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PREVALENCE OF AND FACTORS ASSOCIATED WITH HEALTHCARE-ASSOCIATED INFECTIONS IN SLOVENIAN ACUTE CARE HOSPITALS: RESULTS OF THE THIRD NATIONAL SURVEY

PREVALENCA IN DEJAVNIKI, POVEZANI Z BOLNIŠNIČNIMI OKUŽBAMI V SLOVENSKIH BOLNIŠNICAH ZA AKUTNO OSKRBO: REZULTATI TRETJE NACIONALNE PRESEČNE RAZISKAVE

Irena KLAVS[1*], Mojca SERDT[1], Aleš KOROŠEC[1], Tatjana LEJKO ZUPANC[2], Blaž PEČAVAR[2], SNHPS III[3]

[1]National Institute of Public Health, Communicable Diseases Centre, Zaloška 29, 1000 Ljubljana, Slovenia
[2]University Medical Centre Ljubljana, Clinic for Infectious Diseases and Fever Conditions, Japljeva 2, 1000 Ljubljana, Slovenia
[3]Members of the SNHPS III Network are listed at the end of the article

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ABSTRACT

Introduction: In the third 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 factors associated with them.

Methods: Patients were enrolled into a one-day cross-sectional study in November 2017. 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 5,743 patients, 4.4% had at least one HAI and an additional 2.2% were still treated for HAIs on the day of the survey, with a prevalence of HAIs of 6.6%. The prevalence of pneumoniae was the highest (1.8%), followed by surgical site infections (1.5%) and urinary tract infections (1.2%). Prevalence of blood stream infections was 0.3%. In intensive care units (ICUs), the prevalence of patients with at least one HAI was 30.6%. Factors associated with HAIs included central vascular catheter (adjusted odds ratio [aOR] 4.1; 95% confidence intervals [CI]: 3.1–5.4), peripheral vascular catheter (aOR 3.0; 95% CI: 2.3–3.9), urinary catheter (aOR 1.8; 95% CI: 1.4–2.3).

Conclusions: The prevalence of HAIs in Slovenian acute care hospitals in 2017 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: *Tretja 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, ki so povezani z BO.*

Metode: *V enodnevno presečno raziskavo smo vključili vse bolnike, ki so bili na izbrani dan v novembru 2017 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 4,4 % (95 % interval zaupanja (IZ): 3,9 %-4,9 %) bolnikov in dodatnih 2,2 % (95% IZ: 1,8 %-2,6 %) bolnikov je bilo še vedno zdravljenih zaradi BO, torej je imelo BO 6,6 % (95% IZ: 6,0 %-7,3 %) bolnikov oziroma je bila prevalenca BO 6,6 %. Na 100 bolnikov je bilo 7,1 epizod BO, ker so nekateri bolniki imeli več kot eno epizodo. Najvišja je bila prevalenca pljučnic (1,8 %), sledile so okužbe kirurške rane (1,5 %) in okužbe sečil (1,2 %). Prevalenca okužb krvi je bila 0,3 %. Delež bolnikov z vsaj eno BO je bil najvišji v enotah za intenzivno zdravljenje (30,6 %). Na 100 bolnikov v enotah za intenzivno zdravljenje je bilo 38,3 epizod BO. V primerjavi z bolniki brez različnih invazivnih posegov so imeli bolniki s centralnim žilnim katetrom 4,1-krat višji obet BO (prilagojeno razmerje obetov (pRO) 4,1; 95 % interval zaupanja (IZ): 3,1-5,4), bolniki s perifernim žilnim katetrom 3,0-krat višji obet BO (pRO 3,0; 95 % IZ: 2,3-3,9), bolniki z urinskim katetrom 1,8-krat višji obet BO (pRO 1,8; 95 % IZ: 1,4-2,3) in bolniki z operacijo v času hospitalizacije 1,6-krat višji obet BO (pRO 1,6; 95% IZ: 1,2-2,0).*

Zaključki: *Prevalenca BO v slovenskih bolnišnicah za akutno oskrbo je bila v letu 2017 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 477; E-mail: irena.klavs@nijz.si

1 INTRODUCTION

Healthcare-associated infections (HAIs) represent a problem for patient safety and their impact implies prolonged hospital stay, long-term disability, increased resistance of microorganisms to antimicrobials, additional financial burdens, an excess of deaths, high costs for healthcare systems and emotional stress for patients and their families (1). More than half of certain types of HAIs are considered preventable with comprehensive evidence-based prevention strategies (2).

In the second Slovenian national HAIs prevalence survey (SNHPS II), conducted in October 2011 in all acute care hospitals, we estimated that on the day of the survey 3.8% (95% confidence interval [CI]: 3.3%–4.4%) of patients had at least one HAI and an additional 2.6% (95% CI: 2.1%–3.0%) were still on treatment because of at least one HAI (not present on the day of the survey), corresponding to overall HAIs prevalence of 6.4% (95% CI: 5.7%–7.0%) (3). As 36 of 358 patients with at least one HAI had more than one HAI, there were 7.0 episodes of HAIs per 100 patients (3).

The third Slovenian national HAIs prevalence survey (SNHPS III) was conducted in 2017 within the second European Point prevalence survey (EU PPS II) of HAIs and antimicrobial use in acute care hospitals of the European Union (EU) and European Economic Area (EEA) under the coordination of 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, microorganisms identified and association of potential risk factors with HAIs in Slovenian acute care hospitals in 2017 and compare them to the corresponding estimates 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. The SNHPS III protocol had been adapted from the EU PPS protocol (version 5.3) (4) to ensure comparability of our results with other EU/EEA countries participating in EU PPS II and with the results of the SNHPS II conducted in 2011. Data was collected during the period from 13th to 30th November 2017 by trained teams led by SNHPS III coordinators for data collection in individual hospitals. One hospital collected data on 10th January 2018. Patients from all wards, including long-term care and acute psychiatric wards, were included, while patients from accident and emergency departments (except, if monitored for >24 hours) were excluded. 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 and neonates and their mothers were included, if born before or at 8:00 am on the day of the survey. We also 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. It included age, sex, admission date, date of data collection (survey date), and ward specialty. Patients were classified using the McCabe criteria 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) (5). Exposures to indwelling devices (central vascular catheter, peripheral vascular catheter, urinary catheter and intubation) on the day of the survey and surgical procedures during current hospitalisation were recorded. All types of HAIs were identified by reviewing all medical records available at the time of the survey and through consultations with attending physicians and nurses. We used European standard surveillance definitions for different types of HAIs (4). In contrast to the ECDC EU PPS II 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 on the day of the survey for previous HAIs. 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 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 (or if deep or organ/space surgical site infection and implant within 90 days 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. We collected data on the microorganisms causing HAIs available at the time of the survey (4).

2.2 Data Management and Analysis

Completed data collection forms were checked for possible errors, missing information and inconsistencies. SNHPS III hospital coordinators were approached for clarifications and to obtain missing information. Data was double entered using inhouse developed web-based (HTML, JavaScript, Apache Tomcat and MySQL) data entry solutions, featuring code range and filter checks. 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 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 of HAIs). 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). In addition, since some patients had more than one HAI, the ratio of episodes of HAIs per 100 patients was computed.

Univariate and multivariate analyses of association of any HAI acquired during current hospitalisation with selected risk factors were performed. Univariate analyses were first performed using the classical method for analyses of the 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 adjustment for other risk factors in the model (borderline significance, $p=0.05$). Maximum likelihood estimates of adjusted ORs (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. 5,743 patients were surveyed. Over half of them (55.7%) were hospitalised in three hospitals with over 650 beds and only 9.7% in nine with fewer than 200 beds.

3.2 Patient Characteristics and Exposure to Invasive Procedures

The mean age of patients was 59 years (range 0 to 102, median 65 years), 27.7% were less than 50 years old, 52.5% were 50 to 79, and 19.8% were aged 80 years or more. There were fewer males (48.6%) than females. Of 5,665 patients (98.6% of all surveyed) who were categorized according to McCabe index, 7.0% had a rapidly fatal disease and 19.9% had an ultimately fatal disease. The average length of hospital stay from admission to the survey day was 12.3 days (median 6 days). The length of stay was one to three days for 32.9% of patients, four to seven days for 25.0%, eight to 14 days for 20.1% and more than 14 days for 22.0% of patients. A total of 31.8% of patients had undergone surgery since admission. On the day of the survey, 48.2% had a peripheral vascular catheter, 9.4% a central vascular catheter, 19.1% a urinary catheter, and 3.1% were intubated. Exposures to indwelling devices were most common in intensive care units (ICUs). The prevalence of exposures to different indwelling devices, overall and according to the ward specialty is shown in Table 1.

3.3 Prevalence of Healthcare-Associated Infections

On the day of the survey, 4.4% (95% CI: 3.9%–4.9%) of patients had at least one HAI and additional 2.2% (95% CI: 1.8%–2.6%) were still on treatment because of a previous HAI (symptoms and signs not present anymore on the day of the survey), corresponding to the overall prevalence of 6.6% (95% CI: 6.0%–7.2%). In different hospitals, the prevalence of HAIs ranged from 0.0% to 28.6%. Among patients hospitalised in large hospitals with more than 650 beds the prevalence was 6.9% (95% CI: 6.1%–7.9%) and among those hospitalised in small hospitals with less than 200 beds 5.5% (95% CI: 3.9%–7.8%).

Overall, the prevalence of pneumoniae was the highest (1.9%; 95% CI: 1.5%–2.2%), followed by surgical site infections (1.5%; 95% CI: 1.2%–1.8%) and urinary tract infections (1.2%; 95% CI: 1.0%–1.5%). Excluding HAIs that were not present on the day of the survey, but patients

Table 1. Prevalence of exposures to indwelling devices on the day of the survey, overall and according to different ward specialties, Slovenian national healthcare-associated infection prevalence survey, 2017.

	Intensive care	General medicine	Surgery	Gynaecology, obstetrics & neonatology	Paediatrics	Other/ mixed	All	(95% CI)
Peripheral vascular catheter	68.9%	56.8%	49.7%	21.7%	57.3%	22.1%	48.2%	(46.9% - 49.5%)
Central vascular catheter	74.0%	6.9%	9.6%	0.2%	7.1%	5.2%	9.4%	(8.6% - 10.1%)
Urinary catheter	81.1%	20.9%	18.5%	6.8%	1.1%	13.7%	19.1%	(18.1% - 20.2%)
Intubation	48.0%	1.0%	2.3%	0.6%	2.1%	1.3%	3.1%	(2.7% - 3.6%)
Number of patients	196	2190	1997	545	281	534	5743	

were still treated for them, the corresponding prevalence estimates were 0.6% (95% CI: 0.4%–0.8%), 0.6% (95% CI: 0.4%–0.8%) and 0.5% (95% CI: 0.3%–0.7%). The proportion of patients with at least one HAI or still treated for at least one HAI was the highest in ICUs (30.6%; 95% CI: 24.6%–37.4%), followed by surgical wards (6.7%; 95% CI: 5.7%–7.9%), general medical (5.8%; 95% CI: 4.9%–6.9%), paediatric (3.2%; 95% CI: 1.7%–6.0%), and gynaecology and obstetrics wards (2.9%; 95% CI: 1.8%–4.7%). Excluding HAIs that were no longer present on the day of the survey, but patients were still treated for them, the corresponding prevalence estimates were 6.9%; 95% CI: 3.8%–12.1%), 2.1% (95% CI: 1.5%–2.8%), 3.0% (95% CI: 2.4–3.8%), 1.1% (95% CI: 0.4%–3.2%), and 0.4% (95% CI: 0.1%–1.4%). Numbers of patients with different types of HAIs and respective prevalence, overall and according to different ward specialties are shown in Table 2.

409 episodes of HAIs occurred in 377 patients (349 had one, 24 had two and four had three episodes). 322 episodes (78.7%) started during the current hospitalisation, of which all were attributed to current hospitalisation. 20.5% of all HAIs were present at admission, of which 70.2% were associated with a previous stay in the same hospital and 40.5% were surgical site infections. The median duration of hospital stay until the onset of HAIs acquired during current hospitalisation was 10 days (mean 20.2 days).

Among 409 episodes of HAIs, pneumoniae was most common (26.7%), followed by surgical site infections (20.5%) and urinary tract infections (16.9%). The highest proportion of healthcare-associated pneumoniae occurred in general medicine wards (35.5% of all), the highest proportion of surgical site infections in surgical wards (77.4% of all) and the highest proportion of urinary tract infections in general medicine wards (59.4% of all).

The mean number of HAI episodes per infected patient was 1.1. There were 7.1 episodes of HAIs per 100 patients. The corresponding ratio was the highest in ICUs (38.3/100), followed by surgery (6.9/100), general medicine (6.3/100), paediatrics (3.6/100), and gynaecology, obstetrics and neonatology (2.9/100).

At least one microorganism was identified in 52.3% episodes of HAIs, one in 36.4% and more than one in 15.9% episodes of HAIs. The numbers of different microorganisms identified in HAIs overall and according to most common types of HAIs are shown in Table 3.

Table 2. Number and prevalence of different types of healthcare-associated infections (HAIs), overall and according to ward specialties, Slovenian national healthcare-associated infections prevalence survey, 2017.

	Intensive care	General medicine	Surgery	Gynaecology, obstetrics & neonatology	Paediatrics	Other	All
	Number (prevalence)	Number (prevalence)	Number (prevalence)	Number (prevalence)	Number (prevalence)	Number (prevalence)	Number (prevalence)
Pneumoniae	35 (17.9%)	38 (1.7%)	19 (1.0%)	1 (0.2%)	3 (1.1%)	11 (2.1%)	107 (1.9%)
Surgical site infections	5 (2.6%)	4 (0.2%)	65 (3.3%)	3 (0.6%)	0 (0.0%)	7 (1.3%)	84 (1.5%)
Urinary tract infections	6 (3.1%)	41 (1.9%)	15 (0.8%)	1 (0.2%)	1 (0.4%)	5 (0.9%)	69 (1.2%)
Systemic infections	3 (1.5%)	22 (1.0%)	13 (0.7%)	0 (0.0%)	0 (0.0%)	2 (0.4%)	40 (0.7%)
Gastro-intestinal system infections	2 (1.0%)	13 (0.6%)	4 (0.2%)	0 (0.0%)	0 (0.0%)	5 (0.9%)	24 (0.4%)
Bloodstream infections with CRI3	6 (3.1%)	10 (0.5%)	3 (0.2%)	0 (0.0%)	1 (0.4%)	0 (0.0%)	20 (0.3%)
Skin and soft tissue infections	0 (0.0%)	4 (0.2%)	4 (0.2%)	0 (0.0%)	0 (0.0%)	2 (0.4%)	10 (0.2%)
Central nervous system infections	1 (0.5%)	3 (0.1%)	3 (0.2%)	0 (0.0%)	1 (0.4%)	0 (0.0%)	8 (0.1%)
Eye, Ear, Nose or Mouth infection	0 (0.0%)	5 (0.2%)	1 (0.1%)	1 (0.2%)	0 (0.0%)	1 (0.2%)	8 (0.1%)
Other lower respiratory tract infections	4 (2.0%)	3 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	7 (0.1%)
Bone and joint infections	0 (0.0%)	0 (0.0%)	5 (0.3%)	0 (0.0%)	0 (0.0%)	1 (0.2%)	6 (0.1%)
Cardiovascular system infections	0 (0.0%)	1 (0.0%)	4 (0.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (0.1%)
Catheter-related infections w/o BSIs	0 (0.0%)	2 (0.1%)	1 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (0.1%)
Reproductive tract infections	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.4%)	0 (0.0%)	0 (0.0%)	2 (0.0%)
Specific neonatal infections	4 (2.0%)	0 (0.0%)	0 (0.0%)	8 (1.5%)	4 (1.4%)	0 (0.0%)	16 (0.3%)
Patients with at least one HAI[a]	60 (30.6%)	127 (5.8%)	134 (6.7%)	16 (2.9%)	9 (3.2%)	31 (5.8%)	377 (6.6%)

CRI3: catheter-related bloodstream infection with microbiological documentation of the relationship between the vascular catheter and the bloodstream infection.

w/o BSIs: without bloodstream infections.

[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.

Table 3. Microorganisms identified in healthcare-associated infections (HAIs) overall and by most common types of HAIs, Slovenian national healthcare-associated infections prevalence survey, 2017.

	Pneumonia/ lower respiratory tract infections	Surgical site infections	Urinary tract infections	Bloodstream infections	Gastrointestinal tract infections	All HAIs
	Number	Number	Number	Number	Number	Number
Number of all HAIs	116	84	69	33	25	409
Number of HAIs with microorganisms all	50	44	50	25	19	214
Number of microorganisms	83	73	60	27	23	301
Gram-positive cocci	16	34	10	13	3	94
Staphylococcus aureus	9	9	0	4	0	30
***Streptococcus* spp.**	4	12	7	3	2	30
Coagulase-negative staphylococci	1	9	3	5	0	23
Other gram-positive cocci	2	4	0	1	1	11
Gram-negative cocci	0	0	0	0	0	0
Enterobacteriaceae	38	20	39	11	6	123
Escherichia coli	5	6	19	7	2	40
***Enterobacter* spp.**	10	7	4	2	1	28
***Klebsiella* spp.**	11	2	7	1	1	24
***Proteus* spp.**	3	3	5	0	1	13
Other Enterobacteriaceae	9	2	4	1	1	18
Non-fermenting gram-negative bacteria	18	6	7	0	1	33
Pseudomonas aeruginosa	9	4	6	0	1	21
Other non-Enterobacteriaceae	9	2	1	0	0	12
Anaerobic bacilli	0	8	0	1	12	22
Clostridium difficile	0	0	0	0	12	12
Other anaerobes	0	8	0	1	0	10
Other bacteria	0	0	0	0	0	0
Fungi	11	5	4	2	0	27
***Candida* spp.**	9	5	4	2	0	25
Other fungi	2	0	0	0	0	2
Virus	0	0	0	0	1	2
Negative codes	62	40	19	7	6	189
Examination not done	37	24	6	0	2	87
Not yet available/missing	11	11	9	6	2	51
Sterile examination	13	5	3	1	1	48
Microorganism not identified	1	0	1	0	1	3

Most frequently isolated microorganism was *Escherichia coli* (13.3%), followed by *Staphylococcus aureus* (10.0%) and *Streptococcus* spp. (10.0%). Among 19 gastrointestinal infections with identified microorganisms, infection with *Clostridium difficile* was confirmed in 12 cases.

3.4 Factors Associated with HAIs

The results of univariate and multivariate analyses of association of selected patients' characteristics, exposure to indwelling devices on the day of the survey and surgery during current hospitalisation with HAIs acquired during current hospitalisation are shown in Table 4. The presence of at least one HAI acquired during current hospitalisation was independently associated with surgery during current hospitalisation, presence of a central vascular catheter, presence of a peripheral vascular catheter, presence of a urinary catheter and length of hospitalisation.

4 DISCUSSION

We obtained estimates for the distribution of selected characteristics of patients, for the prevalence of exposure to selected invasive procedures and for the prevalence of HAIs in Slovenian acute care hospitals for the year 2017

using standardised European methods and European HAIs surveillance definitions. Our results are well comparable to the results of SNHPS II conducted in 2011 and with overall 2016/2017 EU PPS II results. Our estimated prevalence of HAIs (6.6%) was similar to the overall prevalence of HAIs in the EU PPS II (5.9%; country range: from 2.9% in Lithuania to 10.0% in Greece), and almost identical to the overall validation corrected prevalence of HAIs (6.5%; 95% CI: 5.4%–7.8%) (6). It is of concern that our estimated prevalence of HAIs among patients in ICUs (30.6%) was rather high in comparison to the overall European estimate of 19.2% for patients categorised as ICU specialty patients in 2016/2017 (6).

In comparison to SNHPS II conducted in 2011, in the SNHPS III in 2017, the patients were older, with the average age of 55 years in 2011 and 59 years in 2017 (p<0.01) (3). On average, they were hospitalised longer, 11 days in 2011 and 12 days in 2017 (p<0.01) (3). In addition, exposure of patients to some indwelling devices has increased. In 2017, 9.4% of patients had a central vascular catheter on the day of the survey, while in 2011 7.3% (p<0.01) and in 2017 19.1% of patients had a urinary catheter on the day of the survey and in 2011 16.2% (p<0.01) (3).

Our estimated overall prevalence of HAIs (6.6%) was very similar to the overall estimated prevalence of HAI in 2011 (6.4%) (2). The estimated prevalence of HAIs among patients in ICUs was again rather high (30.6%), although somewhat lower than the corresponding estimate in 2011 (35.7%) (p=0.27) (3).

Table 4. Prevalence of healthcare-associated infections (HAIs) acquired during current hospitalisation according to patients' characteristics, ward specialties, and exposure to extrinsic risks and results of univariate and multivariate analysis of association, Slovenian national healthcare-associated infections prevalence survey, 2017.

	Univariate analyses (whole data)				Univariate analyses (restricted data)		Multivariate analyses (restricted data)	
	Prevalence of HAIs	Number of patients (base)	Odds ratio	p-value (95% CI)	Odds ratio	p-value (95% CI)	Adjusted odds ratio	p-value (95% CI)
Age								
<50 years	3.9%	1588	1	p<0.001	1	p<0.001		
50-79 years	7.7%	3017	2.1	(1.5-2.7)	2.0	(1.5-2.7)		
≥80 years	7.3%	1138	1.9	(1.4-2.7)	1.9	(1.4-2.7)		
McCabe index								
Non-fatal disease	4.7%	4143	1	p<0.001	1	p<0.001		
Ultimately fatal disease	10.3%	1128	2.3	(1.8-2.9)	2.3	(1.8-2.9)		
Rapidly fatal disease	14.5%	394	3.4	(2.5-4.7)	3.3	(2.4-4.6)		
Surgery (during current hospitalisation)								
No	4.9%	3904	1	p<0.001	1	p<0.001	1	p<0.01
Yes	10.2%	1827	2.2	(1.8-2.7)	2.2	(1.8-2.7)	1.6	(1.2-2.0)
Intubation								
No	5.8%	5565	1	p<0.001	1	p<0.001		
Yes	30.3%	178	7.1	(5.0-9.9)	7.1	(5.0-9.9)		
Central vascular catheter								
No	4.7%	5202	1	p<0.001	1	p<0.001	1	p<0.001
Yes	24.8%	537	6.7	(5.3-8.5)	6.7	(5.3-8.5)	4.1	(3.1-5.4)
Peripheral vascular catheter								
No	4.6%	2967	1	p<0.001	1	p<0.001	1	p<0.001
Yes	8.7%	2769	2.0	(1.6-2.5)	2.0	(1.6-2.5)	3.0	(2.3-3.9)
Urinary catheter								
No	4.1%	4640	1	p<0.001	1	p<0.001	1	p<0.001
Yes	16.8%	1099	4.7	(3.8-5.8)	4.7	(3.8-5.8)	1.8	(1.4-2.3)
Length of hospital stay[a]:								
≤3 days	1.1%	1892	1	p<0.001	1	p<0.001	1	p<0.001
4-7 days	3.1%	1434	2.8	(1.7-4.8)	2.8	(1.7-4.8)	2.6	(1.5-4.4)
8-14 days	9.5%	1153	9.3	(5.8-14.9)	9.3	(5.8-14.9)	9.4	(5.8-15.2)
≥15 days	16.1%	1264	17.0	(10.8-26.9)	16.9	(10.7-26.7)	15.5	(9.7-24.8)

5,719 individuals with information on all risk factors included in the final multivariate model were included in multivariate analyses on the restricted data (99.6% of all individuals surveyed).

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

Similar to 2011, the three most frequently reported HAIs in 2017 were pneumonia (2017: 26.7%; 2011: 18.7%), surgical site infection (2017: 20.5%; 2011: 16.7%), and urinary tract infection (2017: 16.9%; 2011: 19.4%); together accounting for almost two thirds of all HAIs in 2017 (3).

In 2017, factors independently associated with HAIs were central vascular catheter, peripheral vascular catheter, urinary catheter, surgery during current hospitalisation and having a prolonged hospital stay. In 2011, in addition to these, older age, having a fatal disease and intubation with or without ventilation were also associated with HAIs (3). It should be noted that factors associated with higher odds of HAIs do not necessarily precede HAIs. For example, a central or peripheral vascular catheter can be inserted because of antimicrobial parenteral treatment of a HAI.

The strength of our survey was the participation of all Slovenian acute care hospitals ensuring representativeness of our results for Slovenian acute care hospitals and the use of standardised European methods (4) that were comparable to our methods used in SNHPS II in 2011 (3). Nevertheless, we should be cautious with comparisons, as the methods used to ascertain patients' characteristics, exposures to potential risks, and HAIs in both Slovenian surveys may have differed (including the slightly different HAI surveillance definition for pneumonia used in 2011).

The major limitation was the possibility that the sensitivity and specificity of approaches to ascertain HAIs were less than optimal and may have differed substantially between individual hospitals and also between the two surveys. This could have resulted in under- or over-estimation of the different estimates for the prevalence of HAIs (nationally, in individual hospitals, according to wards' specialty, etc.) and misclassification of some HAIs. Similarly, to the SNHPS II, we did not have the resources needed for the concurrent validation of the data collection methods within the European point prevalence survey of HAIs and antimicrobial use, as suggested by ECDC (7).

However, we have assessed the sensitivity and specificity of the methods used for the ascertainment of six selected types of HAIs during the SNHPS II in the largest Slovenian teaching hospital, the University Medical Centre Ljubljana (UMCL) by retrospective medical chart review to be 83% and 99% (8). These estimates were very similar to the corresponding estimates in the 2010/2011 EU PPS validation study, 83% and 98% respectively (9). As the estimated overall sensitivity and specificity of our data collection methods for ascertaining HAIs in the UMCL during SNHPS II were relatively high and the level of agreement between the primary survey data collection and validation results was very good for HAIs overall, this is also reassuring with respect to the validity and reliability of SNHPS III results.

5 CONCLUSIONS

Our results indicate that prevalence of HAIs in Slovenian acute care hospitals in 2017 remained substantial. Slightly higher point estimate of the prevalence of HAIs in 2017 in comparison to 2011 (the difference was not statistically significant), together with the evidence for increased average age of patients, prolonged hospitalisation, increased prevalence of exposure to some indwelling devices associated with HAIs, suggest that overall HAIs prevention and control efforts in Slovenian acute care hospitals have managed to contain the magnitude of the problem, but not to appreciably decrease the occurrence of HAIs. To achieve this, prevention and control efforts should be targeted at preventing pneumonia, surgical site infections and urinary tract infections. Reducing the high prevalence of HAIs in ICUs remains a priority. Appropriate resources for the national coordination of prevention and control of HAIs as well as in individual acute care hospitals should be ensured.

For evidence-based national and individual hospitals' HAIs prevention and control policies and practices, the national HAIs surveillance system, coordinated at the National Institute of Public Health, including the repeated SNHPSs every five years, should be developed further.

MEMBERS OF THE SNHPS III NETWORK

Irena Klavs (National Institute of Public Health), Jana Kolman (National Institute of Public Health), Aleš Korošec (National Institute of Public Health), Mojca Serdt (National Institute of Public Health), Maja Šubelj (National Institute of Public Health), Tatjana Lejko Zupanc (University Medical Centre Ljubljana), Blaž Pečavar (University Medical Centre Ljubljana), Živa Alič (General Hospital Izola), Gabrijela Damevska Kaučič (General Hospital Ptuj), Matej Dolenc (General Hospital Jesenice), Jerneja Fišer (General Hospital Nova Gorica), Milena Kerin Povšič (Institute of Oncology Ljubljana), Božena Kotnik Kevorkijan (University Medical Centre Maribor), Tanja Lužnik Bufon (Surgical Centre Rožna Dolina), Anže Mihelič (Orthopaedic Hospital Valdoltra), Irena Milotić (General Hospital Celje), Tatjana Mrvič (University Medical Centre Ljubljana), Marko Mugoša (Gynaecology and Obstetrics Hospital Postojna), Gregor Nemec (General Hospital Nova Gorica), Emil Pal (General Hospital Murska Sobota), Andreja Pečnik (Hospital Topolšica), Irena Piltaver Vajdec (General Hospital Slovenj Gradec), Lidija Pohar (Diagnostic Centre Bled), Tatjana Remec (General Hospital Novo mesto), Maja Rojko (International Center for Cardiovascular Diseases MC Medicor), Mojca Savnik Iskra (General Hospital Brežice), Viktorija Tomič (University Clinic of Respiratory and Allergic Diseases Golnik), Katja Kalan Uštar (General Hospital Trbovlje), Irena Virant (Gynaecology and Obstetrics Hospital Kranj).

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CONFLICT OF INTEREST

No conflicts of interest exist.

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ETHICAL APPROVAL

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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