Characterization of Microbiological Pathogens and Antimicrobial Resistance Profiles in Skin and Mucosal Infections Among Outpatients in Sarajevo Canton, Q1 2024

Azra Kudumovic, Sadeta Hamzic

University of Sarajevo, Faculty of Medicine, Sarajevo, Bosnia and Herzegovina

Abstract

Skin and mucosal infections provide a considerable public health challenge, particularly in outpatient environments where treatments occur frequently prior to microbiological diagnoses. This includes application of antibiotics. Further on, it has been found that the increased antimicrobial resistance (AMR) in the context of application of antibiotics, is associated with the treatment complexities, and consequently increase risks of complications and expenses of treatment. Increased Antimicrobial Resistance has been defined as a global challenge and this study aims to identify the predominant causal agents of skin and mucosal diseases and evaluate their antibiotic susceptibility profiles in Sarajevo Canton in Bosnia and Herzegovina during the first quarter of 2024.

Data were meticulously examined from microbiological laboratory records covering the period from January to March 2024, incorporating swab results from the skin and mucosa of outpatient cases. Isolates were identified through established microbiological techniques, and antimicrobial susceptibility was assessed using the disk-diffusion method in accordance with EUCAST standards.

A total of 5,227 samples containing identified pathogens were documented. The predominant etiological agent identified was Staphylococcus aureus (54.3% cases), followed by Escherichia coli (11.7%), Pseudomonas spp. (7.3%), Proteus spp. (5.5%), and MRSA (S. aureus - MRSA) (2.9%).

In regard to Antimicrobial Resistance in 90% of Staphylococcus aureus was showing resistance to Penicillin G. In contrast, susceptibility rates for Clindamycin, Cefoxitin, and Vancomycin were notably high, exceeding 95%. Strains of MRSA exhibited notable resistance to beta-lactam antibiotics while maintaining susceptibility to Linezolid and Vancomycin.

The findings indicate that Staphylococcus aureus continues to be the predominant pathogen in skin and mucosal infections, aligning with worldwide trends. The detection of MRSA and other resistant strains underscores the necessity for continuous monitoring of antimicrobial resistance and the judicious use of antibiotics in outpatient care.

Keywords: *skin infections, mucosal infections, antimicrobial resistance, Staphylococcus aureus, MRSA, outpatients.*

Introduction

Skin and mucosal infections pose a considerable medical problem in both inpatient and outpatient environments. Significant public health concern starts especially in outpatient settings where empirical treatment is frequently initiated prior to microbiological diagnoses. Consequently, the rising prevalence of antibiotic resistance exacerbates difficulties. (3)

Skin and mucosal infections are initiated by the entrance of the microorganism, usually a variety of bacteria, through a breach of the skin or mucosa. Pathogens can infiltrate via a hair follicle or compromised skin, potentially caused by scratches, puncture wounds, surgical interventions, burns, insect or animal bites, open wounds, or pre-existing dermatological diseases, and it can further involve local structures or spread to distant organs to generate life-threatening invasive infections such as bacteremia, pneumonia, and osteomyelitis.

Staphylococcus is since the beginning of the microbiological era recognized as an important pathogen responsible for infections in the healthcare setting and in the community. (1,4)

Futher on, bacterial antimicrobial resistance (AMR) is among a major public health threats of our time due to inability of the drugs, in particular antibiotics to be effective. (2) The escalating issue of antimicrobial resistance (AMR) is rendering the effective treatment of numerous diseases progressively more challenging. In here, Methicillin-resistant Staphylococcus aureus (MRSA), resistant to most frequently applied antibiotics, is presently the predominant cause of skin infections.

The aim of this study was to identify the most common causative agents of skin and mucosal infections and to analyse their antimicrobial susceptibility profiles in Sarajevo Canton during the first quarter of 2024.

Materials and Methods

This retrospective analysis encompassed microbiological data regarding skin and mucosal infections in outpatients, gathered from January to March 2024 in primary healthcare facilities within Sarajevo Canton. The investigation utilised laboratory data from the Institute of Public Health of Sarajevo Canton for the same period, encompassing results from skin and mucosal swabs of outpatients. Isolates were identified by standard microbiological techniques, and antimicrobial susceptibility was assessed using the disc diffusion method in compliance with EUCAST criteria (5).

Results

The results show that in microbiological diagnostics of skin and mucosal infections among outpatients in Sarajevo Canton, out of a total of 5,227 samples, the most dominant pathogen was Staphylococcus aureus, isolated in more than half of the cases (2,837; 54.3%), followed by Escherichia coli (612; 11.7%), Pseudomonas spp. (384; 7.3%), commonly associated with wound and burn infections, Proteus spp. (290; 5.5%), and MRSA (152; 2.9%).

Table 1. Prevalence of the most common causative agents of skin and mucosal infections

Number	Causative agents	Representation (%)
1	*Staphylococcus aureus*	54,3%
2	*Escherichia coli*	11,7%
3	*Pseudomonas* spp.	7,3%
4	*Proteus* spp.	5,5%
5	*Staphylococcus aureus* – MRSA	2,9%
6	*Klebsiella* spp.	2,3%
7	*Enterobacter* spp.	1,5%
8	*Streptococcus* ß hemolyticus (gr. B)	1,4%
9	*Streptococcus* ß hemolyticus (gr. A)	1,1%
10	*Enterococcus faecalis*	0,7%
11	Other	11,2%
	Total	**100%**

Notable presence of other opportunistic pathogens such as Proteus spp., Klebsiella spp., and Enterobacter spp. indicates the complex etiology of community-acquired skin infections.

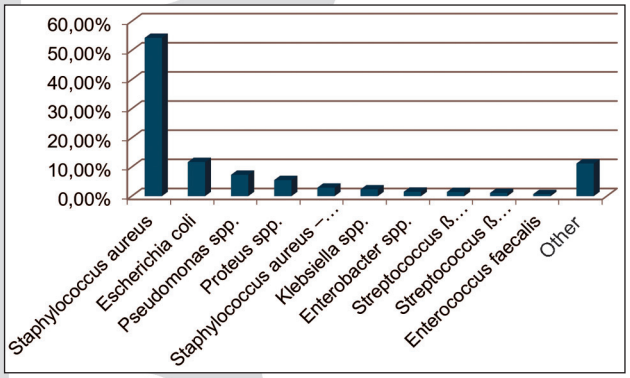

Chart 1. Overview of the Prevalence of the Most Common Causative Agents of Skin and Mucosal Infections

The presence of MRSA (2.9%) indicates the ongoing circulation of resistant strains in the outpatient setting. Gram-positive β-hemolytic streptococci of groups A and B, as well as *Enterococcus faecalis*, comprised a smaller but clinically significant portion of the isolates.

Infections caused by *Escherichia coli* are significantly more common in women, while *Staphylococcus aureus* and *Pseudomonas* species are almost equally distributed between both sexes. MRSA isolates are slightly more frequent in men.

Table 2. Distribution of most common skin and mucosal causes by sex

Pathogen	Female (n=2669)	Male (n=2060)
Staphylococcus aureus	54,64%	66,89%
Escherichia coli	17,84%	6,60%
Proteus species	5,55%	6,89%
Pseudomonas species	8,99%	6,99%
Staphylococcus aureus – MRSA	2,66%	3,93%
Other	10,32%	8,70%
Total	**100,00%**	**100,00%**

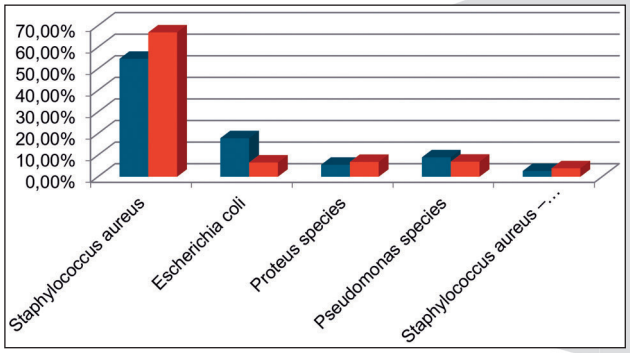

Chart 2. Overview of the most common causes of skin and mucous membrane infections by gender

An overview of antimicrobial resistance - *Staphylococcus aureus* is given in the following table.

Table 3. Antimicrobial resistance – Staphylococcus aureus

Antibiotic	Sensitive (S)	Intermedium (I)	Resistant (R)
Penicilin G	10%	0%	90%
Klindamicin	95%	2%	3%
Cefoksitin	96%	1%	3%
Trimetoprim-Sulfametoksazol	90%	3%	7%
Ciprofloksacin	85%	5%	10%
Gentamicin	93%	2%	5%
Eritromicin	70%	5%	25%
Vankomicin	100%	0%	0%
Linezolid	100%	0%	0%

During the observed period, a high rate of resistance was recorded for penicillin G (90%) and erythromycin (25%), while preserved susceptibility to clindamycin, vancomycin, and linezolid indicates maintained effectiveness of these antibiotics in treatment.

The presence of MRSA strains (2.9%) represents a concerning but still relatively low proportion in the outpatient population, which necessitates continuous monitoring. The recorded resistance of MRSA strains to beta-lactam antibiotics confirms their clinical resistance, while susceptibility to vancomycin and linezolid offers therapeutic options.

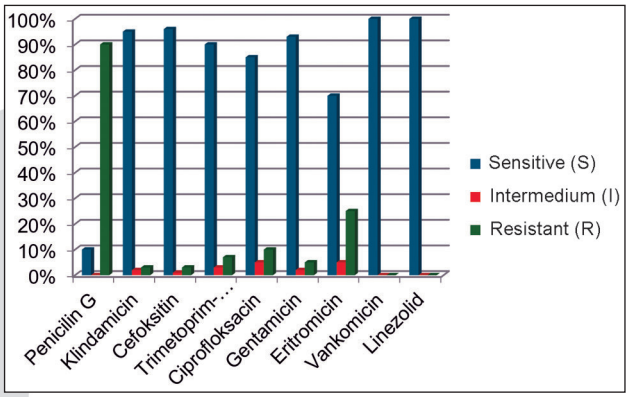

Chart 3. Overview of Antimicrobial Resistance – Staphylococcus aureus

Table 4. Antimicrobial Resistance – MRSA

Antibiotic	(S)	(I)	(R)
Cefoksitin	0%	0%	100%
Penicilin G	0%	0%	100%
Klindamicin	75%	5%	20%
Trimetoprim-Sulfametoksazol	88%	3%	9%
Linezolid	100%	0%	0%
Vankomicin	100%	0%	0%

The presence of MRSA strains (2.9%) represents a concerning, yet still relatively low proportion in the outpatient population, requiring continuous monitoring. The recorded resistance of MRSA strains to beta-lactams confirms their clinical resistance, while susceptibility to vancomycin and linezolid provides therapeutic options.

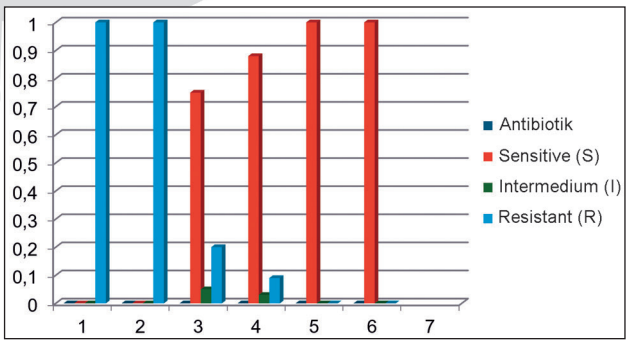

Chart 4. Overview of Antimicrobial Resistance – MRSA

Although the proportion of MRSA among the total causative agents of skin and mucosal infections was 2.9%, which is below the global average in many regions, its presence in the outpatient population is a cause for caution. The presence of MRSA outside the hospital system (so-called CA-MRSA) indicates the spread of resistant strains in the community, which can have significant public health consequences. A positive aspect is the high susceptibility of MRSA isolates to vancomycin, linezolid, and to some extent clindamycin and trimethoprim-sulfamethoxazole, which still allows effective treatment. However, continuous monitoring, microbiological surveillance, and rational antibiotic use remain crucial to prevent further resistance increase.

Besides *S. aureus*, significant isolates include *Escherichia coli*, *Pseudomonas* spp., and *Proteus* spp., which can cause more complex infections and whose antimicrobial resistance must also be monitored. These data emphasize the need for rational antibiotic use and enhanced microbiological testing prior to therapy initiation.

Conclusion

In Sarajevo Canton, skin and mucosal infections in outpatients are predominantly attributed to Staphylococcus aureus, exhibiting a substantial level of penicillin resistance, although MRSA strains represent a notable yet restricted proportion of the isolates. Ongoing monitoring of antimicrobial resistance is essential for effective therapy management and the avoidance of resistant strain dissemination.

While the present prevalence of MRSA isolates is not concerning, their existence in the outpatient demographic necessitates vigilant surveillance and continuous evaluation of treatment approaches. Ongoing microbiological monitoring and the enforcement of antimicrobial policy, coupled with the education of healthcare professionals and the public, are crucial for mitigating the dissemination of resistance strains.

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Corresponding Author
Azra Kudumovic,
University of Sarajevo,
Faculty of Medicine,
Sarajevo,
Bosnia and Herzegovina,
E-mail: azrakudumovic@yahoo.com