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# A Clinicomicrobiological Study of Necrotising Fasciitis from A Tertiary Care Centre

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## Abstract

**Introduction:** Necrotising fasciitis (NF) is a rapidly progressive and potentially fatal soft tissue infection marked by widespread necrosis of fascia and subcutaneous tissue. Early diagnosis, aggressive surgical debridement, and appropriate antimicrobial therapy are crucial for survival. This prospective study was conducted to evaluate the clinical presentation, microbiological profile, and antibiotic resistance patterns in patients with NF at a tertiary care hospital in South India.

**Methods:** A prospective observational study was conducted from May 2024 to May 2025 at K R Hospital, Mysore. Sixty clinically diagnosed NF patients were included based on specific diagnostic criteria. Wound swabs or tissue samples were collected post-debridement and processed using standard microbiological techniques. Bacterial identification and antibiotic susceptibility testing were performed per CLSI guidelines. Patient demographics, comorbidities, and risk factors were analysed using SPSS version 25.

**Results:** The majority of patients were males (70%) and aged 50–80 years. All patients were diabetic, and common comorbidities included liver disease (25%) and alcohol use (23.3%). Clinical presentation was consistent across all cases with pain, oedema, vesicles/bullae, and

woody hard texture. Polymicrobial infections were predominant (66%), with Escherichia coli (26%), Pseudomonas spp. (22%), and Proteus spp. (21%) being the most common isolates. High resistance was observed to cephalosporins and fluoroquinolones across isolates. Carbapenem sensitivity was moderate (≤44% in E. coli), while piperacillin-tazobactam showed the highest sensitivity for Pseudomonas spp. (82%). Among gram-positive organisms, MRSA and MRCONS showed complete resistance to beta-lactams but retained sensitivity to doxycycline and linezolid.

**Conclusion**: Necrotising Fasciitis in this region presents predominantly as polymicrobial infections in older diabetic males. Gram-negative bacteria were the major pathogens, exhibiting significant multidrug resistance, especially against cephalosporins and carbapenems. These findings underscore the necessity of early culture-based diagnosis and tailored antimicrobial therapy. Continuous monitoring of resistance trends is critical to improve outcomes and guide empiric treatment protocols.

**Keywords:** Antimicrobial Sensitivity; Bacterial Agents; Gram Negative Pathogens; Necrotising Fasciitis

## Introduction

Necrotising Soft Tissue Infection (NSTI), also known as necrotising fasciitis, is a rapidly progressive and life-threatening infection characterized by widespread necrosis of soft tissues, ranging from the superficial epidermis to deep musculature. It is considered a rare condition, with an incidence of 0.3–3 cases per 100,000 persons per year and a mortality rate of up to 32% in Asia and Europe [1]. The infection can affect various body regions, most commonly the lower limbs (32%), followed by the upper limbs (24%), perineum (16%), trunk (16%), and head and neck (10%) [1].

Several risk factors have been associated with NSTI, including diabetes mellitus, peripheral vascular disease, chronic pulmonary and liver disease, chronic renal failure, heart failure, immunosuppressive states (such as HIV/AIDS), intravenous drug use, chronic alcoholism, and malignancy [2]. However, NSTI may also occur in otherwise healthy individuals following trauma or injury [2].

Clinically, NSTI often mimics other soft tissue infections like cellulitis, which can delay diagnosis. Typical clinical features include disproportionate pain, edema, a woody-hard consistency of subcutaneous tissues, skin vesicles, and soft tissue crepitus. Wong et al. reported that 73% of necrotising fasciitis cases were initially misdiagnosed as cellulitis, leading to the development of the Laboratory Risk Indicator for Necrotising Fasciitis (LRINEC) score to improve diagnostic accuracy [3]. The LRINEC score is calculated based on six laboratory parameters: C-reactive protein, total white cell count, hemoglobin, sodium, creatinine, and glucose [3].

Necrotising fasciitis is classified into four microbiological types. Type I is polymicrobial, involving organisms such as Streptococcus pyogenes, Staphylococcus aureus, Bacteroides fragilis, Clostridium perfringens, and various Enterobacterales. Type II is typically monomicrobial, caused by Group A Streptococcus or methicillin-resistant Staphylococcus aureus (MRSA). Type III is associated with marine organisms like Vibrio vulnificus, usually following exposure to seawater. Type IV, although rare, is caused by fungal pathogens [4].

Prompt diagnosis, surgical debridement, and empiric broad-spectrum antimicrobial therapy are essential for improving patient outcomes. Delay in treatment is

associated with significantly increased mortality [5]. Moreover, the rise of antimicrobial resistance poses an escalating threat, with six pathogens—Pseudomonas aeruginosa, Escherichia coli, MRSA, Klebsiella pneumoniae, Streptococcus pneumoniae, and Acinetobacter baumannii—being major contributors to resistance-related deaths globally [6].

Despite the clinical significance, much of the bacteriologic data on necrotising fasciitis in the literature is outdated or skewed by secondary opportunistic infections. This prospective study aims to evaluate the current clinical and microbiological profile of necrotising fasciitis.

**Materials and Methods**

It is a prospective observational study done in K R hospital, Mysore. The study period was from May 2024 to May 2025. 60 patients who were clinically diagnosed with necrotizing fasciitis admitted in various wards were included in the study. The detailed clinical history and clinical examination of these patients was done. Diagnosis was made by the following clinical features: Pain, Edema and Erythema of skin, Woody hard texture to subcutaneous tissue, Inability to distinguish fascial planes and muscle groups, Presence of skin vesicles or bullae and the patients presented with these symptoms were included in our study. Patients with other skin manifestations like Cellulitis, Diabetic gangrene, Abscess, Patients who had received antibiotic treatment or with ongoing antibiotic treatment were excluded from the study.

Wound swab from all patients diagnosed to have NF was collected after surgical debridement. If tissue sample was sent, it was homogenized under sterile conditions. The tissue sample or the wound swab was inoculated immediately into Blood and MacConkey agar. The culture plates were incubated overnight at $37^0$C for aerobic growth. Gram staining of the samples were done for preliminary identification. Bacterial growth was identified by the standard microbiological techniques and the antimicrobial sensitivity was done by Kirby-Bauer disc diffusion method according to CLSI (Clinical and Laboratory Standards Institute) guidelines. Antibiotics tested include the following: ampicillin, azithromycin, erythromycin, clindamycin, amoxicillin/clavulanic acid, piperacillin/tazobactam, doxycycline, ceftazidime, cefoxitin, cefipime, ceftazidime, ceftriaxone, cefuroxime, imipenem, meropenem, Mertapenem, amikacin, gentamicin, ciprofloxacin, co-trimoxazole, aztreonam, linezolid, vancomycin and colistin.

Demographic details of the patient, underlying co-morbid illness, etiological factors were also included. Statistical Analysis was performed using SPSS statistical software (version 25).

**Results**

This is a prospective study of 60 patients admitted in K R hospital, Mysore with the diagnosis of necrotizing fasciitis which comprised of 41 males and 19 females - table 1.

Table 1: Gender Distribution of Patients

| sex | Number of patients | percentage |
|---|---|---|
| males | 41 | 70% |
| females | 19 | 30% |

Table 2: Age Distribution of Patients

| Age group(years) | Number of patients | percentage |
|---|---|---|
| 40-49 | 4 | 6.60% |
| 50-59 | 29 | 48.30% |
| 60-69 | 16 | 26.60% |
| 70-79 | 10 | 16.60% |
| 80-89 | 1 | 1.60% |

The maximum number of patients were found between the age group of 50 to 80 years-table 2.

Table 3: Comorbidities and Other Factors Associated With Patients

| comorbidities and other factors | T2DM | Liver disease | Hypertension | CVA | On Steroids | Alcohol | Smoking | History of trauma |
|---|---|---|---|---|---|---|---|---|
| number of pts (percentage) | 60 (100%) | 15 (25%) | 9 (15%) | 5 (33.3%) | 10 (16.6%) | 14 (23.3%) | 7 (11.6%) | 10 (16.6%) |

Out of 60 patients, all patients had T2DM followed by Liver disease (n=15) and Alcohol consumption (n=14)-table 3.

Table 4: Anatomic Distribution of Necrotising Fasciitis

| Location | Number | Percentage |
|---|---|---|
| Lower Limb | 42 | 70% |
| Upper Limb | 11 | 18.3% |
| Abdominal Wall | 5 | 8.3% |
| Scrotum | 2 | 3.3% |

The most frequent site of presentation of Necrotising Fasciitis was Lower limbs (70%) followed by upper limbs(18.3%) – table 4.

Table 5: Symptomatic Presentation Of The Patients

| Symptoms | Pain | Edema | Vesicles/ Bullae | Woody Hard Texture | Erythema |
|---|---|---|---|---|---|
| number of pts presented(percentage) | 60(100%) | 60(100%) | 60(100%) | 60(100%) | 57(95%) |

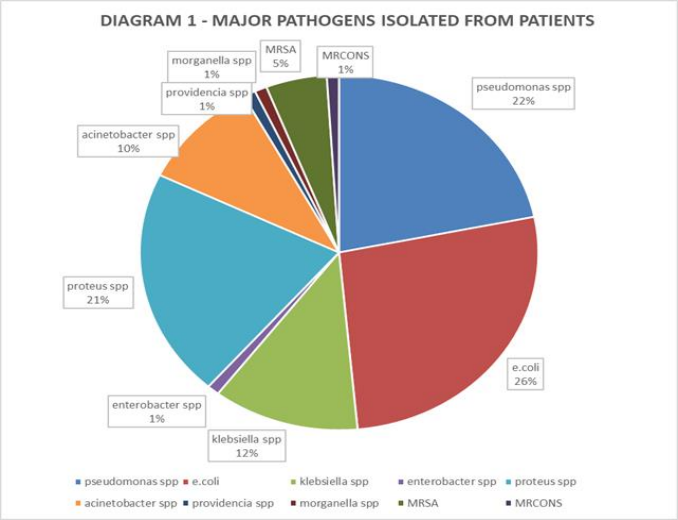
All the patients (n=60) presented with pain, edema, woody hard texture and vesicles/bullae-table 5.

Table 6: Type of Growth Observed From Patient Sample

| type of growth | number | percentage |
|---|---|---|
| monomicrobial | 20 | 34% |
| polymicrobial | 40 | 66% |

Of all the cultures 66% of cases show polymicrobial growth while the remaining 34% showed monomicrobial growth - table 6.

Diagram 1:




It is observed that among gram negative pathogens, Escherichia coli (26%), Pseudomonas species(22%) and Proteus species(21%) were the commonest organisms isolated from cultures while gram positive bacteria showed less prevalence – MRSA (5%) and MRCONS(1%)- diagram 1.

Table 7: drug sensitivity pattern of gram negative pathogens

| Drugs | E.Coli (N=27) | | Klebsiella Spp (N=12) | | Proteus Spp (N=21) | | Morganella Spp (N=2) | |
|---|---|---|---|---|---|---|---|---|
| | Sensitive | Resistant | Sensitive | Resistant | Sensitive | Resistant | Sensitive | Resistant |
| Cefipime | 0 | 27(100%) | 0 | 12(100%) | 0 | 21(100%) | 0 | 2(100%) |
| Cotrimoxazole | 9(33%) | 18(67%) | 0 | 12(100%) | 5(24%) | 16(76%) | 2(100%) | 0 |
| Ciprofloxacin | 0 | 27(100%) | 0 | 12(100%) | 2(9%) | 19(91%) | 0 | 2(100%) |
| Imipenem | 12(44%) | 15(56%) | 1(8%) | 11(92%) | 8(38%) | 13(62%) | 2(100%) | 0 |
| Meropenem | 12(44%) | 15(56%) | 1(8%) | 11(92%) | 8(38%) | 13(62%) | 2(100%) | 0 |
| Ertapenem | 11(41%) | 16(59%) | 1(8%) | 11(92%) | 8(38%) | 13(62%) | 2(100%) | 0 |
| Gentamicin | 6(22%) | 21(78%) | 1(8%) | 11(92%) | 5(24%) | 16(76%) | 2(100%) | 0 |
| Amikacin | 20(74%) | 7(26%) | 0 | 12(100%) | 6(28%) | 15(72%) | 0 | 2(100%) |
| Cefuroxime | 0 | 27(100%) | 0 | 12(100%) | 2(9%) | 19(91%) | 0 | 2(100%) |
| Cefotaxime | 0 | 27(100%) | 0 | 12(100%) | 2(9%) | 19(91%) | 0 | 2(100%) |
| Ceftriaxone | 0 | 27(100%) | 0 | 12(100%) | 3(10%) | 18(90%) | 0 | 2(100%) |
| Tetracycline | 13(48%) | 14(52%) | 0 | 12(100%) | 5(24%) | 16(76%) | 0 | 2(100%) |
| Piptaz | 13(48%) | 14(52%) | 0 | 12(100%) | 5(24%) | 16(76%) | 2(100%) | 0 |
| Netilimycin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ceftazidime | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Minocycline | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Drugs | Enterobacter Spp (N=1) | | Providencia Spp (N=1) | | Pseudomonas Spp (N=22) | | Acinetobacter Spp (N=10) | |
|---|---|---|---|---|---|---|---|---|
| | Sensitive | Resistant | Sensitive | Resistant | Sensitive | Resistant | Sensitive | Resistant |
| Cefipime | 0 | 1(100%) | 0 | 1(100%) | 0 | 22(100%) | 0 | 10(100%) |
| Cotrimoxazole | 1(100%) | 0 | 0 | 1(100%) | 3(14%) | 19(86%) | 2(20%) | 8(80%) |
| Ciprofloxacin | 0 | 1(100%) | 0 | 1(100%) | 0 | 22(100%) | 0 | 10(100%) |
| Imipenem | 0 | 1(100%) | 0 | 1(100%) | 8(34%) | 14(66%) | 2(20%) | 8(80%) |
| Meropenem | 0 | 1(100%) | 0 | 1(100%) | 8(34%) | 14(66%) | 2(20%) | 8(80%) |
| Ertapenem | 0 | 1(100%) | 0 | 1(100%) | 8(34%) | 14(66%) | 2(20%) | 8(80%) |
| Gentamicin | 0 | 1(100%) | 0 | 1(100%) | 7(32%) | 15(68%) | 1(10%) | 9(90%) |
| Amikacin | 0 | 1(100%) | 0 | 1(100%) | 0 | 0 | 0 | 0 |
| Cefuroxime | 0 | 1(100%) | 0 | 1(100%) | 0 | 0 | 0 | 0 |
| Cefotaxime | 0 | 1(100%) | 0 | 1(100%) | 0 | 0 | 0 | 0 |
| Ceftriaxone | 0 | 1(100%) | 0 | 1(100%) | 0 | 0 | 0 | 0 |
| Tetracycline | 0 | 1(100%) | 0 | 1(100%) | 0 | 0 | 0 | 0 |
| Piptaz | 0 | 1(100%) | 0 | 1(100%) | 18(82%) | 4(18%) | 0 | 0 |
| Netilimycin | 0 | 0 | 0 | 0 | 18(82%) | 4(18%) | 0 | 0 |
| Ceftazidime | 0 | 0 | 0 | 0 | 2 | 20 | 0 | 10(100%) |
| Minocycline | 0 | 0 | 0 | 0 | 0 | 0 | 5(50%) | 5(50%) |

E.coli showed resistance majorly towards cephalosporins and penicillins followed by carbapenems. All 27 E. coli isolates were completely resistant to cefepime, ciprofloxacin, cefuroxime, cefotaxime, and ceftriaxone. Among the 27 E. coli isolates, 8 (29.6%) were sensitive and 19 (70.4%) resistant to cotrimoxazole; 11 (40.7%) were sensitive and 16 (59.3%) resistant to both imipenem and meropenem; 10 (37.0%) were sensitive and 17 (63.0%) resistant to ertapenem and piperacillin-tazobactam showed 12 (44.4%) sensitive and 15 (55.6%) resistant isolates.

Among 22 Pseudomonas spp isolates, complete resistance was observed with cefepime and ciprofloxacin. Low sensitivity was seen with cotrimoxazole (13.6%), ceftazidime (9.1%), and gentamicin (31.8%). The highest sensitivity was observed with netilimycin and piperacillin-tazobactam, each at 81.8%.

Across the tested organisms, cefepime, ciprofloxacin, cefuroxime, cefotaxime, and ceftriaxone showed high resistance, with nearly all isolates of E. coli, Klebsiella spp., Proteus spp., Morganella spp., Enterobacter spp., Providencia spp., Pseudomonas spp., and Acinetobacter spp. resistant. Carbapenems (imipenem, meropenem, ertapenem) showed moderate activity against E. coli and Proteus spp. (40–48% sensitivity), but less than 40% in Klebsiella spp., Acinetobacter spp., and Pseudomonas spp. Piperacillin-tazobactam was effective against Pseudomonas spp. (82%) and moderately effective in E. coli and Proteus spp. (48%), but ineffective in Klebsiella spp.

Table 8: Drug Sensitivity of Gram Positive Pathogens

| Drugs | MRSA | | MRCONS | |
|---|---|---|---|---|
| | Sensitive | Resistant | Sensitive | Resistant |
| Cefoxitin | 0 | 5(100%) | 0 | 1(100%) |
| Ciprofloxacin | 0 | 5(100%) | 0 | 1(100%) |
| Erythromycin | 0 | 5(100%) | 0 | 1(100%) |
| Clindamycin | 0 | 5(100%) | 0 | 1(100%) |
| Doxycycline | 5(100%) | 0 | 1(100%) | 0 |
| Linezolid | 5(100%) | 0 | 1(100%) | 0 |
| Penicillin | 3(60%) | 2(40%) | 0 | 1(100%) |
| Gentamicin | 5(100%) | 0 | 0 | 1(100%) |

All MRSA isolates and the MRCONS isolate were resistant to cefoxitin, ciprofloxacin, erythromycin, and clindamycin. MRSA and MRCONS were sensitive to Doxycycline and Linezolid. Gentamicin was effective against MRSA but not against MRCONS. Penicillin showed partial sensitivity among MRSA (3/5, 60%), while MRCONS was resistant.

**Discussion**

We studied 60 cases of necrotising fasciitis, out of which majority of them were in the age group of 50-80 yrs and predominantly they were males. This was consistent with previous reports suggesting a higher incidence of necrotizing fasciitis in older males[1,2]

Our study revealed most common underlying comorbidities were diabetes mellitus, liver disease, and use of alcohol. These findings align with studies by Wong et al. (2003) and Anaya & Dellinger (2007), which identified diabetes as a significant risk factor predisposing patients to severe soft tissue infections [1,2].

The most common site of presentation was lower limbs followed by upper limbs with limited cases affecting abdominal wall and scrotum[19]. All our patients presented with pain, edema, woody hard texture and vesicles/bullae. This was consistent with study by Chen et all(2008)[12]. Our study cohort majorly presented as polymicrobial growth which was consistent with previous study by Hadid et al(2022)[13].

Microbiologically, the predominance of Gram-negative organisms such as Escherichia coli, Pseudomonas spp., Proteus spp., and Klebsiella spp. corroborates findings from other Indian[14,15,16] and global studies [3,4], which reported a similar shift towards Gram-negative polymicrobial infections in necrotizing fasciitis. The relatively low prevalence of Gram-positive pathogens, including MRSA, differs somewhat from Western literature where Staphylococcus aureus is often a leading cause [5,17]. This discrepancy may reflect regional variations in microbial flora and antibiotic usage patterns.

The antimicrobial resistance patterns observed are particularly concerning. The complete resistance of E. coli isolates to cephalosporins and ciprofloxacin echoes the growing global trend of extended-spectrum beta-lactamase (ESBL) producing strains, as documented by Pitout & Laupland (2008) [6]. Moderate resistance to carbapenems further complicates treatment, consistent with reports of emerging carbapenem-resistant Enterobacteriaceae (CRE) in hospital settings [7,18].

Piperacillin-tazobactam sensitivity was limited, with nearly half the isolates showing resistance, while cotrimoxazole sensitivity was observed in less than one-third of isolates[18].

Our findings of high amikacin sensitivity align with studies suggesting aminoglycosides remain valuable agents against resistant Gram-negative pathogens [8]. Pseudomonas spp. demonstrated multidrug resistance with complete resistance to cefepime and ciprofloxacin, consistent with known intrinsic resistance mechanisms in this species [9]. The observed sensitivity to netilmicin and piperacillin-tazobactam mirrors findings by Lee et al. (2017), emphasizing these agents' roles in managing *Pseudomonas* infections [10,18].

The widespread resistance to beta-lactams and variable carbapenem sensitivity across other Gram-negative species reinforces the critical need for culture-guided therapy. Our data align with prior studies indicating that empirical broad-spectrum coverage should be initiated promptly, especially in polymicrobial infections [2,4]. However, antimicrobial stewardship is essential to mitigate the rise of resistant strains.

Tetracycline and minocycline's limited but notable activity against select isolates is supported by prior work exploring their role as adjunctive therapy [11]. Klebsiella spp. resistant to piperacillin-tazobactam underscores the challenge of treating infections by the multidrug organisms.

**Conclusion**

These findings emphasize the challenges posed by multidrug-resistant Gram-negative pathogens in necrotizing fasciitis, complicating empirical antibiotic selection. The high prevalence of polymicrobial infections further necessitates broad-spectrum coverage initially, tailored later to culture and sensitivity results. The resistance patterns highlight the critical need for ongoing surveillance, judicious antibiotic use, and consideration of alternative agents such as amikacin, piperacillin-tazobactam, and netilmicin in managing these infections. Future studies should explore the clinical outcomes correlated with these resistance patterns and evaluate newer therapeutic strategies to improve patient prognosis.

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