

PREVALENCIJA INTRAHOSPITALNIH INFEKCIJA I UPOTREBE ANTIBIOTIKA NA NIVOU OPŠTE BOLNICE

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ABSTRAKT

Uvod. Intrahospitalne infekcije (IHI) predstavljaju značajan javnozdravstveni problem zbog povećanja morbiditeta, mortaliteta, trajanja hospitalizacije i troškova liječenja. Pored toga, neracionalna primjena antibiotika doprinosi razvoju antimikrobne rezistencije koja predstavlja jedan od najvećih izazova savremene medicine. Cilj ove studije bio je da se utvrde rizici za razvoj IHI, prevalencija intrahospitalnih infekcija u JZU Bolnica „Sveti apostol Luka“ Doboј, kao i da se analiziraju najčešće vrste infekcija, uzročnici primjene antimikrobnih lijekova.

Materijal i metode. Sprovedena je studija presjeka prema jedinstvenom protokolu Evropskog centra za prevenciju i kontrolu bolesti (ECDC PPS verzija 6.1).

Rezultati. U istraživanje je uključeno 306 hospitalizovanih pacijenata sa svih 17 bolničkih odjeljenja. Prikupljeni su podaci o demografskim karakteristikama pacijenata, faktorima rizika, invazivnim procedurama, vrstama infekcija i

PREVALENCE OF HEALTHCARE- ASSOCIATED INFECTIONS AND ANTIBIOTIC USE AT THE LEVEL OF A GENERAL HOSPITAL

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ABSTRACT

Introduction. Healthcare-associated infections (HAI) represent a significant public health problem due to increased morbidity, mortality, length of hospital stay, and treatment costs. In addition, irrational use of antibiotics contributes to the development of antimicrobial resistance, which represents one of the greatest challenges of modern medicine. The aim of this study was to determine the risks for the development of IHI, the prevalence of intrahospital infections in the "Sveti apostol Luka" Hospital in Doboј, as well as to analyze the most common types of infections, the causes of the use of antimicrobial drugs.

Material and methods. A point prevalence study was conducted according to the unified protocol of the European Centre for Disease Prevention and Control (ECDC PPS version 6.1).

Results. The study included 306 hospitalized patients from all 17 hospital departments. Data were collected on patients' demographic characteristics, risk factors, invasive procedures, types of infections,

primjeni antibiotika. Prevalencija intrahospitalnih infekcija iznosila je 3,2%, dok je antibiotike primalo 57,2% hospitalizovanih pacijenata. Najveća prevalencija IHI registrovana je na neurologiji i jedinicama intenzivne medicine. Najčešće korišteni antibiotici bili su cefalosporini treće generacije, penicilini proširenog spektra i fluorokinoloni. Produžena hirurška profilaksa registrovana je kod 90% pacijenata.

Zaključak. Rezultati ukazuju na potrebu unapređenja nadzora nad intrahospitalnim infekcijama, racionalnije upotrebe antibiotika i jačanja programa kontrole infekcija.

Ključne riječi: intrahospitalne infekcije, prevalencija intrahospitalnih infekcija, prevalencija upotrebe antibiotika.

UVOD

Intrahospitalna infekcija (infekcija povezana sa zdravstvenom zaštitom, IHI) je infekcija nastala kod pacijenata, osoblja, posjetilaca, učenika ili studenata tokom pružanja usluga zdravstvene zaštite u bolnici ili nekoj drugoj zdravstvenoj ili socijalnoj ustanovi, a koja nije bila prisutna na prijemu, niti je pacijent bio u inkubaciji [1, 2, 3, 4, 5]. Epidemiološki nadzor nad bolničkim infekcijama može biti aktivan i pasivan i može se sprovoditi studijama prevalencije i incidencije. Studije prevalencije, poznate i kao studije presjeka, nude efikasan način prikupljanja visokokvalitetnih podataka o određenim zdravstvenim problemima [6]. Istraživanje prevalencije bolničkih infekcija koje koristi standardizovanu metodologiju i konsenzusne definicije infekcija su relativno jeftina i laka metoda za prikupljanje podataka i mogu pružiti dragocjene informacije [7, 8]. Različite zemlje sa visokim dohotkom [8, 9], kao i zemlje sa niskim i srednjim prihodima izvan Evrope su sprovodile studije prevalencije bolničkih infekcija [10, 11], a dovode do ozbiljnih komplikacija koje utiču na morbiditet, mortalitet i troškove zdravstvene zaštite širom svijeta. Neodgovarajuća upotreba antibiotika i posljedično povećanje antimikrobne rezistencije uzročnika IHI mogu ugroziti ishod liječenja [12]. U

and antibiotic use. The prevalence of healthcare-associated infections was 3.2%, while 57.2% of hospitalized patients were receiving antibiotics. The highest prevalence of HAI was recorded in neurology and intensive care units. The most commonly used antibiotics were third-generation cephalosporins, extended-spectrum penicillins, and fluoroquinolones. Prolonged surgical prophylaxis was recorded in 90% of patients.

Conclusions. The results indicate the need to improve surveillance of healthcare-associated infections, more rational use of antibiotics, and strengthening of infection control programs.

Key words: healthcare-associated infections, prevalence of healthcare-associated infections, prevalence of antibiotic use.

INTRODUCTION

A healthcare-associated infection (HAI) is an infection occurring in patients, staff, visitors, pupils or students during the provision of healthcare services in a hospital or another healthcare or social institution, which was not present at admission, nor was the patient in the incubation period [1, 2, 3, 4, 5]. Epidemiological surveillance of hospital infections can be active or passive and can be carried out through prevalence and incidence studies. Prevalence studies, also known as point prevalence studies, offer an efficient way of collecting high-quality data on specific health problems [6]. Prevalence studies of hospital infections using standardized methodology and consensus infection definitions are a relatively inexpensive and easy method for data collection and can provide valuable information [7, 8]. Various high-income countries [8, 9], as well as low- and middle-income countries outside Europe, have conducted prevalence studies of hospital infections [10, 11]. HAI lead to serious complications affecting morbidity, mortality, and healthcare costs worldwide. Inadequate use of antibiotics and the consequent increase in antimicrobial resistance of HAI pathogens may jeopardize treatment outcomes [12]. In some

nekim zemljama u razvoju udio pacijenata sa IHI može premašiti 25%. Neki su pacijenti tada u težem stanju nego što bi bili u normalnoj situaciji. Jedni zahtijevaju dugotrajnu hospitalizaciju, drugi pate od dugotrajnog invaliditeta, a neki umiru. Osim medicinskih i etičkih posljedica, nose i finansijske posljedice po zdravstvene sisteme [13]. Intrahospitalne infekcije pogađaju otprilike 1 od 10 odraslih osoba i 1 od 12 djece u bolnicama za akutnu njegu. Predstavljaju značajnu zabrinutost za sigurnost pacijenata zbog rizika za pacijente, kao i zbog ekonomskih implikacija [14]. Pacijenti primljeni u jedinice intenzivne njege izloženi su višem riziku od IHI zbog osjetljivosti povezane sa ozbiljnošću njihovog stanja, ali i invazivnih medicinskih postupaka kojima se podvrgavaju [15]. Radi sagledavanja stanja u pogledu IHI u 2016 - 2017. godini Evropski centar za prevenciju i kontrolu bolesti (ECDC) organizovao je drugu evropsku studiju prevalencije o IHI i upotrebi antibiotika, dok su po istoj metodologiji treću studiju sprovedi u 2022 -2023. u bolnicama EU/EEA za akutnu njegu [16, 17, 18]. Osim toga, bile su pozvane i ostale evropske zemlje. Dok su Srbija i Crna Gora učestvovala u studiji, dotle se BiH nije uključila. Obje studije koje su u Srbiji sprovedene u okviru studije u EU obezbijedile su značajne podatke o opterećenju bolničkim IHI, prevalenciji upotrebe antibiotika i rezistenciji uzročnika IHI [19, 20, 3]. Prema programu mjera za sprečavanje i suzbijanje, eliminaciju i eradicaciju zaraznih bolesti za područje Republike Srpske, koji se svake godine donosi za tekuću godinu, u bolnicama je neophodno kontinuirano prikupljati podatke o IHI i infekcijama izazvanim bakterijama rezistentnim na antibiotike. Takođe, programom je predviđeno da se svake treće godine u bolnicama sprovede studije prevalencije, a studije incidencije po potrebi [21]. Međutim, ove aktivnosti se uglavnom zbog nedostatka stručnog kadra ne sprovedu u bolnicama Republike Srpske, kako na nacionalnim, tako ni na nivou bolnica ili se periodično sprovedu samo na ciljanim odjeljenjima. U JZU Bolnica „Sveti apostol Luka“ do sada nije sprovedena studija prevalencije IHI i upotrebe

developing countries, the proportion of patients with HAI may exceed 25%. Some patients are then in a more severe condition than they would be in normal circumstances. Some require prolonged hospitalization, others suffer long-term disability, and some die. Besides medical and ethical consequences, they also carry financial consequences for healthcare systems [13] and affect approximately 1 in 10 adults and 1 in 12 children in acute care hospitals. They represent a significant concern for patient safety due to risks for patients, as well as economic implications [14]. Patients admitted to intensive care units are at higher risk of HAI due to vulnerability associated with the severity of their condition, as well as invasive medical procedures they undergo [15]. In order to assess the situation regarding HAI in 2016–2017, the European Centre for Disease Prevention and Control (ECDC) organized the second European point prevalence study on HAI and antibiotic use, while, using the same methodology, the third study was conducted in 2022–2023 in EU/EEA acute care hospitals [16, 17, 18]. In addition, other European countries were invited. While Serbia and Montenegro participated in the study, Bosnia and Herzegovina did not join. Both studies conducted in Serbia within the EU study provided significant data on the burden of hospital HAI, prevalence of antibiotic use, resistance of HAI pathogens, and prevalence of antibiotic use [19, 20, 3]. According to the program of measures for prevention and control, elimination and eradication of communicable diseases in the territory of the Republic of Srpska, which is adopted each year for the current year, it is necessary for hospitals to continuously collect data on HAI and infections caused by antibiotic-resistant bacteria. The program also envisages that prevalence studies are carried out in hospitals every third year, and incidence studies as needed [21]. However, due to the lack of professional staff, these activities are mostly not carried out in hospitals of the Republic of Srpska, neither at the national level nor at the level of individual hospitals, or they are periodically carried out only in targeted departments. In the Public

antibiotika na nivou bolnice, pa je nepoznato opterećenje sa IHI, njihovi uzročnici i rezistencija, kao i upotreba antibiotika. Samim tim, nema dovoljno argumenata za unapređenje nadzora nad BI i za smanjenje opterećenja i antibiotske rezistencije. Cilj ove studije bio je da se utvrde rizici za razvoj IHI, prevalencija intrahospitalnih infekcija u JZU Bolnica „Sveti apostol Luka“ Doboj, kao i da se analiziraju najčešće vrste infekcija i uzročnici primjene antimikrobnih lijekova.

MATERIJAL I METODE

Tip studije

Istraživanje je sprovedeno po tipu studije presjeka po jedinstvenom protokolu studije (ECDC PPS, verzija 6.1) uz upotrebu srpskog prevoda jedinstvenih ECDC definicija IHI [22, 1].

Ispitanici

Kriterijumi za uključivanje/isključivanje pacijenata i odjeljenja su bili u skladu sa metodologijom ECDC. U studiju prevalencije su uključena sva odjeljenja u bolnici, izuzev odjeljenja za prijem i zbrinjavanje urgentnih stanja i dnevne bolnice. U studiju su uključeni svi pacijenti primljeni na odjeljenje prije ili u osam časova ujutru i nisu otpušteni sa odjeljenja u vrijeme izvođenja studije. Iz studije su se isključili: pacijenti podvrgnuti jednodnevnoj terapiji ili operaciji, pacijenti pregledani u ambulantni, pacijenti u onkološkoj dnevnoj bolnici, i pacijenti na dijalizi (ambulantni). Podaci su se prikupljali u jednom danu za svako odjeljenje/jedinicu. Sproveden je epidemiološki nadzor nad pacijentima, uz uvid u dostupnu medicinsku dokumentaciju (istorija bolesti, temperaturna lista, rezultati dijagnostičkih procedura, laboratorijski i mikrobiološki nalaz). Dijagnoze i lokalizacija IHI postavljali su se na osnovu kriterijuma propisanih u priručniku o definicijama intrahospitalnih infekcija [1].

Instrumenti istraživanja

U cilju prikupljanja podataka koristili su se: upitnik za bolnicu; upitnik za odjeljenje i epidemiološki

Health Institution Hospital “Sveti apostol Luka” a prevalence study of HAI and antibiotic use at the hospital level has not yet been conducted, so the burden of HAI, their pathogens and resistance, as well as antibiotic use, remain unknown. Consequently, there is insufficient evidence to improve surveillance of HAI and to reduce the burden and antibiotic resistance. The aim of this study was to determine the risks for the development of IHI, the prevalence of intrahospital infections in the "Sveti apostol Luka" Hospital in Doboj, as well as to analyze the most common types of infections, the causes of the use of antimicrobial drugs.

MATERIAL AND METHODS

Type of study

The research was conducted as a point prevalence study according to the unified study protocol (ECDC PPS, version 6.1) using the Serbian translation of the unified ECDC HAI definitions [22, 1].

Participants

The inclusion/exclusion criteria for patients and departments were in accordance with the ECDC methodology. All departments in the hospital were included in the prevalence study, except for the emergency admission and treatment department and the day hospital. All patients admitted to the department before or at eight o'clock in the morning and not discharged from the department at the time of the study were included. The following were excluded from the study: patients undergoing one-day therapy or surgery, patients examined in outpatient clinics, patients in the oncology day hospital, and (ambulatory) dialysis patients. Data were collected on a single day for each department/unit. Epidemiological surveillance of patients was carried out, with access to available medical records (medical history, temperature chart, results of diagnostic procedures, laboratory and microbiological findings). Diagnoses and localization of HAI were established according to

upitnik za pacijenta. Jedan upitnik se popunjavao za bolnicu, po jedan za svako odjeljenje i po jedan epidemiološki upitnik za svakog pacijenta. Podaci o pacijentima su uključivali osnovne podatke o pacijentima, podatke o faktorima rizika za svakog pacijenta sa ili bez IHI ili antimikrobnog lijeka, podaci o primjeni invazivnih procedura u terapijske svrhe (periferni venski kateter, centralni venski kateter, urinarni kateter, intubacija, hirurška intervencija) i McCabe skor. Prikupljali su se podaci o IHI i/ili podaci o upotrebi antimikrobnih lijekova za sve pacijente koji ih primaju.

Statistička analiza

Kompjuterska obrada podataka je izvršena u softverskom paketu SPSS 26.0 for Windows. Analiza i obrada podataka obuhvatila je deskripciju pacijenata, prevalenciju pacijenata sa IHI na nivou bolnice i odjeljenja, deskripcija uzročnika IHI, prevalencija pacijenata sa upotrebom antibiotika, deskripcija najčešće korištenih antibiotika. Statistička značajnost varijabli procjenjivala se χ^2 testom i t testom. Radi procjene faktora rizika za nastanak IHI korištena je univarijantna, a zatim multivarijantna logistička regresija. Za zavisno promjenjivu veličinu uzela se pripadnost grupi (pacijenti sa ili bez IHI), a za nezavisne sve ostale varijable. Sva obilježja po kojima su se prema naprijed navedenim testovima grupe statistički značajno razlikovale ušle su u model multivarijantne logističke regresije. Za zavisnu varijablu će se, takođe, uzeti pripadnost grupi (pacijenti sa ili bez BI). Adekvatnost logističkog modela procjenjivala se sa vjerovatnoćom $p \leq 0,05$ kao i značajnost nezavisnih varijabli sa vjerovatnoćom $p \leq 0,05$.

REZULTATI

Istraživanje u JZU Bolnici "Sveti apostol Luka" sprovedeno je u decembru 2025. Uključeno je 306 hospitalizovanih pacijenata, od kojih je 155 (50,6%) bilo ženskog pola, a 151 (49,4%) muškog pola. Prosječna starost ispitanika iznosila je 61,9 godina. Najzastupljenija starosna grupa bili su pacijenti uzrasta preko 60 godina, pa su tako ispitanici od 60

the criteria set out in the manual on definitions of healthcare-associated infections [1].

Research instruments

The following were used to collect data: a hospital questionnaire; a department questionnaire; and an epidemiological questionnaire for the patient. One questionnaire was completed for the hospital, one for each department, and one epidemiological questionnaire for each patient. Patient data included basic patient information, data on risk factors for each patient with or without HAI or antimicrobial drugs, data on invasive procedures used for therapeutic purposes (peripheral venous catheter, central venous catheter, urinary catheter, intubation, surgical intervention) and McCabe score. Data on HAI and/or data on antimicrobial drug use were collected for all patients receiving them.

Statistical analysis

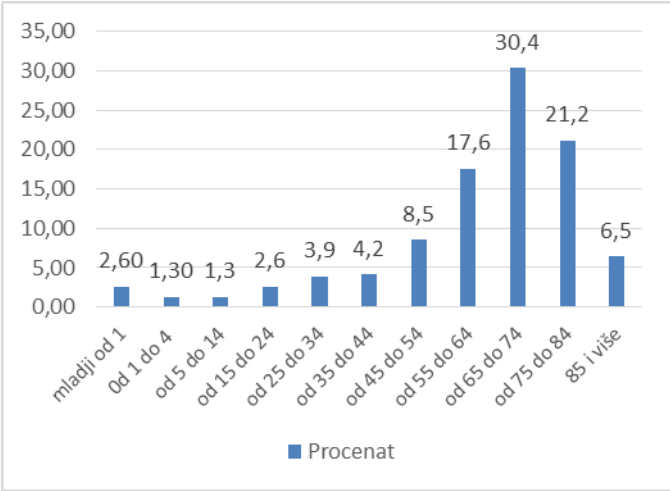
Computer data processing was performed using the software package SPSS 26.0 for Windows. Data analysis and processing included the description of patients, prevalence of patients with HAI at the hospital and department level, description of HAI pathogens, prevalence of patients receiving antibiotics, and description of the most commonly used antibiotics. Statistical significance of variables was assessed using the χ^2 test and t-test. To assess risk factors for the occurrence of HAI, univariate and then multivariate logistic regression were used. The dependent variable was group membership (patients with or without HAI), and independent variables were all other variables. All characteristics for which, according to

the above-mentioned tests, the groups differed statistically significantly were entered into the multivariate logistic regression model. The dependent variable was also group membership (patients with or without HAI). Adequacy of the logistic model was assessed with a probability of $p \leq 0.05$, as well as the significance of independent variables with a probability of $p \leq 0.05$.

i više godina činili 68,2% među svim ispitanicima, dok su ispitanici do 18 godina činili svega 5,9%. Najzastupljeniji uzrast bio je 65-74 godine (30,4%), što je prikazano na tabeli 1 i grafikonu 1.

Tabela 1. Polna i uzrasna struktura ispitanika

Uzrast	Muški (broj)	%	Ženski (broj)	%	Ukupno	%
0-18	9	6	9	5,8	18	5,9
19-59	32	21,2	47	30,3	79	25,9
60 i više	110	72,8	99	63,9	209	68,2
Ukupno	151	49,4	155	50,6	306	100



Grafikon 1. Uzrast uključenih pacijenata

Najveći broj hospitalizovanih pacijenata bio je u Internističkoj službi (21,2%), a zatim u Službi za hirurgiju (16,7%) (Tabela 2).

Tabela 2. Distribucija pacijenata po odjeljenjima

Naziv odjeljenja	Muški pol	Ženski pol	Ukupno	%
Služba za hirurgiju	25	26	51	16,7
Služba za anesteziju i reanimaciju	3	1	4	1,3
Služba za ortopediju i traumatologiju	8	8	16	5,2
Služba za ginekologiju i akušerstvo	2	22	24	7,9
Služba za ORL	4	0	4	1,3

RESULTS

The study in the Public Health Institution Hospital “Sveti apostol Luka” was conducted in December 2025. The study included 306 hospitalized patients, of whom 155 (50.6%) were female and 151 (49.4%) male. The average age of respondents was 61.9 years. The most represented age group was patients over 60 years of age, so patients aged 60 and over accounted for 68.2% of all respondents, while respondents up to 18 years of age accounted for only 5.9%. The most represented age group was 65–74 years (30.4%), as shown in Table 1 and Figure 1.

Table 1. Gender and age structure of respondents

Age	Male (number)	%	Female (number)	%	Total	%
0–18	9	6	9	5.8	18	5.9
19–59	32	21.2	47	30.3	79	25.9
60 and over	110	72.8	99	63.9	209	68.2
Total	151	49.4	155	50.6	306	100

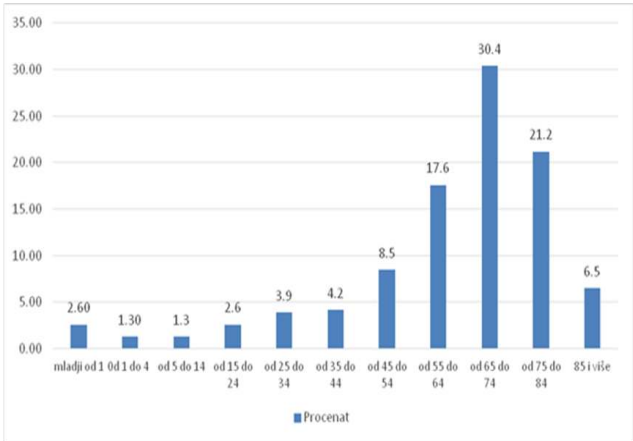


Figure 1. Age of included patients

The largest number of hospitalized patients was in the Internal Medicine Service (21.2%), followed by the Surgery Service (16.7%) (Table 2).

Služba za oftalmologiju	5	3	8	2,6
Služba za urologiju	10	6	16	5,2
Internistička služba	34	31	65	21,2
Služba za psihijatriju	19	16	35	11,4
Služba za neurologiju	11	13	24	7,9
Služba za pedijatriju	7	2	9	3,0
Služba za pulmologiju	13	9	22	7,1
Služba za onkologiju	4	2	6	2,0
Služba za intenzivnu medicinu	3	4	7	2,3
nehirurških grana	3	5	8	2,6
Služba za infektologiju	0	7	7	2,3
Dermatologija	151	155	306	100
UKUPNO				

Prosječna dužina hospitalizacije iznosila je 6, 7 dana. Najveći broj pacijenata imao je nefatalnu bolest prema McCabe skoru (Tabela 3).

Tabela 3. Distribucija pacijenata prema McCabe skoru

McCabe skor	Broj	%
Nefatalna bolest	190	62,1
Fatalna bolest	106	34,6
Brzofatalna bolest	10	3,3
Ukupno	306	100

Kod 38,2% hospitalizovanih pacijenata bio je plasiran urinarni kateter, dok je centralni venski kateter bio prisutan kod 4,2% pacijenata. Tokom tekuće hospitalizacije operisano je 33,8% pacijenata. U vrijeme sprovođenja studije registrovano je ukupno 10 intrahospitalnih infekcija kod 9 pacijenata. Prevalencija intrahospitalnih infekcija iznosila je 3,2%, dok je prevalencija pacijenata sa najmanje jednom infekcijom iznosila 2,9%. Najveća prevalencija infekcija registrovana je na odjeljenju neurologije (16,6%) i u jedinicama intenzivne medicine nehirurških grana (14,2%). Povišena prevalencija zabilježena je i na ortopediji i hirurgiji (Grafikon 2).

Table 2. Distribution of patients by departments

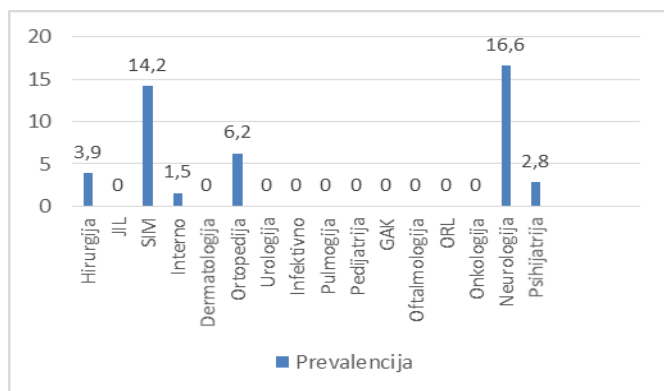
Department name	Male	Female	Total	%
Surgery Service	25	26	51	16.7
Anaesthesia and Resuscitation Service	3	1	4	1.3
Orthopaedics and Traumatology Service	8	8	16	5.2
Gynaecology and Obstetrics Service	2	22	24	7.9
ENT Service	4	0	4	1.3
Ophthalmology Service	5	3	8	2.6
Urology Service	10	6	16	5.2
Internal Medicine Service	34	31	65	21.2
Psychiatry Service	19	16	35	11.4
Neurology Service	11	13	24	7.9
Paediatrics Service	7	2	9	3.0
Pulmonology Service	13	9	22	7.1
Oncology Service	4	2	6	2.0
Intensive Care Service for Non-surgical Specialties	3	4	7	2.3
Infectious Diseases Service	3	5	8	2.6
Dermatology	0	7	7	2.3
TOTAL	151	155	306	100

Average length of hospital stay was 6.7 days. The largest number of patients had a non-fatal disease according to the McCabe score (Table 3).

Table 3. Distribution of patients according to McCabe score

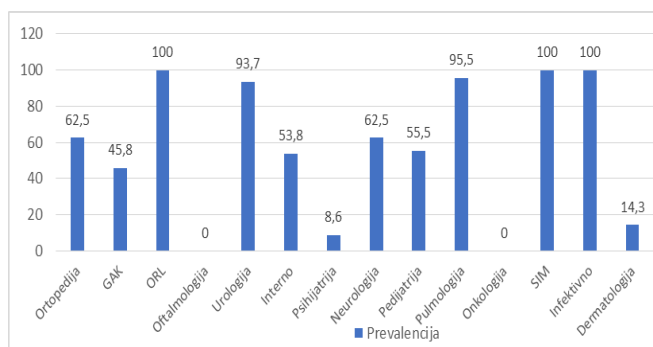
McCabe score	Number	%
Non-fatal disease	190	62.1
Fatal disease	106	34.6
Rapidly fatal disease	10	3.3
Total	306	100

In 38.2% of hospitalized patients a urinary catheter was inserted, while a central venous catheter was present in 4.2% of patients. During the current hospitalization, 33.8% of patients underwent surgery. At the time of the study, a total of 10 healthcare-associated infections were recorded in 9 patients. The prevalence of healthcare-associated



Grafikon 2. Prevalencija IHI po odjeljenjima

Najčešće registrovane infekcije bile su pneumonije, infekcije gastrointestinalnog trakta izazvane bakterijom *Clostridioides difficile*, infekcije operativnog polja, infekcije krvi i infekcije mokraćnog sistema. Uzročnici infekcija potvrđeni su u osam slučajeva. Među registrovanim mikroorganizmima dominirali su *Acinetobacter* spp., *Pseudomonas aeruginosa*, *Staphylococcus aureus* (MRSA), *Proteus mirabilis* i *Clostridioides difficile*. Antibiotike je primalo 175 hospitalizovanih pacijenata, što predstavlja prevalenciju upotrebe antibiotika od 57,2%. Na infektivnom, ORL i odjeljenju nehirurške intenzivne njege svi pacijenti su primali antimikrobne lijekove, dok na onkologiji i oftalmologiji nije bilo pacijenata sa primjenom antimikrobnih lijekova (Grafikon 3).



Grafikon 3. Prevalencija upotrebe antimikrobnih lijekova prema odjeljenjima

Parenteralna primjena antibiotika registrovana je kod 87,3% pacijenata. Najčešće indikacije za

infections was 3.2%, while the prevalence of patients with at least one infection was 2.9%. The highest prevalence of infections was recorded in the neurology department (16.6%) and in intensive care units for non-surgical specialties (14.2%). Increased prevalence was also recorded in orthopedics and surgery (Figure 2).

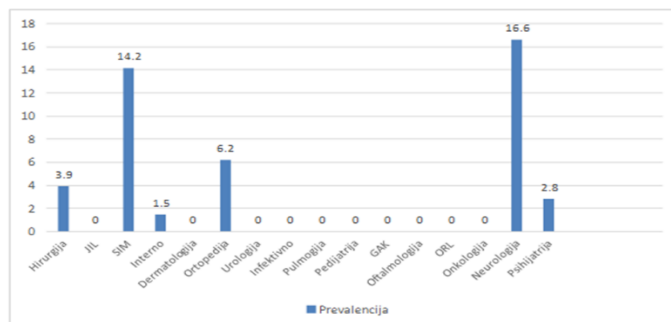


Figure 2. Prevalence of HAI by departments

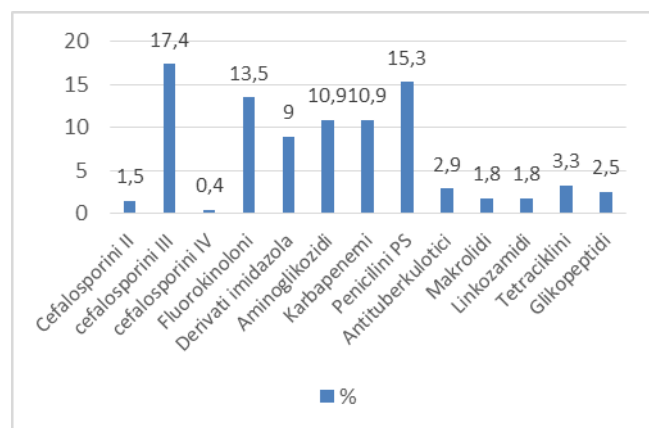
The most frequently recorded infections were pneumonia, gastrointestinal tract infections caused by *Clostridioides difficile*, surgical site infections, bloodstream infections, and urinary tract infections. Causative agents of infections were confirmed in eight cases. Among the recorded microorganisms, *Acinetobacter* spp., *Pseudomonas aeruginosa*, *Staphylococcus aureus* (MRSA), *Proteus mirabilis*, and *Clostridioides difficile* predominated. Antibiotics were received by 175 hospitalized patients, which represents a prevalence of antibiotic use of 57.2%. At the Infectious Diseases, ENT, and Non-Surgical Intensive Care departments, all patients received antimicrobial drugs, while in the Oncology and Ophthalmology departments there were no patients receiving antimicrobial therapy (Figure 3).

primjenu antibiotika bile su liječenje infekcija stečenih u zajednici, hirurška profilaksa i medicinska profilaksa (Tabela 4).

Tabela 4. Indikacije za primjenu antimikrobnih lijekova

Indikacija	Broj pacijenata	%
Infekcija stečena u zajednici	108	61,7
Infekcija stečena u ustanovi dugotrajnog liječenja	1	0,6
Liječenje intrahospitalnih infekcija	9	5,1
Hirurška profilaksa	40	22,9
Medicinska profilaksa	16	9,1
Nepoznat razlog	1	0,6
Ukupno	175	100

Najčešće propisivane grupe antimikrobnih lijekova bili su cefalosporini treće generacije, penicilini proširenog spektra, fluorokinoloni, aminoglikozidi i karbapenemi, što je prikazano na grafikonu 4.



Grafikon 4. Najčešće propisivane klase antimikrobnih lijekova (AML) u studiji prevalencije

Kod 90% pacijenata hirurška profilaksa trajala je duže od jednog dana, dok je 10% operisanih pacijenata hiruršku profilaksu primilo u jednoj dozi. Kada je u pitanju hirurška profilaksa, 40 pacijenata je primalo hiruršku profilaksu. Među njima je 5 pacijenata primalo jedan, 22 je primalo 2 antibiotika, a 13 tri antibiotika u hirurškoj profilaksi. Od ukupno 60 antimikrobnih lijekova u hirurškoj profilaksi, 28% otpada na derivate imidazole, aminoglikozidi (16%), 14,7% na peniciline proširenog spektra, i po

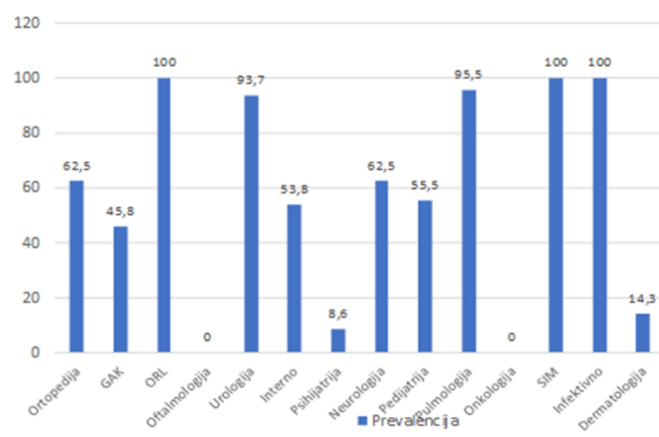


Figure 3. Prevalence of antimicrobial drug use by departments

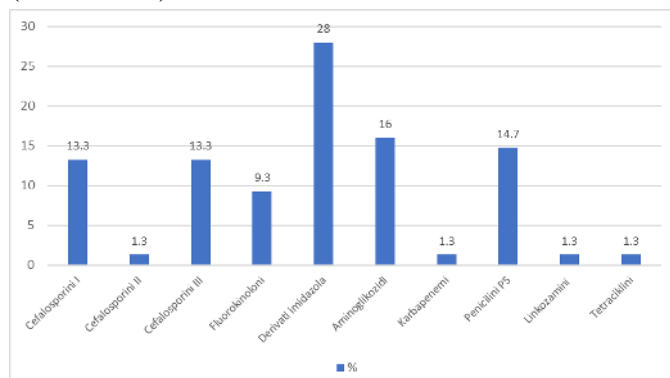
Parenteral administration of antibiotics was recorded in 87.3% of patients. The most common indications for antibiotic use were treatment of community-acquired infections, surgical prophylaxis, and medical prophylaxis (Table 4).

Table 4. Indications for antibiotic use

Indication	Number of patients	%
Community-acquired infection	108	61.7
Infection acquired in a long-term care facility	1	0.6
Treatment of healthcare-associated infections	9	5.1
Surgical prophylaxis	40	22.9
Medical prophylaxis	16	9.1
Unknown reason	1	0.6
Total	175	100

The most commonly prescribed groups of antibiotics were third-generation cephalosporins, extended-spectrum penicillins, fluoroquinolones, aminoglycosides, and carbapenems, which is shown on figure 4.

13,3% cefalosporina prve i treće generacije (Grafikon 5).



Grafikon 5. Najčešće propisivani antimikrobni lijekovi u hirurškoj profilaksi

Univarijantnom logističkom regresijom među faktorima rizika za nastanak IHI identifikovani su produžena hospitalizacija (RR 1,96; 95% CI 1,043-1,153) i centralni venki kateter (RR 6,585; 95% CI 1,726-25,126) (Tabela 5).

Tabela 5. Faktori rizika za nastanak IHI. Univarijantna logistička regresija

Varijabla	Pacijenti		P	RR (95% CI)
	Sa IHI (N=10)	Bez IHI (N=296)		
Dužina hospitalizacije (dani) $\bar{x} \pm SD$	28,3 $\pm$ 31,8	6,04 $\pm$ 6,6	0,000	1,096 (1,043-1,153)
Centralni venski kateter	3 (30%)	7 (2,3%)	0,006	6,585 (1,726-25,126)
Uzrast	67,4 $\pm$ 8,946	61,723 $\pm$ 20,929	0,396	1,017 (0,978-1,057)
Operacija	1 (10%)	72 (24,3%)	0,439	0,628 (0,194-2,040)
Urinarni kateter	6 (60%)	111 (37,5%)	0,180	2,328 (0,676-8,013)
McCabe – fatalna i brzo fatalna	6 (60%)	110 (37,1)	0,156	2,536 (0,700-9,186)
Intubacija	1 (10%)	9 (3,04%)	0,375	2,350 (0,355-15,545)

RR – relativni rizik; CI – interval povjerenja; $\bar{x} \pm SD$ – prosječna vrijednost $\pm$ standardna devijacija

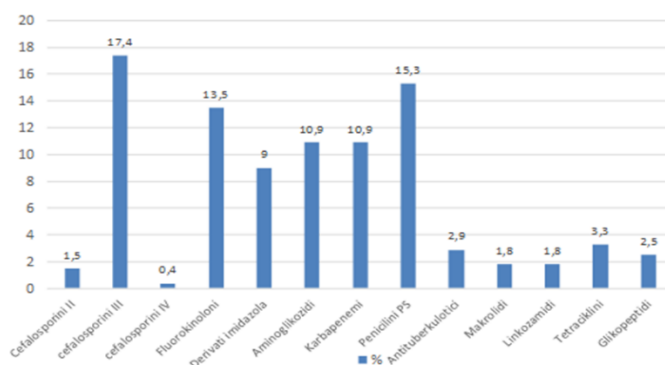


Figure 4. Most commonly prescribed classes of antimicrobial drugs (AMD) in the prevalence study

In 90% of patients, surgical prophylaxis lasted longer than one day, while 10% of operated patients received surgical prophylaxis in a single dose. Regarding surgical prophylaxis, 40 patients were receiving surgical prophylaxis. Among them, 5 patients received one antibiotic, 22 received 2 antibiotics, and 13 received 3 antibiotics in surgical prophylaxis. Of a total of 60 antimicrobial drugs used in surgical prophylaxis, 28% were imidazole derivatives, aminoglycosides (16%), 14.7% extended-spectrum penicillins, and 13.3% first and third generation cephalosporins each (Figure 5).

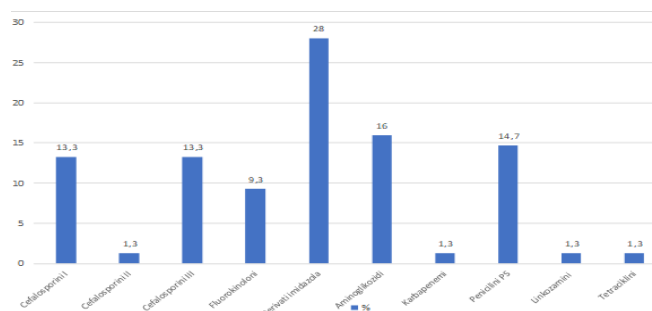


Figure 3. Most commonly prescribed antimicrobial drugs in surgical prophylaxis

Using univariate logistic regression, prolonged hospitalization (RR 1.96; 95% CI 1.043–1.153) and central venous catheter (RR 6.585; 95% CI 1.726–25.126) were identified among risk factors for the occurrence of HAI (Table 5).

Multivarijantnom logističkom regresijom kao nezavisan faktor rizika za nastanak IHI utvrđena je produžena hospitalizacija (RR 1,008; 95%CI 1,035-1,143) (Tabela 6).

Tabela 6. Faktori rizika za nastanak IHI, multivarijantna logistička regresija

Varijabla	RR	95% CI	S.E.	p
Dani hospitalizacije	1,008	1,035-1,143	0,025	0,001

RR – relativni rizik; CI – interval povjerenja; S.E. – standardna greška

DISKUSIJA

Rezultati sprovedene studije pokazali su da prevalencija intrahospitalnih infekcija u JZU Bolnica „Sveti apostol Luka“ Doboj iznosi 3,2%, što je niže u odnosu na većinu Evropskih studija prevalencije. Prema nalazima Evropske studije prevalencije (2022 - 2023. godine) prevalencija pacijenata s barem jednom HAI u uzorku EU/EEA bila je 7,1% (raspon zemalja: 3,1–13,8%) [18]. Niža prevalencija može se djelimično objasniti kraćom prosječnom dužinom hospitalizacije (6,7 dana), dok je prosječna dužina bolničkog liječenja u Evropskoj studiji bila 8,1 dana. Takođe, u našoj bolnici bile su rjeđe zastupljene visokorizične procedure. U našoj studiji centralni venski kateter imalo je 4,2% pacijenata u odnosu na 9,5% u EU/EEA, iako je procenat intubiranih bio veći (3,3% u našoj u odnosu na 2,4% u EU/EEA). Zabrinjavajuća činjenica je da je 38,2% naših pacijenata imalo urinarni kateter, u odnosu na 20,3% Evropskih pacijenata. U prilog manjoj prevalenciji ide i uzrast naših pacijenata u odnosu na pacijente iz Evropske studije. Prosječan uzrast naših pacijenata bio je 61,9 godina, dok je ova vrijednost u Evropskim zemljama iznosila 67 godina. U našem uzorku pacijenata 3,3% njih je imalo brzo fatalnu bolest, odnosno 5,6% među Evropskim pacijentima. Najveća prevalencija registrovana je na odjeljenjima neurologije (16,6%) i nehirurške intenzivne medicine, što je očekivano zbog prisustva teških pacijenata, češće primjene invazivnih procedura i duže hospitalizacije. Među

Table 5. Risk factors for occurrence of HAI. Univariate logistic regression

Variable	Patients		p	RR (95% CI)
	With HAI (N=10)	Without HAI (N=296)		
Length of hospitalization (days) $\bar{x} \pm SD$	28.3 $\pm$ 31.8	6.04 $\pm$ 6.6	0.000	1,096 (1,043-1,153)
Central venous catheter	3 (30%)	7 (2.3%)	0.006	6,585 (1,726-25,126)
Age	67.4 $\pm$ 8.946	61.723 $\pm$ 20.929	0.396	1,017 (0,978-1,057)
Surgery	1 (10%)	72 (24.3%)	0.439	0,628 (0,194-2,040)
Urinary catheter	6 (60%)	111 (37.5%)	0.180	2,328 (0,676-8,013)
McCabe – fatal and rapidly fatal	6 (60%)	110 (37.1)	0.156	2,536 (0,700-9,186)
Intubation	1 (10%)	9 (3.04%)	0.375	2,350 (0,355-15,545)

RR – relative risk; CI – confidence interval; $\bar{x} \pm SD$ – mean value $\pm$ standard deviation

Using multivariate logistic regression, prolonged hospitalization was identified as an independent risk factor for the occurrence of HAI (RR 1.008; 95% CI 1.035–1.143) (Table 6).

Table 6. Risk factors for the occurrence of HAI, multivariate logistic regression

Variable	RR	95% CI	S.E.	p
Days of hospitalization	1.008	1.035–1.143	0.025	0.001

RR – relative risk; CI – confidence interval; S.E. – standard error

DISCUSSION

The results of the conducted study showed that the prevalence of healthcare-associated infections in the Public Health Institution Hospital “Sveti apostol Luka” Doboj is 3.2%, which is lower compared to most European prevalence studies. According to the

našim pacijentima najučestalije IHI bile su pneumonije, kao i među Evropskim pacijentima, mada nam mali broj infekcija uskraćuje mogućnost za poređenje sa velikim brojem infekcija. U V nacionalnoj studiji prevalencije bolničkih infekcija i upotrebe antibiotika, koja je u Srbiji sprovedena u okviru EU studije 2022. godine, prevalencija pacijenata sa najmanje jednom IHI iznosila je 4,8% (4,5–5,2%), a prevalencija IHI iznosila je 5,3%. Prevalencija pacijenata sa IHI bila je najmanja na ginekološkim odjeljenjima (1,2%), a najveća u jedinicama intenzivnog liječenja (16,9%). Među najučestalijim IHI bile su infekcije mokraćnog sistema (28,2%), pneumonije (19,4%), infekcije operativnog polja (14,4%) i infekcije krvi (11,5%) [3]. U studiji prevalencije IHI i upotrebe antibiotika u Opštoj bolnici Sremska Mitrovica, koja je sprovedena u okviru V nacionalne studije u Srbiji prevalencija IHI i prevalencija pacijenata sa IHI iznosila je 4,6%, pri čemu ova bolnica predstavlja opštu bolnicu i ima približan broj kreveta kao naša bolnica [23]. U studiji prevalencije IHI u Kliničkom centru Kragujevac, koja je sprovedena u okviru V nacionane studije u Srbiji, prevalencija pacijenata sa bar jednom IHI iznosila je 8,3%, a prevalencija svih IHI 8,6%. Najviše prevalencije bile su u jedinicama intenzivnog liječenja za odrasle (34,6%) i pedijatrijske/neonatološke pacijente (21,2%). Najčešće su registrovane pneumonije (32,7%), zatim infekcije mokraćnog sistema (28,6%), dok su infekcije operativnog mjesta i infekcije krvi bile podjednako zastupljene (16,3%) [24]. U studiji prevalencije IHI u javnim bolnicama na Novom Zelandu, prevalencija pacijenata sa IHI iznosila je 6,6%. Najčešće infekcije povezane sa zdravstvenom zaštitom bile su: infekcije operativnog polja (25%), infekcije mokraćnog sistema (19%), pneumonije (18%) i infekcije krvi (13%) [25]. U studiji prevalencije u Lombardiji IHI su registrovane kod 10,1% pacijenata. Najučestalije su bile infekcije krvi (18,9%), infekcije mokraćnog sistema (17,1%), infekcije SARS-CoV-2 (17,0%), pneumonije (16,7%) i infekcije operativnog polja (11,0%). Isključujući infekcije SARS-CoV-2, ukupna

findings of the European prevalence study (2022–2023), the prevalence of patients with at least one HAI in the EU/EEA sample was 7.1% (country range: 3.1–13.8%) [18]. Lower prevalence can be partially explained by shorter average length of hospital stay (6.7 days), while the average length of hospital treatment in the European study was 8.1 days. Also, high-risk procedures were less represented in our hospital. In our study, 4.2% of patients had a central venous catheter compared to 9.5% in the EU/EEA, although the percentage of intubated patients was higher (3.3% in our study compared to 2.4% in the EU/EEA). A worrying fact is that 38.2% of our patients had a urinary catheter, compared to 20.3% of European patients. The lower prevalence is also supported by the age of our patients compared to patients in the European study. The average age of our patients was 61.9 years, while this value in European countries was 67 years. In our sample, 3.3% of patients had a rapidly fatal disease, versus 5.6% among European patients. The highest prevalence was recorded in the neurology departments (16.6%) and non-surgical intensive care units, which is expected due to the presence of severely ill patients, more frequent use of invasive procedures, and longer hospitalization. Among our patients, the most frequent HAI were pneumonia, as in European patients, although the small number of infections prevents comparison with the large number of infections in European studies. In the Fifth National Prevalence Study of Hospital Infections and Antibiotic Use, conducted in Serbia as part of the EU study in 2022, the prevalence of patients with at least one HAI was 4.8% (4.5–5.2%), and the prevalence of HAI was 5.3%. The prevalence of patients with HAI was the lowest in gynecology departments (1.2%), and the highest in intensive care units (16.9%). The most common HAI were urinary tract infections (28.2%), pneumonia (19.4%), surgical site infections (14.4%), and bloodstream infections (11.5%) [3]. In the prevalence study of HAI and antibiotic use in the General Hospital Sremska Mitrovica, conducted as part of the Fifth National Study in Serbia, the prevalence of HAI and

prevalencija IHI bila je 8,4% [26]. Posebno značajan nalaz predstavlja visoka prevalencija upotrebe antibiotika. Više od polovine hospitalizovanih pacijenata primalo je antibiotike (57,2%), što ukazuje na veoma široku primjenu antimikrobnih lijekova. Dominacija cefalosporina treće generacije i fluorokinolona predstavlja važan epidemiološki problem, jer ove grupe antibiotika značajno doprinose razvoju antimikrobne rezistencije i pojavi infekcija izazvanih bakterijom *Clostridioides difficile*, koje su kod nas bile pozicionirane na drugom mjestu po učestalosti. Prevalencija upotrebe antibiotika se kretala od 35,5% (od 20,8% do 56,5%) u Evropskoj studiji (18), do 42% u Lombardiji (26) i 44,8% u V nacionalnoj studiji prevalencije IHI i upotrebe antibiotika u Srbiji [3]. U našoj studiji produžena hirurška profilaksa registrovana kod 90% pacijenata koji su primali hiruršku profilaksu, što odstupa od međunarodnih preporuka koje predviđaju jednokratnu ili kratkotrajnu primjenu antibiotika u hirurškoj profilaksi. U Evropskoj studiji hirurška profilaksa bila je indikacija za 14,9% pacijenata koji su primali antibiotike, a duže od jednog dana je primalo u 48,3% pacijenata koji su primali kiruršku profilaksu [18]. Među pacijentima koji su primali hiruršku profilaksu u V nacionalnoj studiji u Srbiji, 71,1% je primalo duže od jednog dana [3]. Da je situacija u našoj bolnici povoljnija, ukazuje i činjenica da je samo kod 10,5% pacijenata došlo do promjene antimikrobnih lijekova, pri čemu je u 8,5% promjena registrovana zbog eskalacije, dok je u evropskoj studiji promjena antibiotika nastala u 18,3% pacijenata, pri čemu je to zbog eskalacije učinjeno kod 10,9% pacijenata sa promijenjenim antibiotikom [18]. Naša studija obezbijedila je takođe podatke o uzročnicima IHI i njihovoj rezistenciji. Međutim, zbog ključnog nedostatka studije, koja se odnosi na mali uzorak pacijenata sa IHI, ne možemo postaviti paralelu sa drugim zemljama. Među 8 izolata koji su identifikovani kao uzročnici IHI, svakako zabrinjava rezistencija *Acinetobacter spp.* na karbapeneme, ali ne možemo govoriti o veličini problema. Radi sagledavanja problema, neophodno je pratiti stanje kroz studiju

the prevalence of patients with HAI were 4.6%, and this hospital is a general hospital with approximately the same number of beds as our hospital [23]. In the prevalence study of HAI in the Clinical Centre Kragujevac, conducted as part of the Fifth National Study in Serbia, the prevalence of patients with at least one HAI was 8.3%, and the prevalence of all HAI was 8.6%. The highest prevalence was in adult intensive care units (34.6%) and pediatric/neonatal intensive care units (21.2%). The most frequently recorded infections were pneumonia (32.7%), followed by urinary tract infections (28.6%), while surgical site infections and bloodstream infections were equally represented (16.3%) [24]. In the prevalence study of HAI in public hospitals in New Zealand, the prevalence of patients with HAI was 6.6%. The most common healthcare-associated infections were: surgical site infections (25%), urinary tract infections (19%), pneumonia (18%), and bloodstream infections (13%) [25]. In the prevalence study in Lombardy, HAI were recorded in 10.1% of patients. The most common were bloodstream infections (18.9%), urinary tract infections (17.1%), SARS-CoV-2 infections (17.0%), pneumonia (16.7%), and surgical site infections (11.0%). Excluding SARS-CoV-2 infections, overall HAI prevalence was 8.4% [26]. A particularly important finding is the high prevalence of antibiotic use. More than half of hospitalized patients were receiving antibiotics (57.2%), which indicates very extensive use of antimicrobial drugs. The predominance of third-generation cephalosporins and fluoroquinolones represents an important epidemiological problem, as these groups of antibiotics significantly contribute to the development of antimicrobial resistance and the occurrence of infections caused by *Clostridioides difficile*, which in our setting were in second place by frequency. The prevalence of antibiotic use ranged from 35.5% (20.8–56.5%) in the European study [18], to 42% in Lombardy [26], and 44.8% in the Fifth National Prevalence Study of HAI and Antibiotic Use in Serbia [3]. In our study, prolonged surgical prophylaxis was recorded in 90% of patients

incidencije u našoj bolnici, kao i sprovedi studiju prevalencije na nivou Republike Srpske. Po ugledu na brojne studije, i naša studija se bavila ispitivanjem faktora rizika koji su povezani sa učestalijom pojavom IHI. Multivarijantna logistička regresija identifikovala je sljedeće nezavisne faktore rizika za nastanak IHI u kliničkom centru Kragujevac: produžen boravak u bolnici, lošiji *McCabe* skor, intubacija pacijenata i primjena antimikrobnih lijekova [24]. U multivarijantnoj analizi, u studiji na Novom Zelandu nezavisni faktori rizika za infekcije povezane sa zdravstvenom zaštitom uključivali su prisustvo perifernog (OR=2,0) ili centralnog (OR=5,7) intravenskog katetera [25]. U studiji u Sremskoj Mitrovici među nezavisnim faktorima rizika za nastanak IHI registrovani su produženi boravak u bolnici, i primjena antimikrobnih lijekova [24]. Slično navedenim nalazima, multivarijantnom analizom i u našoj studiji produžena hospitalizacija je registrovana kao nezavisan faktor rizika za nastanak IHI. Sprovedena studija je obezbijedila ključne podatke o učestalosti IHI na nivou naše bolnice, kao i o prevalenciji upotrebe antimikrobnih lijekova. Bez obzira što je studija u kratkom vremenskom intervalu pružila značajne informacije, ona ima i nedostatke. Ključni nedostatak se odnosi na mali uzorak pacijenata sa registrovanom IHI, pa je bilo nemoguće sagledati veličinu problema koja se odnosi na rezistenciju uzročnika IHI. Dobijeni rezultati ukazuju na značaj unapređenja epidemiološkog nadzora nad IHI putem dodatnih studija incidencije, kao i racionalizaciju upotrebe antimikrobnih lijekova.

ZAKLJUČAK

Prevalencija intrahospitalnih infekcija u JZU Bolnica „Sveti apostol Luka“ Doboj iznosila je 3,2%, dok je prevalencija upotrebe antibiotika bila visoka i iznosila 57,2%. Najveća prevalencija infekcija registrovana je na odjeljenjima neurologije i intenzivne medicine. Najčešće registrovane infekcije bile su pneumonije, infekcije gastrointestinalnog trakta izazvane bakterijom *Clostridioides difficile*, infekcije operativnog polja,

who received surgical prophylaxis, which deviates from international recommendations that foresee single-dose or short-term antibiotic use in surgical prophylaxis. In the European study, surgical prophylaxis was an indication in 14.9% of patients receiving antibiotics, and 48.3% of patients receiving surgical prophylaxis received it for more than one day [18]. Among patients receiving surgical prophylaxis in the Fifth National Study in Serbia, 71.1% received it for more than one day [3]. The fact that only 10.5% of patients had a change in antimicrobial drugs indicates a more favourable situation in our hospital, with 8.5% of changes recorded due to escalation, while in the European study antibiotic changes occurred in 18.3% of patients, with escalation in 10.9% of patients with changed antibiotics [18]. Our study also provided data on HAI pathogens and their resistance. However, due to the main limitation of the study, relating to the small sample of patients with HAI, we cannot draw parallels with other countries. Among the 8 isolates identified as HAI pathogens, carbapenem-resistant *Acinetobacter spp.* is particularly concerning, although we cannot assess the magnitude of the problem. To assess the problem, it is necessary to monitor the situation through an incidence study in our hospital and to conduct a prevalence study at the level of the Republic of Srpska. Following numerous studies, our study also examined risk factors associated with the more frequent occurrence of HAI. Multivariate logistic regression identified the following independent risk factors for the occurrence of HAI in the Clinical Centre Kragujevac: prolonged hospital stay, worse *McCabe* score, intubation of patients, and use of antimicrobial drugs [24]. In multivariate analysis in the study in New Zealand, independent risk factors for healthcare-associated infections included the presence of a peripheral (OR=2.0) or central (OR=5.7) intravenous catheter [25]. In the study in Sremska Mitrovica, prolonged hospital stay and use of antimicrobial drugs were registered among independent risk factors for the occurrence of HAI [24]. Similar to these findings,

infekcije krvi i infekcije mokraćnog sistema. Uzročnici infekcija potvrđeni su u osam slučajeva. Među registrovanim mikroorganizmima dominirali su *Acinetobacter* spp., *Pseudomonas aeruginosa*, *Staphylococcus aureus* (MRSA), *Proteus mirabilis* i *Clostridioides difficile*. Najčešće korišteni antibiotici bili su cefalosporini treće generacije i penicilini proširenog spektra. Rezultati istraživanja ukazuju na potrebu unapređenja sistema nadzora nad intrahospitalnim infekcijama, racionalnije upotrebe antibiotika, smanjenja trajanja hirurške profilakse.

Multivariate analysis in our study identified prolonged hospitalization as an independent risk factor for the occurrence of HAI. The conducted study provided key data on the frequency of HAI at the level of our hospital, as well as on the prevalence of antimicrobial drug use. Regardless of the fact that the study provided important information in a short time interval, it also has limitations. The main limitation concerns the small sample of patients with recorded HAI, making it impossible to assess the magnitude of the problem relating to resistance of HAI pathogens. The obtained results indicate the importance of improving epidemiological surveillance of HAI through additional incidence studies, as well as rationalizing the use of antimicrobial drugs.

CONCLUSION

The prevalence of intrahospital infections in the "St. Apostol Luka" Dobož Hospital was 3.2%, while the prevalence of antibiotic use was high and amounted to 57.2%. The highest prevalence of infections was registered in the departments of neurology and intensive care medicine. The most frequently registered infections were pneumonia, gastrointestinal tract infections caused by the bacterium *Clostridioides difficile*, operative field infections, blood infections, and urinary tract infections. The causative agents of infections were confirmed in eight cases. Among the registered microorganisms, *Acinetobacter* spp., *Pseudomonas aeruginosa*, *Staphylococcus aureus* (MRSA), *Proteus mirabilis* and *Clostridioides difficile* dominated. The most commonly used antibiotics were third-generation cephalosporins and extended-spectrum penicillins. The research results point to the need to improve the system of monitoring intrahospital infections, more rational use of antibiotics, and reducing the duration of surgical prophylaxis.

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