Original Article

The Dominance of Staphylococcus Aureus in Wound Infections and Its Resistance Profile from North India Tertiary Care Hospital

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Abstract

Background: The emergence of antimicrobial resistance (AMR) makes the management of wound infections a serious issue, leading to considerable morbidity worldwide. Local surveillance information plays a vital role in guiding empirical therapy for multidrug-resistant organisms. This research paper set out to define the bacteriological profiles and susceptibilities of pathogens causing pyogenic wound infections at a tertiary care hospital in North India. **Material and Methods:** 100 sequential patients suspected of having pyogenic wound infections were recruited in this cross-sectional study. Conventional culture, identification, and antimicrobial susceptibility testing of pus samples were performed using the Kirby-Bauer method according to CLSI guidelines. The results of the associations between the demographic data and culture were analyzed using the Chi-squared and Fisher's exact tests. **Results:** 72 out of 100 (72) samples were positive on culture. The predominant bacterial type is gram-positive (n=42), with gram-negative (n=30) as the only dominant type. The most common isolate was Staphylococcus aureus (n=27, 37.5%), followed by Pseudomonas aeruginosa (n=11, 15.3%). The possibility of being culture-positive was significantly associated with male gender (p=0.0217). Gram-positive isolates were very resistant to Ampicillin and Ciprofloxacin (>94%). Nonetheless, Vancomycin and Linezolid were susceptible to gram-positive pathogens, whereas Imipenem was susceptible to gram-negative pathogens. **Conclusion:** The predominant cause of wound infections in our current environment is Staphylococcus aureus, which shows alarming resistance to the most common antibiotics, such as fluoroquinolones, which should not be used empirically. This work provides an essential local antibiogram and explains why continuous monitoring should inform institutional antibiotic policy, why antimicrobial stewardship should be embraced, and why the effectiveness of last-resort drugs should be maintained.

Keywords: Wound Infections, Antimicrobial Resistance (AMR), Staphylococcus aureus, Bacterial Prevalence, Cross-Sectional Study, North India.

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INTRODUCTION

Wound infection is a significant health issue in the world and has a highly effective impact on morbidity, mortality, and economic impact on the healthcare industry. Wounds constitute breaches in the protective barrier of the skin and are therefore highly vulnerable to colonization by microorganisms. They may delay healing and cause serious systemic complications, including cellulitis, bacteraemia, and sepsis.[1] These wounds are generally divided into acute wounds, i.e., surgical site infections (SSI) and traumatic injuries, and chronic wounds, i.e., diabetic foot ulcers (DFU), pressure ulcers, and venous leg ulcers. The global burden of such wounds is phenomenal. This is one of the prevalent healthcare-associated infections (HAIs), where surgical site infections affect hundreds of millions of patients each year, costing them on average 7-10 days of hospital stay.[2] DFUs and chronic wounds, in general, are a growing problem caused by the worldwide diabetes epidemic; it is projected that a DFU is the antecedent of nearly 85% of all non-traumatic lower limb amputations.[3] To further increase this, a recent landmark study in The Lancet, 2022, estimated that bacterial antimicrobial resistance (AMR) caused 1.27 million deaths worldwide in 2019 directly and was the cause of 4.95 million deaths, therefore, becoming a dominant cause of death worldwide, more than HIV/AIDS and malaria.[4] Microbiology of wound infection has undergone a dramatic and alarming change. Although formerly dominated by gram-positive cocci, an increasingly heterogeneous, and often polymicrobial, environment composed of both gram-positive and gram-negative organisms is now common in the etiological milieu. Staphylococcus aureus is still a fearsome gram-positive pathogen, famous for its virulence factors that facilitate tissue

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invasion.[5] The prevalence of Methicillin-resistant Staphylococcus aureus (MRSA) across the world has turned it into a nosocomial infection and a major menace to the community.[3] At the same time, gram-negative bacteria have been viewed as overt competitors, especially in nosocomial and chronic wound infections. Candida albicans and Pseudomonas aeruginosa are known for their inherent resistance and biofilm-forming capacity, and Enterobacteriaceae, including Escherichia coli and Klebsiella pneumoniae, are now commonly isolated and often have a more adverse clinical history.[6]

This changing epidemiological picture is necessarily connected with the growing crisis of AMR. The years after 2010 have been characterized by an alarming increase in the spread of multidrug-resistant organisms (MDROs). The spread of strains that encode Extended-Spectrum Beta-Lactamases (ESBLs) has made many cephalosporins ineffective. The dissemination of Carbapenem-Resistant Enterobacteriaceae (CRE) has led to the emergence of so-called superbugs resistant to virtually all known drugs, with the spread of AMR in India being among the highest worldwide due to a perfect storm of factors such as high population density, heavy burden of infectious diseases, and unregulated sale of antibiotics.[8] Surveillance network data from the Indian Council of Medical Research (ICMR) indicate alarming rates of resistance. However, these findings are steadily increasing among bacteria such as carbapenem-resistant E. coli and K. pneumoniae.[9] Both community-and hospital-acquired MRSA are also of a high prevalence, which only contributes to the burdens of therapeutic challenges.[10] The most important aspect of AMR in India is the extreme geographic heterogeneity; medical resistance can vary greatly between hospitals.[11] Such variation highlights the limitations of using national guidelines in local clinical practice. Empirical therapy cannot be effectively done without sound, current, and local epidemiological surveillance data. Hence, this research was designed to fill this gap by providing a current picture of the pathogens that cause wound infections and their resistance patterns at one of the largest tertiary care hospitals in North India. The proposed research question will evaluate the frequency of different types of bacterial pathogens isolated from wound infections in hospitalised patients, analyse the antimicrobial susceptibility patterns of the identified gram-positive and gram-negative strains, and ascertain demographic risk factors attributable to culture-positive wound infections.

Materials and Methods

Study Design and Setting: This was a cross-sectional, descriptive study conducted in the Department of Microbiology at Santosh Medical College and Hospital, a tertiary care teaching hospital in Ghaziabad, Uttar Pradesh, India.

Participants: The research population included both in-patient (IPD) and out-patient (OPD) of the hospital patients whose clinical presentations were considered having pyogenic wound infections. Participants were selected according to the predefined eligibility criteria.

Inclusion Criteria:

- Patients who have clinical suspicions of wound infections, such as but not limited to surgical site infections, drain abscesses, diabetic ulcers, and soft tissue abscesses.
- Written informed consent by the patient or his or her legal 1 to whom this type of assistance is to be provided.

Exclusion Criteria:

- Patients who were not willing to take part in the study.
- Patients who have a known history of HIV, being positive with Hepatitis B surface antigen (HBsAg) and Hepatitis C virus (HCV), or cancer.

Variables and Data Collection: The data gathered regarding patient demographics and clinical history includes age, sex, department, and medical history. The main findings of the research included the culture positivity rate, the rate of isolated bacterial species, and the antimicrobial susceptibility profiles of the isolated species.

Collection and Processing of Specimen: Aseptic collection was done on pus samples collected at the sites of the wound. Samples in the case were obtained using a sterile cotton swab or a sterile syringe, depending on the nature of the wound. Two swabs were taken from one patient: one for a smear that could be examined directly under the microscope, and the other for culture. All samples were labeled with vital patient information and promptly delivered to the microbiology laboratory.

All patients who reported to the inpatient (IPD) and outpatient (OPD) departments with a clinically suspected outbreak of pyogenic wound infections and met the eligibility criteria were included. The study population included 100 participants, deemed sufficient to meet the descriptive goals, including the prevalence of the pathogens and local trends in antimicrobial resistance.

Culture and Identification: The samples were cultured on Blood, MacConkey, and Nutrient agar and incubated aerobically at 37 °C for 24-48 hours. After incubation, bacterial isolates were characterized according to standard protocols, including assessment of colony morphology, Gram staining, and biochemical tests for Catalase, Coagulase, and Oxidase.[12]

Antimicrobial Susceptibility Testing (AST): All isolates were tested by Antimicrobial Susceptibility Testing (AST) by the Kirby-Bauer disc diffusion technique on the agar of the Mueller-Hinton using the CLSI parameters. A bacterial suspension was adjusted to a 0.5 McFarland turbidity standard to make an inoculum. This was further compared with a collection of antibiotic discs applicable to Gram-positive and Gram-negative pathogens.[13]

Bias: Eligible patients were recruited consecutively, as all hospital departments (IPD and OPD) were eligible to minimize bias. All microbiological tests were performed according to standardized operating procedures (SOPs). Quality control was conducted strictly in accordance with the CLSI guidelines, using ATCC reference strains (S. aureus and E. coli) to assess the reproducibility of the results.

Statistical Analysis: The data were discussed through descriptive statistics (frequencies [n] and percentages [%]). To conduct inferential analysis, the Pearson Chi-square test (2) was employed to evaluate the relationships between patient demographics and culture outcomes. The exact test of Fisher was used to identify differences in antimicrobial susceptibility sampling in Gram-positive and Gram-negative isolates, especially when the expected frequencies are small. All tests were considered statistically significant if the p-value was below 0.05.

Ethical Considerations: Formal approval of the study protocol was obtained from the institution's ethics committee of Santosh Medical College and Hospital. Informed consent was obtained from all participants or their legal guardians for minors before sample collection. The consent forms were provided in English and Hindi to ensure they were well understood. Patient confidentiality was strictly maintained at all stages of the study by de-identifying samples and data during analysis.

Results

Participant Flow and Characteristics: A total of 100 patients with clinically suspected wound infections were enrolled in the study. All 100 participants provided samples that were successfully processed and included in the final analysis.

Demographic Characteristics: Based on an analysis of 100 patient samples, the results show a statistically significant association between gender and culture outcome (p = 0.0217), but no significant link with age (p = 0.5053). Males had a higher number of positive cultures, with 23 gram-positive and 19 gram-negative isolates. In contrast, females had a considerably higher incidence of "No Growth" results (20 cases) than males (8 cases). Although the distribution of outcomes was spread across all age groups without a clear pattern, the highest number of total infections was observed in patients aged 26-51 years. [Table 1]

Prevalence and Distribution: The screening of 72 bacterial isolates from wound infections showed that gram-positive bacteria were most common, with Staphylococcus aureus as the most common isolated pathogen (37.5). The other notable gram-positive isolates were Staphylococcus epidermidis (8.3%) and Staphylococcus hominis (5.6%). Pseudomonas aeruginosa was the most widespread gram-negative bacterium, found in 15.3 percent of the total isolates, followed by Klebsiella pneumoniae and Escherichia coli, both found in 5.6 percent of the total isolates. [Table 2]

Table 1: Demographic Characteristics of Patients with Gram-Positive, Gram-Negative, and No Growth Cultures

Parameter		Gram Positive (n=42)	Gram Negative (n=30)	No Growth (n=28)	P value
Age	< 12	4	1	2	0.5053
	13 – 25	4	3	2	
	26 – 38	13	5	10	
	39 – 51	6	11	5	
	52- 64	9	4	6	
	>65	5	6	3	
Gender	Male	23	19	8	0.0217
	Female	19	11	20	

Table 2: Prevalence and Distribution of Bacterial Isolates from Wound Infections

Bacterial Isolate	Number of Isolates (n)
Staphylococcus aureus (MRSA & MSSA)	27(37.50%)
Pseudomonas aeruginosa	11(15.30%)
Staphylococcus epidermidis	6(8.30%)
Klebsiella pneumoniae	4(5.60%)
Escherichia coli	4(5.60%)
Staphylococcus hominis	4(5.60%)
Acinetobacterlwoffii group	3(4.20%)
Staphylococcus haemolyticus	2(2.80%)
Enterococcus faecalis	2(2.80%)
Diphtheroids spp.	2(2.80%)
Acinetobacter baumannii complex	2(2.80%)
Enterobacter cloacae	1(1.40%)
Proteus mirabilis	1(1.40%)
Serratiaplymuthica	1(1.40%)
Staphylococcus auricularis	1(1.40%)
Staphylococcus lugdunensis	1(1.40%)

Antimicrobial Susceptibility Patterns: A study on 29 antibiotics demonstrated that there are different patterns of susceptibility to gram-positive and gram-negative bacteria. Gram-positive bacteria were found to be highly resistant to generic antibiotics similar to Ampicillin, Ciprofloxacin, and Levofloxacin, but is very vulnerable to Daptomycin, Linezolid, Teicoplanin, and Vancomycin. Carbapenems in gram-negative isolates. Imipenem was particularly effective, but increased resistance was found with respect to Aztreonam and Ciprofloxacin. A relative statistical study indicated that in the vast majority of antibiotics. [Table 3]

Table 3: Antimicrobial Susceptibility Patterns of Gram-Positive and Gram-Negative Isolates

Drug Name	Gram-positive Sensitive	Gram-positive Resistant	Gram-negative Sensitive	Gram-negative Resistant
Amikacin	0	0	3	1
Amoxicillin-clavulanic acid	8	11	2	1

Ampicillin	0	18	0	0
Aztreonam	0	0	1	3
Cefepime	0	0	1	3
Cefotaxime	0	0	1	2
Cefoxitin	5	6	3	1
Ceftazidime	0	0	1	2
Ciprofloxacin	1	18	0	4
Clindamycin	11	8	0	0
Colistin	0	0	0	0
Daptomycin	19	0	0	0
Ertapenem	0	0	3	1
Erythromycin	10	9	0	0
Fosfomycin	2	0	0	0
Gentamicin	7	10	3	1
Imipenem	0	0	6	2
Levofloxacin	1	17	0	3
Linezolid	18	0	0	0
Meropenem	0	0	3	1
Nitrofurantoin	14	1	2	2
Oxacillin	8	10	0	0
Penicillin	8	11	0	0
Piperacillin-Tazobactam	0	0	3	1
Teicoplanin	18	0	0	0
Tetracycline	16	3	0	0
Tobramycin	0	0	2	2
Trimethoprim-sulfamethoxazole	16	3	0	0
Vancomycin	18	0	0	0

Discussion

This paper presents a critical analysis of the bacteriological and antimicrobial resistance profiles of wound infections in a tertiary care facility in North India. The 72 percent culture positivity rate is essential in highlighting the significant burden of microbial infection in this patient cohort. This percentage is also comparable to that of Zubair et al,[14] who reported a positivity rate of 76.8% in the surrounding area. The presence of such rates may depend on such factors as the particularity of the population of patients, the rate of chronic infections, and the local practice of infection control.[15] A significant demographic result will be the statistically significant association with the male gender and higher rates of culture-positive infections ($p = 0.0217$). The current observation is supported by several other studies on wound infections, in which researchers such as Yakha et al,[16] have frequently explained this difference by the higher frequency of occupational and outdoor activities among males. Conversely, we were unable to establish a significant correlation with age, as other studies have reported, such as those conducted by Gardner and Frantz,[17] who noted that Staphylococcus aureus was the most dominant pathogen in the survey (37.5%). Our observation is in very good agreement with the overwhelming body of literature worldwide, with studies by Dryden,[18] and Wadekar et al,[19] finding consistent results, in which S. aureus is consistently identified as the main agent in pyogenic infections.[20] Pseudomonas aeruginosa was the most prevalent among the gram-negative samplings (15.3%). This becomes the typical feature of a tertiary hospital environment, where P. aeruginosa is a notorious nosocomial pathogen as observed by Breidenstein et al.[21]

The most clinically relevant outcomes may be antimicrobial susceptibility patterns. Among the gram-positive isolates, the high level of resistance to the most prevalent oral agents, such as Ciprofloxacin (92.2% resistance), aligns with other surveillance data from India; a study by Mansoor et al,[22] also reported universal fluoroquinolone resistance in staphylococci. On the contrary, the consistent sensitivity to Vancomycin, Linezolid, and Daptomycin is a positive avenue of development, as global records indicate that resistance to these last-resort agents is infrequent,[23] (Rayner and Munckhof. In gram-negative isolates, the preponderance of ESBL-producing strains is shown to have high background prevalence, and this has been emphasized by Tesfaye et al,[24] Although the carbapenems were active in our research, it should be used with caution as several recent Indian studies have described an increased rate of Carbapenem-Resistant Enterobacteriaceae (CRE) that, these include a study by Taneja and Sharma.[25]

Conclusion

The present study reports that gram-positive bacteria, mainly Staphylococcus aureus, are the cause of wound pyogenic infections at our hospital. An alarming discovery was that the resistance of common agents such as fluoroquinolones is high, and they are not suitable for empirical therapy. Nevertheless, last-resort antibiotics like Vancomycin (gram-positive) and carbapenems (gram-negative) are essential, as they are highly effective. This information provides a basic, evidence-based antibiogram indicating the need for continuous local monitoring. This monitoring is necessary to inform clinical practice, develop antibiotic-use policies, and enhance stewardship, ensuring the effectiveness of these highly important last-resort medications is maintained.

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Conflicts of interest

There are no conflicts of interest.

References

1. Bowler PG, Duerden BI, Armstrong DG. Wound microbiology and associated approaches to wound management. ClinMicrobiol Rev. 2001;14(2):244-269. doi:10.1128/CMR.14.2.244-269.2001
2. World Health Organization. (2018). Global guidelines for the prevention of surgical site infection, 2nd ed. WHO Press.
3. Turner NA, Sharma-Kuinkel BK, Maskarinec SA, et al. Methicillin-resistant Staphylococcus aureus: an overview of basic and clinical research. Nat Rev Microbiol. 2019;17(4):203-218. doi:10.1038/s41579-018-0147-4
4. Antimicrobial Resistance Collaborators. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. Lancet. 2022;399(10325):629-655. doi:10.1016/S0140-6736(21)02724-0
5. Lowy FD. Staphylococcus aureus infections. N Engl J Med. 1998;339(8):520-532. doi:10.1056/NEJM199808203390806
6. Serra R, Grande R, Butrico L, et al. Chronic wound infections: the role of Pseudomonas aeruginosa and Staphylococcus aureus. Expert Rev Anti Infect Ther. 2015;13(5):605-613. doi:10.1586/14787210.2015.1023291
7. Logan LK, Weinstein RA. The Epidemiology of Carbapenem-Resistant Enterobacteriaceae: The Impact and Evolution of a Global Menace. J Infect Dis. 2017;215(suppl_1):S28-S36. doi:10.1093/infdis/jiw282
8. Laxminarayan R, Chaudhury RR. Antibiotic Resistance in India: Drivers and Opportunities for Action. PLoS Med. 2016;13(3):e1001974. Published 2016 Mar 2. doi:10.1371/journal.pmed.1001974
9. Indian Council of Medical Research. (2022). Antimicrobial resistance surveillance network: Annual report 2021. ICMR.
10. Taneja N, Sharma M. Antimicrobial resistance in the environment: The Indian scenario. Indian J Med Res. 2019;149(2):119-128. doi:10.4103/ijmr.IJMR_331_18.
11. Admas D, Demeke G, Adugna A, Esmael A. Bacterial etiologies, antimicrobial susceptibility pattern, and associated factors among patients suspected of sterile body site infections at Debre Markos Comprehensive Specialized Hospital, Northwest Ethiopia. Front Med (Lausanne). 2024;11:1260841. Published 2024 May 7. doi:10.3389/fmed.2024.1260841
12. Clinical and Laboratory Standards Institute (CLSI). Performance Standards for Antimicrobial Susceptibility Testing. CLSI supplement M100, 32nd ed. 2022.
13. Datta S, Wattal C, Goel N, Oberoi JK, Raveendran R, Prasad KJ. A ten-year analysis of multidrug-resistant bloodstream infections caused by Escherichia coli & Klebsiella pneumoniae in a tertiary care hospital. Indian J Med Res. 2012;135(6):907-912.
14. Zubair M, Malik A, Ahmad J. Clinico-microbiological study and antimicrobial drug resistance profile of diabetic foot infections in North India. Foot (Edinb). 2011;21(1):6-14. doi:10.1016/j.foot.2010.10.003
15. Yimer O, Abebaw A, Adugna A, Adane F, Esmael A. Bacterial profile, antimicrobial susceptibility patterns, and associated factors among lower respiratory tract infection patients attending at Debre Markos comprehensive specialized hospital, Northwest, Ethiopia. BMC Infect Dis. 2025;25(1):266. Published 2025 Feb 24. doi:10.1186/s12879-025-10633-y
16. Yakha, J. K., Sharma, A. R., Dahal, N., Lekhak, B., & Banjara, M. R. (2015). Antibiotic Susceptibility Pattern of Bacterial Isolates Causing Wound Infection Among the Patients Visiting B & B Hospital. Nepal Journal of Science and Technology, 15(2), 91–96. https://doi.org/10.3126/njst.v15i2.12121
17. Gardner SE, Frantz RA. Wound bioburden and infection-related complications in diabetic foot ulcers. Biol Res Nurs. 2008;10(1):44-53. doi:10.1177/1099800408319056
18. Dryden MS. Complicated skin and soft tissue infection. J AntimicrobChemother. 2010;65 Suppl3:iii35-iii44. doi:10.1093/jac/dkq302
19. Wadekar MD, V SJ, Jayashree, C P. Bacteriological profile of pus samples and their antibiotic susceptibility pattern [Internet]. Indian J Microbiol Res. 2020 [cited 2025 Sep 24];7(1):43-47. Available from: https://doi.org/10.18231/j.ijmr.2020.010
20. Becker K, Heilmann C, Peters G. Coagulase-negative staphylococci. ClinMicrobiol Rev. 2014;27(4):870-926. doi:10.1128/CMR.00109-13
21. Breidenstein EB, de la Fuente-Núñez C, Hancock RE. Pseudomonas aeruginosa: all roads lead to resistance. Trends Microbiol. 2011;19(8):419-426. doi:10.1016/j.tim.2011.04.005
22. Mansoor T, Angmo D, Nehvi N. Prevalence and Antimicrobial Susceptibility of Wound Pathogens in a Tertiary Care Hospital in Kashmir: A Cross-sectional Study. Infect Chemother. 2024;56(4):502-509. doi:10.3947/ic.2024.0083
23. Rayner C, Munckhof WJ. Antibiotics are currently used to treat infections caused by Staphylococcus aureus. Intern Med J. 2005;35 Suppl2:S3-S16. doi:10.1111/j.1444-0903.2005.00976.x
24. Tesfaye S, Tafere W, Abebe W, Wondimeneh Y. Prevalence of Extended-Spectrum Beta-Lactamase Producer Gram-Negative Rods and Associated Factors Among Patients With Wound Infection at University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia. Int J Microbiol. 2024;2024:1478975. Published 2024 Nov 11. doi:10.1155/2024/1478975
25. Taneja N, Sharma M. Antimicrobial resistance in the environment: The Indian scenario. Indian J Med R.