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HEALTHCARE-ASSOCIATED INFECTIONS AND MICROBIOLOGICAL ANALYSIS AT THE CLINIC FOR ANESTHESIA AND INTENSIVE THERAPY IN A TERTIARY HEALTH INSTITUTION DURING A ONE-YEAR PERIOD

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The term Healthcare-Associated Infections (HAI) or Nosocomial Infections (NI) refers to infections that occur in patients during their stay and treatment in medical conditions, but were not present at the time of admission and that manifest at least 48 h after hospital admission. HAIs are more frequent in developing countries (5.7–19.1%) than in developed ones (3.5–12%). Antimicrobial resistance is one of the global health problems with a significant burden, and it is an inevitable consequence of using antimicrobial drugs. The unjustified use of antibiotics has contributed to antimicrobial resistance and changes in the causative pathogens responsible for HAIs. These types of infections prolong the length of hospital stay, lead to long-term disability, and increase morbidity and mortality. The most common types of HAIs are: Ventilator-Associated Pneumonia (VAP), Central Line-Associated Bloodstream Infections (CLABSI), Catheter-Associated Urinary Tract Infections (CAUT) and Surgical Site Infections (SSI).

This study aimed to determine the most common bacteria causes of HAIs as well as the distribution according to the type of isolated bacteria from different types of samples.

The retrospective study was conducted at the Clinic for Anesthesia and Intensive Therapy, University Clinical Center Niš, during the period from January to December 2024. The patient samples were obtained, namely: blood, groin swab, oral cavity swab, wound swab, rectum swab, armpit swab, urine, aspirate from the endotracheal tube, nose swab, drain content, abdominal cavity content, tip of the central venous catheter, tip of the drain and aspirate from bronchia. The material was sent to the local microbiological laboratory with the aim of obtaining a biogram and antibiogram.

Depending on the type of bacteria, the distribution was as follows: *Klebsiella* spp. (20.15%), *Enterococcus faecalis* (19.26%), *Acinetobacter* spp. (14.41%), *Pseudomonasaeruginosa* (7.9%), *Escherichia coli* (7.17%), *Staphylococcus epidermidis* (4.99%), *Proteus mirabilis* (3.96%), *Enterococcus faecium* (2.94%), *Enterobacter* spp. (2.94%) and *Staphylococcus* spp. (2.19%). *Klebsiella* spp. was the dominant bacterium isolated from oral cavity swab (3.28%), *Enterococcus faecium* from groin swab (5.60%), *Acinetobacter* spp. from endotracheal aspirate (1.91%), *Pseudomonas aeruginosa* from wound swab (2.25%) and *Escherichia coli* from rectal swab (1.84%).

Healthcare-associated infections have a significant negative impact on hospitalized patients. They lead to permanent disability, prolonged patients' length of stay and increased mortality as well as expenditure and waste of medical resources. The predominance of microorganisms depends both on the hospital conditions, as well as on the patients and antibiotics prescribed by physicians. It is recommended to establish a precise schedule for antibiotic use in each region based on the most common pathogens and antibiotic resistance patterns, and surveillance programs as important tools which would be helpful to clinicians to choose the most appropriate antimicrobial therapy for hospitalized patients.

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Key words: *healthcare-associated infection, nosocomial, bacteria, antibiotic*

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Introduction

The term Healthcare-Associated Infections (HAI) or Nosocomial Infections (NI) refers to infections that occur in patients during their stay and treatment in medical conditions, but were not present at the time of admission, and they should

manifest at least 48h after hospital admission (1–3). The term HAIs refers not only to hospital infections, but also to infections acquired in any healthcare facilities, public and private (nursing homes, ambulatory, and rehabilitation centers) which provide healthcare or diagnostic services to patients. According to World Health Organization (WHO) data, about 5–15% of hospitalized patients develop HAIs (4), and the results of the EPIC II study showed that HAIs can be expected in even 51% of patients in intensive care units (ICUs) (5). A lack of data results in an inadequate and insufficiently developed system of supervision and control.

HAIs are more frequent in developing countries (5.7–19.1%) than in developed ones (3.5–12%) (6). Among newborns, the occurrence of ICU-related infections is 3–20 times higher. In developing countries two-thirds of operated patients develop HAI, which is nine times higher than in developed regions (7). Literature review estimates that 10–70% of HAIs are preventable with appropriate infection control (8).

The most common risk factors for HAIs include mechanical ventilation, critical care units, wound and burn units, dialysis unit, operation theatres, delivery rooms, neonates, prolonged hospital stay, utilization of invasive life-prolonging procedures including venous and arterial catheterization, urinary catheterization, invasive intracranial pressure monitoring, prior and prolonged antibiotic therapy, colonization of neighboring patients and health care personnel, weakened immune system of the patient, chronic and debilitating disease and diabetes (9). In addition to the host's susceptibility, it is important to know the biological characteristics of the infectious agent (10).

Aim

This study aimed to determine the most common bacterial causes of HAIs as well as the distribution according to the type of isolated bacteria from different types of samples.

Materials and Methods

The retrospective study was conducted at the Clinic for Anesthesia and Intensive Therapy, Clinical Center Niš, Serbia, during the period from the beginning of 2024 until the end of the same year. The patient samples were obtained, including blood, groin swab, oral cavity swab, wound swab, rectum swab, armpit swab, urine, aspirate from the endotracheal tube, nose swab, drain content, abdominal cavity content, tip of the central venous catheter, tip of the drain, and aspirate from the bronchia. The material was sent to the local microbiological laboratory.

The data are presented as absolute numbers and percentages, which are then compared with data from the literature.

Results

The total number of samples was 1464. Of them, 232 were blood samples, 179 groin swabs, 166 oral cavity swabs, 132 wound swabs, 122 rectal swabs, 108 armpit swabs, 106 urine samples, 94 endotracheal aspirate samples, 63 nose swabs, 56 aspirates, 43 drain contents, 15 abdominal cavity contents, 15 tips of the central venous catheters, 11 tips of the drains, 10 aspirates from bronchia and 112 the other samples, (unclassified) (Figure 1).

Depending on the type of bacteria, the distribution was as follows: *Klebsiella* spp. (20.15%), *Enterococcus faecalis* (19.26%), *Acinetobacter* spp. (14.41%), *Pseudomonas aeruginosa* (7.9%), *Escherichia coli* (7.17%), *Staphylococcus epidermidis* (4.99%), *Proteus mirabilis* (3.96%), *Enterococcus faecium* (2.94%), *Enterobacter* spp. (2.94%) and *Staphylococcus* spp. (2.19%) (Figure 2).

Klebsiella spp. was the dominant bacterium isolated from oral cavity swab (3.28%), *Enterococcus faecium* from groin swab (5.60%), *Acinetobacter* spp. from endotracheal aspirate (1.91%), *Pseudomonas aeruginosa* from wound swab (2.25%) and *Escherichia coli* from rectal swab (1.84%) (Table 1).

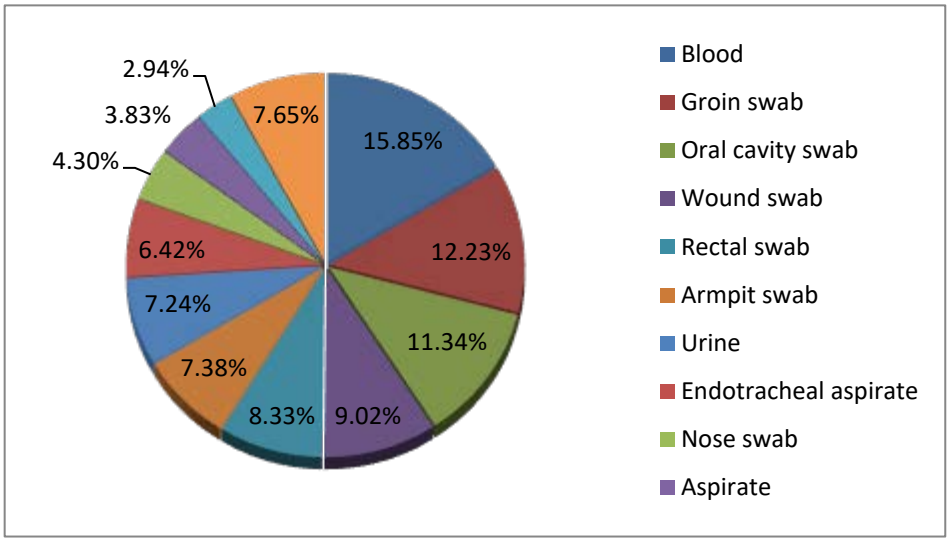

Figure 1. Distribution according to sample type

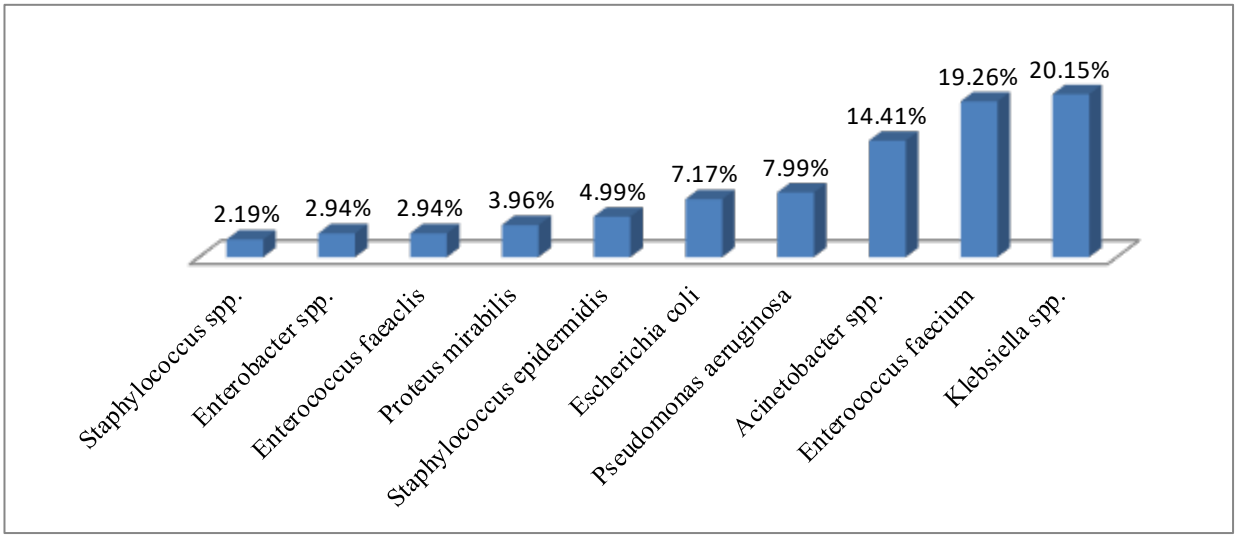

Figure 2. Distribution of bacteria by species

Table 1. Distribution according to the type of the sample and isolated bacteria

			Klebsiella spp.		*E. faecium*		*Acinetobacter* spp.		*Pseudomonas aeruginosa*		*Escherichia coli*	
Sample type	Number of samples	Percent of samples	No.	%	No.	%	No.	%	No.	%	No.	%
Blood	232	15.85%	3	0.20%	13	0.89%	6	0.41%	6	0.41%	9	0.61%
Groin swab	179	12.23%	30	2.05%	82	5.60%	18	1.23%	9	0.61%	18	1.23%
Oral cavity swab	166	11.34%	48	3.28%	51	3.48%	22	1.50%	13	0.89%	17	1.16%

Wound swab	132	9.02%	24	1.64%	7	0.48%	25	0.71%	33	2.25%	5	0.34%
Rectal swab	122	8.33%	16	1.09%	52	3.55%	7	0.48%	4	0.27%	27	1.84%
Armpit swab	108	7.38%	19	1.30%	48	3.28%	20	1.37%	4	0.27%	3	0.20%
Urine	106	7.24%	43	2.94%	2	0.14%	13	0.89%	3	0.20%	13	0.89%
Endotracheal aspirate	94	6.42%	25	1.71%	1	0.07%	28	1.91%	11	0.75%	2	0.14%
Nose swab	63	4.30%	12	0.82%	14	0.96%	17	1.16%	5	0.34%	3	0.20%
Aspirate	56	3.83%	12	0.82%			22	1.50%	8	0.55%	2	0.14%
Drain content	43	2.94%	18	1.23%	3	0.20%	2	0.14%	1	0.07%		
Abdominal cavity content	15	1.02%	2	0.14%					2	0.14%	3	0.20%
Central venous catheter tip	15	1.02%	6	0.41%	3	0.20%	2	0.14%	1	0.07%		
Drain tip	11	0.75%	2	0.14%			2	0.14%	1	0.07%	1	0.07%
Bronchial aspirate	10	0.68%	5	0.14%			2	0.14%				
Other	112	7.65%	39	0.25%	6	0.41%	22	1.50%	13	0.89%	1	0.07%
Total	1464	100%	**295**	**20.15%**	**282**	**19.26 %**	**211**	**14.41 %**	**117**	**7.99%**	**105**	**7.17 %**

Discussion

Antimicrobial resistance is one of the global health problems with a significant burden, and it is an inevitable consequence of using antimicrobial drugs. Unjustified use of antibiotics has led to antimicrobial resistance and changes in the causative pathogens responsible for HAIs. These types of infections prolong the length of hospital stay, lead to long-term disability, and increase morbidity and mortality. All this has a negative impact on healthcare costs, and annual costs are estimated to be about 7 billion euros in Europe and 6.5 billion dollars in the United States (11). Some examples are methicillin-resistant *Staphylococcus aureus* (MRSA), which is still an important challenge for many countries. In addition to MRSA, multidrug-resistant *Escherichia coli*, vancomycin-resistant enterococci (VRE), and carbapenem-resistant Enterobacteriaceae are becoming a problem of public health importance (10).

Antibiotic resistance is responsible for the death of a child every five minutes in the Southeast Asian region. Medicines that were used to treat deadly diseases are now losing their potential, precisely because of the development of resistance (12). Self-medication, inadequate dosage, prolonged use, and lack of standards among healthcare institutions are the main reasons. Resistance threatens effective control against bacteria caused by urinary tract infections, pneumonia and bloodstream infections. The most common among them are MRSA and multidrug-resistant gram-negative bacteria (13). In the region of Southeast Asia are strains of *E. coli* and *Klebsiella pneumoniae* resistant to third-generation cephalosporines, and more than a quarter of infections caused by *S. aureus* are resistant to methicillin (14).

The sources of HAI infections are: 1) endogenous—the patient's microflora, and most frequently, 2) exogenous. Bacteria are the most common cause of HAIs (90%). Some of them are part of the patient's normal flora and lead to infection only when the patient's immune system declines. About 5% of HAIs are caused by viruses (15). Among them, the most common are influenza, HIV, rotavirus, herpes simplex virus and hepatitis. Among the fungi, the most

common causative agents are *Aspergillus* spp. and *Candida albicans* (16). The main routes of transmission include contact (direct and indirect), airborne, common vehicle (through contaminated items like food, water, medications, equipment) and vector-borne (mosquitoes, flies, rats) (17).

Nowadays, according to WHO, the most common causes of HAI are *Pseudomonas aeruginosa, Acinetobacter baumannii, Klebsiella pneumonia, Clostridium difficile, E. coli* and *Staphylococcus aureus* (18). These bacteria developed additional mechanisms against currently available antibiotics (19). That is why the development and introduction of new antibiotics into clinical practice is urgently necessary.

According to the current guidelines, when the patient is at risk of infection with resistant organisms, it is advisable to use broad-spectrum combination therapy with more than two antibiotics as the initial empirical therapy (20).

Results showed that the total number of samples was 1,464. Of them, 232 (15.85%) were blood samples, 179 groin swabs (12.23%), 166 oral cavity swabs (11.34%), 132 wound swabs (9.02%), 122 rectal swabs (8.33%), 108 armpit swabs (7.38%), 106 urine samples (7.24%), 94 endotracheal aspirate samples (6.42%), 63 nose swabs (4.30%), 56 aspirates (3.83%), 43 drain contents (2.94%), 15 abdominal cavity contents (1.02%), 15 tips of the central venous catheter (1.02%), 11 tips of the drain (0.75%), 10 aspirates from bronchi (0.68%) and 112 (7.65%) the other samples (unclassified)(Figure 1). Depending on the type of bacteria, the distribution was as follows: *Klebsiella* spp. (20.15%), *Enterococcus faecalis* (19.26%), *Acinetobacter* spp. (14.41%), *Pseudomonas aeruginosa* (7.9%), *Escherichia coli* (7.17%), *Staphylococcus epidermidis* (4.99%), *Proteus mirabilis* (3.96%), *Enterococcus faecium* (2.94%), *Enterobacter* spp. (2.94%) and *Staphylococcus* spp. (2.19%) (Figure 2).

Table 1 shows the distribution of bacteria according to the type of biological material from which they were isolated. *Klebsiella* spp. was the dominant bacterium isolated from oral cavity swab (3.28%), *Enterococcus faecium* in groin swab (5.60%), *Acinetobacter* spp. in endotracheal aspirate (1.91%), *Pseudomonas aeruginosa* in wound swab (2.25%) and *Escherichia coli* in rectal swab (1.84%).

The most common types of HAIs are Ventilator-Associated Pneumonia (VAP), Central Line-Associated Bloodstream Infections (CLABSI), Catheter-Associated Urinary Tract Infections (CAUT) and Surgical Site Infections (SSI).

Central line-associated bloodstream infections incidence is about 12–25% (21). Catheters can cause serious and deadly infections, resulting in compromised health and increased care costs. They are usually caused by gram-positive organisms, including coagulase-negative *Staphylococcus*, *Staphylococcus aureus* and Enterococci (22).

According to the Liao et al. study (23) of 584 blood samples, a total of 267 (45.7%) were caused by fermentative gram-negative organisms, 137 (23.5%) by non-fermentative gram-negative organisms, and 134 (22.9%) by gram-positive organisms. Fungi were isolated in samples (6.8%). The most common bacteria causing bloodstream infections among gram-negative strains were *Klebsiella* spp. (14%), *E. coli* (14%), *Enterococcus* spp. (11%), *Acinetobacter* spp. (10%), *Enterobacter* spp. (9%), *S. aureus* (9%) and *Pseudomonas* spp. (8%). In our study, the main cause was gram-positive bacteria, namely *Enterococcus faecium.*

In 1990, the predominant bacteria causing bloodstream infections were gram-positive, namely *Staphylococcus aureus.* Later, in 2000, it was *Acinetobacter baumannii*, and in recent years, it has been gram-negative Enterobactriales (24).

Some of the mortality risk factors according to the above-mentioned study are: low body weight, comorbidity with malignancy and liver cirrhosis, high C- reactive protein level, high Charlson Comorbidity Index, and internal medicine and hematology/oncology patients.

According to European national prevalence studies, the rate of nosocomial urinary tract infections (UTI) is 23–49% (25). They are mainly caused by the patients' microflora, where the catheters serve as a conduit for entry of bacteria and imperfect drainage, and retained urine provides the stability to bacterial residence. A common cause of nosocomial urinary tract infections are *E. coli, Pseudomonas aeruginosa, Klebsiella* spp., *Proteus mirabilis, Staphylococcus epidermidis*, Enterococci and *Candida* spp. (25, 26).

Asymptomatic bacteriuria in catheterized patients, according to most clinicians, should not be treated. As long as the presence of a catheter is temporary, this condition is transient and will resolve spontaneously. In justified cases, it is recommended to use silver-coated catheters. The most significant preventive measure is to avoid the use of the indwelling catheters whenever possible. The study of Jain P et al. (27) showed that the unjustified use of urinary catheters was in 21% of cases.

The study conducted by Nouri et al. (28) showed that among gram-negative bacteria in the urine samples, *E. coli* was the most common, accounting for 832 cases (59.6%). Other notable findings included *K. pneumoniae* with 139 cases (9.9%), *P. aeruginosa* with 71 cases (5.09%), *Enterobacter* spp. with 31 cases (2.2%), *Acinetobacter baumannii* with 30 cases (2.15%) and *Klebsiella oxytoca* with 18 cases (1.2%). The most frequent pathogens identified in tracheal aspirates were *K. pneumoniae* (164 cases; 27.8%), *Acinetobacter baumannii* (118 cases; 20.06%), *Pseudomonas aeruginosa* (97 cases;

16.4%) and *E. coli* (57 cases; 9.6%). In our study, *Klebsiella* spp. was the most prevalent bacterium.

The frequency of surgical site infections in surgical patients is 2–5%, mainly caused by endogenous microflora of the patients. Among bacteria, the most often isolated is *Staphylococcus aureus,* commonly found amongst the normal flora of the skin (29, 30), followed by *Candida* spp*., E. coli, P. aeruginosa and S. epidermidis* (31).

Nosocomial pneumonia, which develops at least 48 h after intubation, is defined as ventilator-associated pneumonia. The prevalence is 10–65%, and the mortality rate is about 20% (32, 33). The most common risk factors are elderly men, smokers, coexisting lung diseases and admission because of respiratory problems (34). The most common pathogens are gram-negative bacteria such as *Acinetobacter sp., Pseudomonas aerugnosa, Klebsiella pneumonia* and gram-positive cocci like *Staphylococcus aureus*, especially MRSA (35). In the study conducted by George et al. (35, 36), the most common isolate was *Acinetobacter* spp*.* (37.5%). Our findings are consistent with the aforementioned study.

Infection Control Programs and Prevention of HAIs

The standard procedure performed on patients suspected of having infections in the ICU implies: 1) Gram staining results, usually available after 24 h; 2) organism identification from the culture, typically returned after 48 h (16); 3) the full antibiogram results, which actually present a susceptibility test for various antimicrobials available after approximately 72 h. The antibiogram will give a definitive answer (37).

Some of the most important preventive measures include early detection of a colonized patient, eradication of the source of reservoir, isolation of the infected or colonized patient, emphasis on hand hygiene before and after patient handling, use of disposable gloves, prohibition of unjustified antibiotic prescription/use, establishment and implementation of the surveillance system for antimicrobial resistance, education of hospital staff and community (38).

The Centers for Disease Control and Prevention estimates that about 100 million antibiotics are prescribed annually, of which about 50% are unnecessary (39). Antibiotic selection should be based on the patient's tolerance, in addition to the nature of the disease and the pathogen. The goal of antimicrobial therapy is to choose an antibiotic that is selective for the suspected pathogen, has a low probability of causing resistance, and has no adverse reactions (16).

Adequate surveillance of HA involves data collection from various sources: information should include administrative data, demographic risk factors, patient medical history, diagnostic tests and data validation.

Surveillance led by the WHO can serve as a guide to help healthcare institutions introduce their own system of surveillance and control of HA infections. Adequate training of hospital staff is of great importance in the prevention of HA infections. Also, decontamination of the patient by treating the gut and skin has been proven to be effective.

Recently, a strong focus has been placed on the prevention and control of these types of infections, as well as on the non-negligible financial aspect.

To reduce the costs, it is important: 1) for healthcare facilities to follow strict infection control protocols, 2) to improve surveillance of HAIs, 3) to educate the staff to follow the preventive practice, and 4) to implement standard precautions such as hand hygiene practice at the bedside (40).

Conclusion

Healthcare-associated infections have a significant negative impact on hospitalized patients. They lead to permanent disability, prolong patients' length of stay and increase mortality and both expenditure and waste of medical resources. The bacterial types causing nosocomial infections differ from country to country, even among the institutions in the same region. The predominance of microorganisms depends on the hospital conditions, patients, and antibiotics prescribed by physicians. Bacteria develop effective defense mechanisms and develop resistance to the most commonly prescribed antibiotics. Thus, temporary restriction in the use of certain antibiotics is one of the solutions to reduce resistance, but also giving antibiotics only when needed. Further, it is recommended to establish a precise schedule for antibiotic use in each region based on its antibiotic resistance pattern. An increase in antimicrobial resistance requires the need for surveillance programs as important tools, which would be helpful to clinicians to choose the most appropriate antimicrobial therapy for hospitalized patients.

References

1. Kollef MH, Torres A, Shorr AF, Martin-Loeches I, Micek ST. Nosocomial infection. Criti Care Med2021; 49:169–87. [CrossRef][PubMed]
2. Monegro AF, Muppidi V, Regunath H. Hospital Acquired Infections. Treasure Island, FL: Stat Pearls Publishing 2022.[PubMed]
3. Blot S, Ruppé E, Harbarth S, Asehnoune K, Poulakou G, Luyt CE, et al. Healthcare-associated infections in adult intensive care unit patients: Changes in epidemiology, diagnosis, prevention and contributions of new technologies. Intensive Crit Care Nurs 2022;70:103227. [CrossRef][PubMed]
4. WHO. The burden of health care-associated infection worldwide. 2016 [Online] Available from: http://www.who.int/gpsc/country_ work/burden_hcai/en/
5. Vincent JL, Marshall J, Silva E, Anzueto A, Martin CD, Moreno R, et al. International study of the prevalence and outcomes of infection in intensive care units. JAMA 2009; 302(21): 2323-9. [CrossRef][PubMed]
6. Khan HA, Baig FK, Mehboob R. Nosocomial infections: Epidemiology, prevention, control and surveillance. Asian Pac J Trop Biomed 2017; 7(5): 478–82.[CrossRef]
7. World Health Organization. Healthcare-associated infections: fact sheet, 2014. Available at: http://www.who.int/gpsc/country_work/gpsc_ccisc_ fact_sheet_en.pdf.
8. Harbarth S, Sax H, Gastmeier P. The preventable proportion of nosocomial infections: an overview of published reports. J Hosp Infect 2003; 54(4):258-66.[CrossRef][PubMed]
9. Joshi SG, Litake GM. Acinetobacter baumannii: An emerging pathogenic threat to public health. *World J Clin Infect Dis* 2013; 3(3): 25-36. [CrossRef] [PubMed]
10. Friedrich AW. Control of hospital acquired infections and antimicrobial resistance in Europe: the way to go Wien Med Wochenschr 2019; 169(suppl1):25– 30. [CrossRef][PubMed]
11. Klevens RM, Edwards JR, Richards CL Jr. Estimating health care-associated infections and deaths in US hospitals, 2002. Public Health Rep 2007;122(2):160-6. [CrossRef][PubMed]
12. Singh PK. Antibiotics, handle with care. Geneva: WHO; 2016. [Online] Available from: http://www.searo.who.int/mediacentre/ releases/2015/antibiotics-awareness-week-2015/en/
13. WHO. Antimicrobial resistance. Geneva: WHO; 2014. [Online] Available from: http://www.searo.who.int/thailand/factsheets/ fs0023/en/
14. WHO. WHO's first global report on antibiotic resistance reveals serious, worldwide threat to public health. Geneva: WHO; 2014.
15. Aitken CJD. Nosocomial spread of viral disease. Clin Microbiol Rev 2001; 14(3): 528-46.[CrossRef][PubMed]
16. Ducel JF, Nicolle L. Prevention of hospital-acquired infections. Geneva: WHO; 2002.
17. Prevention of hospital-acquired infections. A practical guide 2nd edition. World Health Organization Department of Communicable Disease, Surveillance and Response. 2002. Available at: http://www.who.int/csr/resources/publications/whoc dscsreph200212.pdf.
18. Asokan GV, Ramdahan T, Ahmed E, Sanad H. WHO global priority pathogens list: a bibliometric analysis of medline-pubmed for knowledge mobilization to infection prevention and control practices in bahrain. Oman Med J 2019;34 (3): 184–93.[CrossRef][PubMed]
19. Christaki E, Marcou M, Tofarides A. Antimicrobial resistance in bacteria: mechanisms, evolution, and persistence. J Mol Evol 2020; 88 (1): 26–40. [CrossRef][PubMed]
20. American Thoracic Society, Infectious Diseases Society of America. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. *Am J Respir Crit Care Med* 2005; 71:388–416. [CrossRef][PubMed]
21. Centers for Disease Control and Prevention (CDC).Vital signs: Central line–associated blood stream infections – United States, 2001, 2008, and 2009. Morb Mortal Wkly Rep 2011; 60(08): 243-8. [PubMed]
22. WHO. Preventing bloodstream infections from central line venous catheters. Geneva: WHO; 2016. [Online] Available from: http:// www.who.int/patientsafety/implementation/bsi/en/
23. Wei-Chih Liao, Wei-Sheng Chung, Ying-Chieh Lo, Wen-Hsin Shih , Chia-Hui Chou, et al. Changing epidemiology and prognosis of nosocomial bloodstream infection: A singlc enter retrospective study in Taiwan Journal of Microbiology, Immunology and Infection 2022;55(6): 1293-300. [CrossRef][PubMed]
24. Diekema DJ, Hsueh PR, Mendes RE, Pfaller MA, Rolston KV, Sader HS, Jones RN. The microbiology of bloodstream infection: 20- year trends from the SENTRY antimicrobial surveillance program. Antimicrob Agents Chemother 2019;63(7):19. e00355. [CrossRef][PubMed]
25. Gastmeier P, Kampf G, Wischnewski N, Schumacher M, Daschner F, Ruden H. Importance of the surveillance method various national prevalence studies on nosocomial infections and limits of comparison. Infect Control Hosp Epidemiol 1998; 19: 661–7.[CrossRef][PubMed]
26. CDC. Urinary tract infection (catheter-associated urinary tract infection [CAUTI] and non-catheter associated urinary tract infection [UTI]) and other urinary system infection [USI]) events. Atlanta, Georgia: CDC; 2016. [Online] Available from: http:// www.cdc.gov/nhsn/pdfs/pscmanual/7psccauticurrent.pdf
27. Jain P, Parada J, David A, Smith L. Overuse of the indwelling urinary tract catheter in hospitalized medical patients. Arch Intern Med 1995; 155: 1425–9.[CrossRef][PubMed]

28. Nouri F, Karami P, Zarei O, Kosari F, Alikhani MY, Zandkarimi E, ZarandiER, Taheri M. Prevalence of Common Nosocomial Infections and Evaluation of Antibiotic Resistance Patterns in Patients with Secondary Infections in Hamadan, Iran. Infect Drug Resist 2020; 15:13:2365-74. [CrossRef][PubMed]
29. Anderson DJ. Surgical site infections. Infect Dis Clin North Am 2011; 25(1): 135-53.[CrossRef][PubMed]
30. Owens CD. Surgical site infections: epidemiology, microbiology and prevention. J Hosp Infect 2008; 70(Suppl 2): 3-10. [CrossRef][PubMed]
31. Percival SP, Suleman L, Vuotto C. Healthcare-associated infections, medical devices and biofilms: risk, tolerance and control. Journal of Medical Microbiology 2015; 64: 323–34. [CrossRef][PubMed]
32. Hunter JD. Ventilator associated pneumonia. BMJ 2012; 344: 40-4. [CrossRef][PubMed]
33. Garner JS, Jarvis WR, Emori TG, Horan TC, Hughes JM. CDC definitions for nosocomial infections. Am J Infect Control 1988;16:128-40. [CrossRef][PubMed]
34. Kumar AV, Pillai VS, Dinesh KR, Karim S. The phenotypic detection of Carbapenemase in meropenem resistant Acinetobacter calcoaceticus baumannii complex in a tertiary care hospital in south India. J Clin Diagn Res. 2011;5(2):223-6.
35. George P, Sequiera, A. Antimicrobial sensitivity pattern among organisms isolated from the endotracheal aspirates of patients with ventilator associated pneumonia. J Clin Diag Res 2010;4: 3397-401.
36. Steven M, Koenig JDT. Ventilator-associated pneumonia: diagnosis, treatment, and prevention. Clin Microbiol Rev 2006; 19(4): 637-57.[CrossRef][PubMed]
37. Tabak YP, Vankeepuram L, YeG, Jeffers K, Gupta V, Murray PR. Blood culture turnaround time in U.S. acute care hospitals and implications for laboratory process optimization. J. Clin. Microbiol. 2018; 56: e00500–18. [CrossRef][PubMed]
38. Joshi SG, Litake GM. Acinetobacter baumannii: An emerging pathogenic threat to public health. *World J Clin Infect Dis* 2013; 3(3): 25-36. [CrossRef] [PubMed]
39. Dowell S, Marcy S, Phllips W, Gerber M, Scwartz B. Principles of judicious use of antimicrobial agents for pediatric upper respiratory tract infections. Pediatrics 1998;101(suppl):163-84. [CrossRef]
40. Custodio HT. Medscape: hospital-acquired infections, 2014. Available at: http://emedicine.medscape.com/article/967022-overview. Accessed 12 October 2014

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INTRAHOSPITALNA I MIKROBIOLOŠKA ANALIZA NA KLINICI ZA ANESTEZIOLOGIJU I INTENZIVNU TERAPIJU TERCIJARNE ZDRAVSTVENE USTANOVE U JEDNOGODIŠNJEM PERIODU

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Naziv intrahospitalne infekcije ili nozokomijalne infekcije podrazumeva infekcije koje se javljaju kod pacijenata u zdravstvenim ustanovama a nisu bile prisutne u vreme njihovog prijema u zdravstvenu ustanovu i manifestuju se u prvih četrdeset osam sati posle prijema. Češće su u zemljama u razvoju (od 5,7% do 19,1%) nego u razvijenim zemljama (od 3,5% do 12%). Antimikrobna rezistencija predstavlja globalni problem koji nastaje kao posledica upotrebe antimikrobnih lekova. Neopravdana upotreba antibiotika dovodi do razvoja bakterijske rezistencije i promene uzročnika infekcije odgovornih za intrahospitalne infekcije. Ove vrste infekcija produžavaju dužinu bolničkog lečenja, dovode do invaliditeta i povećavaju morbiditet i mortalitet. Najčešći tipovi intrahospitalnih infekcija jesu pneumonija povezana sa upotrebom respiratora, infekcije krvi izazvane upotrebom centralnog venskog katetera, urinarne infekcije uzrokovane kateterom i infekcije hirurških rana.

Cilj ove studije bio je da se odrede najčešći bakterijski uzročnici intrahospitalnih infekcija, kao i da se prikaže distribucija uzročnika prema vrsti biološkog materijala.

Ova retrospektivna studija se sprovodila na Klinci za anesteziologiju i intenzivnu terapiju Univerzitetskog kliničkog centra u Nišu od početka do kraja 2024. godine. Od pacijenata se uzimao biološki materijal: krv, bris prepona, bris usne duplje, bris rane, bris pazuha, bris čmara, urin, endotrahealni aspirat, bris nosa, obični aspirat, sadržaj drena, saržaj trbušne duplje, vrh centralnog venskog katetra, vrh drena, bronhoaspirat i drugo. Sav biološki materijal poslat je u mikrobiološku laboratoriju radi dobijanja biograma i antibiograma.

Pokazalo se da je ukupan broj materijala bio 1464: 232 (15,85%) uzorka krvi, 179 (12,23%) briseva prepona, 166 (11,34%) briseva usne duplje, 132 (9,02%) brisa rane, 122 (8,33%) brisa čmara, 108 (7,38%) briseva pazuha, 106 (7,24%) uzoraka urina, 94 (6,42%) endotrahealna aspirata, 63 (4,30%) brisa nosa, 56 (3,83%) aspirata, 43 (2,94%) sadržaja drenova, 15 (1,02%) sadržaja trbušne duplje, 15 (1,02%) vrhova centralnih venskih katetera, 11 (0,75%) vrhova drena, 10 (0,68%) aspirata iz bronhija i 112 (7,65%) ostalih uzoraka.

Distribucija bakterija prema vrsti bila je sledeća: *Klebsiella* sp. 20,15%, *Enterooccus faecalis* 19,26%, *Acinetobacter* sp. 14,41%, *Pseudomonas aeruginosa* 7,9%, *Escherichia coli* 7,17%, *Staphylococcus epidermidis* 4,99%, *Proteus mirabilis* 3,96%, *Enterococcus faecium* 2,94%, *Enetrobacter* sp. 2,94% i *Staphylococcus* sp. 2,19%. *Klebsiella* sp. je bila dominantno prisutna u brisu usne duplje (3,28%), *Enterococcus faecium* u brisu prepona (5,60%), *Acinetobacter* sp. u endotrahealnom aspiratu (1,91%), *Pseudomonas aeruginosa* u brisu rane (2,25%), a *Escherchia coli* u brisu čmara (1,84%).

Intrahospitalne infekcije izuzetno loše utiču na hospitalizovane pacijente. Dovode do dugotrajnog invaliditeta, produženog vremena boravka u bolnici i lečenja, povećanja smrtnosti, potrošnje medicinskih resursa i troškova lečenja. Uzročnici ovih infekcija zavise kako od bolničkih uslova, tako i od samih pacijenata i antibiotika koje prepisuju lekari. Trebalo bi da postoje smernice za davanje antibiotika u svakom regionu u skladu sa najčešćim uzročnicima i samom rezistencijom na antibiotike, budući da bi to pomoglo zdravstvenim radnicima pri odabiru najadekvatnije antimikrobne terapije za hospitalizovane pacijente.

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***Ključne reči**: intrahospitalne infekcije, nozokomijalne infekcije, bakterije, antibiotik*