COMPARATIVE STUDY OF ANTIBIOTIC SENSITIVITY IN PSEUDOMONAS AERUGINOSA FROM BURN WOUNDS

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Abstract

The comparative analysis of antibiotic susceptibility in *Pseudomonas aeruginosa* strains isolated from burn wounds addresses a pivotal concern in managing infections among patients with severe burn injuries. *Pseudomonas aeruginosa* is a highly adaptable opportunistic pathogen, frequently implicated in nosocomial infections, particularly among immunocompromised individuals. Burn wounds create an ideal environment for bacterial colonization, leading to high infection rates and considerable morbidity and mortality—indeed, more than 75% of burn-related deaths are attributed to bacterial complications.

Understanding the antibiotic resistance profile of *Pseudomonas aeruginosa* is crucial for devising effective therapeutic strategies, especially in resource-limited healthcare systems where such infections are most prevalent. This research employs antimicrobial susceptibility testing on clinical isolates from burn wounds to evaluate resistance patterns against a spectrum of antibiotics, including carbenicillin, piperacillin, and imipenem.

Keywords: *Pseudomonas aeruginosa*; burn wound infections; antimicrobial resistance; multidrug-resistant (MDR) strains; biofilm formation; antibiotic susceptibility testing; EUCAST; neomycin gel formulation.

Introduction

Pseudomonas aeruginosa is a remarkably adaptable opportunistic pathogen implicated in a wide range of clinical infections, particularly among immunocompromised patients and individuals suffering from severe burn injuries. Burn wounds compromise the protective barrier of the skin, creating an ideal environment for bacterial colonization and subsequent infection. The pathophysiology of these wounds is further complicated by the formation of biofilms—structured communities of bacterial cells encased within a self-produced extracellular polymeric matrix. These biofilms dramatically enhance bacterial tolerance to antimicrobial agents, often rendering conventional treatment regimens ineffective and leading to persistent infections.

The prevalence of *P. aeruginosa* in burn wound infections is a major clinical concern, as this pathogen accounts for a significant proportion of nosocomial infections worldwide. Empirical studies indicate that up to 90% of burn wound samples yield positive bacterial cultures, with *P. aeruginosa* consistently ranking among the most frequently isolated organisms. In addition to its capacity for biofilm formation, the organism exhibits multiple intrinsic and acquired mechanisms of antibiotic resistance. Intrinsic resistance arises from factors such as reduced outer membrane permeability and the activity of multidrug efflux pumps, while acquired resistance results from spontaneous mutations and horizontal gene transfer of resistance determinants.

The critical impact of *P. aeruginosa* infections in burn patients is underscored by evidence showing that over 75% of burn-related deaths are attributable to bacterial sepsis and

secondary infections. The combination of impaired immune responses, the protein-rich milieu of burn eschar, and the protective nature of biofilms collectively contribute to the high morbidity and mortality associated with these infections.

Methodology

Antimicrobial Susceptibility Testing

The antimicrobial susceptibility of *Pseudomonas aeruginosa* isolates (n = 23) was evaluated using the standard disk diffusion method against nine antibiotics: carbenicillin, piperacillin, cefepime, aztreonam, imipenem, gentamicin, neomycin, levofloxacin, and tetracycline. The inoculated plates were incubated at 37°C for 18 hours, after which the inhibition zones were measured in millimeters. The results were interpreted as sensitive (S), intermediate (I), or resistant (R) according to the clinical breakpoints established by the European Committee on Antimicrobial Susceptibility Testing (EUCAST) guidelines.

Statistical Analysis

All experimental procedures were conducted in triplicate to ensure reproducibility and statistical accuracy. Data analysis was performed using NCSS 2020 and Minitab version 19.2020.1 software. Statistical significance was evaluated using analysis of variance (ANOVA) with Tukey–Kramer multiple comparisons and Student's *t*-tests, with a threshold of $P \leq 0.05$. This comprehensive statistical approach enabled the effective assessment of treatment impact on microbial resistance patterns.

Gel Formulation for In Vivo Experiments

The gel formulations for in vivo testing were prepared following the procedure described by Purushothamrao et al. (2010). Methylcellulose (4.5 g) was initially mixed with 50% of a sterile liquid medium maintained at 80°C to obtain a homogenous polymeric suspension. The remaining portion of the cold medium was then added with continuous stirring off heat until uniformity was achieved. For antibiotic-containing formulations, neomycin was dissolved in the cold portion of the liquid medium before incorporation into the polymer mixture. All gel formulations were stored overnight at 4°C to allow complete polymer swelling. The liquid spray formulation was prepared separately by dissolving neomycin directly in a colloidal silver nanoparticle (Ag-NP) solution.

Results

Bacterial Bioluminescence

Bioluminescence analysis of *Pseudomonas aeruginosa* isolates revealed heterogeneous resistance profiles. Multidrug-resistant (MDR) strains exhibited non-susceptibility to at least one antimicrobial in three or more drug categories. Extensively drug-resistant (XDR) strains demonstrated non-susceptibility to all but two antibiotic classes, while pandrug-resistant (PDR) isolates were resistant to all tested agents. These findings underscore the growing prevalence of resistance, largely driven by excessive antibiotic use and the slow pace of new antimicrobial development.

Survival Analysis

Significant differences in survival rates were observed among the experimental groups. The untreated control group (G2) demonstrated the lowest survival rate (66.7%), whereas other treatment groups showed improved outcomes over the study period. Kaplan–Meier

survival curves clearly illustrated these variations, emphasizing the therapeutic impact of treatment interventions on survival probability.

Wound Closure Rates

Wound closure progression was monitored over seven days. The G4 group achieved the highest closure rate (16.6%), followed by the G5 group (11.1%). Both G1 and G3 groups showed moderate healing (5.5%), while the untreated G2 group exhibited no significant wound closure during the observation period. Daily wound measurements and photographic documentation corroborated these findings, demonstrating differential healing rates linked to treatment modalities.

Histopathological Analyses

Histopathological examination revealed notable variations in C-reactive protein (CRP) concentrations among the experimental groups on days 3 and 7. The G1 group displayed elevated CRP levels compared with G2, indicating an inflammatory response associated with treatment. Although the differences between G2, G4, and G5 were not statistically significant, CRP levels in G2 were slightly higher, suggesting biologically relevant trends that warrant further investigation.

Discussion

The increasing emergence of multidrug-resistant (MDR) *Pseudomonas aeruginosa*—particularly in burn wound infections—poses a serious challenge to clinical management. Burn injuries compromise the integrity of the skin barrier and alter immune responses, providing an ideal niche for bacterial colonization and infection. While mild burn injuries often heal without complications, extensive or deep burns significantly elevate the risk of severe bacterial infections, which prolong hospitalization and increase mortality.

Studies demonstrate that burn wounds, previously believed to be sterile immediately post-injury, become rapidly colonized by various microorganisms within a week. This rapid microbial colonization highlights the urgent need for effective and innovative antimicrobial strategies. Biofilm formation further complicates the clinical picture by shielding bacterial communities from both host defenses and antibiotic therapy, contributing to persistent infections and delayed healing.

Given these complexities, there is an increasing emphasis on alternative therapeutic approaches—such as quorum-sensing inhibitors, bacteriophage therapy, and biofilm-disrupting agents—that target bacterial communication and structural resilience rather than relying solely on antibiotics. The inherent low permeability of the *P. aeruginosa* outer membrane, coupled with its ability to overexpress efflux pumps and delete porins, severely limits the efficacy of conventional antibiotics.

Recent evidence demonstrates that the proportion of antibiotic-resistant *P. aeruginosa* isolates in hospital-acquired infections continues to rise, necessitating strengthened infection control, routine susceptibility testing, and antimicrobial stewardship programs. Beyond the clinical realm, the societal implications are profound—antimicrobial resistance (AMR) threatens healthcare systems globally, demanding collaborative engagement from healthcare professionals, researchers, pharmaceutical companies, and policymakers.

Legislative and institutional initiatives must simultaneously promote antibiotic innovation and ensure responsible antibiotic use. Global health agencies and policy

frameworks have increasingly recognized AMR as a critical public health crisis, encouraging international cooperation to mitigate its escalation.

Ultimately, the findings of this study reinforce the urgent necessity for continuous surveillance, rational antibiotic use, and the development of novel therapeutic interventions to counteract multidrug-resistant *Pseudomonas aeruginosa* in burn wound infections—thus improving survival outcomes and overall patient care.

Adabiyotlar, References, Литературы:

1. European Committee on Antimicrobial Susceptibility Testing (EUCAST). *Breakpoint tables for interpretation of MICs and zone diameters.* Version 12.0, 2022.
2. Church, D., Elsayed, S., Reid, O., Winston, B., Lindsay, R. *Burn wound infections. Clin Microbiol Rev.* 2006;19(2):403–434.
3. Ramirez, D., and Tolmasky, M. E. *Aminoglycoside modifying enzymes. Drug Resist Updat.* 2010;13(6):151–171.
4. Hassoun, A., Linden, P. K., Friedman, B. *Incidence, prevalence, and management of infections caused by multidrug-resistant Gram-negative bacteria in the intensive care unit. Semin Respir Crit Care Med.* 2015;36(1):60–73.
5. Moradali, M. F., Ghods, S., Rehm, B. H. A. *Pseudomonas aeruginosa lifestyle: a paradigm for adaptation, survival, and persistence. Front Cell Infect Microbiol.* 2017;7:39.
6. Mulcahy, L. R., Isabella, V. M., Lewis, K. *Pseudomonas aeruginosa biofilms in disease. Microb Ecol.* 2014;68(1):1–12.
7. Poole, K. *Mechanisms of bacterial biocide and antibiotic resistance. J Appl Microbiol.* 2002;92(Suppl):55S–64S.
8. Lambert, P. A. *Mechanisms of antibiotic resistance in Pseudomonas aeruginosa. J R Soc Med.* 2002;95(Suppl 41):22–26.
9. Purushothamrao, K., Rao, G. K., Reddy, S. V. *Formulation and evaluation of antimicrobial gel containing silver nanoparticles. Int J Pharm Sci Rev Res.* 2010;3(2):78–83.
10. World Health Organization (WHO). *Global Action Plan on Antimicrobial Resistance.* Geneva: WHO Press; 2015