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Resistance Phenotypes of Bacterial Strains Isolated from Patients Admitted to Surgical Wards

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Rezumat

Fenotipuri de rezistență ale tulpinilor bacteriene izolate de la pacienți internați pe secțiile chirurgicale

Fundament şi obiectiv: Studiul de față are ca scop identificarea fenotipurilor de rezistență în cadrul Secției de Chirurgie Plastică a unui spital terțiar din România. Obiectivul principal este de a ghida administrarea adecvată a terapiei antibiotice, în vederea optimizării rezultatelor clinice şi a reducerii riscului de apariție a tulpinilor bacteriene multirezistente.
Materiale şi metode: A fost realizat un studiu clinic prospectiv pe un lot de 78 de pacienți internați în Secția de Chirurgie Plastică, prin prelevarea probelor de către medicii curanți. Identificarea tulpinilor bacteriene s-a realizat prin însămânțare pe medii de cultură şi utilizarea cardurilor API. Testarea sensibilității la antibiotice s-a efectuat prin metoda de difuzie Kirby-Bauer.
Rezultate: Au fost izolate în total 100 de tulpini bacteriene din cele 78 de probe clinice. Cele mai frecvent identificate bacterii au fost: *Staphylococcus aureus* (32%), *Klebsiella pneumoniae* (21%), *Escherichia coli* (10%), *Proteus mirabilis* (10%) şi *Pseudomonas aeruginosa* (10%). Dintre acestea, 20% din tulpinile de *Escherichia coli* şi 28,5% din cele de *Klebsiella pneumoniae* au prezentat

Abbreviations:
DNA: Deoxyribonucleic acid;
API: Analytical Profile Index;
CLSI: Clinical & Laboratory Standards Institute;
FqR: Fluoroquinolone resistance;
MRSA: Methicillin-resistant *Staphylococcus aureus*;
ESBL: Extended-spectrum beta-lactamase;
KTGANt: Resistance to all aminoglycosides (kanamycin, tobramycin, gentamicin, amikacin, and netelmicin resistance);
KTG: Resistance to aminoglycosides (kanamycin, tobramycin, gentamicin).

fenotip producător de beta-lactamază cu spectru extins (ESBL). Rezistența la fluorochinolone a fost observată la 23,8% dintre tulpinile de *Klebsiella pneumoniae* şi la 10% dintre cele de *Escherichia coli*. Rezistența la aminoglicozide a fost detectată la 30% din tulpinile de *Escherichia coli* şi la 71,5% din cele de *Klebsiella pneumoniae*. *Pseudomonas aeruginosa* a evidențiat rezistență față de carbapeneme – în special imipenem (40%), cefalosporine (50%) şi fluorochinolone (20%). Tulpinile de *Staphylococcus aureus* au fost clasificate în mai multe fenotipuri: tulpini meticilino-rezistente (MRSA) – 62,5%, producătoare de beta-lactamază – 37,5%, rezistente la aminoglicozide – 78,1%, şi tulpini rezistente la fluorochinolone – 18,8%.
Concluzie: Rezultatele obținute evidențiază o susceptibilitate crescută a tulpinilor bacteriene testate față de fluorochinolone, sugerând potențiala eficiență a acestora în cadrul terapiei antibiotice aplicate în practica chirurgicală.

Cuvinte cheie: bacterii, rezistență la antibiotice, administrare rațională a antibioticelor, infecții ale plăgilor chirurgicale, fluorochinolone, chirurgie plastică

Abstract

Background/aim: This study aims to identify resistance phenotypes within the Plastic Surgery Department of a tertiary hospital in Romania. The goal is to guide the appropriate administration of antimicrobial therapy to optimize patient outcomes while minimizing the risk of multidrug-resistant bacterial strain development.
Methods: A prospective clinical study was conducted on 78 patients admitted to the Plastic Surgery Department. Pus samples were collected by attending physicians. Bacterial culture and identification using API cards were conducted. Antibiotic susceptibility testing was performed through the Kirby-Bauer disk diffusion method.
Results: A total of 100 bacterial strains were isolated from 78 clinical samples. The most frequently identified strains were: *Staphylococcus aureus* (32%), *Klebsiella pneumoniae* (21%), *Escherichia coli* (10%), *Proteus mirabilis* (10%), and *Pseudomonas aeruginosa* (10%). Among these, 20% of *Escherichia coli* and 28.5% of *Klebsiella pneumoniae* strains exhibited an extended-spectrum beta-lactamase (ESBL) phenotype. Resistance to fluoroquinolones was observed in 23.8% of *Klebsiella pneumoniae* and 10% of *Escherichia coli* strains. Aminoglycoside resistance was detected in 30% of *Escherichia coli* and 71.5% of *Klebsiella pneumoniae* strains. Analysis of *Pseudomonas aeruginosa* isolates revealed resistance to carbapenems – namely imipenem (40%), cephalosporins (50%), and fluoroquinolones (20%). *Staphylococcus aureus* strains were classified into different phenotypes, including methicillin-resistant *Staphylococcus aureus* (62.5%), beta-lactamase producers (37.5%), aminoglycoside-resistant (78.1%), and fluoroquinolone-resistant strains (18.8%).
Conclusion: The findings highlight that the bacterial strains identified in this study demonstrated a high level of susceptibility to fluoroquinolones, suggesting their potential efficacy in antimicrobial therapy.

Keywords: bacteria, antibiotic resistance, antibiotic stewardship, surgical wound infection, fluoroquinolones, plastic surgery

Introduction

The antibacterial susceptibility profile of microorganisms isolated from hospitalized patients with surgical wound infections is constantly changing over time. On a global scale, Plastic

Surgery Departments are frequently faced with bacterial infections (1-4). Assessment of sensitivity of bacterial isolates to antibiotics can assist clinicians in selecting the most suitable antimicrobial treatment (4).

In medical units, it is recommended to establish the resistance phenotypes of circulating bacterial strains to make an appropriate decision in antibiotic selection (5). Antimicrobial treatment should be carefully chosen for the benefit of the patient and to prevent the selection of multidrug-resistant bacterial strains. Antibiotic stewardship and knowledge of the phenotypes allow for decreased resistance development mechanisms and dissemination (5).

Gram-negative bacteria, such as *Klebsiella pneumoniae*, *Escherichia coli*, *Proteus mirabilis*, and *Pseudomonas aeruginosa*, are major disease-causing agents worldwide and are acquiring resistance to available antibiotics. Among the available antibiotics, fluoroquinolones are frequently prescribed (6). However, the emergence of resistance has become a significant issue in clinical practice (7).

In our region, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Escherichia coli*, and *Proteus mirabilis* are among the most prevalent pathogens exhibiting antimicrobial resistance in hospital setting. Recent studies highlight the significant presence of methicillin-resistant *Staphylococcus aureus* (MRSA) and extended-spectrum beta-lactamase (ESBL) - producing *Klebsiella pneumoniae* and *Escherichia coli* (8,9). These findings align with broader antimicrobial resistance trends reported across Eastern Europe, underlining the critical importance of infection control and antibiotic stewardship programs tailored to local hospital needs.

Fluoroquinolones undoubtedly belong to the most successful class of antibiotics of the modern era (6). They exhibit potent activity against both Gram-positive and Gram-negative bacteria, with superior tissue penetration as compared to alternatives. They are used for urinary tract infections, pyelonephritis, gastroenteritis, sexually transmitted infections, prostatitis, community-acquired pneumonia, skin, and soft tissue infections. These advantages have led to the global usage of this class of antibiotics (10,11). The mechanism of action of fluoroquinolones is to inhibit bacterial enzymes DNA gyrase and DNA topoisomerase IV, establishing covalent links with the enzyme-DNA complex (10). Resistance to fluoroquinolones can arise through various mechanisms, including mutations in the genes encoding the target enzymes, efflux pumps that remove the antibiotic from the cell, or alterations in the outer membrane that prevent the antibiotic from entering the cell (12). In Plastic Surgery Departments, fluoroquinolones are frequently prescribed due to their broad-spectrum efficacy against common pathogens involved in wound infections (13). This widespread use underscores the importance of monitoring resistance patterns to ensure their continued effectiveness in this specialized clinical context (13).

Another antibiotic class that mainly acts on Gram-negative bacteria is represented by aminoglycosides. They interact with the ribosome and interfere with protein translation, halting protein synthesis (14). Aminoglycosides remain valuable in treating hospital-acquired wound infections, particularly when caused by Gram-negative bacteria in well-perfused tissues (15). However, their effectiveness is reduced in anaerobic, biofilm-associated, or hypoxic infections, as they require oxygen-dependent transport into bacterial cells (14,16,17). Combination therapy and local delivery methods help optimize their use while mitigating systemic toxicity risks. Resistance mechanisms include enzymatic modification of the drug (e.g., acetylation, phosphorylation), mutations in ribosomal proteins, and increased activity of efflux pumps that expel the antibiotic from the bacterial cell (18).

The beta-lactams class of antibiotics includes penicillin, cephalosporins, and carbapenems, which target the bacterial cell wall synthesis, therefore being initially mainly used against Gram-positive bacteria. Resistance often arises through the production of beta-lactamases that hydrolyze the antibiotic, rendering it ineffective (19). Additionally, modifications in penicillin-binding proteins can reduce drug affinity, contributing to resistance (19).

Plastic Surgery Departments of tertiary hospitals present a high nosocomial potential due to several factors: the severity of the underlying diseases of hospitalized patients, prolonged hospitalization and immobilization, the need for venous, arterial, and urinary catheterizations, and last but not least, prolonged antibiotic therapy. Under these conditions, the normal flora that colonizes the skin and mucous membranes is replaced by bacterial strains with pathogenic potential. *Staphylococcus aureus* is often implicated in surgical site infections, including those involving implants (4,20).

Fermentative and non-fermentative Gram-negative bacilli, such as *Pseudomonas aeruginosa*, are known to cause infections in moist areas and

have been identified in various wound infections (4,20). Hospital-acquired infections pose a particular danger due to the virulence of the involved pathogens and their multidrug resistance to antimicrobial agents (21).

Infections have consistently been among the common and concerning admissions, as well as complications following plastic surgery. Trauma stands as one of the most prevalent factors contributing to infection among patients admitted to Plastic Surgery Departments worldwide. Two primary factors contribute to the occurrence of postoperative infections. Firstly, certain treatment areas addressed by Plastic Surgery, such as the ear, nose, oral cavity, breast, and perineum, are inhabited by opportunistic pathogens. When these colonizing bacteria breach the epithelial barrier, they have the potential to invade the body and lead to an infection (1,22). Alternatively, infection commonly occurs following the introduction of foreign bodies, such as osteosynthesis materials, expanders and prostheses, during plastic surgery procedures (22).

Unfortunately, eradicating nosocomial strains is not possible within a hospital due to the aforementioned characteristics of the departments, making it of vital importance to take all necessary precaution to avoid hospital-acquired infections and spread of antibiotic resistance.

In this work, we present a prospective cohort study conducted to investigate the extent of antibiotic usage and microbial resistance patterns in a Plastic Surgery Department of a tertiary hospital in Romania.

Material and Methods

The current prospective cohort study was conducted between June 1st, 2022, and December 30th, 2022. From 78 patients, 104 bacterial strains were isolated from the Plastic Surgery Department of Pius Brînzeu Emergency County Hospital in Timişoara, Romania. Some patients harbored multiple bacterial species.

Inclusion Criteria

Patients admitted to the Plastic Surgery Department, exhibiting clinical symptoms indicative of wound infection (erythema, edema, warmth, purulent discharge) and agreeing to be part of the prospective study.

Out of the 104 bacterial strains isolated, 4 were excluded from the study due to the of isolation of MDROs (multi-drug resistant organisms) collected from patients who had been hospitalized and received various antibiotics for more than 3 months. The 3-month hospitalization cut-off for excluding patients with multidrug-resistant organisms (MDROs) was implemented to minimize the influence of prolonged healthcare exposure on the findings of our study (23).

The isolated strains were identified using analytical profile index (API) cards: API-Staph for *Staphylococci*, API 20 E for *Enterobacteria*, and API 20 NE for non-fermentative Gram-negative bacteria (bioMerieux SA, Craponne, France).

Sensitivity assay to antimicrobial agents was performed according to the standardized Kirby-Bauer disk diffusion method (24). Reading and interpretation of the results were performed in accordance with the international standards of CLSI 2022 (25).

Results

Through this prospective study, 100 bacterial strains were isolated from 78 patients admitted to the Plastic Surgery Department. The distribution by gender reveals a clear male preponderance without statistically significant differences in between the groups in the patient cohort analyzed (60.25%, with 47 males, p-value of 0.07 in chi-square test). Moreover, *Fig. 1* illustrates the gender and age distribution of patients, underscoring that the majority of patients belong to the 40-49 years old age group (p-value of 5.34 * 10-7 in z-test for one proportion), while age follows a normal distribution on a Gaussian curve (p-value of 0.0027 in Shapiro-Wilk test).

Table 1 presents the main admission diagnoses of patients in the Plastic Surgery Department or patients treated by a multidisciplinary team. Mainly, burns (25.64%) provide an entry point for bacteria by denuding the skin covering. Initially, colonization occurs with bacteria from the existing skin flora and bacteria carried by foreign bodies. In this study, the least often encountered infections were observed for patients in status post breast neoplasm with reconstruction, with only one female admitted.

Then, the strain with the highest pathogenic potential or synergistic microbial associations is selected, as depicted in *Fig. 2* (26). S*taphylococcus aureus* is observed as the most common pathogen in wound infection in this study, isolated in 32 cases. *Klebsiella pneumoniae* was isolated from 21 patients, while *Escherichia coli*, *Proteus mirabilis*,

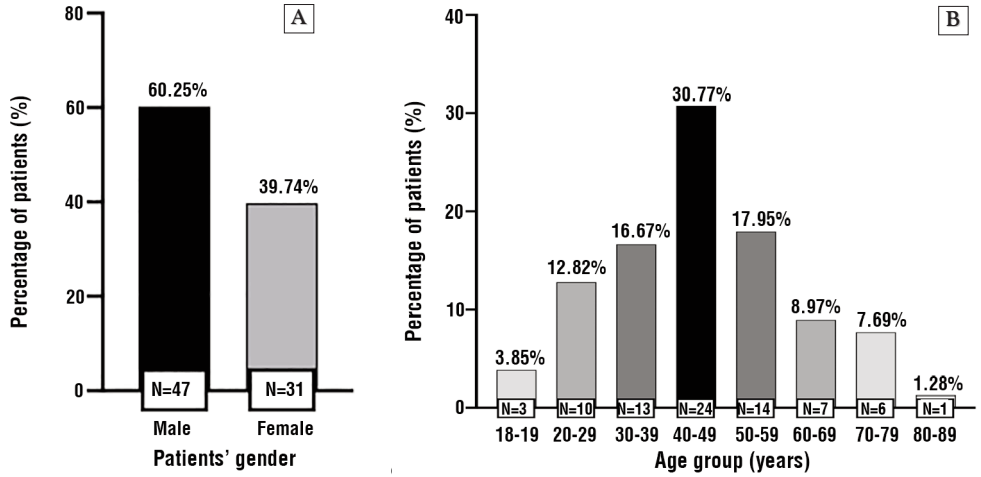

Figure 1. Distribution of patients by: **(A)** gender and **(B)** age.

Table 1. Admission diagnoses of patients.

Diagnosis	Number of patients	Percentage of patients (%)
Burns	20	25.64
Achilles tendon rupture	9	11.53
Necrotizing fasciitis	7	8.97
Periungual panaritium	6	7.69
Osteitis	5	6.41
Open fracture GA IIIB left calf	5	6.41
Septic arthritis left knee	4	5.12
Dog bite wound	4	5.12
Pulp necrosis	3	3.84
Status post septic supracondylar right femur fracture	3	3.84
Status post right ankle fracture	3	3.84
Polytrauma after accidental fall Open dislocation fracture GAIII	2	2.56
Right thigh tumor	2	2.56
Skin tumors	2	2.56
Other tumors	2	2.56
Status post breast neoplasm with reconstruction	1	1.28

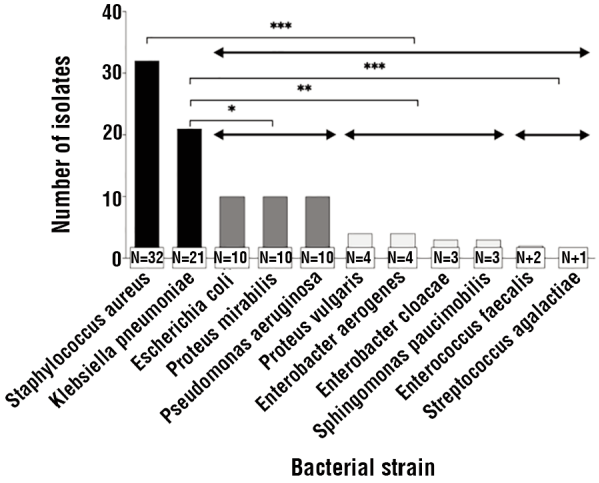

Figure 2. Isolated bacterial strains. Statistic significant differences in z-test for proportions are marked based on the p-value (* for p-value < 0.05; ** for p-value < 0.01; *** for p-value < 0.001).

and *Pseudomonas aeruginosa* were each isolated in 10 cases. Additional bacterial strains were isolated, in a much lower percentage, namely: *Proteus vulgaris*, *Enterobacter cloacae*, *Sphingomonas paucimobilis*, *Enterococcus faecalis*, and *Streptococcus agalactiae* (*Fig. 2*). *Staphylococcus aureus* has a statistically significant higher proportion compared to all species except for *Klebsiella pneumoniae* (p-value of 0.078 in z-test for proportions). For all other species, the p-values are well below 0.05, indicating that *Staphylococcus aureus* and *Klebsiella pneumoniae* are isolated more frequently than most other bacterial species, supporting targeted interventions or further research focusing on these prevalent pathogens and their antibiotic resistance mechanisms.

Associations of bacterial strains, such as *Staphylococcus aureus* and various enterobacteria (*Escherichia coli*, *Klebsiella pneumoniae*, *Proteus mirabilis*, and *Enterobacter cloacae*), or *Pseudomonas aeruginosa*, are frequently observed in wound infections and pose significant challenges due to increased pathogenicity and multidrug resistance (*Table 2*). *Staphylococcus aureus* and an enterobacterium (*Escherichia coli*, *Klebsiella pneumoniae*, *Proteus mirabilis*, *Enterobacter cloacae*), or *Pseudomonas aeruginosa*, can sometimes be isolated from the same pathological product (wound secretion). Associations

Table 2. Main bacterial associations.

Bacterial associations		Number of patients
Staphylococcus aureus	*Klebsiella pneumoniae*	8
	Escherichia coli	3
	Pseudomonas aeruginosa	3
	Enterobacter aerogenes	2
	Proteus mirabilis	1
	Proteus vulgaris	1
	Enterobacter cloacae	1
	Sphingomonas paucimobilis	1
Pseudomonas aeruginosa	*Klebsiella pneumoniae*	1
	Proteus mirabilis	1

between two Gram-negative bacteria (*Klebsiella pneumoniae* with *Pseudomonas aeruginosa* or *Proteus mirabilis* + *Pseudomonas aeruginosa*) are much less common (27).

For *Staphylococcus aureus*, resistance phenotypes are presented in *Fig. 3A*, including MRSA, beta-lactamase production (ESBL), aminoglycoside resistance to kanamycin, tobramycin, and gentamicin (KTG), and fluoroquinolone resistance (FqR). In this study, 62.5% of *Staphylococcus aureus* strains are resistant to methicillin.

Klebsiella pneumoniae is a common cause of nosocomial infections, particularly in surgical setting. *Fig. 3B* outlines its resistance phenotypes, including ESBL, high KTG (71.5%), and FqR (23.8%). However, *Klebsiella pneumoniae* strains in this study showed increased sensitivity to fluoroquinolones, with 76.2% of strains susceptible.

Fig. 3C presents the resistance phenotypes of *Pseudomonas aeruginosa* (*Pyocyanic Bacillus*) strains. Among the strains, 60% exhibited KGT, 50% were cephalosporinase hyperproducers, 40% showed resistance to imipenem, and 20% exhibited FqR. *Pseudomonas aeruginosa* is often multidrug-resistant bacteria, with notable resistance to aminoglycosides and cephalosporins.

Fig. 3D presents the resistance and sensitivity phenotypes of *Escherichia coli* strains. One strain exhibited FqR (10%), three strains were KGT (30%), two strains were ESBL (20%), and three strains secreted penicillinase (PAZA). The highest sensitivity was observed for fluoroquinolones (90%), followed by aminoglycosides (70%).

Fig. 3E presents the resistance and sensitivity

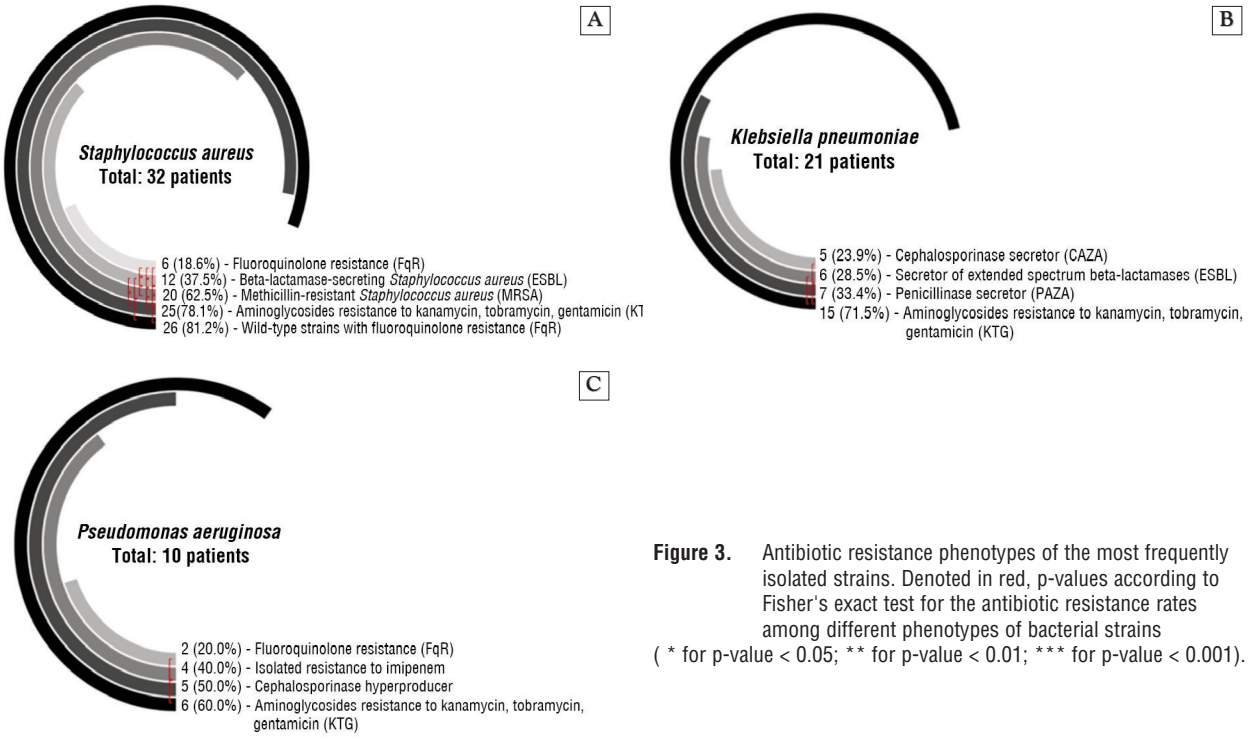

Figure 3. Antibiotic resistance phenotypes of the most frequently isolated strains. Denoted in red, p-values according to Fisher's exact test for the antibiotic resistance rates among different phenotypes of bacterial strains (* for p-value < 0.05; ** for p-value < 0.01; *** for p-value < 0.001).

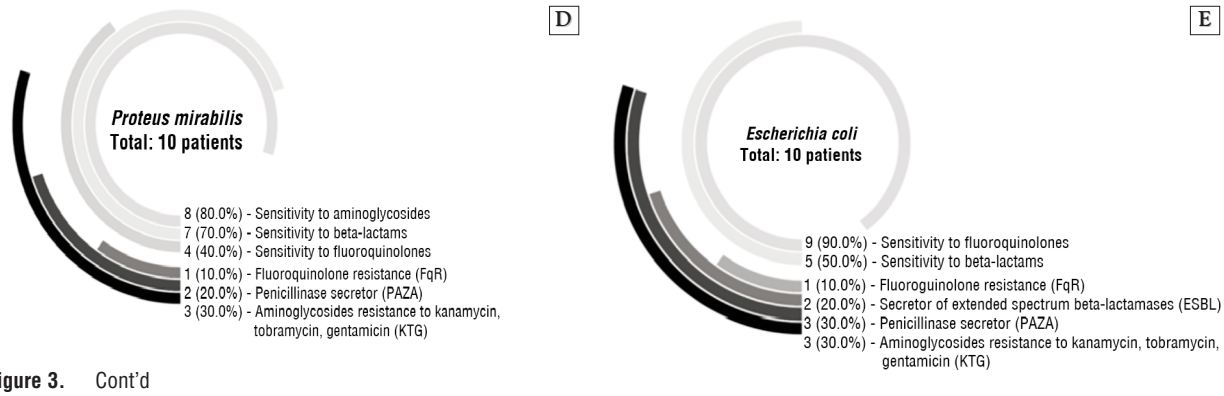

Figure 3. Cont'd

phenotypes of *Proteus mirabilis* strains. Among the 10 strains, 2 were penicillinase producers (PAZA no ESBL), 3 were resistant to all aminoglycosides (30%), and 1 exhibited FqR (10%). The highest sensitivity was observed for fluoroquinolones (90%), followed by beta-lactams (80%).

Discussion

The primary finding of our study is that the bacterial strains isolated from the Plastic Surgery Department of a tertiary hospital in Romania exhibited a high sensitivity to fluoroquinolones, consistent with other European studies (4). Regarding the incorporation of fluoroquinolones into treatment protocols, it is important to balance the efficacy with the potential for resistance development. While fluoroquinolones are effective against a wide range of pathogens, their overuse could contribute to increased resistance (28). Additionally, in 2024, examined fluoroquinolone prescription patterns and bacterial resistance profiles in a tertiary care hospital revealed that this class is among the most commonly prescribed antibiotics, and that their overuse is associated with increased resistance (29).

Identifying resistance phenotypes would guide healthcare practitioners in choosing the appropriate antibiotic treatment and prevent the emergence of multidrug-resistant bacterial strains. The data collected and analyzed support this hypothesis, demonstrating that understanding resistance patterns allows for more targeted and effective use of antibiotics, potentially reducing the incidence of multidrug-resistant strains.

Wild type bacterial strains do not exhibit acquired antibiotic resistance mechanisms. The development of acquired resistance leads to the emergence of resistance phenotypes. These phenotypes usually render useless one antibiotic class, such as resistance to beta-lactams induced by beta-lactamase-producing *Escherichia coli*. Less commonly, they act against multiple antibiotic classes, as observed in the case of membrane impermeability resistance phenotype of *Klebsiella pneumoniae* that combines resistance to tetracycline, chloramphenicol, nalidixic acid, and trimethoprim (30).

The current study was conducted using microtablets of antibiotics as recommended by the CLSI 2022 guidelines. For fluoroquinolones, ciprofloxacin, levofloxacin, pefloxacin, ofloxacin, and moxifloxacin (exclusively for *Staphylococcal infections*) were used (31,32). Our findings are consistent with the international literature focusing on Plastic Surgery Departments (1,2). Similarly, a ten-year study of pathogen distribution in Plastic Surgery found that Gram-positive bacteria outnumbered Gram-negative bacteria (1). However, other studies have shown a predominance of Gram-negative bacteria, such as *Pseudomonas aeruginosa*, patients sharing characteristics with the ones included in our study cohort – *Fig. 1* and *Table 1* (2,4,33). A study recent study pointed out that *Staphylococcus aureus* was the most dominant organism in the skin and soft tissue infections, with MRSA cultured in 80% of cases, highlighting the need for rigorous infection control (34).

Our study found that a significant proportion of *Escherichia coli* (20.0%) and *Klebsiella pneumoniae* (28.50%) strains exhibited the ESBL phenotype. This is consistent with other reports, highlighting the ongoing challenge of managing infections caused by multidrug-resistant organisms (35,36). The production of ESBLs results in increased resistance to penicillin and first, second, and third-

generation cephalosporins, except for cephamycin and related antibiotics (e.g., cefoxitin, cefotetan, latamoxef). There is also synergy between beta-lactamase inhibitors and certain antibiotics (37).

Our study identifies significant resistance to aminoglycosides in *Klebsiella pneumoniae* (71.50%) and *Escherichia coli* (30%). This underscores the necessity for careful selection of antibiotics to avoid ineffective treatments and further resistance development. Additionally, the high prevalence of MRSA strains (62.5%) is consistent with global trends, indicating the persistent challenge posed by these resistant bacteria in clinical settings. *Staphylococcus aureus* develops resistance to beta-lactams through target modification (methicillin-resistant strains) or beta-lactamase production. The MRSA phenotype implies cross-resistance to all beta-lactams and is particularly common in hospital settings, especially in high-risk departments such as surgical wards (38,39).

Pseudomonas aeruginosa is the most common pathogen involved in surgical wound infections (4,40,41). The resistance patterns observed in *Pseudomonas aeruginosa*, including a 40% resistance to imipenem and a 50% resistance to cephalosporins, suggest that these bacteria are becoming increasingly difficult to treat with conventional antibiotics. This trend necessitates the exploration of alternative therapeutic options and the development of new antibiotics.

The findings underscore the importance of local surveillance in hospital settings, particularly in Plastic Surgery Departments, where wound infections are common. By incorporating fluoroquinolones into treatment protocols, clinicians could more effectively treat infections while avoiding the overuse of broad-spectrum antibiotics. This could be crucial in managing hospital-acquired infections and preventing the escalation of antimicrobial resistance (42).

While the study provides valuable insights into bacterial resistance patterns in the Plastic Surgery Department of a tertiary hospital in Romania, several limitations must be acknowledged to provide a comprehensive understanding of the topic. While the relatively small sample size of 78 patients increases the likelihood of statistical variability and may not fully represent the broader bacterial resistance trends globally, the sample remains representative for the population of the Timiș county that the institution is dedicated to, with a population of 619104 individuals according to the 2021 census (43). For the population of the county, the minimal sample size would be 384 patients, nevertheless, according to Eurostat, the rate of hospital admission in Romania is 15% per year in the general population (44). Furthermore, geographic and institutional bias should be considered, alongside the relatively homogenous nature of population in the region, rendering the study less representative globally. The study duration does not allow for seasonal variation assessment in microbial spread. Future research should aim to comprise larger, multicenter studies conducted over a longer period of time to obtain more representative data and improve the robustness of the conclusions. To overcome these limitations, future research should consider the following:

1. Expanding the sample size to include a more diverse patient population.
2. Conducting multicenter studies across different geographic regions to reduce bias.
3. Investigating long-term resistance trends through continuous surveillance programs.
4. Evaluating the impact of hospital-specific infection control measures on resistance patterns.
5. Utilizing advanced diagnostic technologies to improve accuracy and reproducibility.

Conclusions

This study underscores the critical importance of establishing resistance phenotypes in clinical settings, particularly within the Plastic Surgery Departments. The findings point out the high prevalence of multidrug-resistant organisms, which complicate treatment strategies and emphasize the critical need for improved infection control measures and targeted antibiotic use. The observed resistance trends provide a valuable foundation for refining empirical antibiotic therapy and developing institution-specific antimicrobial stewardship programs. Our results highlight the substantial nosocomial burden, as reflected by the bacterial spectrum and resistance patterns identified, with *Staphylococcus aureus* (32%), *Klebsiella pneumoniae* (21%), and *Escherichia coli* (10%) being the most frequently isolated pathogens. Additionally, the alarming 62.5% occurrence of MRSA aligns with global trends, highlighting the ongoing challenge of managing hospital-associated infections. Furthermore, the prevalence of extended-spectrum beta-lactamase (ESBL) producing bacteria (20% of *Escherichia coli* and 28.5% of *Klebsiella pneumoniae*) raises significant concerns

regarding multidrug resistance and therapeutic limitations.

The study also confirms the high sensitivity of most bacterial strains to fluoroquinolones, with *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Escherichia coli*, and *Proteus mirabilis* exhibiting significant sensitivity to the therapy. These findings suggest that fluoroquinolones remain an effective therapeutic option for wound infections, but their use must be carefully monitored to prevent the emergence of further resistance.

Author's Contributions

Conceptualization, O-MM, PBM, L-CM; Methodology, BDT, CN, D-RC, CDM, A-AN, A-RN; Software, A-AN, A-RN; Validation, BDT, CN, D-RC, CDM, IFF, LD; Formal Analysis, O-MM, PBM, L-CM; Investigation, O-MM, PBM, L-CM, BDT, CN, D-RC, CDM, A-AN, A-RN; Resources, C-AD, PZC, AGMM; Data Curation, A-AN, A-RN; Writing – Original Draft Preparation, O-MM, PBM, L-CM, A-AN, A-RN, IFF, LD; Writing – Review & Editing, BDT, CN, D-RC, CDM, A-AN, A-RN, C-AD, PZC, AGMM; Visualization, IFF, LD, O-MM, PBM, L-CM, A-AN, A-RN; Supervision, C-AD, PZC, AGMM; Project Administration, AGMM; Funding Acquisition, C-AD, PZC, AGMM.

Conflicts of Interests

The authors declare no conflicts of interests.

Source of Funding

The authors have no financial interest to declare in relation to the content of this article.

Ethical Statement

The study was conducted in accordance with the Declaration of Helsinki with respect to the rules of good clinical practice in biomedical research, and the protocol was approved by the Ethics Committee of Victor Babeş University of Medicine and Pharmacy Timişoara, Romania (Approval No.67/17.12.2020) and by the Institutional Review Board and Ethics Committee for Scientifical Research of Pius Brânzeu Emergency Clinical County Hospital Timişoara, Romania (Approval No. 223/05.02.2021).

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