and additional Caesarean sections for KISS. In PREZIES, 4.5% of the operations were performed in university hospitals and 9.3% for KISS. The patients were significantly older in KISS for six procedures and older in PREZIES for two. PREZIES had significantly more male patients than KISS for arterial reconstruction of the lower extremities and more female patients for hip and knee arthroplasty. In KISS, a significantly higher ASA classification was recorded than in PREZIES for all surgical procedures.

Table 2. Comparison of patient characteristics between PREZIES and KISS, according to surgical procedure.

Procedure	No. of operations		Age (years) median (IQR[c])		Difference[a]	Gender % male		Difference[b]	ASA classification % ≥3		Difference[b]
	PREZIES	KISS	PREZIES	KISS	*P*-value	PREZIES	KISS	*P*-value	PREZIES	KISS	*P*-value
Appendectomy	3071	5744	28 (16-43)	27 (18-45)	<0.0001	49	47	0.08	3	9	<0.0001
Colon resection	3403	8023	68 (57-76)	68 (58-76)	0.32	47	46	0.88	26	48	<0.0001
Femur fraction	4847	2126	80 (69-86)	81 (73-87)	<0.0001	29	28	0.59	34	71	<0.0001
Mastectomy	7775	8972	56 (47-69)	60 (48-69)	<0.0001	1	1	0.45	5	22	<0.0001
Abdominal hysterectomy	3539	3287	47 (42-54)	50 (44-64)	<0.0001	0	0	-	4	22	<0.0001
Caesarean section	5269	20 771	31 (28-33)	31 (27-35)	<0.0001	0	0	-	1	5	<0.0001
Hip arthroplasty	36 542	30 643	72 (65-79)	71 (64-78)	<0.0001	28	36	<0.0001	16	42	<0.0001
Knee arthroplasty	12 726	13 817	72 (65-77)	71 (65-76)	<0.0001	22	30	<0.0001	13	40	<0.0001
Arterial reconstruction of lower extremities	2346	4262	68 (60-74)	69 (63-77)	<0.0001	77	67	<0.0001	34	66	<0.0001

PREZIES, SSI surveillance data for the Netherlands; *KISS*, SSI surveillance data for Germany; *ASA*, American Society of Anesthesiologists.

[a] The difference in distribution, not median, between PREZIES and KISS was tested by using the Wilcoxon test.

[b] The difference in percentage between PREZIES and KISS was tested by using the Chi-squared test.

[c] Interquartile range, 25th percentile and 75th percentile.

Table 3. Comparison of procedure characteristics between PREZIES and KISS, according to surgical procedure.

Procedure	Wound class, % ≥3		Difference[a]	Duration of surgery, median (IQR[c])		Difference[b]	Postoperative LOS, median (IQR[c])		Difference[b]
	PREZIES	KISS	*P*-value	PREZIES	KISS	*P*-value	PREZIES	KISS	*P*-value
Appendectomy	37	59	<0.0001	35 (25-45)	44 (30-60)	<0.0001	3 (3-5)	4 (3-5)	<0.0001
Colon resection	25	45	<0.0001	110 (80-147)	140 (105-180)	<0.0001	11 (8-15)	11 (8-15)	0.09
Femur fraction	1	0	0.14	60 (45-90)	55 (40-72)	<0.0001	14 (8-24)	14 (11-18)	0.70
Mastectomy	5	1	<0.0001	70 (45-95)	70 (47-98)	0.06	4 (2-7)	7 (5-10)	<0.0001
Abdominal hysterectomy	1	2	<0.0001	67 (55-90)	90 (70-122)	<0.0001	6 (5-7)	8 (7-10)	<0.0001
Caesarean section	0	16	<0.0001	35 (30-45)	36 (30-45)	0.07	5 (4-6)	6 (5-7)	<0.0001
Hip arthroplasty	0	0	0.68	76 (60-95)	80 (61-101)	<0.0001	10 (7-14)	13 (11-15)	<0.0001
Knee arthroplasty	0	0	0.07	90 (73-105)	82 (65-101)	<0.0001	10 (7-14)	14 (12-15)	<0.0001
Arterial reconstruction of lower extremities	1	2	<0.0001	180 (141-225)	120 (85-170)	<0.0001	10 (8-15)	11 (8-15)	0.03

PREZIES, SSI surveillance data for the Netherlands; *KISS*, SSI surveillance data for Germany; *LOS*, length of stay; *IQR*, interquartile range.

[a] The difference between PREZIES and KISS was tested by using the Chi-squared test.

[b] The difference between PREZIES and KISS was tested by using the Wilcoxon test.

[c] Interquartile range, 25th percentile and 75th percentile.

Table 4. Comparison of surgical site infection (SSI) rates for superficial and deep SSI between PREZIES and KISS, according to surgical procedure.

Procedure	Superficial SSI % (No.)			Deep SSI % (No.)			Deep SSI in hospital % (No.)			SSI after discharge %		
	PREZIES	KISS	*P*-value[a]	PREZIES	KISS	*P*-value[a]	PREZIES	KISS	*P*-value[a]	PREZIES	KISS	*P*-value[b]
Appendectomy	1.7 (52)	1.6 (90)	0.65	2.9 (88)	0.8 (48)	<0.0001	1.5 (47)	0.6 (32)	<0.0001	54	31	0.0002
Colon resection	4.6 (156)	3.3 (266)	0.001	6.7 (228)	4.1 (331)	<0.0001	5.9 (202)	4.0 (320)	<0.0001	12	3	<0.0001
Femur fraction	2.5 (123)	0.8 (18)	<0.0001	1.5 (71)	1.9 (41)	0.16	1.1 (52)	1.4 (30)	0.23	18	22	0.56
Mastectomy	2.7 (210)	0.8 (69)	<0.0001	1.1 (84)	0.2 (22)	<0.0001	0.5 (36)	0.1 (12)	<0.0001	49	38	0.10
Abdominal hysterectomy	1.2 (42)	1.4 (45)	0.50	0.9 (33)	0.7 (23)	0.29	0.6 (22)	0.7 (22)	0.81	32	16	0.05
Caesarean section	1.3 (67)	0.8 (168)	0.002	0.5 (28)	0.2 (40)	<0.0001	0.2 (11)	0.1 (25)	0.12	60	31	<0.0001
Hip arthroplasty	1.9 (702)	0.4 (117)	<0.0001	1.1 (415)	1.0 (315)	0.18	0.6 (210)	0.7 (213)	0.05	31	26	0.11
Knee arthroplasty	0.9 (116)	0.2 (31)	<0.0001	0.9 (119)	0.5 (66)	<0.0001	0.2 (25)	0.2 (24)	0.67	59	48	0.10
Arterial reconstruction of lower extremities	2.6 (62)	1.3 (57)	0.0001	2.2 (51)	1.6 (67)	0.08	1.6 (38)	1.1 (49)	0.11	21	24	0.70

[a] Difference in SSI rate between PREZIES and KISS, tested by using the Chi-squared test.

[b] Difference in percentage of registered SSIs that were detected after hospital discharge between PREZIES and KISS, tested by using the Chi-squared test.

Table 3 shows the comparison of procedure characteristics per surgical procedure. A substantially higher wound contamination class was recorded in KISS compared to PREZIES for appendectomy, colon resection and Caesarean section. The postoperative length of hospitalization of patients without a SSI was significantly longer in KISS for seven procedures. The surgeries lasted significantly longer in KISS than in PREZIES for appendectomy, colon resection, abdominal hysterectomy, and hip arthroplasty, whereas a significantly longer duration of surgery was observed in PREZIES for femur fraction, knee arthroplasty, and arterial reconstruction of the lower extremities. For most procedures, the duration of surgery was longer in university hospitals than in non-university hospitals, but the differences in duration of surgery between PREZIES and KISS were still apparent if only non-university hospitals were taken into account. Patients in KISS often had a higher NNIS score than those in PREZIES (data not shown), due to the higher wound class and higher ASA classification in KISS. In both surveillance systems, the SSI rate significantly increased with a higher NNIS index score for all procedures (except for Caesarean section in PREZIES). After stratification by surgical procedure and NNIS index, the absolute SSI rate was still significantly higher in PREZIES than in KISS for many strata.

In Table 4, the SSI rates are compared between PREZIES and KISS according to surgical procedure. Regarding superficial SSI, PREZIES had a significantly higher infection rate than KISS for seven of the nine procedures, except for appendectomy and abdominal hysterectomy. PREZIES had a significantly higher infection rate than KISS for deep SSI from five procedures. When considering only deep SSI during hospitalization, the differences in SSI rate were smaller, with a significantly higher SSI rate in PREZIES for only three procedures, namely appendectomy, colon resection and mastectomy. The smaller difference in deep SSI rate between PREZIES and KISS after hip and knee arthroplasty for SSI during hospitalization can be explained by the longer duration of hospitalization of three to four days in KISS for these surgical procedures. In PREZIES 34% of all registered SSIs were found after discharge and in KISS 21%. In PREZIES, more SSI were found after discharge for seven surgical procedures with a statistically significant difference for four of those procedures.

DISCUSSION

This study showed that comparison of SSI data between countries may not be reliable, even if the countries have public healthcare systems of comparable high quality and use similar infection surveillance protocols.

For some surgical procedures, the results revealed a higher SSI rate in PREZIES compared to KISS, even though in PREZIES the patients seemed to be healthier (i.e. a lower ASA classification was recorded), were less often operated on in university hospitals and had a shorter postoperative length of stay. The higher SSI rate in PREZIES might at least partly be explained by the more intensive postdischarge surveillance performed in Dutch hospitals, leading to 34% of the recorded SSI detected after discharge in PREZIES and 21% in KISS. The difference between the two countries in procedure-specific SSI rates disappeared for most surgical procedures when only deep SSIs that developed during hospitalization were taken into account.

Possible sources of bias

In KISS, patients had a longer duration of hospitalization, which is likely to result in more SSIs developing during hospital stay. In PREZIES, postdischarge surveillance was performed more intensively than in KISS, leading to more recorded SSIs after discharge. Therefore, there is no perfect method to compare the data, i.e., with or without SSIs after discharge. The inclusion of postdischarge SSIs results in more accurate and reliable SSI rates.[7]

Reasons for hospitals to participate in the national SSI surveillance might be different between the two countries. In both countries, participation is voluntary. In the Netherlands, hospitals are encouraged to participate in PREZIES for procedures where a relatively high SSI rate is expected. In PREZIES, 68% of all Dutch hospitals participate. In KISS, only 14% of the German hospitals are official participants. We cannot guarantee that participating hospitals are representative for all hospitals in either country. However, participating hospitals in both countries were not thought to be substantially different from non-participating hospitals with respect to patients and SSI risks.

In KISS, all surgical procedures within a category must be registered, whereas in PREZIES, specific surgical procedures could be chosen (e.g. partial hip arthroplasty, total hip arthroplasty, Caesarean section with preliminary treatment, or Caesarean section without preliminary treatment). Therefore, the distribution of specific procedures within a category might be slightly different. We could not assess the size of this difference because the specific procedure codes were not recorded in KISS. We do not think that this possible difference in distribution of specific surgical procedures in a category would have a major impact on the SSI rate (and the distribution of risk factors like wound class or duration of surgery) of the surgical category, as the procedures included in each category are comparable regarding surgical technique and SSI risk.

We used recent data from the KISS network (2004-2005) and all data from PREZIES (1996-2004) to obtain sufficient statistical power for the analyses. When considering only PREZIES data since 2000, the results were not much different, with still a higher SSI rate than in KISS.

Remarkable differences were found in the registered wound class and ASA classification between KISS and PREZIES, which limit the international comparison. Correct application of these variables is taught during courses and workshops in both surveillance networks. However, these meetings are mostly attended by infection control professionals, while the wound class should be recorded by the surgeon and the ASA classification by the anesthetist. The difference in recorded ASA classification may indicate the subjectiveness of this variable, because we did not expect the health of the patients to be different in these countries.[11-14] The possible difference in assigning the wound class and ASA classification makes international comparison very difficult, as these variables are assumed to be important intrinsic risk factors for which SSI rates should be adjusted before comparing SSI data. Therefore, adjustment of SSI rates by the NNIS index even may distort instead of facilitate international comparison of SSI data.

The validation visits of the PREZIES team to all participating hospitals increase the reliability of the surveillance data. The absence of validation studies in KISS is a limitation, but validation visits to the hospitals are not feasible because of the large number of hospitals and the size of the country. Ideally, validation studies in participating hospitals regarding data collection and the application of definitions should be part of national nosocomial surveillance networks.

International comparison

The NNIS risk index changed in 1998; for endoscopically or laparoscopically performed procedures one point was subtracted from the score, as a lower SSI risk was expected for these procedures.[15] However, not every national nosocomial surveillance system that registered the NNIS index adopted this change. In KISS, they do not subtract one point from the NNIS score for laparoscopic procedures, but they calculate separate reference rates for laparoscopic and non-laparoscopic procedures if analysis shows different SSI rates. In the Netherlands, before 2005 it was not recorded whether a procedure was performed endoscopically or laparoscopically.

Surveillance results published in scientific articles or on the internet usually only include the name of a procedure category and not a detailed description of the surgical procedures, e.g. whether revisions are included. This makes international comparison very difficult, as the specific procedures inlcuded within a category will influence the SSI rate of that category. In the present article we clearly described the surgical procedures included in each category.

This is not the first study comparing SSI data from different countries. Other studies have also showed differences in SSI rates and/or occurrence of risk factors between countries. Belgium and the Netherlands differed in the use of antibiotic prophylaxis, length of hospital stay and frequency of urgent appendectomies.[16] A study comparing SSI data from Hungary with the NNIS data found differences in application of NNIS risk classes, performance of postdischarge surveillance, and duration of surgery.[17] The Italian SSI rates were higher for several procedures than those of the NNIS and of Hungary, mostly due to the performance of postdischarge surveillance in Italy.[18] The Spanish SSI rates were to be higher for cholecystectomy and appendectomy than those of the NNIS, but not for herniorraphy.[19]

This study showed that even though in the Netherlands and Germany similar infection surveillance protocols were used, differences occurred in the surveillance implementation. Rigorous standardization of surveillance protocols is needed when one attempts to compare data between hospitals or countries. Furthermore, it is important to take into account possible differences between hospitals or countries in aspects that may influence the SSI rate like performance of postdischarge surveillance, length of hospitalization and the surgical procedures included. External validation visits or validation checks on the data could help to monitor the quality and reliability of the surveillance data. A comparison of infection rates is most reliable within a hospital over time. A comparison between hospitals within a country, where the health care system is quite similar, is feasible within national surveillance systems like KISS and PREZIES. Comparison between countries seems to be most reliable for deep SSIs during hospitalization, since these SSIs are not affected by postdischarge surveillance and the diagnostic sensitivity for deep SSI is probably more similar between countries than for superficial SSI.

ACKNOWLEDGEMENTS

We gratefully acknowledge all the infection control practitioners, medical specialists and nurses of the participating hospitals in PREZIES and KISS for their invaluable contribution to the data collection.

REFERENCES

1. Emori TG, Culver DH, Horan TC *et al*. National nosocomial infections surveillance system (NNIS): description of surveillance methods. *Am J Infect Control* 1991; 19(1): 19-35.
2. Coello R, Gastmeier P, de Boer AS. Surveillance of hospital-acquired infection in England, Germany, and The Netherlands: will international comparison of rates be possible? *Infect Control Hosp Epidemiol* 2001; 22(6): 393-7.
3. Geubbels EL, Mintjes-de Groot AJ, van den Berg JM, de Boer AS. An operating surveillance system of surgical-site infections in The Netherlands: results of the PREZIES national surveillance network. Preventie van Ziekenhuisinfecties door Surveillance. *Infect Control Hosp Epidemiol* 2000; 21(5): 311-8.
4. Gastmeier P, Geffers C, Sohr D, Dettenkofer M, Daschner F, Ruden H. Five years working with the German nosocomial infection surveillance system (Krankenhaus Infektions Surveillance System). *Am J Infect Control* 2003; 31(5): 316-21.
5. Wong ES. Surgical site infections. In: Mayhall CG. Hospital Epidemiology and infection control. 3rd edition. Philadelphia, USA: Lippincott Williams & Wilkins, 2004: 287-310.
6. Manniën J, van der Zeeuw AE, Wille JC, van den Hof S. Validation of surgical site infection surveillance in The Netherlands. *Infect Control Hosp Epidemiol* 2007; 28(1): 36-41.
7. Manniën J, Wille JC, Snoeren RL, van den Hof S. Impact of postdischarge surveillance on surgical site infection rates for several surgical procedures: results from the nosocomial surveillance network in the Netherlands. *Infect Control Hosp Epidemiol* 2006; 27(8): 809-16.
8. Owens WD, Felts JA, Spitznagel EL Jr. ASA physical status classifications: a study of consistency of ratings. *Anesthesiology* 1978; 49(4): 239-43.
9. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. Guideline for Prevention of Surgical Site Infection, 1999. *Am J Infect Control* 1999; 27(2): 97-134.
10. Culver DH, Horan TC, Gaynes RP *et al*. Surgical wound infection rates by wound class, operative procedure, and patient risk index. National Nosocomial Infections Surveillance System. *Am J Med* 1991; 91(3B): 152S-7S.
11. Haynes SR, Lawler PG. An assessment of the consistency of ASA physical status classification allocation. *Anaesthesia* 1995; 50(3): 195-9.
12. Keita-Perse O, Gaynes RP. Severity of illness scoring systems to adjust nosocomial infection rates: a review and commentary. *Am J Infect Control* 1996; 24(6): 429-34.
13. Platt R, Yokoe DS, Sands KE. Automated methods for surveillance of surgical site infections. *Emerg Infect Dis* 2001; 7(2): 212-6.
14. Salemi C, Anderson D, Flores D. American Society of Anesthesiology scoring discrepancies affecting the National Nosocomial Infection Surveillance System: surgical-site-infection risk index rates. *Infect Control Hosp Epidemiol* 1997; 18(4): 246-7.
15. Gaynes RP, Culver DH, Horan TC, Edwards JR, Richards C, Tolson JS. Surgical site infection (SSI) rates in the United States, 1992-1998: the National Nosocomial Infections Surveillance System basic SSI risk index. *Clin Infect Dis* 2001 ; 33 Suppl 2: S69-77.
16. Mertens R, Van den Berg JM, Veerman-Brenzikofer ML, Kurz X , Jans B, Klazinga N. International comparison of results of infection surveillance: The Netherlands versus Belgium. *Infect Control Hosp Epidemiol* 1994; 15(9): 574-8.
17. Gulacsi L, Kiss ZT, Goldmann DA, Huskins WC. Risk-adjusted infection rates in surgery: a model for outcome measurement in hospitals developing new quality improvement programmes. *J Hosp Infect* 2000; 44(1): 43-52.
18. Moro ML, Morsillo F, Tangenti M, Mongardi M, Pirazzini MC, Ragni P. Rates of surgical-site infection:

an international comparison. *Infect Control Hosp Epidemiol* 2005; 26(5): 442-8.

19. Jodra VM, Rodela AR, Martinez EM, Fresnena NL. Standardized infection ratios for three general surgery procedures: a comparison between Spanish hospitals and U.S. centers participating in the National Nosocomial Infections Surveillance System. *Infect Control Hosp Epidemiol* 2003; 24(10): 744-8.