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THE MOST FREQUENT HOSPITAL-ACQUIRED INFECTIONS RELATED TO MEDICAL INTERVENTIONS IN HOSPITALS IN VOJVODINA PROVINCE

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Abstract - Infections associated with medical procedures, or hospital-acquired infections (HAIs), occur in all hospitals worldwide. An integrated infection-control program with HAI surveillance as its cornerstone can reduce the incidence of HAIs and contribute to economic benefits. The aim of this paper was to report the prevalence and epidemiological features of HAI in hospitals in Vojvodina, Serbia. The study population examined herein was compromised of all of the patients present in the ward at least 48 hours before the day of surveillance. It also included patients that were scheduled for discharge or transfer, and those temporarily absent from the ward for examinations or diagnostic procedures. Data were collected using uniform questionnaires, created by the scientific board of the study. Data from paper questionnaires were entered into a specially created electronic database and analyzed using standard statistical methods. A total of 2 435 patients were included in the study. The frequency of patients with HAI was 6.6% (95% CI: 5.6%-7.6%), and the prevalence of infection was 7.1% (95% CI: 6.1%-8.1%). HAI prevalence was significantly different depending on the ward, ranging from 1.7% in the gynecology department to 18.1% in intensive care departments. The most common type of HAI was pneumonia, representing 20.9% of all reported HAIs. The second most frequently reported type of HAI was surgical site infection (19.8%), followed by urinary tract infection (17.4%), gastro-intestinal infection (14.5%) and bloodstream infection (11.0%). The most commonly found microorganisms were *Enterococcus* spp. (14.5%), *Klebsiella pneumoniae* (14.5%), *Acinetobacter* spp. (13.7%), coagulase-negative *Staphylococcus* spp. (12.1%), *Pseudomonas aeruginosa* (10.5%) and *Clostridium difficile* (7.3%). The most frequently used antibiotics in therapy were third generation cephalosporins to which most of the isolates showed resistance. Although the consumption of carbapenems in this sample was only 8%, the registered carbapenem resistance in some bacteria indicates more frequent and longer use of carbapenems in hospitals with the side effect of selective pressure.

Key words: Prevalence, hospital-acquired infections

INTRODUCTION

Hospital-acquired infections (HAIs) are a major worldwide public health problem dating back to the first hospitals, and it remains important today. It is well known that HAIs have been associated with significant morbidity and attributable mortality, as well as greatly increased healthcare costs (Rosenthal et al., 2008).

Studies conducted in the United States more than 30 years ago and recently validated in Germany have shown that an integrated infection-control program with HAI surveillance as its cornerstone can reduce the incidence of HAIs by 30%, yielding economic benefits (Haley et al., 1980; Gastmeier et al., 2006).

Surveillance of HAIs is an important component of comprehensive infection prevention and control programs (Haley et al., 1985). The gold standard for epidemiological surveillance is prospective active surveillance. Point prevalence surveys (PPS), although not as accurate as the traditional prospective method, provide baseline information about the occurrence and distribution of HAIs within a healthcare institution and help to establish priorities for infection prevention and control departments.

Repeated prevalence surveys have been used for the evaluation of infection control programs, for intra-hospital comparisons, to follow trends in HAI rates, to determine rates of device utilization and antibiotic usage, and to measure adverse effects and costs associated with these infections (French et al., 1989; Weinstein et al., 1999; Sax et al., 2001; French et al., 1991).

During an expert meeting held in Brussels in November 2010, it was recommended that PPSs of HAIs and antimicrobial use should be carried out at least once every five years, and the patient-based protocol was selected as the preferred methodology for future PPSs (Goossens et al., 2011). The first prevalence study of hospital infections in Serbia was conducted in 1999, the second in 2005 and the third in 2010 (Marković-Denić et al., 2000, 2007, 2010).

This paper presents data obtained during the third national prevalence survey of the prevalence of HAIs and their general epidemiological features in the Autonomous Province of Vojvodina (APV), northern Serbia. The aim was to identify the most common localization and prevalence of HAIs in different departments, to consider the most common risk factors, the most frequent microbiological agents of HAIs, as well as their resistance to antibiotics, and to determine patterns of antimicrobial use.

MATERIALS AND METHODS

The point prevalence study was carried out in November 2010 in 12 hospitals in the APV. It included 8 general hospitals (secondary level), 5 university hospitals (tertiary level) and 4 specialized institutes. Patients hospitalized in the internal medicine, surgery, obstetric and gynecology, pediatrics and intensive care departments, at least 48 hours before the day of surveillance (including those scheduled for discharge or transfer, and those temporarily absent from the ward for examinations or diagnostic procedures) were included.

All patients with acute infection on the day of study were registered as patients with HAI except those who already had an infection or were in the incubation period on the day of admission. Several infections of different anatomic localization in the same patient were registered as separate (other) infections. National definitions and criteria based on US CDC definitions were used to set up diagnosis of HAIs (Drndarević et al., 1998).

Trained medical staff completed the questionnaires for each patient with data collected from clinical records, temperature charts, laboratory reports, and information provided by physicians and nurses in each ward. Study variables included demographics (sex, age), primary diagnosis (primary diagnostic group: diseases of circulatory system, neoplasms, diseases of genitourinary, respiratory, musculoskeletal and central nervous system, infectious diseases, and the newborn), comorbidities (diabetes, arterial hypertension, trauma), and factors related to health care, including surgery procedures, mechanical ventilation, central and peripheral venous catheter, urinary catheter, and the use of antimicrobials. Information on variables associated with surgery (type of surgical site, duration of surgery, antibiotic prophylaxis) was also collected. Microbiological data were recorded as microorganisms identified in cultures, as well as antimicrobial sensitivity tests. In cases of material for microbiological examination taken on the day of the study or earlier with no results available, microbiological analyses were collected within the next 72 hours.

Data were collected by the uniform questionnaire according to the protocol created by the scientific board of the study and the National Expert Committee for HAIs (www.batut.org.sr), offering detailed instructions to pollsters for the registration and classification of hospital infections.

Hospital personnel dedicated to collect data were educated in the first phase of the study and in the phase of study implementation were coordinated by epidemiologists from the regional Public Health Institutes. Final evaluation of data from all hospitals in the province was done at the Institute of Public Health of Vojvodina.

Statistical analysis was performed using the Statistical Package for Social Sciences Software (SPSS Inc, version 7.50, Chicago, IL). The results were expressed as the mean ± SD or as a proportion of the total number of patients. Relations between categorical variables and NI were first evaluated using contingency table analysis and χ^2 test or Fisher's Exact Probability Test and univariate logistic regression analysis. The Student's *t*-test was used for comparison of parametric continuous variables. The odds ratios (OR) and corresponding 95% confidence intervals were computed for overall site infection rate.

RESULTS

A total of 2 435 patients were included in the study. The mean age of the patients was 54.7 ± years (ranging from 3 days to 94 years). The male-female ratio was 1:1.1.

There were 1 162 (47.7%) patients on medical units, 652 (26.8%) on surgical units, 280 (11.5%) on gynecology units, 214 (8.8%) on pediatric units and 127 (5.2%) in critical care units.

Overall, 6.6% patients had at least one HAI, ranging from 1.7% in gynecology departments, to 18.1% in intensive care departments (Table 1). The HAI prevalence was significantly different depending on ward type (χ^2 = 111.762, P = 0.0000).

The prevalence of HAIs was 6.2% in general hospitals, 6.3% in institute hospitals and 8.1% in clinical centers. There were no statistically differences in HAI prevalence and hospital types (χ^2 = 0.836, P(χ^2 > 0.836) = 0.3605).

On the day of the survey, 160 patients had a total of 172 HAIs. Thus, the prevalence of patients with HAI was 6.6 % (95% CI: 5.6-7.6%) and the prevalence of infection was 7.1% (95% CI: 6.1-8.1%). On average, there were 1.1 HAIs per infected patient (or a total of 172 HAIs in 160 patients with HAI). Twelve patients (0.5%) had two HAIs.

The epidemiological characteristics of the patients, medical devices and interventions provided to the patients and their association with HAIs are shown in Table 1.

The most common devices used were peripheral catheters (46.2% of patients) and urinary catheters (24.0% of patients) which were either *in situ* or present within the seven days before the survey was conducted. Mechanical ventilation and nasogastric sonde were less frequently applied but showed a significant association with HAIs. Relative risk for the development of pneumonia was significantly higher for patients with mechanical ventilation and nasogastric sonde (P <0.0001).

The epidemiological variables with significant association with HAIs after univariate analysis indicated that 7 (36.8%) of the 19 bloodstream infections (BSI) were central venous catheter- related and 10 (27.7%) of the 36 pneumonias were ventilator-associated. The relative risk for development of pneumonia or BSI was statistically significant for patients with invasive devices (p< 0.0001).

Table 2 shows the distribution of HAIs by type and anatomical site. The most common type of HAI was pneumonia, representing 20.9% of all HAIs. The second most frequently registered type of HAI was

Table 1. Epidemiological variable in patients with and without hospital-acquired infection (univariate analysis), Vojvodina, Serbia, 2010.

Variable	Number of Patients	%	Patients with HAI	Prevalence of HAI (%)	Patients without HAI,	p value
Mean age	2 435	100				
Sex – male/female	2 435	100				
Hospitalized in Internal medicine	1 162	47.7	60	5.2		
Hospitalized in Gynecology	652	26.8	11	1.7		
Hospitalized in Surgery	280	11.5	49	17.5		
Hospitalized in Pediatrics	214	8.8	17	7.9		
Intensive care unit	127	5.2	23	18.1		
Infection on admission - YES	680	27.9	49	7.2	631	0.620, 0.4311
Immunosuppression- YES	149	6.1	16			25.910, 0.0000
Peripheral intravenous catheter- YES	1126	46.2	105/110			25.881 0.0000
Central intravenous catheter- YES	107	4.4	25/32HAI/7 BSI			51.415 0.0000
Mechanically ventilated- YES	46	1.9	10 PN			RR
Nasogastric sonde- YES	65	2.7	13 PN			RR
Urinary indwelling catheter within the previous seven days - YES	587	24.1	7UTI			12.610 0.0004
Stay in intensive care unit >1day						
Average length of stay in intensive care unit (days)	?		8.4 ±			71.380 0.0000
Surgical treatment - YES (N=2435)	629	25.8	61 (32 SSI)			18.139 0.0000
Surgical drains - YES (n=2435)	147	23.4	18			8.204 0.0042
Endoscopic procedures - YES	50	7.9	3 (1 SSI)			
ASA score (in operated patients N=629)	629	100				
ASA score 1 and 2 (in operated patients N= 629)	304	48.3	21 (14 SSI)			0.616 0.4327
ASA score >=3 (in operated patients N= 629)	298	47,4	39 (18 SSI)			
ASA score unknown (in operated patients N= 629)	27	4,3	1 (0 SSI)			
Wound classification (in operated patients N= 629)	629	100				
Clean	350	55.6	9 SSI			
Clean/contaminated	163	25.9	10 SSI			
Contaminated	77	12.2	9 SSI			
Dirty	39	6.2	4 SSI			
Surgical drains (in operated patients n= 629)	129	2.5				
Average duration of surgery among operated N=629, (min)	629		94.4 ±			
Average length of stay in intensive care (days) for surgery patients	7.5					

Table 2. Prevalence and relative percentage of healthcare-associated infection by type of infection, Vojvodina Province, Serbia, 2010.

Type of infection	HAIs		Prevalence of HAIs (%) N=2435	95 CI (%)
	Nbr.	%		
Surgical site infection	34	19.8	1.4 5.4*	0.93-1.87
Urinary tract infection	30	17.4	1.2	0.77-1.63
Pneumonia	36	20.9	1.5	1.02-1.98
Bloodstream infection (BSI)	19	11.0	0.8	0.45-1.15
Bone or joint infection	0	0.0	0.0	
Cardiovascular system infection	1	0.6	0.0	
Central nervous system infection	0	0.0	0.0	
Eye, ear, nose or mouth infection	1	0.6	0.0	
Gastrointestinal infection	25	14.5	1.0	0.60-1.40
Lower respiratory tract infection	11	6.4	0.5	0.22-0.78
Reproductive tract infection	1	0.6	0.0	0.0- 0.0%
Skin and soft tissue infection	8	4.7	0.3	0.08-0.52
Systemic infection	6	3.5	0.2	0.02-0.38
Total	172	100.0	7.1	6.08- 8.12

*The denominator is 629 (patients that underwent surgery).

Table 3. Major groups of microorganisms, Vojvodina, Serbia, 2010.

Group of microorganisms	Isolates N	%
Gram-positive cocci	42	33.9
Gram-negative - *Enterobacteriaceae*	42	33.9
Gram-negative bacteria - non fermentative	30	24.2
Gram-positive bacilli - *Clostridium difficile*	9	7.3
Candida albicans	1	0.8
Total	124	100

surgical site infection (19.8%), followed by urinary tract infection (17.4%), gastro-intestinal infection (14.5%) and bloodstream infection (11.0%). Gastrointestinal infection caused by *Clostridium difficile* represented 5.2% of all HAIs.

Microbiology

72.1% of the HAIs (124/172) were documented by microbiological results. The total number of isolates was 124 and total number of microorganisms 25. The most commonly isolated groups of microorganisms were equally Gram-positive cocci and Enterobacteriaceae (33.9% each) (Table 3).

The most commonly found micro- organisms were *Enterococcus* spp. (14.5%), *Klebsiella pneumoniae* (14.5%), *Acinetobacter* spp. (13.7%), coagulase-

Table 4. Most prevalent species of microorganisms, Vojvodina, Serbia, 2010.

Most common types of microorganisms	Number of isolates	%
Acinetobacter spp.	17	13.7
Klebsiella pneumoniae	18	14.5
Pseudomonas aeruginosa	13	10.5
Citrobacter spp.	1	0.8
Clostridium difficile	9	7.3
Other *Streptococcus* spp.	1	0.8
Other	1	0.8
Enterobacter spp.	6	4.8
Enterococcus spp.	18	14.5
Escherichia coli	11	8.9
Proteus mirabilis	2	1.6
Staphylococcus aureus	6	4.8
Staphylococcus spp. coagulase-negative	15	12.1
Streptococcus pneumoniae	1	0.8
Candida albicans	1	0.8
Other *Enterobacteriaceae*	1	0.8
Morganella morganii	1	0.8
Proteus vulgaris	1	0.8
Streptococcus agalactiae (B)	1	0.8
Total	124	100.0

Table 5. Distribution of microorganisms isolated in healthcare-associated infections by main type of infection point prevalence survey in 2010 (n=124).

Pneumonia	%	SSI	%	UTI	%	BSI	%
Acinetobacter spp	37.9	*Enterobacter* spp.	21.7	*Enterococcus* spp.	41.4	*Staphylococcus* spp. coag. neg	52.9
Pseudomonas aeruginosa	24.1	Staphylococcus aureus	17.4	Klebsiella pneumoniae	20.7		
Klebsiella pneumoniae	24.1	*Enterococcus* spp.	17.4	E. Coli	17.2		
		Acinetobacter spp.	13.0				

negative *Staphylococcus* spp. (12.1%), *Pseudomonas aeruginosa* (10.5%) and *Clostridium difficile* (7.3%).

Gram-negative organisms accounted for the majority of cases of pneumonia while most UTIs and BSIs were caused by Gram-positive cocci (staphylococci and enterococci).

Microbiological examination results were available in 55.6% of PN, 55.8% of SSI, 84.2% of BSI and 90% of UTI.

For 72.1% of the HAIs, a positive microbiology result was available. It revealed the presence of 36.0% gastro-intestinal infections and 90.0% in urinary tract infections (Table 5).

Table 6. Distribution of antimicrobial agents by main indication for use. Point prevalence survey 2010 (n= 1433 antimicrobial agents)

Antimicrobial agents in prophylaxis (%)	Antimicrobial agents in therapy (%)	Antimicrobial agents in HAI therapy (%)
Cephalosporins (58.6)	Cephalosporins (34.8)	Cephalosporins (28.3)
Aminoglycosides (11.6)	Combinations of penicillins with beta-lactamase inhibitors (14.3)	Combinations of penicillins with beta-lactamase inhibitors (13.1)
Derivatives of Imidazole (9.4)	Fluoroquinolones (12.5)	Derivatives of imidazole (12.7)
Fluoroquinolones (6.9)	Aminoglycosides (12.1)	Aminoglycosides (11.8)
Combinations of penicillins with beta-lactamase inhibitors (6.7)	Derivatives of imidazole (8.8)	Glycopeptides (11.0)

Table 7.

Types of hospital	Antibiotics used in prophylaxis (%)	Antibiotics used in therapy (%)	Antibiotics used in HAI therapy (%)
Institute	11.3	29.1	23.6
Clinical center	41.2	15.7	24.3
General hospital	47.5	55.2	52.0
Total	100.0	100.0	100.0
Wards with the most common antibiotic use	ICU and surgery department	Pediatric department and ICU	

With 36%, *Clostridium difficile* was the main pathogen causing gastrointestinal infections (infection prevalence 5.2%).

The percentage of methicillin-resistant *S. aureus* (MRSA) was 33.3% and that of glycopeptide-resistant *Enterococcus* spp. 5.6%.

Carbapenem resistance was reported in 46.1% of *Pseudomonas aeruginosa* and 52.9% of *Acinetobacter* spp.

Antimicrobial use

At the time of the survey, 1 067 (43.8%) patients were receiving at least one antimicrobial agent, while 311 (21.1%) were being treated with two drugs, 49 (4.6%) with three drugs and 6 (0.5%) with four drugs.

Of these, 326 (30.5%) patients were receiving at least one antimicrobial agent for prophylaxis and 714 (66.9%) patients were receiving at least one antimicrobial agent for therapy indication.

Of those patients with an HAI, 92.5% were receiving at least one antibiotic at the time of survey.

The most frequently used drugs for prophylaxis were cephalosporins (58.6%), aminoglycosides (11.6%) and derivatives of imidazole (9.4%).

The most commonly prescribed antimicrobial agents for therapy were cephalosporins (34.8%), combinations of penicillins with beta-lactamase inhibitors (14.3%), fluoroquinolones (12.5%), aminoglycosides (12.1%) and derivatives of imidazole (8.8%); 4.5% of the patients surveyed were on vancomycin.

The proportion of patients receiving antimicrobial treatment at the time of survey varied in different types of hospitals from 11.3% in institutes, to 47.5% in general hospitals (χ^2 = 122.454. P(χ^2 > 122.454) = 0.0000), and also varied in different departments (from 0.5% in pediatric department to 29.9% in intensive care).

Table 8. Prevalence of healthcare-associated infections and antimicrobial use in surveyed patients, by specialty, during the point prevalence survey, 2010 (n=2435).

Specialty	Surveyed patients		Patients with HAI		Patients with antimicrobial use in therapy	
	N	%	N	%	N	%
Internal medicine	1162	47.7	60	5.2	52	35.1
Gynecology	652	26.8	11	1.7	45	30.4
Surgery	280	11.5	49	17.5	11	7.4
Pediatrics	214	8.8	17	7.9	17	11.5
Intensive care	127	5.2	23	18.1	23	15.5
All specialties	2435	100	160	6.6	148	100.0

Among the patients with HAI, 148 (92.5%) were receiving at least one antibiotic for therapeutic purposes. Two antibiotics were being given to 71 (44.4%) patients, three antibiotics to 16 (10%) and four antibiotics to 3 (1.8%) patients.

The proportion of patients with antimicrobial treatment for therapy varied in different types of hospitals from 15.7% in clinical centers to 55.2% in general hospitals (χ^2 = 22.615. P(χ^2 > 22.615) = 0.0000). In addition, there were statistically significant differences between hospital departments, ranging from 15.5% for gynecology to 53.7% for pediatric departments (χ^2 = 116.481. P(χ^2 > 116.481) = 0.0000).

DISCUSSION

Large multicenter prevalence surveys have been conducted in Europe during the past decades and have shown an overall prevalence of HAI infections of 4-10 % (7.1%) (Gravel et al., 2007; Kampf et al., 1997; Emmerson et al., 1996; Scheel et al., 1998; Vaque et al., 1999; Pittet et al., 1999).

The range of reported prevalence results in studies that used CDC definitions for HAIs in non-EU countries ranged from 4.9% in Mauritius in 1992 to 19.1% in Malaysia in 2001 (Allegranzi et al., 2011).

Such a range in the prevalence of HAIs could be explained by differences in methodology and patient case-mix, and should not immediately be interpreted as an indication of variations in performance (Zarb et al., 2012).

The first national prevalence study in Serbia was performed in 1999 in 27 hospitals; the second was done in 2005 in 56 hospitals and the third in 2010 in 61 hospitals. The prevalence of patients with at least one HAI was 6.3%, 3.1% and 4.9%, respectively, and the HAI prevalence was 7.5%, 3.5% and 5.3%, respectively.

Thus, the HAI prevalence of 7.1% (with 6.6% of patients infected) observed in our study is comparable to that reported in other European studies (Lanini et al., 2009; Struwe et al., 2006; The RAISIN Working Group, 2009) and to the European prevalence of HAIs of 7.1% estimated by ECDC based on a review of 30 national or multicenter PPSs in 19 countries in its Annual Epidemiological Report for 2008 (ECDC, 2008).

The prevalence of HAI in this study is within the range reported by researchers from developing countries (Zarb et al., 2012; Lanini et al., 2009; Struwe et al., 2006).

However, it is very difficult to compare the prevalence studies and their results in different countries because of different patient characteristics different medical experience and, in many cases, different methodologies (Marković-Denić, 2011).

The prevalence of HAIs and the prevalence of patients with HAIs in the results of our survey were little higher than results of third national point prevalence study, but very similar to the results of a recently published pilot prevalence study in Europe (7.1% and 7.6%, respectively) (Zarb et al., 2012).

The occurrence of nosocomial infections differs in different hospitals and different wards, and in patients diagnosed differently. The highest prevalence rates of HAI were observed in intensive care units and surgery wards, similar to results of other studies (Gravel et al., 2007; Scheel and Stormark, 1998; Zarb et al., 2012; Struwe et al., 2006; van der Kooi et al., 2010; Sánchez-Payá et al., 2009; Smyth et al., 2008; Eriksen et al., 2005)

The prevalence of HAI in critical care units (18.1%) or surgery departments (17.5%) was much higher than the overall prevalence of HAI (6.6%). This is an expected finding since the severity of illness and susceptibility to HAI in such units is by definition higher than that in patients in general units.

Differences in infection rates between hospital wards can be explained by differences between patients, patient care, operations and other invasive procedures.

According to the results of previously conducted point prevalence studies, urinary tract infections are the leading health care-associated infection in developed countries, while in developing countries or in countries that have recently established HAI control programs, the most frequent type of HAI is surgical site infection (Pittet et al., 1999).

According to the results of the first national prevalence study in Serbia, the leading type of HAI was SSI, while in the second and third prevalence studies, the most frequent type of HAI was urinary tract infection.

The most common type of HAI in our survey was pneumonia, representing 20.9% of all reported HAIs. Similar results were found in a recently published pilot prevalence study of HAI in the EU (Zarb et al., 2012).

The following patient characteristics were significantly associated with pneumonia: infections present at time of admission, immunosuppression and surgery procedures, stay in the ICU; having a nasogastric sonde or endotracheal tube and mechanical ventilation were also significantly associated with the development of pneumonia.

In our study, the use of devices was comparable with the results of other recent European studies (Humphreys et al., 2008; Lyytikainen et al., 2008).

The frequency of risk factors linked to medical services of patients with at least one risk factor is extremely high (69.3%). The risk factor analysis indicated that the use of devices and procedures could be improved (urinary catheters, open surgical drains in approximately 20% of cases).

In our study, the percentage of HAIs documented by microbiological results was similar to the results of the third national prevalence study (68.2%), but higher than results from some other studies (59.1% were recorded in a European point prevalence study, and 41.1% in a Lithuanian national study) (Zarb et al., 2012; Struwe et al., 2006).

According to the results of systematic review and meta–analysis, Gram-negative bacilli were the most common nosocomial isolates, both in mixed population and in high-risk patients. More than half of the isolates in our survey belong to this group of microorganisms.

The pathogens predominantly cultured are known to be a major cause for HAIs. Overall, the most commonly isolated microorganisms were *Enterococcus* spp. (14.5%) and *Klebsiella pneumoniae* (14.5%), followed by *Acinetobacter* spp. (13.7%), coagulase-negative *Staphylococcus* spp. (12.1%) and

Table 9.

Variable	Patients N	%	Patients with HAI	Prevalence of HAI (%)	Patients without HAI,	p value
Mean age	2435	100				
Sex - male/female	2435	100				
Hospitalized in Internal Medicine	1162	47.7	60	5.2		
Hospitalized in Gynecology	652	26.8	11	1.7		
Hospitalized in Surgery	280	11.5	49	17.5		
Hospitalized in Pediatrics	214	8.8	17	7.9		
Intensive Care Unit	127	5.2	23	18.1		
Infection on admission - YES	680	27.9	49	7.2	631	0.620, 0.4311
Immunosuppression - YES	149	6.1	16			25.910, 0.0000
Peripheral intravenous catheter - YES	1126	46.2	105/110			25.881 0.0000
Central intravenous catheter - YES	107	4.4	25/32HAI/7 BSI			51.415 0.0000
Mechanically ventilated - YES	46	1.9	10 PN			RR
Nasogastric sonde - YES	65	2.7	13 PN			RR
Urinary indwelling catheter within the previous seven days - YES	587	24.1	7UTI			12.610 0.0004
Stay in intensive care unit >1day						
Average length of stay in intensive care unit (days)	?		8.4 ±			71.380 0.0000
Surgical treatment - YES (N=2435)	629	25.8	61 (32 SSI)			18.139 0.0000
Surgical drains - YES (n=2435)	147	23.4	18			8.204 0.0042
Endoscopic procedures - YES	50	7.9	3 (1 SSI)			
ASA score (in operated patients N=629)	629	100				
ASA score 1 and 2 (in operated patients N= 629)	304	48.3	21 (14 SSI)			0.616 0.4327
ASA score >=3 (in operated patients N= 629)	298	47,4	39 (18 SSI)			
ASA score unknown (in operated patients N= 629)	27	4,3	1 (0 SSI)			
Wound classification (in operated patients N= 629)	629	100				
Clean	350	55.6	9 SSI			
Clean/contaminated	163	25.9	10 SSI			
Contaminated	77	12.2	9 SSI			
Dirty	39	6.2	4 SSI			
Surgical drains (in operated patients n= 629)	129	2.5				
Average duration of surgery among operated N=629, (min)	629		94.4 ±			
Average length of stay in intensive care (days) for surgery patients	7.5					

Pseudomonas aeruginosa (10.5%). Similar results were obtained in the third national point prevalence survey.

Some differences in results were reported regarding the most common isolates of HAI in European studies, where the most common isolates were *E. coli* (15.2%) and *Staphylococcus aureus* (12.1%) (Zarb et al., 2012).

Carbapenem resistance was reported in 46.1% of *Pseudomonas aeruginosa* and 52.9% of *Acinetobacter* spp., which was much higher than the results of the third national prevalence survey (24.0% and 30.3%, respectively) and the results of some other studies (23.4% and 20.4%, respectively).

The percentage of methicillin-resistant *S. aureus* (MRSA) and that of glycopeptide-resistant *Enterococcus* spp. was similar to results of the European point prevalence study (33% and 5.6%, respectively), but lower than results of the third national study (51% and 9%, respectively).

The overall prevalence of patients receiving antimicrobials in our survey was high (43.8%). This is consistent with results of the third national study (43.1%). Lower-use rates were found by a multi-center European study (29.6%), in Spain (33.8%), Lithuania (26%), Canada (36.1%), the UK and the Republic of Ireland (33.1%), in the Netherlands (30.9%) and in Sweden (34.9%) (Zarb et al., 2012; Sánchez-Payá et al., 2009; Struwe et al., 2006; Gravel et al., 2007; Humphreys et al., 2008; van der Kooi et al., 2010; Reilly et al., 2008).

The highest percentage of antibiotic consumption in Vojvodina was registered in general hospitals, both for prophylaxis and for treatment of infections. Compared with the results of European studies, the percentage of antibiotic use was also the highest in general hospitals, but the percentage of use of antibiotics in relation to the type of hospital was fairly uniform from 36.2% in general hospitals to 35.7% in institutes (36.2%. 32.1% and 35.7%) (Zarb et al., 2012).

Antibiotic therapy for prophylaxis was the highest in intensive care and surgical wards, while for therapy, the highest use was in pediatric wards and in ICUs.

The most frequently used classes of antibiotics were similar to the results of the national prevalence study and some other studies regarding the consumption of cephalosporins, penicillins, quinolones and imidazole derivatives. Aminoglycoside use in our hospitals was higher (12.1%) compared to the results of other studies (12.1% in ECDC and <2% in Canada). Cephalosporin use was also higher in comparison to the results of some studies (34.8% vs 17.6%) (Zarb et al., 2012; Gravel et al., 2007).

Similar to results of other studies, the most frequently used antibiotics for prophylaxis were cephalosporins of the first and the second generation (77%), while for therapy third generation cephalosporins dominated (67%).

CONCLUSION

The analysis of results presented herein has elucidated some critical points for epidemiological intervention. One was the high carbapenem resistance of *Pseudomonas aeruginosa* and *Acinetobacter* spp. Others were the high administration of antimicrobials. Due to this, intervention and development of policies aiming to reduce the use of antibiotics at both local and national levels is necessary.

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