Journal of Hospital Infection (2009) 71, 74—80

Available online at www.sciencedirect.com

ScienceDirect

www.elsevierhealth.com/journals/jhin

The national nosocomial surveillance network in Hungary: results of two years of surgical site infection surveillance

E. Szilágyi [a,*], K. Böröcz [a], P. Gastmeier [b], A. Kurcz [a], E. Horváth-Puhó [c]

[a] *National Center for Epidemiology, Department of Hospital Epidemiology and Hygiene, Budapest, Hungary*
[b] *Institute of Medical Microbiology and Hospital Epidemiology, Hannover Medical School, Germany*
[c] *Foundation for Community Control of Hereditary Diseases, Budapest, Hungary*

Received 9 January 2008; accepted 1 July 2008
Available online 23 August 2008

KEYWORDS
Surgical site infection;
Surveillance network;
Hungary

Summary In 2004, a secure web-based national nosocomial infection surveillance system was established in Hungary. The system, named NNSR (Nemzeti Nosocomiális Surveillance Rendszer), is based on the US National Nosocomial Infection Surveillance System (NNIS). Surgical procedures, definitions, surveillance methodology and patient risk indices are those established by NNIS. In this paper, we present the results of the first two years of the surgical patient component of our system. During this period, 41 hospitals participated and selected 11 surgical procedures for surveillance. Altogether 15 812 procedures were surveyed and 360 resulting surgical site infections (SSI) were recorded. The overall SSI rate was 2.27%. The most commonly selected procedures and corresponding SSI rates were caesarean section (1.31%), herniorrhaphy (2.09%), cholecystectomy (1.52%) and hip replacement (2.91%). Standardised infection ratios (SIR) were calculated for chosen surgical procedures in order to compare against NNIS published rates. SSI rates for colonic surgery, caesarean section and mastectomy were lower than expected according to the NNIS data but higher for cholecystectomy, herniorrhaphy and hip prosthesis infection rates. We intend to recruit more participating hospitals,

* Corresponding author. Address: National Center for Epidemiology, Department of Hospital Epidemiology and Hygiene, Gyali u. 2-6, H-1097 Budapest, Hungary. Tel./fax: +36 1 4761178.
E-mail address: szilagyi.emese@oek.antsz.hu

doi:10.1016/j.jhin.2008.07.001

leading to a robust national database that can be used to target infection control interventions for patients in Hungary.

Introduction

Nosocomial infections continue to be an important cause of morbidity and mortality in hospitals, prolonging hospital stay, increasing antibiotic usage and hospital costs.[1,2] Surveillance of hospital-acquired infections (HAI) remains an important tool in the reduction of nosocomial infection rates and has been acknowledged as an important component of infection control programmes. It is increasingly recognised as the key to improving clinical outcomes. Nosocomial infection rates are considered as important indicators of the quality of patient care.[3] Surveillance of nosocomial infection has been a fundamental component of infection control in the USA since the 1960s.[3] The US National Nosocomial Infections Surveillance System (NNIS) was established in 1970 and periodically reports its findings.[4] Many countries have developed their own national nosocomial surveillance systems based on NNIS and have published their findings.[5–9] In 2005 there was a transition of healthcare-associated infection surveillance in the USA from NNIS to National Healthcare Safety Network (NHSN).

In 1996 there was a survey of surgical site infections (SSIs) in 20 Hungarian hospitals with results compared to NNIS benchmarks, but this was not part of a continuing surveillance programme.[10] In 2004, as a result of public health demand for improving quality of care, an ongoing national nosocomial infections surveillance network was established in Hungary ('NNSR': Nemzeti Nosocomiális Surveillance Rendszer). NNSR is a standardised system based on NNIS and has two components: (1) surgical and (2) adult and paediatric ICU.[11–13]

NNSR will enable the creation of a national reference database for nosocomial infections and facilitate feedback of results so that participating hospitals can compare their rates with national aggregated data and use that as a benchmark to measure their own performance. Further national and local hospital aims are to identify critical control points, put in place the necessary interventions, move toward good practice, improve the quality of care and patient safety by reduction of HAI rates.

The purpose of this study was to investigate whether the NNIS data could be used for comparison with our own, smaller database sufficiently to provide a reliable distribution of SSI rates for benchmarking.

Methods

NNSR is a secure web-based reporting system developed at the Hungarian National Center for Epidemiology (NCE). The definitions of surgical procedures and SSI, the surveillance methodology and patient risk index categories were those established by NNIS. The NNIS System for diagnosis of SSI classifies cases as superficial incisional, deep incisional, or organ/space. The NNIS risk index comprises three major risk factors for SSI: (1) the severity of the patient's underlying illness (2) the likely microbial contamination at the site of infection and (3) a prolonged operation. These were translated into Hungarian and made available on our website. Prior to establishing the network, we performed a three-month pilot study without including these data in the NNSR database.

Training on case definitions, surveillance methodology, case finding and on software use was provided by NCE on a regular basis, attendance at which was mandatory for infection control nurses and doctors before joining the network. Participation of hospitals was voluntary and all their data were confidential. Software was offered free for paticipating hospitals. The minimum period of participating was six months. Hospitals could choose SSI surveillance of one or more surgical procedures within the NNIS categories and active prospective surveillance was required from the time of surgery until discharge. Local surveillance teams comprised one or more trained infection control nurses responsible for data collection and an infection control doctor responsible for data validation. SSI data were collected by reviewing medical and nursing records, laboratory results, and by medical staff attending the patients and the survey team's participation on ward rounds.

Data entry was performed at hospital level and automatically sent to NCE. Analyses and feedback of national aggregated data were provided twice a year by NCE. For each patient in the procedure selected for SSI surveillance, an electronic worksheet had to be completed, containing: age, sex, American Society of Anesthesiologists (ASA) risk category, date of admission, operation and discharge, wound class, duration of operation, whether the surgery was elective or urgent, whether the operation was performed laparoscopically, antibiotic prophylaxis, reoperation and death. If an SSI occurred, the details required relating to it were: the date of infection, the type of infection (superficial, deep, organ/space) and the micro-organism isolated.

Minimally invasive surgery (MIS), such as the use of laparoscopes, was incorporated into the SSI risk index, as described in NNIS.[4] MIS incorporates the influence of laparoscopic surgery on SSI rates. For cholecystecomy and colonic surgery (incision, resection or anastomosis of the large bowel including large-to-small and small-to-large bowel anastomosis), when the operation was performed laparoscopically, 1 was substracted from the number of risk factors present (for an ASA score of 3, 4 or 5; or duration of surgery >75th centile; or contaminated or dirty wound) in the NNIS index. When no risk factors were present and the procedure was performed laparoscopically (i.e. $0 - 1 = -1$), we designated this new modified risk category as -1 or M (minus).

Only procedures undertaken at least 500 times were considered for analysis. Statistical analyses were performed with SAS 9.1 (SAS Institute Inc., Cary, North Carolina, USA) statistical package. Initially we constructed frequency tables based on included variables by category of surgical procedure. Descriptive statistics were then applied to determine means, range, centile and 95% confidence intervals (CIs). Chi-squared test and Fisher's exact test were used for comparison of SSI rates by risk index category for each procedure.

Standardised infection rates (SIR), developed at the Centers for Disease Control and Prevention (CDC), were used for comparing Hungarian SSI rates with NNIS rates. Each SIR was calculated by dividing the observed number of infections by the expected number of infections during a particular period. The expected number of infections was calculated by indirect standardisation; for each risk category, the number of specific procedures performed was multiplied by the specific rate with which they were compared (in our case data reported by NNIS).[4] The resultant SIR indicates the relative risk of infection for a given procedure.

Results

In the period from November 2004 to October 2006, 41 hospitals participated in the NNSR representing 25% of Hungarian hospitals. Data provider hospitals were: four university hospitals, six teaching hospitals and 31 general hospitals, representing all regions within Hungary.

In the studied period 11 surgical procedures were chosen, with total numbers of 15 812 operations and 360 SSIs. The overall SSI rate was 2.27%. Table I shows types of surgical procedure selected for study, the total number of operations in each category, the median age and sex distribution of patients, and the risk factors by procedure. Procedures undertaken <500 times were excluded. Rates of SSI varied by procedure category, reflecting the different risks associated with different types of surgery. Table I shows the number of surgical site infections, rates of SSI and CIs by procedure. Type of SSI by surgical procedure is shown in Figure 1. The use of MIS was: cholecystectomy 83% and colon surgery 3%.

We compared statistical differences in the rates of SSI associated with risk categories for each surgical procedure. With an increase in risk category there were significantly higher SSI rates for the following procedures: cholecystectomy ($P < 0.0001$), herniorraphy ($P < 0.0001$), hip replacement ($P < 0.0001$) and mastectomy ($P < 0.0118$). For colonic surgery SSI rates were higher in patients in the higher risk index categories, but differences were not significant. For caesarean sections, SSI rates were higher in patients with lower risk index category.

Table II shows the standardised infection ratios. The observed rates are our results stratified by NNIS risk index. Comparing all six procedures, SSI rates were lower than expected in colon surgery, caesarean section and mastectomy and higher than expected in cholecystectomy, herniorrhaphy and hip replacement.

We calculated the median postoperative stay for all operations by procedure and also separately for patients with and without an SSI. Table III shows the median postoperative days by procedure.

Table IV shows the surgery duration's 75th centile in the NNSR survey compared with NNIS, the SSI component of the European Nosocomial Infection Surveillance Network, Hospital in Europe Link for Infection Control through Surveillance (HELICS) and the component for SSI surveillance of the German national nosocomial surveillance system KISS (KISS: Krankenhaus Infektions Surveillance System).[17]

Discussion

Nosocomial infection surveillance is time consuming and needs substantial human resources.

Table I Number and category of surgical procedures, patient characteristics, risk factors and surgical site infections (SSIs)

Operative procedure category	No. of operations	Patients' age (median in years)	% of male patients	% of patients with ASA ≥3	% of patients with wound class contaminated or dirty	% of patients with duration of operation >75th centile (NNIS)	No. of operations	No. of SSIs	Rate of SSI	95% CI
Cholecystectomy	2627	57.0	26.7	32.4	8.5	4.3	2627	40	1.52	1.05–1.99
Colon	1048	68.0	51.1	67.7	66.5	14.5	1048	66	6.30	4.82–7.77
Caesarean section	4963	29.0	0.0	2.5	1.0	12.9	4963	65	1.31	0.99–1.63
Herniorrhaphy	3203	58.0	71.4	35.1	1.8	2.6	3203	67	2.09	1.60–2.59
Hip prosthesis	2096	69.0	36.3	29.2	0.5	19.1	2096	61	2.91	2.19–3.63
Mastectomy	840	56.0	1.9	40.9	1.4	0.1	840	13	1.55	0.71–2.38

ASA, American Society of Anesthesiologists; NNIS, US National Nosocomial Infection Surveillance System (NNIS); CI, confidence interval.

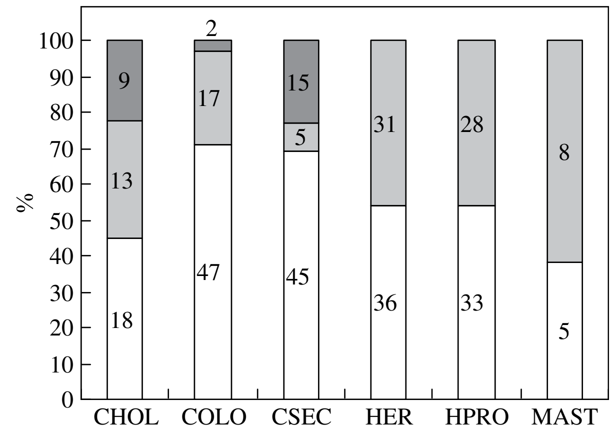

Figure 1 Type and number of surgical site infections by surgical procedure. Dark grey: organ/space; light grey: deep incisional; white: superficial incisional. CHOL, cholecystectomy; COLO, colon; CSEC, caesarean section; HER, herniorrhaphy; HPRO, hip prosthesis; MAST, mastectomy.

Nevertheless investment in infection control and prevention of infections through surveillance has been found to be cost effective and improves patient safety.[14–17] NNSR was established in 2004. In the first two years there was a continuous increase in participation of hospitals and in the number of chosen surgical procedures. Hospitals joined our study in order to receive valid, standardised local infection rates and for individual hospitals to have a comparison with national data and follow-up trends. SIR can be used by hospitals to compare their results with national aggregated data. Surveillance activity on a surgical ward has provided an opportunity for infection control staff to develop working relationships with clinical staff, to use surveillance data to review practice, to identify non-adherence to good practice, to introduce necessary changes for improvement and to follow up trends after interventions.

The observed higher SSI rates in lower risk index categories for caesarean section can perhaps be explained by the low number of procedures in the higher risk categories. However, some studies have shown that the NNIS risk index is not appropriate for stratification in the case of caesarean section.

SIR has been used for comparison of Hungarian SSI rates because the present database does not allow determination of centiles of the distribution of SSI rates. SIR has also been used by other networks for comparison of their rates with NNIS rates.[9,18] Though standardised surveillance protocols have been used, local differences might occur in interpretation of definitions and intensity of surveillance, so comparison of results is difficult. SSI rates were lower than expected for colonic surgery, caesarean section

Table II Patients and infections according to risk categories and calculation of standardised infection ratios (SIRs)

Operative procedure category	Risk index category	NNSR			NNIS	No. of infections expected	SIR
		No. of infections	No. of patients	Observed rate[a]	Observed rate[a]		
Cholecystectomy	−1	4	1458	0.27	0.45	6.56	
	0	14	721	1.94	0.68	4.90	
	1	12	331	3.63	1.78	5.89	
	2/3	10	117	8.55	3.51	4.11	
	Total	40	2627	1.52		21.46	1.86
Colon	−1/0	4	75	5.33	3.98	2.99	
	1	17	409	4.16	5.66	23.15	
	2	36	471	7.64	8.54	40.22	
	3	9	93	9.68	11.25	10.46	
	Total	66	1048	6.30		76.82	0.86
Caesarean section	0	57	4174	1.37	2.71	113.12	
	1	8	764	1.05	4.14	31.63	
	2/3	0	25	0.00	7.53	1.88	
	Total	65	4963	1.31		146.63	0.44
Herniorrhapy	0	24	2026	1.18	0.81	16.41	
	1	31	1084	2.86	2.14	23.20	
	2/3	12	93	12.90	4.53	4.21	
	Total	67	3203	2.09		43.82	1.53
Hip prosthesis	0	28	1277	2.19	0.86	10.98	
	1	21	618	3.40	1.65	10.20	
	2/3	12	201	5.97	2.52	5.07	
	Total	61	2096	2.91		26.25	2.32
Mastectomy	0	5	489	1.02	1.74	8.51	
	1	7	344	2.03	2.20	7.57	
	2/3	1	7	14.29	3.42	0.24	
	Total	13	840	1.55		16.32	0.80

NNSR, Hungarian National Nosocomial Infection Surveillance System; NNIS, US National Nosocomial Infection Surveillance System; SIR, standardised infection rate.
[a] Per 100 operations.

and mastectomy. Possible explanations are differences in case-mix, complexity of the procedures and the intensity of case finding. For cholecystectomy, herniorrhaphy and hip replacement, the observed SSI rates were higher than expected, which may be due to the fact that our postoperative length stay is greater than in NNIS, so that more SSI would be detected during hospital stay.

Occurrence of SSI generates considerable extra costs, partly due to the prolongation of hospital stay. Even though they were not adjusted to the severity of underlying disease, our results clearly show the link between SSI and prolonged hospital stay.

With regard to the duration of surgery, our database is insufficiently extensive to have our own cut-offs, therefore for the calculation of the NNIS risk index, the NNIS cut-off point was used. HELICS calculated 75th centiles for the duration of surgery in European hospitals, but the risk index was calculated using NNIS cut-off points. The German national nosocomial surveillance system KISS has established its own duration of surgery that is used for risk index stratification. Comparison of our 75th centile for duration of surgery with NNIS, HELICS and KISS cut-off points shows that the duration of surgery is usually shorter in Europe than recorded in NNIS. With an expansion of our database, we intend to define our own cut-off points and to use them for risk index calculation.

Table III Median postoperative length of stay for patients with and without surgical site infection (SSI)

Surgical procedure category	No. of operations	Median postoperative length of stay (days)	
		Patients with SSI	Patients without SSI
Cholecystectomy	2627	20	4
Colon	1048	21	12
Caesarean section	4963	14	7
Herniorrhaphy	3203	12	4
Hip prosthesis	2096	17	11
Mastectomy	840	13	6

Table IV Duration of operation in minutes in NNSR in comparison with NNIS, HELICS and OP-KISS

Operative procedure category	NNIS[a] 75th percentile (min)	NNSR 75th percentile (min)	HELICS[b] 75th percentile (min)	KISS[c] 75th percentile (min)
Cholecystectomy	120	75	88	80[d]
Colon	180	154	176	180
Caesarean section	60	55	48	45
Herniorrhaphy	120	60	—	72
Hip prosthesis	120	114	107	102
Mastectomy	180	52	—	95

NNSR, Hungarian Nemzeti Nosocomiális Surveillance Rendszer; NNIS, US National Nosocomial Infection Surveillance System.
[a] NNIS only uses values rounded per hours that were transformed in minutes.
[b] Hospital in Europe Link for Infection Control through Surveillance (HELICS)—SSI Statistical Report 2004, European hospitals.
[c] Component for SSI surveillance of the German national nosocomial surveillance system (KISS: Krankenhaus Infektions Surveillance System).
[d] Laparoscopically only.

One of the limitations of NNSR is that there is currently no standardised method for postdischarge surveillance, so rates may be underestimated for procedures with a short postoperative stay.[19] SSIs occurring after discharge have been identified and included in the database only in cases of readmission for wound infection. Another limitation is that antibiotic administration records have not been evaluated in this study and no national validation study has yet been undertaken.

We consider the establishment of a web-based standardised national nosocomial infection surveillance system in Hungary to be of value, since participation in a surveillance network has been shown to have an important impact on decreasing SSI rates.[20,21] As an essential part of this, the surveillance team reviewed practice at each centre in terms of good practice guidance and reported back on this to each hospital. We are now obtaining evidence that, for hip replacements at least, infection rates have fallen. Increasing participation and the experience gained will contribute in a few years to a more robust database, which would create more precise results. We believe that our surveillance system, in time, will contribute to reduction of nosocomial infection rates and improvement of patient safety in Hungarian hospitals.

Acknowledgement

The authors thank all infection control teams at participating hospitals for their collaboration, commitment and contribution to NNSR data and P. Hoffman of the Health Protection Agency in London for help in preparing the manuscript.

Conflict of interest statement
None declared.

Funding sources
None.

References

1. Kirkland KB, Briggs JP, Trivette SHL, Wilkinson WE, Sexton DJ. The impact of surgical site infections in the 1990s: attributable mortality, excess length of hospitalization, and extra costs. *Infect Control Hosp Epidemiol* 1999;**20**:725—730.
2. Wong ES. The price of a surgical site infection: more than just excess length of stay. *Infect Control Hosp Epidemiol* 1999;**20**:722—774.
3. Pittet D. Infection control and quality health care in the new millennium. *Am J Infect Control* 2005;**33**:258—267.
4. National Nosocomial Infections Surveillance (NNIS) Report, data summary from January 1992 through June 2004, issued October 2004: a report from the National Nosocomial Infections Surveillance (NNIS) System. *Am J Infect Control* 2004; **32**:470—485.
5. Gastmeier P, Geffers C, Sohr D, Dettenkofer M, Daschner F, Rüden H. Five years working with German nosocomial infection surveillance system (Krankenhaus Infections Surveillance System). *Am J Infect Control* 2003;**31**:316—321.
6. Geubbels EL, Mintjes-de Groot JA, van de Berg JM, de Boer AS. An operating surveillance system of surgical-site infections in the Netherlands: results of the PREZIES National Surveillance Network. *Infect Control Hosp Epidemiol* 2000;**21**:311—318.
7. Cooke EM, Coello R, Sedgwick J, *et al*. A national surveillance scheme for hospital-associated infections in England. *J Hosp Infect* 2000;**46**:1—3.
8. Mertens R, Jans B, Kurz X. A computerised nationwide network for nosocomial infection surveillance in Belgium. *Infect Control Hosp Epidemiol* 1994;**15**:171—179.
9. Jodra VM, Diad-Agero Perez C, de los Terreros Soler LS, Saa Requejo CM, Ballesteros DD. Results of the Spanish national nosocomial infection surveillance network (VICONOS) for surgery patients from January 1997 through December 2003. *Am J Infect Control* 2006;**34**:134—141.
10. Gulacsi L, Tatar Kiss ZS, 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**:43–52.
11. Emori TG, Culver DH, Horan TC, *et al*. National nosocomial infections surveillance (NNIS) system: description of surveillance methodology. *Am J Infect Control* 1991;**19**:19–35.
12. Horan TC, Emori TG. Definitions of key terms used in the NNIS system. *Am J Infect Control* 1997;**25**:112–126.
13. Culver DH, Horan TC, Gaynes RP, *et al*. Surgical wound infection rates by wound class, operative procedure and patient risk. *Am J Med* 1991;**91**(Suppl. 3B):152S–157S.
14. Haley RW, Culver H, White JW, *et al*. The efficacy of infection surveillance and control programs in preventing nosocomial infections in US hospitals. *Am J Epidemiol* 1985;**8**:183–203.
15. Bruke JP. Infection control — a problem for patient safety. *N Engl J Med* 2003;**348**:651–656.
16. 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.
17. Brandt C, Sohr D, Behnke M, Dashner F, Rüden H, Gastmeier P. Reduction of surgical site infection rates associated with active surveillance. *Infect Control Hosp Epidemiol* 2006;**27**:1347–1351.
18. Kasatpibal N, Jamulitrat S, Chongsuvivatwong V. Standardised incidence rates of surgical site infection: a multicenter study in Thailand. *Am J Infect Control* 2005;**33**:587–594.
19. Reilly J, Allardice G, Bruce J, Hill R, McCoubrey J. Procedure-specific surgical site infection rates and postdischarge surveillance in Scotland. *Infect Control Hosp Epidemiol* 2006;**27**:1318–1323.
20. Geubbels E, Nagelkerke N, Mintjes-de Groot A, Vandenbrroucke-Grauls C, Grobbee D, de Boer A. Reduced risk of surgical site infections through surveillance in a network. *Int J Qual Health Care* 2006;**18**:127–133.
21. Gastmeier P, Geffers C, Brandt C, *et al*. Effectiveness of a nationalwide nosocomial infection surveillance system for reducing nosocomial infections. *J Hosp Infect* 2006;**64**:16–22.