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Original Research Article

CHARACTERIZATION AND ANTIMICROBIAL SENSITIVITY PATTERNS OF BACTERIAL PATHOGENS IN CHRONIC WOUND INFECTIONS

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Abstract
Background: Chronic wound infections are a significant healthcare challenge due to the prevalence of antibiotic-resistant bacterial pathogens. This study aims to characterize the bacterial pathogens and determine their antimicrobial sensitivity patterns in chronic wound infections. **Material and Methods:** A total of 100 samples were collected from patients with chronic wound infections. Bacterial identification and antimicrobial susceptibility testing were performed using standard microbiological methods. The pathogens were identified, and their resistance profiles were documented. **Results:** Out of 100 samples, 75 showed significant bacterial growth. The most common pathogens identified were Staphylococcus aureus (40%), Pseudomonas aeruginosa (26.7%), Escherichia coli (20%), Klebsiella pneumoniae (13.3%), and Proteus mirabilis (6.7%). Staphylococcus aureus isolates showed 100% sensitivity to vancomycin but demonstrated 90% resistance to penicillin and 40% to methicillin. Pseudomonas aeruginosa was 90% sensitive to meropenem and 85% to piperacillin-tazobactam, with 60% resistance to ceftazidime. Escherichia coli exhibited high sensitivity to imipenem (95%) and amikacin (90%) but had 85% resistance to ampicillin. Klebsiella pneumoniae showed 90% sensitivity to amikacin and 95% resistance to ampicillin. Proteus mirabilis was highly sensitive to meropenem (100%) and cefotaxime (90%), with resistance to ampicillin (80%). **Conclusion:** The study highlights the high prevalence of resistant bacterial pathogens in chronic wound infections. Continuous monitoring of antimicrobial sensitivity patterns is essential to inform appropriate treatment strategies and improve patient outcomes.

INTRODUCTION

Chronic wound infections pose a significant challenge in clinical settings due to their prolonged healing process and susceptibility to various bacterial pathogens.[1]These infections can arise from a multitude of factors, including underlying medical conditions such as diabetes, poor circulation, and immune deficiencies, which compromise the body's natural ability to heal.[2,3] The presence of bacterial pathogens in chronic wounds not only exacerbates the condition but also complicates treatment, especially in cases where antibiotic-resistant strains are involved.[4]

The increasing prevalence of antibiotic-resistant bacteria is a growing concern worldwide, complicating the management of chronic wound infections.[5] Resistance mechanisms, such as the production of β-lactamases and efflux pumps, reduce the efficacy of commonly used antibiotics, leading to treatment failures and prolonged hospital stays.[6] The identification and characterization of these bacterial pathogens and their antimicrobial susceptibility patterns are crucial for developing effective treatment strategies and preventing the spread of resistant strains.[7]

In this study, we aim to characterize the bacterial pathogens present in chronic wound infections and assess their antimicrobial sensitivity patterns. By identifying the prevalent bacterial species and their resistance profiles, we seek to provide valuable insights into the current landscape of chronic wound infections and highlight the need for targeted antimicrobial therapy. This study highlights the importance of continuous monitoring and effective infection control measures to manage chronic wound infections and mitigate the impact of antibiotic resistance.

MATERIAL AND METHODS

Study Design and Setting

This descriptive study was conducted at Gandhi Medical College, Secunderabad, over a period of one year, from August 2022 to July 2023. The study focused on patients with chronic wound infections, who were treated at the outpatient and inpatient departments of the hospital.

Sample Collection

A total of 100 patients with clinically diagnosed chronic wound infections were included in the study. Wound swab samples were collected using sterile swabs from the wound bed after debridement and cleansing with sterile saline. Care was taken to avoid contamination from surrounding skin.

Bacterial Isolation and Identification

The collected samples were immediately transported to the microbiology laboratory for processing. Each sample was inoculated onto standard culture media, including Blood Agar and MacConkey Agar plates, and incubated at 37°C for 24-48 hours. The colonies obtained were identified based on morphological characteristics, Gram staining, and biochemical tests. The identification of bacterial pathogens was further confirmed using automated systems, such as the VITEK 2 system, where necessary.

Antimicrobial Susceptibility Testing

Antimicrobial susceptibility testing was performed using the Kirby-Bauer disk diffusion method, in accordance with the Clinical and Laboratory Standards Institute (CLSI) guidelines. A panel of antibiotics, including vancomycin, linezolid, doxycycline, penicillin, methicillin, erythromycin, meropenem, piperacillin-tazobactam, ciprofloxacin, ceftazidime, imipenem, amikacin, nitrofurantoin, ceftriaxone, sulfamethoxazole-trimethoprim, cefepime, cefuroxime, and gentamicin, was used to determine the susceptibility patterns of the isolated bacteria. The zones of inhibition were measured, and the results were interpreted as sensitive, intermediate, or resistant based on the CLSI criteria.

Data Analysis

Data were collected and recorded systematically, including patient demographics, type of wound, isolated bacterial pathogens, and their antimicrobial susceptibility patterns. Descriptive statistics were used to summarize the data, with the frequency and percentage of each bacterial pathogen and their resistance profiles calculated. The results were presented in tables and figures for clarity and easy interpretation.

Ethical Considerations

The study obtained ethical approval from the Institutional Ethics Committee of Gandhi Medical College, Secunderabad. Informed consent was obtained from all participants. Patient confidentiality was maintained, and all data were anonymized to protect privacy. No invasive procedures were involved.

RESULTS

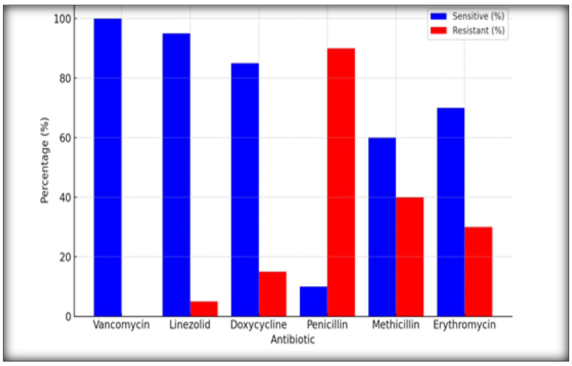

Figure 1: Antimicrobial Sensitivity Patterns of Staphylococcus aureus

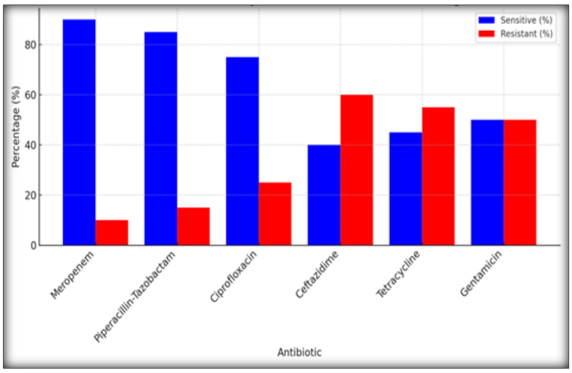

Figure 2: Antimicrobial Sensitivity Patterns of Pseudomonas aeruginosa

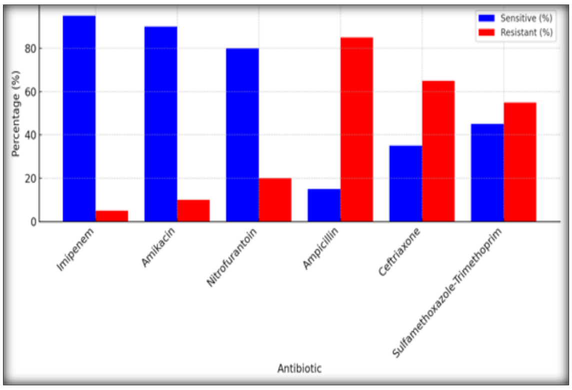

Figure 3: Antimicrobial Sensitivity Patterns of Escherichia coli

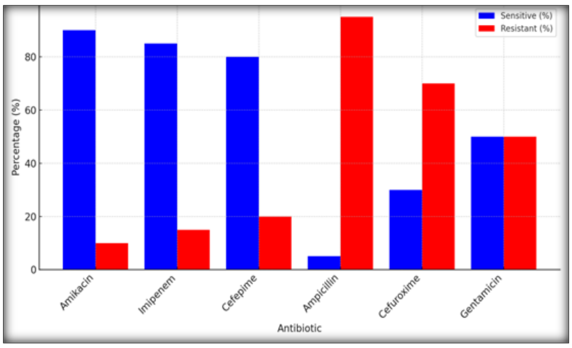

Figure 4: Antimicrobial Sensitivity Patterns of Klebsiella pneumonia

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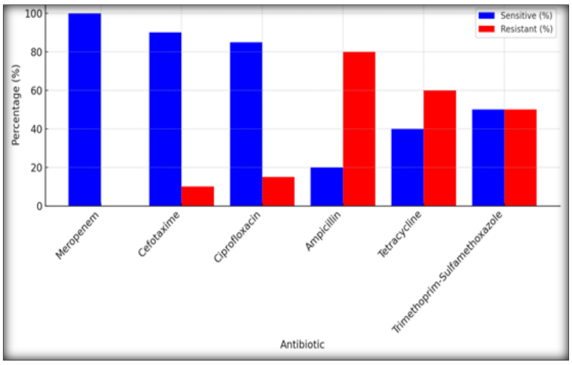

Figure 5: Antimicrobial Sensitivity Patterns of Proteus mirabilis

A total of 100 samples were collected from patients with chronic wound infections. The demographic data, including age and gender distribution, are summarized in Table 1. The age range of the patients was between 18 and 80 years, with a mean age of 50.3 years. The majority of the samples were collected from male patients (55%).

Out of the 100 samples, 75 showed significant bacterial growth, with a variety of pathogens identified. [Table 2] The most prevalent pathogen was Staphylococcus aureus, accounting for 40% of the isolates, followed by Pseudomonas aeruginosa (26.7%), Escherichia coli (20%), Klebsiella pneumoniae (13.3%), and Proteus mirabilis (6.7%). Additionally, 6.7% of the samples contained other pathogens, including mixed infections.

The antimicrobial sensitivity patterns were assessed for the major bacterial pathogens identified in the study. The results for Staphylococcus aureus are shown in Table 3. Notably, 100% of the isolates were sensitive to vancomycin, while a significant resistance was observed to penicillin (90%) and methicillin (40%). Pseudomonas aeruginosa isolates demonstrated high sensitivity to meropenem (90%) and piperacillin-tazobactam (85%), with notable resistance to ceftazidime (60%) and tetracycline (55%) as detailed in. [Table 4]

For Escherichia coli, the highest sensitivity was recorded for imipenem (95%) and amikacin (90%), with significant resistance noted against ampicillin (85%) and ceftriaxone (65%), as presented in. [Table 5] Similarly, Klebsiella pneumoniae isolates exhibited high sensitivity to amikacin (90%) and imipenem (85%), with resistance to ampicillin (95%) and cefuroxime (70%). [Table 6] Lastly, Proteus mirabilis isolates were highly sensitive to meropenem (100%) and cefotaxime (90%), while showing resistance to ampicillin (80%) and tetracycline (60%). [Table 7]

Table 1: Sample Characteristics

Parameter	Number (n=100)
Total samples collected	100
Samples with bacterial growth	75
Samples without bacterial growth	25
Age range (years)	18-80
Mean age (years)	50.3
Gender distribution	
Male	55
Female	45

Table 2: Distribution of Bacterial Pathogens

Bacterial Pathogen	Number of Isolates (n=75)	Percentage (%)
Staphylococcus aureus	30	40
Pseudomonas aeruginosa	20	26.7
Escherichia coli	15	20
Klebsiella pneumoniae	10	13.3
Proteus mirabilis	5	6.7
Other pathogens (mixed infections)	5	6.7

Table 3: Antimicrobial Sensitivity Patterns of Staphylococcus aureus

Antibiotic	Sensitive (%)	Resistant (%)
Vancomycin	100	0
Linezolid	95	5
Doxycycline	85	15
Penicillin	10	90
Methicillin	60	40
Erythromycin	70	30

Table 4: Antimicrobial Sensitivity Patterns of Pseudomonas aeruginosa

Antibiotic	Sensitive (%)	Resistant (%)
Meropenem	90	10
Piperacillin-Tazobactam	85	15
Ciprofloxacin	75	25
Ceftazidime	40	60
Tetracycline	45	55
Gentamicin	50	50

Table 5: Antimicrobial Sensitivity Patterns of Escherichia coli

Antibiotic	Sensitive (%)	Resistant (%)
Imipenem	95	5
Amikacin	90	10
Nitrofurantoin	80	20

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Ampicillin	15	85
Ceftriaxone	35	65
Sulfamethoxazole-Trimethoprim	45	55

Table 6: Antimicrobial Sensitivity Patterns of Klebsiella pneumonia

Antibiotic	Sensitive (%)	Resistant (%)
Amikacin	90	10
Imipenem	85	15
Cefepime	80	20
Ampicillin	5	95
Cefuroxime	30	70
Gentamicin	50	50

Table 7: Antimicrobial Sensitivity Patterns of Proteus mirabilis

Antibiotic	Sensitive (%)	Resistant (%)
Meropenem	100	0
Cefotaxime	90	10
Ciprofloxacin	85	15
Ampicillin	20	80
Tetracycline	40	60
Trimethoprim-Sulfamethoxazole	50	50

DISCUSSION

The present study provides valuable insights into the microbiological landscape of chronic wound infections at Gandhi Medical College, Secunderabad, over a one-year period. The findings reveal a diverse array of bacterial pathogens, with Staphylococcus aureus being the most prevalent, followed by Pseudomonas aeruginosa, Escherichia coli, Klebsiella pneumoniae, and Proteus mirabilis. These results are consistent with previous studies that identified similar organisms as common culprits in chronic wound infections (Guan et al,[8] 2021; Nathaniel et al,[9] 2023).

A significant observation from this study is the high level of antimicrobial resistance among the isolated pathogens. Staphylococcus aureus exhibited substantial resistance to methicillin, indicating the presence of Methicillin-Resistant Staphylococcus aureus (MRSA), which complicates treatment options. Similar findings have been reported in other studies, highlighting the widespread issue of MRSA in chronic wounds (Regassa et al,[10] 2023). The resistance of Pseudomonas aeruginosa to ceftazidime and other antibiotics further underscores the challenge of treating infections caused by this opportunistic pathogen, known for its intrinsic resistance mechanisms (Monk et al,[11] 2024).

The findings underscore the critical need for regular surveillance of antimicrobial susceptibility patterns. The high resistance rates observed in this study suggest the necessity for cautious antibiotic use and the importance of adopting antibiotic stewardship programs to curb the spread of resistant strains. Personalized treatment strategies based on local antibiograms are essential to improve patient outcomes and reduce the incidence of treatment failures (Alharbi,[12] 2022; Sewunet et al,[13] 2013). The study also aligns with other research indicating the diverse resistance profiles of bacterial pathogens in different geographical regions (Abid Khan et al,[14] 2023).

The limitations of the study include its single-center design and the relatively small sample size, which may limit the generalizability of the findings. Future studies with larger cohorts and multi-center involvement could provide a more comprehensive understanding of the epidemiology of chronic wound infections and resistance patterns.

CONCLUSION

This study highlights the critical importance of continuously monitoring bacterial pathogens and their antimicrobial resistance patterns in chronic wound infections. The diverse range of pathogens identified, along with the significant levels of antibiotic resistance observed, highlights the need for precise and informed clinical decision-making.

REFERENCES

1. Mama M, Abdissa A, Sewunet T. Antimicrobial susceptibility pattern of bacterial isolates from wound infection and their sensitivity to alternative topical agents at Jimma University Specialized Hospital, South-West Ethiopia. Ann Clin Microbiol Antimicrob. 2014 Apr 14; 13:14.
2. Puca V, Marulli RZ, Grande R, Vitale I, Niro A, Molinaro G, et al. Microbial Species Isolated from Infected Wounds and Antimicrobial Resistance Analysis: Data Emerging from a Three-Years Retrospective Study. Antibiotics (Basel). 2021 Sep 24;10(10):1162. doi: 10.3390/antibiotics10101162. PMID: 34680743; PMCID: PMC8532735.
3. Mohammed A, Seid ME, Gebrecherkos T, Tiruneh M, Moges F. Bacterial Isolates and Their Antimicrobial Susceptibility Patterns of Wound Infections among Inpatients and Outpatients Attending the University of Gondar Referral Hospital, Northwest Ethiopia. Int J Microbiol. 2017; 2017:8953829. doi: 10.1155/2017/8953829. Epub 2017 Mar 12. PMID: 28386280; PMCID: PMC5366191.
4. Bessa LJ, Fazii P, Di Giulio M, Cellini L. Bacterial isolates from infected wounds and their antibiotic susceptibility pattern: some remarks about wound infection. Int Wound J. 2015 Feb;12(1):47-52. doi: 10.1111/iwj.12049. Epub 2013 Feb 24. PMID: 23433007; PMCID: PMC7950398.
5. Trojan R, Razdan L, Singh N. Antibiotic Susceptibility Patterns of Bacterial Isolates from Pus Samples in a Tertiary Care Hospital of Punjab, India. Int J Microbiol. 2016;

ISSN (O): 2687-5365; ISSN (P): 2753-6556

2016:9302692. doi: 10.1155/2016/9302692. Epub 2016 Oct 30. PMID: 27872643; PMCID: PMC5107258.

6. Hassan MA, Abd El-Aziz S, Elbadry HM, El-Aassar SA, Tamer TM. Prevalence, antimicrobial resistance profile, and characterization of multi-drug resistant bacteria from various infected wounds in North Egypt. Saudi J Biol Sci. 2022 Apr;29(4):2978-2988. doi: 10.1016/j.sjbs.2022.01.015. Epub 2022 Jan 15. PMID: 35531185; PMCID: PMC9073052.
7. Awuor SO, Omwenga EO, Mariita RM, Musila JM, Musyoki S. Monitoring the battleground: exploring antimicrobial resistance and virulence factors in wound bacterial isolates. Access Microbiol. 2023 Nov 9;5(11): 000613.v6. doi: 10.1099/acmi.0. 000613.v6. PMID: 38074109; PMCID: PMC10702375.
8. Guan H, Dong W, Lu Y, Jiang M, Zhang D, Aobuliaximu Y, et al. Distribution and Antibiotic Resistance Patterns of Pathogenic Bacteria in Patients with Chronic Cutaneous Wounds in China. Front Med (Lausanne). 2021 Mar 17; 8:609584. doi: 10.3389/fmed.2021.609584. PMID: 33816517; PMCID: PMC8010674.
9. Nathaniel E, Ikram J, James A, Obaid B, Zahid A, Ahmed Z, et al. Molecular Characterization and Antibiotic Susceptibility Pattern of Bacterial Strains Isolated from Wound of Patients with Diabetes. Cureus. 2023 Oct 25;15(10): e47681. doi: 10.7759/cureus.47681. Retraction in: Cureus. 2024 Mar 13;16(3): r138. doi: 10.7759/cureus. r138. PMID: 38021964; PMCID: PMC10673648.
10. Regassa BT, Tosisa W, Eshetu D, Beyene D, Abdeta A, Negeri AA, et al. Antimicrobial resistance profiles of bacterial isolates from clinical specimens referred to Ethiopian Public Health Institute: analysis of 5-year data. BMC Infect Dis. 2023 Nov 15;23(1):798. doi: 10.1186/s12879-023-08803-x. Erratum in: BMC Infect Dis. 2024 Jan 2;24(1):40. doi: 10.1186/s12879-023-08921-6. PMID: 37968587; PMCID: PMC10647041.
11. Monk EJM, Jones TPW, Bongomin F, Kibone W, Nsubuga Y, Ssewante N, et al. Antimicrobial resistance in bacterial wound, skin, soft tissue and surgical site infections in Central, Eastern, Southern and Western Africa: A systematic review and meta-analysis. PLOS Glob Public Health. 2024 Apr 16;4(4): e0003077. doi: 10.1371/journal.pgph.0003077. PMID: 38626068; PMCID: PMC11020607.
12. Alharbi AS. Bacteriological profile of wound swab and their antibiogram pattern in a tertiary care hospital, Saudi Arabia. Saudi Med J. 2022 Dec;43(12):1373-1382. doi: 10.15537/smj.2022.43.12.20220681. PMID: 36517049; PMCID: PMC9994516.
13. Sewunet T, Demissie Y, Mihret A, Abebe T. Bacterial profile and antimicrobial susceptibility pattern of isolates among burn patients at Yekatit 12 Hospital Burn Center, Addis Ababa, Ethiopia. Ethiop J Health Sci. 2013 Nov;23(3):209-16. doi: 10.4314/ejhs. v23i3.3. PMID: 24307820; PMCID: PMC3847530.
14. Abid Khan RM, Dodani SK, Nadeem A, Jamil S, Zafar MN. Bacterial isolates and their antimicrobial susceptibility profile of superficial and deep-seated skin and soft tissue infections. Asian Biomed (Res Rev News). 2023 Sep 17;17(2):55-63. doi: 10.2478/abm-2023-0045. PMID: 37719324; PMCID: PMC10505063.

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