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10.1515/sjph-2016-0033 Zdrav Var 2016; 55(4): 239-247

Klavs I, Kolman J, Lejko Zupanc T, Kotnik Kevorkijan B, Korošec A, Serdt M, SNHPS Network. The prevalence of and risk factors for healthcare-associated infections in Slovenia: results of the second national survey. Zdrav Var 2016; 55(4): 239-247

THE PREVALENCE OF AND RISK FACTORS FOR HEALTHCARE-ASSOCIATED INFECTIONS IN SLOVENIA: RESULTS OF THE SECOND NATIONAL SURVEY

PREVALENCA IN DEJAVNIKI TVEGANJA ZA BOLNIŠNIČNE OKUŽBE V SLOVENIJI: REZULTATI DRUGE NACIONALNE PRESEČNE RAZISKAVE

Irena KLAVS[1*], Jana KOLMAN[1], Tatjana LEJKO ZUPANC[2], Božena KOTNIK KEVORKIJAN[3], Aleš KOROŠEC[1], Mojca SERDT[1], on behalf of the SNHPS Network[4]

[1]National Institute of Public Health, Trubarjeva 2, 1000 Ljubljana, Slovenia
[2]University Medical Centre Ljubljana, Department of Infectious Diseases, Japljeva 2, 1000 Ljubljana, Slovenia
[2]University Medical Centre Maribor, Department of Infectious Diseases and Febrile Conditions, Ljubljanska cesta 5, 2000 Maribor, Slovenia
[4]Members of the SNHPS Network are listed at the end of the article

Received: Mar 1, 2016
Accepted: May 10, 2016

Original scientific article

ABSTRACT

Introduction. In the second Slovenian national healthcare-associated infections (HAIs) prevalence survey, conducted within the European point prevalence survey of HAIs and antimicrobial use in acute-care hospitals, we estimated the prevalence of all types of HAIs and identified risk factors.

Methods. Patients from acute-care hospitals were enrolled into a one-day cross-sectional study in October 2011. Descriptive analyses were performed to describe the characteristics of patients, their exposure to invasive procedures and the prevalence of different types of HAIs. Univariate and multivariate analyses of association of having at least one HAI with possible risk factors were performed to identify risk factors.

Results. Among 5628 patients, 3.8% had at least one HAI and additional 2.6% were still being treated for HAIs on the day of the survey; the prevalence of HAIs was 6.4%. The prevalence of urinary tract infections was the highest (1.4%), followed by pneumoniae (1.3%) and surgical site infections (1.2%). In intensive care units (ICUs), the prevalence of patients with at least one HAI was 35.7%. Risk factors for HAIs included central vascular catheter (adjusted odds ratio (aOR) 4.0; 95% confidence intervals (CI): 2.9-5.7), peripheral vascular catheter (aOR 2.0; 95% CI: 1.5-2.6), intubation (aOR 2.3; 95% CI: 1.4-3.5) and rapidly fatal underlying condition (aOR 2.1; 95% CI: 1.4-3.3).

Conclusions. The prevalence of HAIs in Slovenian acute-care hospitals in 2011 was substantial, especially in ICUs. HAIs prevention and control is an important public health priority. National surveillance of HAIs in ICUs should be developed to support evidence-based prevention and control.

Keywords:
healthcare-associated infections, prevalence, survey, risk factors, Slovenia

IZVLEČEK

***Izhodišča**. Druga slovenska nacionalna presečna raziskava bolnišničnih okužb (BO) je potekala v okviru evropske presečne raziskave okužb, povezanih z zdravstvom, in uporabe protimikrobnih zdravil v bolnišnicah za akutno oskrbo. Naši cilji so bili oceniti prevalenco vseh vrst BO in opredeliti dejavnike tveganja za BO.*

***Metode**. V enodnevno presečno raziskavo smo vključili vse bolnike, ki so bili na izbrani dan v oktobru 2011 zdravljeni v slovenskih bolnišnicah za akutno oskrbo. Z deskriptivnimi analizami smo opisali značilnosti bolnikov, izpostavljenost invazivnim posegom in ocenili prevalenco različnih vrst BO. Z univariatnimi in multivariatnimi analizami povezanosti BO z možnimi dejavniki tveganja smo opredelili dejavnike tveganja.*

***Rezultati**. Na dan raziskave je imelo BO 3,8% (95-odstotni interval zaupanja: 3,3%-4,4%) bolnikov in dodatnih 2,6% (95-odstotni interval zaupanja: 2,1%-3,0%) bolnikov je bilo še vedno zdravljenih zaradi BO, torej je imelo BO 6,4% (95-odstotni interval zaupanja: 5,7%-7,0%) bolnikov oziroma je bila prevalenca BO 6,4%. Na 100 bolnikov je bilo 7,0 epizod BO, ker so nekateri bolniki imeli več kot eno epizodo. Najvišja je bila prevalenca okužb sečil (1,4%), sledile so pljučnice (1,3%) in okužbe kirurških ran (1,2%). Delež bolnikov z vsaj eno BO je bil najvišji v enotah za intenzivno zdravljenje (35,7%). Na 100 bolnikov v enotah za intenzivno zdravljenje je bilo 42,5 epizod BO. V primerjavi z bolniki brez različnih invazivnih posegov so imeli bolniki s centralnim žilnim katetrom 4,0-krat višji obet za nastanek BO (prilagojeno razmerje obetov (pRO) 4,0; 95-odstotni interval zaupanja: 2,9-5,7), bolniki s perifernim žilnim katetrom 2,0-krat višji obet za nastanek BO (pRO 2,0; 95-odstotni interval zaupanja: 1,5-2,6), intubirani bolniki 2,3-krat višji obet za nastanek BO (pRO 2,3; 95-odstotni interval zaupanja: 1,4-3,5) in bolniki s hitro smrtno boleznijo 2,1-krat višji obet za nastanek BO (pRO 2,1; 95-odstotni interval zaupanja: 1,4-3,3).*

***Zaključki**. Prevalenca BO v slovenskih bolnišnicah za akutno oskrbo je bila v letu 2011 precejšnja. Predvsem je bila visoka v enotah za intenzivno zdravljenje. Preprečevanje in obvladovanje BO je pomembna javnozdravstvena prednostna naloga. Za preprečevanje in obvladovanje BO, ki temelji na dokazih, je treba vzpostaviti nacionalno epidemiološko spremljanje BO tudi v enotah za intenzivno zdravljenje.*

***Ključne besede**:*
okužbe, povezane z zdravstvom, prevalenca, presečna raziskava, dejavniki tveganja, Slovenija

***Corresponding author:** Tel: ++ 386 1 2441 400; E-mail: Irena.Klavs@nijz.si

1 INTRODUCTION

In the first Slovenian national one-day survey of HAIs in acute-care hospitals conducted in October 2001, we estimated that 4.6% of patients had at least one HAI on the day of the survey (1). The second Slovenian national HAIs prevalence survey (SNHPS) was conducted in 2011, within the European point prevalence survey of HAIs and antimicrobial use in European acute-care hospitals (EU PPS), coordinated by the European Centre for Disease Prevention and Control (ECDC).

The objective of this paper is to describe the characteristics of patients, their exposure to invasive procedures, and to report the estimated prevalence of different types of HAIs and identified risk factors for HAIs in Slovenian acute-care hospitals in 2011.

2 METHODS

2.1 Survey Design and Data Collection

A cross-sectional study (one-day prevalence survey) was conducted in all Slovenian acute-care hospitals during three weeks in October 2011. The SNHPS protocol had been adapted from the ECDC point prevalence survey protocol (EU PPS Protocol) (2) to ensure comparability of our results with other European member states participating in the EU PPS, and also with the results of the first Slovenian national one-day survey of HAIs in acute-care hospitals conducted in 2001. We included patients from all acute-care wards, including one acute psychiatric ward and neonatal ICUs. We excluded patients from long-term care wards and accident and emergency departments. Patients were included, if they were admitted to the ward before or at 8:00 am and not yet discharged from the ward at the time of the survey. Neonates on maternity and paediatric wards, if born before or at 8:00 am on the day of the survey, were also included. We excluded patients undergoing same-day treatment or surgery, those seen at outpatient departments and outpatient dialysis patients.
Standard information was collected for all eligible patients by trained teams led by SNHPS coordinators for data collection in hospitals. It included age, sex, admission date, date of data collection (survey date), and ward specialty. As proposed by McCabe, patients were classified according to the severity of their underlying condition into three categories: non-fatal disease (expected survival >5 years), ultimately fatal disease (expected survival 1-4 years), and rapidly fatal disease (expected death within 1 year) (3). Exposures to indwelling devices (central vascular catheter, peripheral vascular catheter, urinary catheter and intubation) on the day of the survey, surgical procedures within 30 days prior to the survey, and insertion of implants within 12 months prior to the survey were recorded. All types of HAIs were identified by reviewing all medical records available at the time of the survey and through consultations with physicians and nurses. We used European standard surveillance definitions for different types of HAIs (2). The prevalence of HAIs was defined as the number of patients with at least one HAI present on the day of the survey (signs and/or symptoms) or still receiving treatment for HAIs on the day of the survey (previously present signs and/or symptoms). In contrast to the ECDC EU PPS Protocol, we have collected the data so that we were able to distinguish between patients with HAIs present on the day of the survey and those still receiving treatment for previous HAIs on the day of the survey. The onset of the signs and/or symptoms suggestive of a HAI was on day 3 of the current admission or later (day 1 was the day of admission). Infections present at admission or occurring on day 1 or day 2, or still being treated on day 1 or day 2, were also counted as HAIs, if fulfilling the HAIs surveillance definitions and additional criteria. These were: (a) If the respective patient has been discharged from acute-care hospital less than two days before re-admission; (b) when the patient had surgical site infection and surgery within 30 days before the survey (deep or organ/space surgical site infection and implant within a year before the survey); (c) in case of a *Clostridium difficile* infection, when the patient had been discharged from acute-care hospital less than 28 days before the current admission; and (d) if an invasive device was placed on day 1 or day 2 and that resulted in a HAI.

2.2 Data Management and Analysis

Completed data collection forms were checked for possible errors, missing information and inconsistencies. SNHPS hospital coordinators were approached for clarifications and to obtain missing information. Data were double-entered using Epi Info (Epi Info, version 3.5.4, CDC, Atlanta, GA, USA). Code range and filter checks were built in. Discrepancies due to entry mistakes were checked against the information on data collection forms and corrected.

Descriptive analyses were performed using the statistical software Stata (Version 11.2, StataCorp, College Station, Texas, USA). Characteristics of patients and their exposure to invasive procedures, including surgery, were described. The proportion of patients with at least one HAI (overall prevalence) and the prevalence of different types of HAIs were computed (overall and according to ward specialties). Univariate and multivariate analyses of association of having any HAI acquired during current hospitalization with selected risk factors studied were performed. Univariate analyses were first performed using the classical method for analyses of 2×k contingency tables and then repeated using logistic regression. Maximum likelihood estimates of odds ratios

(ORs) together with 95% CIs and results of likelihood ratio tests for significance were computed. Risk factors that were found to be significantly associated with any HAI ($p<0.05$) were fitted into a series of multivariate models adding one at a time. They were kept in the multivariate model, if they remained significantly associated with any HAI after the adjustment for other risk factors in the model, except for age (borderline significance, $p=0.05$), which was identified *a priori* as explanatory variable of interest or confounder. Maximum likelihood estimates of aORs together with 95% CIs and results of likelihood ratio tests for significance were computed for all risk factors remaining in the final model.

3 RESULTS

3.1 Participating Hospitals and Numbers of Patients Surveyed

All 21 Slovenian acute-care hospitals participated. 5628 patients were surveyed. Over half of them (56.8%) were hospitalized in three hospitals with over 650 beds, and only 10.0% in nine hospitals with fewer than 200 beds. The number of patients, overall and according to specialties of wards for each participating hospital, is shown in Table 1.

Table 1. A distribution of surveyed patients between acute-care hospitals and different ward specialties, Slovenian national healthcare-associated infections prevalence survey, 2011.

	The number of patients						
Acute-care hospitals	General medicine	Surgery	Gynaecology & obstetrics	Paediatrics	Intensive care	Other/ mixed	All
University Medical Centre Ljubljana	629	707	175	143	88	0	1742
University Medical Centre Maribor	295	388	45	38	24	201	991
General Hospital Celje	146	177	89	28	13	11	464
General Hospital Novo mesto	124	143	43	18	14	0	342
General Hospital Nova Gorica	92	103	38	16	9	22	280
General Hospital Murska Sobota	126	84	37	19	8	0	274
General Hospital Izola	82	57	28	11	8	0	186
General Hospital Slovenj Gradec	68	69	0	22	3	21	183
Oncology Institute Ljubljana	139	35	0	0	8	0	182
General Hospital Jesenice	53	62	0	26	4	19	164
Orthopaedic Hospital Valdoltra	0	149	0	0	0	0	149
Clinic Golnik	130	0	0	0	6	0	136
General Hospital Ptuj	47	41	9	18	7	0	122
General Hospital Trbovlje	33	25	28	6	3	0	95
General Hospital Brežice	36	23	0	2	4	22	87
Hospital Topolšica	70	0	0	0	4	0	74
Gynaecology & Obstetrics Hospital Postojna	0	0	35	16	0	0	51
Gynaecology & Obstetrics Hospital Kranj	0	0	30	12	0	0	42
Diagnostic Centre Bled	35	0	0	0	0	0	35
Surgical Centre Rožna dolina	0	18	0	0	0	0	18
Medicor	0	1	0	0	4	6	11
All	2105	2082	557	375	207	302	5628
Proportion (%)	37.4%	37.0%	9.9%	6.7%	3.7%	5.4%	100%

3.2 Patient Characteristics and Exposure to Invasive Procedures

The mean age of patients was 54.8 years (range from 0 to 102, median 60.7 years), 34.1% were less than 50 years old, 50.9% were from 50 to 79 years old, and 15.0% were aged 80 years or more. There were fewer males (47.8%) than females. Of 5602 patients (99.5% of all surveyed) who were categorized according to McCabe index, 5.1% had rapidly fatal diseases and 16.4% had an ultimately fatal disease. The average length of hospital stay from the admission to the survey day was 11.4 days (median five days). The length of stay was 1-3 days for 33.4% of patients, 4-7 days for 33.4%, 8-14 days for 16.2% and ≥15 days for 17.0% of patients. 30.5% of patients had undergone surgery since admission, 31.6% during the month before the survey, and 9.5% of patients had an implant inserted in the year before the survey. On the day of the survey, 46.8% had a peripheral vascular catheter, 7.3% a central vascular catheter, 16.2% a urinary catheter, and 3.0% were intubated. Exposures to indwelling devices were most common in ICUs. The prevalence of exposures to different indwelling devices, overall and according to the ward specialty, is shown in Table 2.

3.3 The Prevalence of Healthcare-Associated Infections

On the day of the survey, 3.8% (95% CI: 3.3%-4.4%) of patients had at least one HAI, and additional 2.6% (95% CI: 2.1%-3.0%) were still in treatment because of at least one HAI (not present on the day of the survey), corresponding to the overall prevalence of 6.4% (95% CI: 5.7%-7.0%). The prevalence of HAIs ranged from 0.0% to 8.5% in different hospitals. The prevalence was higher among patients hospitalized in large hospitals with more than 650 beds (7.3%), and lower among those hospitalized in small hospitals with less than 200 beds (3.7%). Overall, the prevalence of urinary tract infections was the highest (1.4%), followed by pneumoniae (1.3%) and surgical site infections (1.2%). Excluding HAIs that were not present on the day of the survey, but for which patients were still being treated, the corresponding prevalence estimates were 0.7%, 0.8% and 0.8%. The proportion of patients with at least one HAI or still treated for at least one HAI was the highest in ICUs (35.7%), followed by surgical wards (6.4%), general medical (5.9%), paediatric (2.4%), and gynaecology and obstetrics wards (2.2%). Excluding HAIs that were no longer present on the day of the survey, but for which patients were still being treated, the corresponding prevalence estimates were 26.6%, 3.7%, 3.1%, 2.1%, and 1.3%. The numbers of patients with different types of HAIs and their respective prevalence, overall and according to different ward specialties, are shown in Table 3.

Table 2. The prevalence of exposures to indwelling devices on the day of the survey, Slovenian national healthcare-associated infection prevalence survey, 2011.

	Intensive care	General medicine	Surgery	Gynaecology & obstetrics	Paediatrics	Other/ mixed	All
Peripheral vascular catheter	77.8%	50.3%	50.7%	21.2%	50.1%	18.2%	46.8%
Central vascular catheter	72.5%	5.7%	5.7%	0.5%	5.1%	0.3%	7.3%
Urinary catheter	82.1%	15.1%	17.8%	7.4%	0.0%	4.3%	16.2%
Intubation	53.1%	0.6%	2.0%	0.9%	0.0%	0.3%	3.0%
Number of patients (100%)	207	2105	2082	557	375	302	5628

Table 3. The number (N) and prevalence of different types of healthcare-associated infections (HAIs) overall and according to ward specialties, Slovenian national healthcare-associated infections prevalence survey, 2011.

	Intensive care	General medicine	Surgery	Gynaecology & obstetrics	Paediatrics	Other/ mixed	All
	N (prevalence)	N (prevalence)	N (prevalence)	N (prevalence)	N (prevalence)	N (prevalence)	N (prevalence)
Urinary tract infections	8 (3.9%)	35 (1.7%)	28 (1.3%)	4 (0.7%)	1 (0.3%)	1 (0.3%)	77 (1.4%)
Pneumoniae	30 (14.5%)	25 (1.2%)	19 (0.9%)	0 (0.0%)	1 (0.3%)	0 (0.0%)	75 (1.3%)
Surgical site infections	9 (4.3%)	5 (0.2%)	48 (2.3%)	3 (0.5%)	0 (0.0%)	1 (0.3%)	66 (1.2%)
Systemic infections	12 (5.8%)	22 (1.0%)	13 (0.6%)	1 (0.2%)	6 (1.6%)	1 (0.3%)	55 (1.0%)
Bloodstream infections (BSIs)	12 (5.8%)	14 (0.7%)	7 (0.3%)	1 (0.2%)	0 (0.0%)	0 (0.0%)	34 (0.6%)
Gastro-intestinal system infections	6 (2.9%)	11 (0.5%)	5 (0.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	22 (0.4%)
Other lower respiratory tract infections	10 (4.8%)	5 (0.2%)	6 (0.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	21 (0.4%)
Bone and joint infections	0 (0.0%)	1 (0.0%)	14 (0.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	15 (0.3%)
Skin and soft tissue infections	1 (0.5%)	6 (0.3%)	6 (0.3%)	0 (0.0%)	0 (0.0%)	1 (0.3%)	14 (0.2%)
Eye, Ear, Nose or Mouth infections	0 (0.0%)	6 (0.3%)	0 (0.0%)	0 (0.0%)	1 (0.3%)	0 (0.0%)	7 (0.1%)
Cardiovascular system infections	0 (0.0%)	3 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (0.1%)
Catheter-related infections w/o BSIs	0 (0.0%)	2 (0.1%)	1 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (0.1%)
Reproductive tract infections	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (0.5%)	0 (0.0%)	0 (0.0%)	3 (0.1%)
Patients with at least one HAI[a]	74 (35.7%)	125 (5.9%)	134 (6.4%)	12 (2.2%)	9 (2.4%)	4 (1.3%)	358 (6.4 %)

[a] Patients can have several HAIs, thus the numbers in columns do not necessarily add up to the number of patients with at least one HAI.

Not a single central nervous system infection was detected.

BSIs: bloodstream infections; w/o: without.

396 episodes of HAIs occurred in 358 patients (322 had one, 34 two and 2 had three episodes). 335 episodes (84.6%) started during current hospitalization, of which all were attributed to current hospitalization. 15.4% of all HAIs were present at admission, of which 59.0% were associated with a previous stay in the same hospital, and 23.0% were surgical site infections. The median duration of hospital stay until the onset of HAIs acquired during current hospitalization was 10 days (mean 15.6 days).

Among 396 episodes of HAIs, urinary tract infections were most common (19.4%), followed by pneumoniae (18.7%) and surgical site infections (16.7%). The mean number of HAI episodes per infected patient was 1.1. There were 7.0 episodes of HAIs per 100 patients. The corresponding ratio was the highest in ICUs (42.5/100), followed by surgery (7.1/100), general medicine (6.5/100), paediatrics (2.4/100), and gynaecology and obstetrics (2.2/100).

3.4 Risk Factors

The prevalence of HAIs acquired during current hospitalization, according to patient characteristics, ward specialties, exposure to extrinsic risks and the length of hospital stay is shown in Table 4, along with the results of univariate analysis of association.

The results of multivariate analysis of association of different risk factors with any HAI acquired during current hospitalization, together with the relevant results of univariate analyses, are shown in Table 5. Patients aged 80 years or more had 2.2 times higher odds for any HAI than those less than 50 years old (adjusted OR (aOR) 2.2; 95% CI: 1.4–3.4). In comparison to patients without fatal diseases, those with rapidly fatal diseases had 2.1 times higher odds for any HAI (aOR 2.1; 95% CI: 1.4–3.3). The presence of at least one HAI was further independently associated with surgery during current hospitalization (aOR 1.9; 95% CI: 1.5-2.5), the presence of a central vascular catheter (aOR 4.0; 95% CI: 2.9–5.7), the presence of a peripheral vascular catheter (aOR 2.0; 95% CI: 1.5-2.6), the presence of intubation (aOR 2.3; 95% CI: 1.4-3.5), and the presence of a urinary catheter (aOR 1.8; 95% CI: 1.3–2.4).

Table 4. The prevalence of healthcare-associated infections (HAIs) acquired during current hospitalization according to patients' characteristics, ward specialties, and exposure to extrinsic risks and results of univariate analysis of association, Slovenian national healthcare-associated infections prevalence survey, 2011.

	The prevalence of patients with HAIs	The number of patients (base)	Odds ratio	P-value (95% CI)
Sex				
Male	6.5%	2692	1	P<0.001
Female	4.2%	2936	0.6	(0.5-0.8)
Age				
<50 years	2.2%	1919	1	P<0.001
50–79 years	6.8%	2866	3.2	(2.3-4.5)
≥80 years	7.5%	843	3.6	(2.4-5.4)
McCabe index				
Non-fatal disease	3.5%	4394	1	P<0.001
Ultimately fatal disease	10.9%	921	3.4	(2.6-4.4)
Rapidly fatal disease	15.0%	287	4.9	(3.4-7.0)
Specialities				
General medicine	5.1%	2105	1	P<0.001
Surgery	4.9%	2082	1.0	(0.7-1.3)
Gynaecology & obstetrics	2.0%	557	0.4	(0.2-0.7)
Paediatrics	1.6%	375	0.3	(0.1-0.7)
Intensive care	33.8%	207	9.5	(6.7-13.5)
Other	1.0%	302	0.2	(0.1-0.6)
Surgery - current hospitalization				
No	3.4%	3908	1	P<0.001
Yes	9.7%	1719	3.1	(2.4-3.9)
Implant during the last 12 months				
No	4.7%	4893	1	P<0.001
Yes	9.2%	535	2.1	(1.5-2.8)
Intubation				
No	4.4%	5457	1	P<0.001
Yes	35.9%	170	12.3	(8.7-17.2)
Central vascular catheter				
No	3.5%	5216	1	P<0.001
Yes	28.5%	410	11.0.	(8.5-14.3)
Peripheral vascular catheter				
No	3.4%	2992	1	P<0.001
Yes	7.5%	2635	2.3	(1.8-2.9)
Urinary catheter				
No	3.0%	4715	1	P<0.001
Yes	17.1%	911	6.6	(5.2-8.4)
Length of hospital stay[a]				
≤ 3 days	1.4%	1899	1	P<0.001
4-7 days	4.8%	1630	3.5	(2.2-5.4)
8-14 days	7.2%	1112	5.4	(3.5-8.4)
≥15 days	11.6%	987	9.1	(5.9-13.9)

Maximum likelihood estimates for odds ratios together with 95% confidence intervals (CI) and likelihood ratio tests for significance of association (P-value) were computed using logistic regression.

[a] The length of hospital stay was computed until the day of the survey for patients without HAIs acquired during the current hospitalization and for those with HAIs acquired during the current hospitalization until the day of occurrence of HAIs (first HAI, if several).

Table 5. Risk factors for healthcare-associated infections (HAIs) acquired during current hospitalization, results of multivariate and relevant univariate analysis of association, Slovenian national healthcare-associated infections prevalence survey, 2011.

			Unadjusted		Adjusted[a]	
	The prevalence of patients with HAIs	The number of patients (bases)	Odds ratio	*P-value* (95% CI)	Odds ratio	*P-value* (95% CI)
Patient characteristics						
Age						
<50	2.2%	1913	1	P<0.001	1	P=0.001
50-79	6.7%	2849	3.2	(2.3-4.5)	1.8	(1.2-2.6)
≥80	7.5%	836	3.6	(2.4-5.4)	2.2	(1.4-3.4)
McCabe index						
Nonfatal disease	3.5%	4392	1	P<0.001	1	P=0.001
Ultimately fatal disease	10.9%	919	3.4	(2.6-4.4)	1.4	(1.0-1.9)
Rapidly fatal disease	15.0	287	4.8	(3.4-7.0)	2.1	(1.4-3.3)
Exogenous risk factors						
Surgery - current hospitalization						
No	3.4%	3886	1	P<0.001	1	P<0.001
Yes	9.6%	1712	3.0	(2.4-3.8)	1.9	(1.5-2.5)
Intubation						
No	4.4%	5428	1	P<0.001	1	P<0.001
Yes	35.9%	170	12.3	(8.8-17.3)	2.3	(1.4-3.5)
Central vascular catheter						
No	3.5%	5191	1	P<0.001	1	P<0.001
Yes	28.5%	407	11.0	(8.5-14.3)	4.0	(2.9-5.7)
Peripheral vascular catheter						
No	3.4%	2981	1	P<0.001	1	P<0.001
Yes	7.5%	2617	2.3	(1.7-2.9)	2.0	(1.5-2.6)
Urinary catheter						
No	3.0%	4690	1	P<0.001	1	P<0.001
Yes	17.1%	908	6.6	(5.2-8.4)	1.8	(1.3-2.4)
Hospital stayb						
≤ 3 days	0.3%	1862	1	P<0.001	1	P<0.001
4-7 days	2.2%	1873	3.4	(2.2-5.3)	2.8	(1.7-4.4)
8-14 days	7.5%	909	5.4	(3.4-8.3)	3.8	(2.4-6.0)
≥15 days	19.1%	954	9.0	(5.9-13.8)	5.3	(3.3-8.3)

Maximum likelihood estimates for odds ratios together with 95% confidence intervals (CI) and likelihood ratio tests for significance of association (P-values) were computed using logistic regression. 5598 individuals with information on all risk factors in the table were included in analyses (98.5% of all individuals surveyed).

[a] Adjusted for all other risk factors shown in table.

[b] The length of hospital stay was computed until the day of the survey for patients without HAIs acquired during current hospitalization and for those with HAIs acquired during current hospitalization until the day of occurrence of HAIs (first HAI if several).

4 DISCUSSION

Ten years after the first Slovenian national HAI prevalence survey, we obtained the second national estimate of the overall prevalence of HAIs in Slovenian acute-care hospitals. It was substantial and rather high in ICUs. Three most frequently reported HAIs were urinary tract infections, pneumoniae, and surgical site infections, together accounting for more than half of all HAI episodes. Risk factors associated with HAIs, in addition to fatal underlying conditions, included central and peripheral vascular catheters, urinary catheter, intubation and surgery. Exposures to these invasive procedures were substantial.

Since we used standardised European methods and European HAIs surveillance definitions, our results are comparable to the overall European results. It is reassuring that our estimated prevalence of HAIs (6.4%) was very similar to the overall estimated prevalence of HAI in the European point prevalence survey (6.0%; country range: from 2.3% in Latvia to 10.8% in Portugal) (4). However, our estimated prevalence of HAIs among patients in ICUs (35.7%) was much higher than the corresponding European estimate (19.5%). Similar to our results, the three most frequently reported HAIs in Europe as a whole were urinary tract infection (Slovenia: 19.4%; Europe: 19.0%) pneumonia (Slovenia: 18.9%; Europe: 19.4%), and surgical site infection (Slovenia: 16.7%; Europe: 19.6%). Exposures to indwelling devices (urinary catheter and intubation), surgery, the presence of a rapidly fatal disease, and a prolonged hospital stay (≥15 days) were also associated with HAIs in the European survey. Finally, our exposure rates to indwelling devices on the day of the survey were very similar to overall European exposure rates (peripheral vascular catheter: in Slovenia 46.8% and in Europe 46.7%; central vascular catheter: in Slovenia 7.3% and in Europe 7.5%; urinary catheter: in Slovenia 16.2% and in Europe 17.2%; intubation: in Slovenia 3.0% and in Europe 2.3%).

In comparison to the 2001 Slovenian national HAIs prevalence survey, the SNHPS in 2011 estimate of the proportion of patients with at least one HAI on the day of the survey was lower (4.6% and 3.8%) (1). In contrast, the proportion of patients in ICUs with at least one HAI on the day of the survey was almost the same in 2001 as in 2011 (26.9% and 26.6%). However, we should be cautious with comparisons, as the methods used to ascertain HAIs in both surveys differed (including the slightly different HAI surveillance definitions used in 2001), and may have had different sensitivity and specificity. In 2011, we identified the same risk factors associated with HAIs as in 2001. These were: older age, having a fatal disease, being exposed to indwelling devices (central vascular catheter, peripheral vascular catheter, urinary catheter, intubation with or without ventilation), and having a prolonged hospital stay. In addition, in 2011, surgery was also associated with HAIs. It should be noted that factors associated with higher odds of HAIs do not necessarily precede HAIs. For example, a peripheral vascular catheter can be inserted because of antimicrobial parenteral treatment of a HAI. In 2011, we collected information on indwelling devices on the day of the survey only, while in 2001, we collected information on indwelling devices on the day of the survey and/or during the week before the survey. In 2011, 7.3% of patients had a central vascular catheter and 46.8% of patients had a peripheral vascular catheter on the day of the survey, while in 2001, 6.3% and 45.5% of patients had a central vascular catheter and a peripheral vascular catheter on the day of the survey and/or during the week preceding the survey, respectively. In 2011, 16.2% of patients had a urinary catheter on the day of the survey, while in 2001, 16.3% had a urinary catheter on the day of the survey and/or during the week preceding the survey. These results suggest that, on average, the exposure of patients to indwelling devices may have increased during the last decade. Lower point estimate of prevalence of HAIs on the day of the survey in 2011 (3.8%), in comparison to 2001 (4.6%), together with some indication for higher exposure rates to risk factors associated with HAIs, suggest that there may have been some improvement in HAIs prevention and control in Slovenian acute-care hospitals during the last decade.

The strength of our survey was the use of standardised European methods piloted in 66 hospitals from 23 countries before the main survey, including both University Medical Centres from Slovenia (5). However, there were also some limitations. It is possible that the sensitivity and specificity of approaches to ascertain HAIs in some of participating hospitals in the SNHPS were less than optimal. This could have resulted in under- or over-estimation of the overall prevalence of HAIs and misclassification of some HAIs. During the SNHPS, we did not have resources needed for the concurrent validation of data collection methods within the European point prevalence survey of healthcare-associated infections and antimicrobial use in Europe in 2011 validation study performed in 10 EU Member States in 20 acute hospitals. The sensitivity of 83% (95% CI: 79%–87%) and specificity of 98% (95% CI: 98%–99%) were found for HAIs (6). The level of agreement between the primary survey data collection and validation of results were very good for HAIs overall (Cohen's kappa (κ): 0.81), and across all the types of HAIs (the range: from 0.83 for bloodstream infections to 1.00 for lower respiratory tract infections). The authors concluded that valid and reliable methods for HAIs ascertainment were used. In Slovenia, we have assessed the sensitivity and specificity of the method used in the SNHPS for the ascertainment of six selected types of HAIs in the largest Slovenian teaching hospital, the University Medical Centre Ljubljana. We used a retrospective medical chart review. The estimated

overall sensitivity and specificity of our data collection methods for ascertaining HAIs were relatively high, and the level of agreement between the primary survey data collection and validation of results was very good for HAIs overall (7). This is reassuring with respect to the validity and reliability of our SNHPS results.

5 CONCLUSIONS

Our results indicate that the prevalence of HAIs in Slovenian acute-care hospitals in 2011 was substantial. Lower estimated prevalence of HAIs on the day of the survey in 2011, in comparison to 2001, together with some indication for higher exposure rates to invasive procedures associated with HAIs, suggest that there may have been some improvement in HAIs prevention and control in Slovenian acute-care hospitals during the last decade. An unacceptably high estimated prevalence of HAIs in ICUs requires the development of a national HAIs surveillance system in ICUs to support the intensification of their evidence-based prevention and control.

MEMBERS OF THE SNHPS NETWORK

Irena Klavs, Jana Kolman, Tatjana Lejko Zupanc, Božena Kotnik Kevorkijan, Aleš Korošec, Mojca Serdt, Darja Lavtar, Tanja Lužnik Bufon, Marjeta Škerl, Mateja Logar, Tatjana Mrvič, Tadeja Kotar, Mojca Dolinšek, Maja Šubelj, Viktorija Tomič, Andreja Pečnik, Irena Virant, Jana Čelhar, Lidija Pohar, Sara Habjan, Milena Kerin Povšič, Miriana Pucer-Kruljac, Mojca Savnik Iskra, Aleksandra Krznar, Gorazd Lešničar, Jerneja Fišer, Lea Knez, Helena Ribič, Vlasta Ekart Fakin, Emil Pal, Tatjana Remec, Irena Piltaver Vajdec, Katja Kalan Uštar.

ACKNOWLEDGEMENTS

We would like to thank health care workers in all Slovenian acute-care hospitals who participated in the collection of data.

CONFLICT OF INTEREST

No conflicts of interest exist.

FUNDING

The survey was co-financed by the Slovenian Research Agency and the Ministry of Health as applied research project (L3-2345).

ETHICAL APROVAL

The Medical Ethics Committee of the Republic Slovenia consented to the development and implementation of the National Network for the Surveillance of HAIs, with one of its components, repeated Slovenian national healthcare-associated infections prevalence surveys (consent number: 68/04/08).

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