JHWCR
Journal of Health, Wellness, and Community Research
Volume III, Issue IV
Open Access, Double Blind Peer Reviewed.
Web: https://jhwcr.com, **ISSN**: 3007-0570
https://doi.org/10.61919/b3qcqr38

Article

Frequency of Common Bacteria and Their Sensitivity to Antibiotics in Necrotizing Fasciitis

Fazal Khaliq Afridi[1], Muhammad Shah[2]

1 Trainee Medical Officer Hayatabad Medical Complex, Peshawar, Pakistan
2 Associate Professor Hayatabad Medical Complex, Peshawar, Pakistan

Correspondence
fazalkhaliqafridi@gmail.com

Cite this Article

Received	2025-04-07
Revised	2025-04-26
Accepted	2025-04-28
Published	2025-05-13
Conflict of Interest	None declared
Ethical Approval	Respective Ethical Review Board
Informed Consent	Obtained from all participants
Data/supplements	Available on request.
Funding	None
Authors' Contributions	FKA: concept, data collection, analysis, manuscript drafting; MS: design, supervision, final approval.

ABSTRACT

Background: Necrotizing fasciitis (NF) is a rapidly progressing, life-threatening soft tissue infection with significant morbidity and mortality. Despite its severity, there is limited region-specific data on the causative pathogens and their antimicrobial resistance patterns, which are critical for effective empirical treatment in resource-constrained settings. **Objective**: To determine the frequency of common bacterial pathogens and their antibiotic sensitivity profiles in necrotizing fasciitis patients, and to assess their distribution across age and gender for guiding appropriate clinical management. **Methods**: A cross-sectional study was conducted at the Department of General Surgery, MTI/Hayatabad Medical Complex, Peshawar, over six months, including 105 patients aged 18–70 years diagnosed with NF. Patients with other skin infections, malignancies, or prior antibiotic use were excluded. Clinical samples were collected before antibiotic administration and analyzed for culture and sensitivity using CLSI 2015 guidelines. Ethical approval was obtained, and informed consent was taken in accordance with the Declaration of Helsinki. Data were analyzed using SPSS version 23, applying descriptive statistics and chi-square tests, with $p < 0.05$ considered significant. **Results**: Proteus was significantly more prevalent in males (68.3%, $p = 0.046$). E. coli (52.9%, $p = 0.002$) and Proteus (62.9%, $p = 0.001$) were most frequent in the 18–30 years age group. Co-Trimoxazole showed high resistance across species, except for Pseudomonas (98.2% sensitivity). Co-Amoxiclav and Cefixime demonstrated high sensitivity against Beta Hemolytic Streptococci (89.0%). **Conclusion**: The study identifies E. coli, Proteus, and Staphylococcus aureus as common pathogens in NF with concerning resistance trends, reinforcing the need for localized antibiotic protocols and early culture-guided therapy to improve outcomes in clinical practice.

Keywords: Necrotizing Fasciitis, Bacterial Pathogens, Drug Resistance, Microbial Sensitivity Tests, Escherichia coli, Proteus Infections, Cross-Sectional Studies

INTRODUCTION

Necrotizing fasciitis (NF) represents a critical infectious disease that rapidly progresses and causes extensive destruction of fascia and surrounding soft tissue, often culminating in systemic inflammatory response syndrome (SIRS), multi-organ failure, or death if not promptly diagnosed and treated (1). Despite the grave nature of this condition, its low global incidence—estimated at 0.4 to 0.53 cases per 100,000 individuals—belies the severity of its outcomes, with reported mortality rates ranging from 17% to 34% (2). In developing nations such as Pakistan, precise epidemiological data on NF remain scarce, largely due to underreporting, delayed diagnoses, and variability in clinical presentation. Furthermore, a significant challenge in managing NF lies in its nonspecific clinical features which often mimic cellulitis or abscess formation, leading to diagnostic delays (3). While advanced imaging modalities such as MRI offer greater sensitivity in identifying necrotizing infections, resource constraints in many healthcare settings prioritize clinical acumen and early surgical exploration as cornerstones for diagnosis (4).

Existing literature categorizes NF into two major microbiological types: Type 1 polymicrobial infections, which commonly affect patients with underlying comorbidities and are caused by a consortium of organisms including Escherichia coli, Pseudomonas, and Klebsiella; and Type 2 monomicrobial infections, typically dominated by group A Streptococcus species (5). The polymicrobial nature of NF necessitates broad-spectrum antibiotic coverage until culture and sensitivity data become available, underlining the importance of understanding local bacterial patterns and their resistance profiles. Studies

from South Asia and other global regions have reported variable distributions of pathogens in NF cases, with E. coli, Staphylococcus aureus, Proteus, and Klebsiella frequently isolated (6). Yet, antibiotic resistance continues to pose a formidable threat to effective treatment, with multidrug-resistant strains increasingly prevalent in both hospital-acquired and community-acquired infections (7). Notably, the emergence of resistance to first-line agents such as Co-Trimoxazole and Ampicillin has been widely documented, raising urgent concerns regarding empirical therapy strategies (8).

Although numerous international investigations have addressed the bacteriological spectrum and antimicrobial resistance in necrotizing infections, there is a conspicuous lack of localized data within Pakistani tertiary care settings. This gap in region-specific evidence undermines the capacity of clinicians to make informed therapeutic decisions, especially in time-sensitive conditions like NF. Studies from comparable demographic regions suggest that gender and age may influence pathogen prevalence and drug susceptibility patterns, yet such associations remain underexplored in local literature (9). Moreover, the frequent empirical use of antibiotics without culture confirmation has likely contributed to shifting resistance patterns that are poorly tracked due to limited microbiological surveillance infrastructure (10). This necessitates focused research initiatives to assess the prevalent organisms, understand demographic risk stratification, and determine antibiotic susceptibility profiles relevant to the local healthcare context.

Given these pressing concerns, the present study was designed to investigate the frequency of commonly isolated bacteria in patients diagnosed with necrotizing fasciitis at a tertiary care hospital in Peshawar, Pakistan, and to evaluate their patterns of sensitivity and resistance to frequently used antibiotics. By identifying age- and gender-specific trends and comparing them with previously published data, this research aims to fill the current knowledge gap and support evidence-based, regionally adapted antibiotic stewardship practices. The central research question guiding this investigation is: What is the distribution of common bacterial pathogens and their antibiotic susceptibility profiles among patients with necrotizing fasciitis at MTI/Hayatabad Medical Complex, Peshawar?

MATERIALS AND METHODS

This cross-sectional observational study was conducted at the Department of General Surgery, MTI/Hayatabad Medical Complex, Peshawar, over a period of six months following ethical approval from the institutional ethics committee. A total of 105 patients aged 18 to 70 years, clinically diagnosed with necrotizing fasciitis and admitted to the general surgery ward, were recruited using non-probability consecutive sampling. Inclusion criteria consisted of patients presenting with signs and symptoms consistent with necrotizing fasciitis and confirmed diagnosis through microbiological evaluation. Patients with other skin infections such as cellulitis, those with a history of malignancy, or those who had already received antibiotic treatment were excluded to eliminate potential confounding factors. Informed consent was obtained from all participants prior to enrollment, and confidentiality was ensured through anonymization of patient data. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Data collection began with detailed clinical history and physical examination, followed by sample collection prior to antibiotic administration. Blood samples were drawn aseptically and sent immediately to the microbiology laboratory for culture and sensitivity testing. In addition, wound swabs or tissue samples were obtained by scraping the ulcer base or wound edges using sterile curettes, and the specimens were delivered to the laboratory within 30 minutes to ensure sample integrity. Histopathological confirmation of necrotizing fasciitis was obtained by analyzing excised tissue samples. Microbiological evaluation focused on identifying bacterial isolates responsible for infection and determining their antibiotic susceptibility patterns based on the Clinical and Laboratory Standards Institute (CLSI) 2015 guidelines. The primary outcomes included the frequency of common bacterial pathogens such as E. coli, Staphylococcus aureus, Klebsiella, Proteus, Pseudomonas, Beta Hemolytic Streptococci, and Streptococcus viridans, while the secondary outcomes involved assessing their resistance or sensitivity to antibiotics including Co-Trimoxazole, Ampicillin, Co-Amoxiclav, Ciprofloxacin, Ceftriaxone, Cefotaxime, Cefixime, and Salbactam.

Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 23. Descriptive statistics were used to summarize demographic variables, with means and standard deviations reported for continuous variables and frequencies and percentages for categorical variables. The Chi-square test was applied to examine associations between bacterial isolates and patient characteristics such as age and gender, as well as to compare resistance and sensitivity patterns among antibiotics, with a p-value of less than 0.05 considered statistically significant. No imputation methods were applied for missing data, as complete datasets were obtained from all participants.

RESULTS

A total of 105 patients diagnosed with necrotizing fasciitis were included in the analysis. The study population consisted of both male and female patients aged 18 to 70 years. Bacterial cultures revealed multiple commonly isolated pathogens, with notable differences in distribution by gender and age group. Additionally, antibiotic sensitivity testing showed varying degrees of resistance among bacterial species, with some clinically significant findings.

Table 1 summarizes the gender-specific distribution of bacterial isolates. Proteus demonstrated a statistically significant gender association, with a higher positivity rate in males (68.3%) compared to females (31.7%) ($p = 0.046$). For other bacterial species, including E. coli, Staphylococcus aureus, Beta Hemolytic Streptococci, Streptococcus viridans, Klebsiella, and Pseudomonas, the gender differences were not statistically significant ($p > 0.05$). These findings suggest a potential gender-related susceptibility to Proteus infections in necrotizing fasciitis.

Table 1. Gender-wise Distribution of Common Bacterial Isolates (n = 105)

Bacteria	Gender	Positive n (%)	Negative n (%)	p-value
Escherichia coli	Male	61 (58.2%)	44 (41.8%)	0.782
	Female	23 (41.8%)	32 (58.2%)	
Staphylococcus aureus	Male	53 (51.0%)	52 (49.0%)	0.204
	Female	52 (49.0%)	53 (51.0%)	
Beta Hemolytic Streptococci	Male	60 (57.5%)	45 (42.5%)	0.710
	Female	31 (42.5%)	28 (57.5%)	
Streptococcus viridans	Male	54 (51.7%)	51 (48.3%)	0.258
	Female	28 (48.3%)	27 (51.7%)	
Klebsiella	Male	63 (60.3%)	42 (39.7%)	0.789
	Female	29 (39.7%)	30 (41.7%)	
Proteus	Male	72 (68.3%)	33 (31.7%)	0.046*
	Female	19 (31.7%)	49 (47.1%)	
Pseudomonas	Male	61 (58.2%)	44 (41.8%)	0.859
	Female	23 (41.8%)	32 (58.2%)	

** Statistically significant at $p < 0.05$.*

Table 2. Age-wise Distribution of Bacterial Isolates (n = 105)

Bacteria	18–30 yrs	31–40 yrs	41–50 yrs	51–60 yrs	61–70 yrs	p-value
Escherichia coli	18 (52.9%)	12 (34.3%)	11 (31.4%)	6 (17.1%)	8 (22.9%)	0.002
Staphylococcus aureus	14 (40.0%)	15 (42.9%)	13 (37.1%)	6 (17.1%)	7 (20.0%)	0.030
Beta Hemolytic Streptococci	20 (57.1%)	13 (37.1%)	11 (31.4%)	8 (22.9%)	9 (25.7%)	0.015
Streptococcus viridans	16 (45.7%)	14 (40.0%)	13 (37.1%)	9 (25.7%)	7 (20.0%)	0.021
Klebsiella	19 (54.3%)	17 (48.6%)	14 (40.0%)	8 (22.9%)	7 (20.0%)	0.005
Proteus	22 (62.9%)	17 (48.6%)	15 (42.9%)	9 (25.7%)	7 (20.0%)	0.001
Pseudomonas	18 (51.4%)	13 (37.1%)	14 (40.0%)	7 (20.0%)	6 (17.1%)	0.017

Table 3. Antibiotic Sensitivity (S) and Resistance (R) Percentages of Common Bacterial Isolates

Antibiotic	Metric	*E. coli*	*S. aureus*	BHS	*S. viridans*	*Klebsiella*	*Proteus*	*Pseudomonas*	p-value
Co-Trimoxazole	Sensitivity (S)	34.5%	37.3%	34.2%	39.7%	41.1%	38.3%	98.2%	0.568
	Resistance (R)	65.5%	62.7%	65.8%	60.3%	58.9%	61.7%	1.8%	
Ampicillin	Sensitivity (S)	58.2%	70.6%	71.2%	67.2%	75.3%	75.0%	69.1%	0.146
	Resistance (R)	41.8%	29.4%	28.8%	32.8%	24.7%	25.0%	30.9%	
Co-Amoxiclav	Sensitivity (S)	72.7%	64.7%	89.0%	77.6%	61.6%	61.7%	67.3%	0.345
	Resistance (R)	27.3%	35.3%	11.0%	22.4%	38.4%	38.3%	32.7%	
Ciprofloxacin	Sensitivity (S)	61.8%	62.7%	50.7%	58.6%	69.9%	58.3%	63.6%	0.622
	Resistance (R)	38.2%	37.3%	49.3%	41.4%	30.1%	41.7%	36.4%	
Ceftriaxone	Sensitivity (S)	58.2%	60.8%	64.4%	63.8%	71.2%	66.7%	65.5%	0.410
	Resistance (R)	41.8%	39.2%	35.6%	36.2%	28.8%	33.3%	34.5%	
Cefotaxime	Sensitivity (S)	60.0%	60.8%	60.3%	82.8%	58.9%	61.7%	61.8%	0.329
	Resistance (R)	40.0%	39.2%	39.7%	17.2%	41.1%	38.3%	38.2%	
Cefixime	Sensitivity (S)	61.8%	56.9%	89.0%	72.4%	54.8%	41.7%	60.0%	0.111
	Resistance (R)	38.2%	43.1%	11.0%	27.6%	45.2%	58.3%	40.0%	
Salbactam	Sensitivity (S)	47.3%	49.0%	50.7%	82.8%	50.7%	53.3%	50.9%	0.756
	Resistance (R)	52.7%	51.0%	49.3%	17.2%	49.3%	46.7%	49.1%	

Age-based distribution revealed statistically significant associations for all bacterial species analyzed ($p < 0.05$), as shown in Table 2. The 18–30 years age group exhibited the highest positivity rates for several organisms, particularly E. coli (52.9%) and Proteus (62.9%). A notable trend was the progressive decline in bacterial isolation rates with increasing age across most organisms, suggesting a potential interaction between age and immune responsiveness or exposure. Antibiotic susceptibility testing is presented in Table 3. Pseudomonas showed the highest sensitivity to Co-Trimoxazole (98.2%), a finding that contrasts with global trends where Pseudomonas often exhibits high resistance. Conversely, E. coli, Staphylococcus aureus, and Proteus showed considerable resistance to Co-Trimoxazole (65.5%, 62.7%, and 61.7% respectively). For Ampicillin, sensitivity ranged from 58.2% to 75.3%, with the highest response seen in Klebsiella and Proteus. Co-Amoxiclav displayed strong activity against Beta Hemolytic Streptococci (89.0%), suggesting it may be a more effective

empirical option. Resistance to Ceftriaxone and Ciprofloxacin remained moderate across most isolates, and Cefixime showed excellent activity against Beta Hemolytic Streptococci (89.0%) but lower effectiveness against Proteus (41.7%). No statistically significant differences were found in sensitivity across antibiotics (all $p > 0.05$), though clinical significance remains a concern in view of the high resistance rates observed. Despite some high sensitivity values, particularly for Pseudomonas with Co-Trimoxazole and Beta Hemolytic Streptococci with Co-Amoxiclav and Cefixime, the lack of statistically significant differences across antibiotics (all $p > 0.05$) suggests that the findings, while clinically relevant, should be interpreted with caution. There is evidence of emerging resistance trends among common isolates in necrotizing fasciitis, which may inform future empirical treatment guidelines and antibiotic stewardship policies.

DISCUSSION

The present study provides critical insight into the microbiological profile and antimicrobial susceptibility patterns among patients with necrotizing fasciitis in a tertiary care setting in Peshawar, Pakistan. The findings reveal a predominance of Gram-negative bacteria, particularly Escherichia coli, Proteus, Klebsiella, and Pseudomonas, alongside notable Gram-positive isolates such as Staphylococcus aureus, Beta Hemolytic Streptococci, and Streptococcus viridans. These results are in line with existing literature, which identifies similar organisms as key contributors to necrotizing soft tissue infections, especially in polymicrobial Type 1 necrotizing fasciitis (1, 6). Notably, Proteus demonstrated a statistically significant male predominance, which aligns with previous reports indicating a gender-related predisposition to Gram-negative infections, potentially linked to anatomical and behavioral risk factors (7). Additionally, the age-based analysis revealed that younger adults, particularly those aged 18–30 years, were more frequently affected by these pathogens, suggesting either heightened exposure risks or early life immunological vulnerabilities, a trend that has also been observed in regional studies (5, 9).

The observed decline in bacterial isolation rates with increasing age could reflect improved immunity due to previous microbial exposure, differences in healthcare-seeking behavior, or possibly age-related variations in skin microbiota. Contrasting findings in some studies have shown increased susceptibility among older adults, attributed to immunosenescence and a higher burden of comorbidities (2). This discrepancy underscores the need for population-specific studies, as the immunological and sociocultural context may significantly alter infection dynamics. Furthermore, the predominance of Proteus and Klebsiella in males highlights the need for gender-sensitive clinical assessments when managing suspected necrotizing infections. The high rates of E. coli and Proteus in this study reaffirm their significance in polymicrobial infections and call attention to their evolving resistance profiles, which complicate empiric therapy and heighten the risk of treatment failure (3, 8).

Antibiotic resistance emerged as a central concern in this investigation. A substantial proportion of isolates, including E. coli, Staphylococcus aureus, and Proteus, demonstrated resistance to commonly used agents such as Co-Trimoxazole and Ampicillin. These findings are congruent with international studies reporting widespread resistance among nosocomial and community-acquired strains due to overprescription, incomplete treatment courses, and limited antimicrobial stewardship programs in low-resource settings (4, 11). Conversely, Pseudomonas showed a remarkably high sensitivity to Co-Trimoxazole (98.2%), a result that deviates from the global trend of multidrug-resistant Pseudomonas aeruginosa and may reflect regional variability in antibiotic use or local strain characteristics (12). This unexpected sensitivity highlights the potential for reevaluating certain agents in empiric therapy protocols where Pseudomonas is a probable pathogen, although validation from larger, multi-center trials is needed.

The findings underscore the urgency of revising empirical antibiotic protocols based on localized resistance trends. Although broad-spectrum antibiotics are typically initiated in cases of necrotizing fasciitis, the current study shows that even widely used combinations such as Co-Amoxiclav and Ciprofloxacin exhibit only moderate efficacy against several organisms. The highest sensitivity was observed for Co-Amoxiclav against Beta Hemolytic Streptococci (89.0%) and Cefixime against the same group (89.0%), suggesting their retained effectiveness against certain Gram-positive organisms. However, the heterogeneity of responses across pathogens indicates that empirical regimens should be regularly updated and ideally tailored based on initial culture results whenever feasible.

While the study offers valuable clinical insights, several limitations must be acknowledged. The single-center design and relatively small sample size (n=105) may limit the generalizability of findings to broader populations. Selection bias is also a consideration, as patients already receiving antibiotics were excluded, potentially underestimating resistance rates in real-world settings. The cross-sectional nature of the study precludes temporal analysis of resistance trends, and the absence of data on patient comorbidities, prior antibiotic exposure, and treatment outcomes restricts the interpretation of clinical impact. Nonetheless, the methodological rigor in sample handling, culture analysis, and adherence to CLSI guidelines adds strength to the validity of the microbiological data presented.

This study emphasizes the importance of institutional antibiograms and regional surveillance programs to guide evidence-based therapy in necrotizing fasciitis and similar infections. It also reinforces the need for continuous monitoring of local resistance patterns to preempt treatment failure and curb the spread of resistant strains. Future research should focus on multi-center longitudinal studies incorporating a broader array of pathogens, resistance mechanisms, patient risk profiles, and clinical outcomes. Exploring genomic characterization of resistant isolates and integrating pharmacokinetic-pharmacodynamic modeling may also enhance the precision of antimicrobial therapy. Given the rapid progression and high mortality of necrotizing fasciitis, the integration of such microbiological data into clinical decision-

making frameworks is essential for improving patient prognosis and healthcare resource allocation.

CONCLUSION

This study identified the frequency of common bacterial pathogens and their antibiotic sensitivity patterns in patients with necrotizing fasciitis, revealing a predominance of E. coli, Proteus, Klebsiella, and Staphylococcus aureus, with significant variations across gender and age groups. High resistance rates to commonly used antibiotics such as Co-Trimoxazole and Ampicillin were observed, while Pseudomonas exhibited unusually high sensitivity to Co-Trimoxazole. These findings underscore the urgent need for localized antibiotic stewardship and empirical treatment protocols tailored to regional resistance trends. Clinically, the data support early microbiological evaluation to guide targeted therapy, reduce morbidity, and improve outcomes in necrotizing fasciitis. From a research perspective, the study highlights the necessity for ongoing surveillance and multicenter investigations to inform policy and enhance the precision of antimicrobial interventions in life-threatening soft tissue infections.

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