E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.31838/ijprt/16.02.944

Research Article

A Prospective Study of Clinical Profile and Outcomes of Patients with Necrotizing Soft Tissue Infections

Dr. Sajid Ibrahim Ali[1], Dr. Ishwarappa S. Shetty[2], Dr. C. G. Sunil[3*]
[1]Assistant Professor, Department of General Surgery, SDM College of Medical Sciences and Hospital, Shri Dharmasthala Manjunatheshwara University, Dharwad, Karnataka, India.
[2]Assistant Professor, Department of General Surgery, SDM College of Medical Sciences and Hospital, Shri Dharmasthala Manjunatheshwara University, Dharwad, Karnataka, India.
[3*]Associate Professor, Department of General Surgery, SDM College of Medical Sciences and Hospital, Shri Dharmasthala Manjunatheshwara University, Dharwad, Karnataka, India.
Received: 12.09.2026, Revised: 14.10.2026, Accepted: 29.10.2026

ABSTRACT
Background: Necrotizing soft tissue infections (NSTIs) are rapidly progressive, life-threatening infections associated with extensive tissue destruction, systemic complications, and substantial mortality. Early diagnosis, prompt surgical intervention, and appropriate antimicrobial therapy are essential for improving clinical outcomes.
Aim: To evaluate the clinical profile, predisposing factors, microbiological characteristics, treatment modalities, and outcomes of patients with necrotizing soft tissue infections.
Materials and Methods: This prospective observational study was conducted over 18 months in the Department of General Surgery at a tertiary care hospital. A total of 90 patients diagnosed with NSTIs were included. Demographic characteristics, comorbidities, clinical manifestations, laboratory and microbiological findings, surgical interventions, complications, and hospital outcomes were evaluated.
Results: The majority of patients belonged to the 41–60-year age group (54.44%), with male predominance (70.00%). Diabetes mellitus was the most common comorbidity (53.33%). Pain (94.44%), swelling (91.11%), and erythema (78.89%) were the predominant manifestations, while lower limb involvement was observed in 54.44%. Microbiological cultures were positive in 80.00%, with polymicrobial infections in 43.33%. All patients underwent surgical debridement, and 61.11% required multiple procedures. ICU admission was required in 34.44%, while 10.00% underwent amputation. Septic shock (23.33%) and acute kidney injury (21.11%) were major complications. In-hospital mortality was 15.56%.
Conclusion: NSTIs were associated with considerable morbidity and mortality, particularly among patients with underlying comorbidities. Early recognition, timely surgical debridement, appropriate antimicrobial therapy, and multidisciplinary management were essential for improving clinical outcomes.

Keywords: Necrotizing soft tissue infections; Necrotizing fasciitis; Diabetes mellitus; Surgical debridement; Septic shock; Mortality.

INTRODUCTION

Necrotizing soft tissue infections (NSTIs) are rapidly progressive, life-threatening infections involving the skin, subcutaneous tissue, fascia, and occasionally the underlying muscles. These infections are characterized by extensive tissue necrosis, severe systemic inflammatory responses, and substantial morbidity and mortality. Although relatively uncommon, NSTIs represent an important surgical emergency, with reported annual incidence rates ranging from 0.3 to 15 cases per 100,000 population[1–3]. The infection frequently spreads along fascial planes, resulting in extensive tissue destruction before obvious cutaneous manifestations develop. Consequently, early diagnosis remains challenging, and delayed recognition may lead to severe complications and unfavorable clinical outcomes.

Several predisposing factors have been associated with NSTIs, including advanced age, diabetes mellitus, obesity, peripheral vascular disease, chronic kidney disease, immunosuppression, malignancy, alcoholism, and preceding soft tissue trauma. However, these infections may also

occur in previously healthy individuals without identifiable risk factors[4-6]. The microbiological etiology is diverse and includes polymicrobial infections involving aerobic and anaerobic organisms and monomicrobial infections caused by highly virulent pathogens such as *Streptococcus pyogenes* and *Staphylococcus aureus*. Variations in microbial patterns may occur depending on geographical location, environmental exposure, underlying comorbidities, and host immune status[7,8].

The clinical presentation of NSTIs varies considerably according to the extent of infection and disease progression. Common manifestations include severe pain, swelling, erythema, tenderness, fever, and rapidly progressive skin changes. Pain disproportionate to the visible clinical findings is an important early indicator[9]. Advanced disease may present with hemorrhagic bullae, skin discoloration, crepitus, cutaneous anesthesia, and extensive tissue necrosis. Systemic complications, including septic shock, acute kidney injury, multiorgan dysfunction, and respiratory failure, contribute significantly to disease severity and mortality. Reported mortality rates range from approximately 6% to 33%, emphasizing the importance of early recognition and timely intervention[10].

Diagnosis is primarily based on clinical assessment, supported by laboratory investigations, imaging modalities, and operative findings. Although scoring systems such as the Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC) may assist in clinical evaluation, they cannot reliably exclude the disease. Prompt hemodynamic stabilization, empirical broad-spectrum antimicrobial therapy, and urgent surgical exploration with aggressive debridement remain the cornerstones of management[5,6]. Repeated debridement, intensive care support, reconstructive procedures, and occasionally limb amputation may be necessary in patients with extensive tissue involvement[11].

Despite advances in surgical and critical care management, NSTIs continue to present considerable challenges, particularly in resource-limited settings. Delayed presentation, underlying comorbidities, variable microbiological patterns, and differences in treatment accessibility may influence clinical outcomes[12]. Understanding these factors is essential for identifying high-risk patients and improving management strategies. Furthermore, prospective data regarding the clinical characteristics, treatment requirements, and outcomes of NSTIs in the Indian healthcare setting remain important for strengthening evidence-based clinical practice[10].

Therefore, the present prospective study aims to evaluate the clinical profile and outcomes of patients with necrotizing soft tissue infections, focusing on demographic characteristics, predisposing factors, clinical manifestations, microbiological findings, treatment modalities, complications, and factors associated with unfavorable outcomes. The findings may facilitate early diagnosis, timely intervention, improved risk stratification, and better patient outcomes.

MATERIALS AND METHODS

Study Design

The present study was conducted as a prospective observational study to evaluate the clinical profile, predisposing factors, microbiological characteristics, management strategies, and outcomes of patients diagnosed with necrotizing soft tissue infections (NSTIs).

Study Setting

The study was carried out in the Department of General Surgery at a tertiary care hospital. Patients presenting with necrotizing soft tissue infections and requiring hospitalization and surgical management were evaluated during the study period.

Study Duration

The present prospective observational study was conducted over a period of 18 months in the Department of General Surgery at a tertiary care hospital. During this period, 90 patients diagnosed with necrotizing soft tissue infections who fulfilled the eligibility criteria were enrolled and evaluated. All enrolled patients were followed throughout their hospital stay until discharge or death.

Study Population

The study included adult patients diagnosed with necrotizing soft tissue infections who were admitted to the Department of General Surgery. Patients fulfilling the eligibility criteria were enrolled after obtaining informed consent.

Sample Size

A total of **90 patients** diagnosed with necrotizing soft tissue infections were included in the study. The sample size was determined according to the number of eligible patients available during the study period.

Sampling Technique

A consecutive sampling technique was employed. All eligible patients presenting during the study period were considered for inclusion until the required sample size of 90 patients was achieved.

Inclusion Criteria

1. Patients aged 18 years and above.
2. Patients clinically diagnosed with necrotizing soft tissue infections.
3. Patients admitted for surgical and medical management of NSTIs.
4. Patients who provided written informed consent to participate in the study.

Exclusion Criteria

1. Patients below 18 years of age.
2. Patients presenting with superficial skin and soft tissue infections without evidence of necrotizing infection.
3. Patients with incomplete clinical records or insufficient outcome data.
4. Patients who declined to provide informed consent.

Data Collection Procedure

After enrollment, detailed demographic and clinical information was recorded using a structured data collection proforma. The collected information included age, sex, presenting complaints, duration of symptoms, anatomical site of infection, history of trauma or preceding injury, and associated comorbidities such as diabetes mellitus, hypertension, chronic kidney disease, peripheral vascular disease, and immunosuppression.

A detailed clinical examination was performed to assess the extent and severity of infection. Local findings, including swelling, erythema, tenderness, skin discoloration, bullae, crepitus, and tissue necrosis, were documented. Systemic manifestations such as fever, tachycardia, hypotension, altered sensorium, and features of sepsis were also recorded.

Laboratory and Microbiological Investigations

Routine laboratory investigations were performed as part of the initial clinical evaluation. These included complete blood count, blood glucose, renal function tests, serum electrolytes, C-reactive protein, and other investigations as clinically indicated.

Microbiological specimens, including wound swabs, pus, or tissue samples obtained during surgical debridement, were sent for bacterial culture and antimicrobial susceptibility testing wherever feasible. The organisms isolated and their antimicrobial susceptibility patterns were documented.

Treatment and Management

All patients were managed according to their clinical condition and institutional treatment protocols. Initial management included fluid resuscitation, hemodynamic stabilization, empirical broad-spectrum intravenous antibiotics, analgesia, and supportive care.

Surgical exploration and debridement of necrotic tissue were performed as clinically indicated. The number of debridement procedures, requirement for repeat surgery, wound management techniques, and need for additional procedures such as skin grafting or amputation were recorded. Antimicrobial therapy was modified according to culture and susceptibility findings whenever available.

Patients requiring intensive monitoring or organ support were managed in the intensive care unit according to clinical indications.

Assessment of Clinical Outcomes

Patients were monitored throughout hospitalization to assess treatment response, disease progression, and development of complications.

The following clinical outcomes were evaluated:

1. Duration of hospital stay.
2. Requirement for intensive care unit admission.
3. Number of surgical debridement procedures.
4. Requirement for skin grafting or reconstructive procedures.
5. Requirement for limb amputation.
6. Development of complications, including septic shock, acute kidney injury, and multiorgan dysfunction.
7. Final hospital outcome, categorized as discharge or in-hospital mortality.

The association of demographic characteristics, underlying comorbidities, clinical presentation, laboratory parameters,

and treatment-related factors with clinical outcomes was evaluated.

Statistical Analysis

The collected data were entered into Microsoft Excel and analyzed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation or median with interquartile range, depending on their distribution. Categorical variables were presented as frequencies and percentages. The Chi-square test or Fisher's exact test was used to assess associations between categorical variables. The independent Student's t-test or Mann–Whitney U test was applied to compare continuous variables between groups, as appropriate. Associations between potential risk factors and adverse clinical outcomes were evaluated using suitable statistical methods. A p-value of less than 0.05 was considered statistically significant.

RESULTS

The present prospective study included 90 patients diagnosed with necrotizing soft tissue infections (NSTIs). The demographic characteristics, clinical presentation, laboratory and microbiological findings, treatment modalities, complications, and clinical outcomes were evaluated.

As shown in Table 1, the majority of patients belonged to the 41–60 years age group (54.44%), followed by 18–40 years (26.67%) and above 60 years (18.89%). There was a male predominance, with 63 (70.00%) males and 27 (30.00%) females. Diabetes mellitus was the most common comorbidity, affecting 48 (53.33%) patients, followed by hypertension in 29 (32.22%), smoking history in 25 (27.78%), and chronic kidney disease in 12 (13.33%) patients.

Table 2 and Figure 1 the clinical presentation and anatomical distribution of NSTIs. Pain was the most common presenting symptom, reported in 85 (94.44%) patients, followed by swelling in 82 (91.11%), erythema in 71 (78.89%), and fever in 66 (73.33%) patients. Tissue necrosis was observed in 59 (65.56%) patients. The lower limb was the most frequently involved anatomical site (54.44%), followed by the perineal/genital region (24.44%), upper limb (11.11%), and abdominal wall/trunk (10.00%).

As presented in Table 3 and Figure 2, leukocytosis (>15,000/mm³) was observed in 58 (64.44%) patients, while elevated CRP (>150 mg/L) was recorded in 46 (51.11%) patients. Hyponatremia was reported in 26 (28.89%) patients. Microbiological cultures were positive in 72 (80.00%) patients, with polymicrobial infections identified in 39 (43.33%) and monomicrobial infections in 33 (36.67%) patients. No microbial growth was observed in 18 (20.00%) patients.

Table 4 and Figure 3 summarize the treatment modalities employed. All 90 (100.00%) patients underwent surgical debridement. A single debridement was performed in 35 (38.89%) patients, two debridements in 32 (35.56%), and three or more debridements in 23 (25.56%) patients. ICU admission was required in 31 (34.44%) patients, while 16 (17.78%) required mechanical ventilation. Skin grafting was performed in 24 (26.67%) patients, whereas limb amputation was required in 9 (10.00%) patients.

As shown in Table 5, septic shock was observed in 21 (23.33%) patients, followed by acute kidney injury in 19 (21.11%), respiratory failure in 16 (17.78%), and multiorgan dysfunction in 14 (15.56%) patients. Regarding hospitalization duration, 43 (47.78%) patients stayed for 11–20 days, 29 (32.22%) for more than 20 days, and 18 (20.00%) for 10 days or less. Overall, 76 (84.44%) patients were discharged alive, while 14 (15.56%) patients died during hospitalization.

Table 1. Demographic Characteristics and Comorbidities (N = 90)

Parameter	n (%)
Age 18–40 years	24 (26.67)
Age 41–60 years	49 (54.44)
Age >60 years	17 (18.89)
Male	63 (70.00)
Female	27 (30.00)
Diabetes mellitus	48 (53.33)
Hypertension	29 (32.22)
Chronic kidney disease	12 (13.33)
Smoking history	25 (27.78)

Table 2. Clinical Presentation and Anatomical Distribution (N = 90)

Parameter	n (%)
Pain	85 (94.44)
Swelling	82 (91.11)
Fever	66 (73.33)
Erythema	71 (78.89)
Tissue necrosis	59 (65.56)
Lower limb involvement	49 (54.44)
Perineal/genital involvement	22 (24.44)
Upper limb involvement	10 (11.11)
Abdominal wall/trunk	9 (10.00)

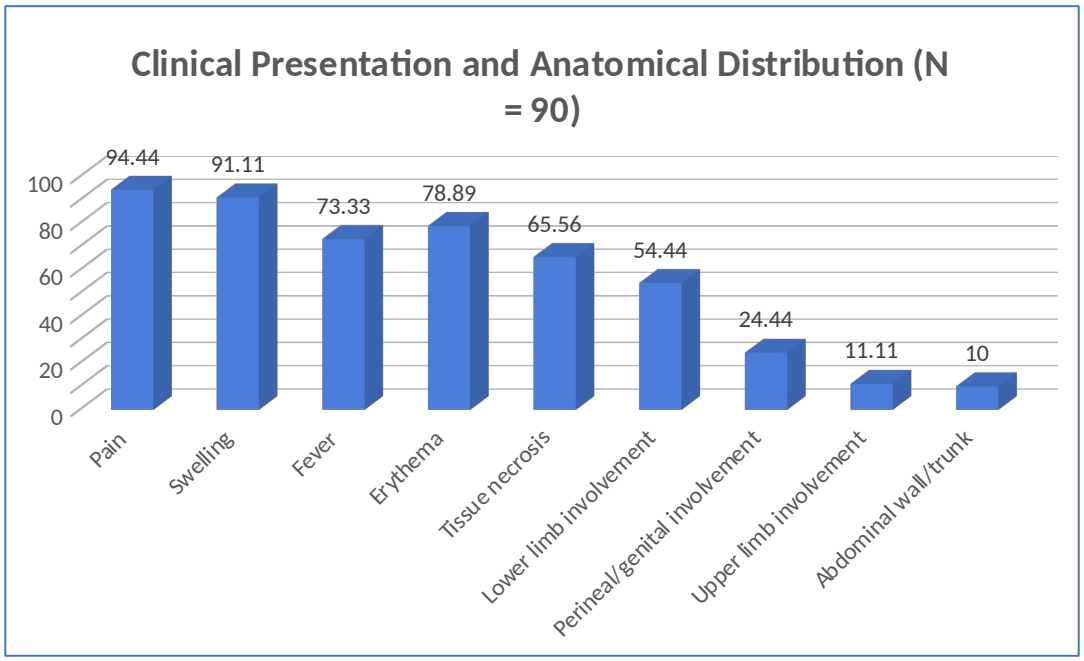

Figure 1. Clinical Presentation and Anatomical Distribution (N = 90)

Table 3. Laboratory and Microbiological Findings (N = 90)

Parameter	n (%)
Leukocytosis (>15,000/mm³)	58 (64.44)
Hyponatremia (1.5 mg/dL)	26 (28.89)
CRP >150 mg/L	46 (51.11)
Culture positive	72 (80.00)
Polymicrobial infection	39 (43.33)
Monomicrobial infection	33 (36.67)
No growth	18 (20.00)

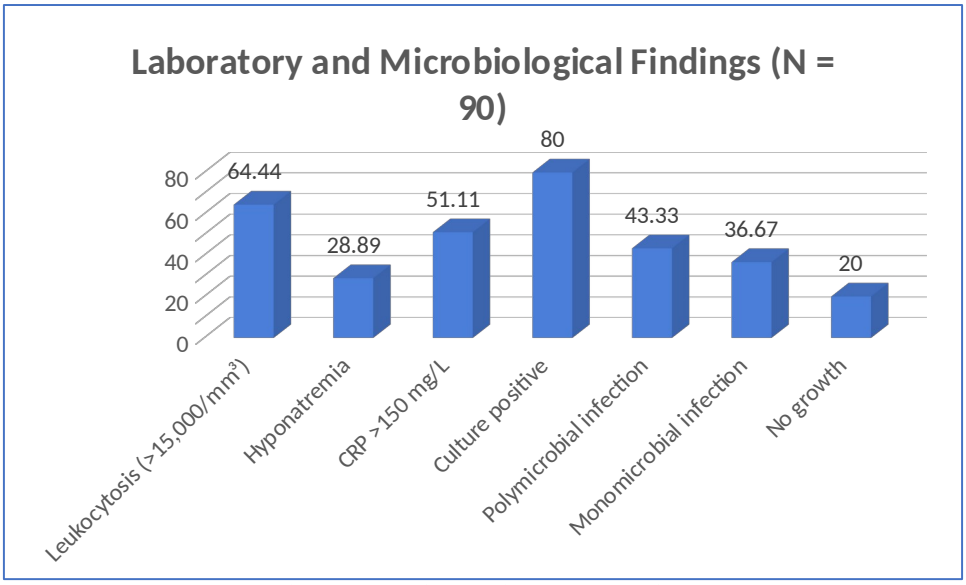

Figure 2. Laboratory and Microbiological Findings (N = 90)

Table 4. Treatment Modalities (N = 90)

Parameter	n (%)
Surgical debridement	90 (100.00)
Single debridement	35 (38.89)
Two debridements	32 (35.56)
≥3 debridements	23 (25.56)
ICU admission	31 (34.44)
Mechanical ventilation	16 (17.78)
Skin grafting	24 (26.67)
Limb amputation	9 (10.00)

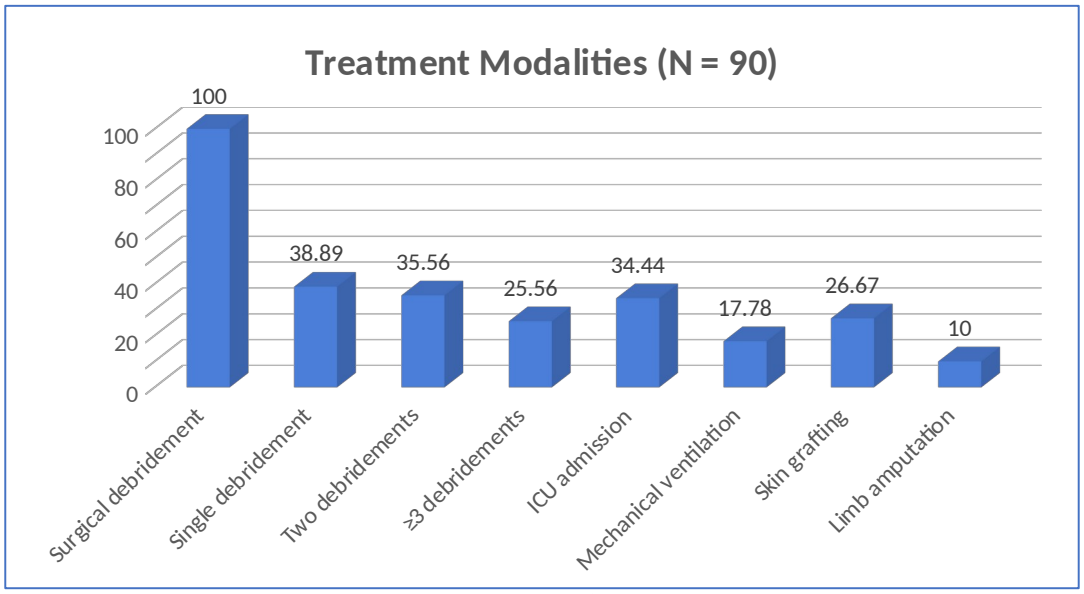

Figure 3. Treatment Modalities (N = 90)

Table 5. Complications and Clinical Outcomes (N = 90)

Parameter	n (%)
Septic shock	21 (23.33)
Acute kidney injury	19 (21.11)
Multiorgan dysfunction	14 (15.56)
Respiratory failure	16 (17.78)

Parameter	n (%)
Hospital stay ≤10 days	18 (20.00)
Hospital stay 11–20 days	43 (47.78)
Hospital stay >20 days	29 (32.22)
Discharged alive	76 (84.44)
In-hospital mortality	14 (15.56)

DISCUSSION

The present prospective observational study evaluated the clinical profile and outcomes of 90 patients with necrotizing soft tissue infections (NSTIs). Most patients belonged to the 41–60-year age group (54.44%), with a male predominance (70.00%). Diabetes mellitus was the most common comorbidity (53.33%), followed by hypertension (32.22%) and chronic kidney disease (13.33%). Similar findings were reported by Kumar and Saxena (2026)[13] in their study of 100 patients from eastern India, where 39% belonged to the 41–60-year age group, 76% were males, and 66% had diabetes mellitus. Likewise, de Haan et al. (2025)[14], in a Dutch multicenter study involving 271 patients, reported a mean age of 56.6 years, male predominance of 66.4%, and diabetes mellitus in 24.4% of patients. These findings indicated that middle-aged and older individuals, particularly those with underlying comorbidities, constituted a substantial proportion of NSTI cases.

Regarding clinical presentation, pain (94.44%) and swelling (91.11%) were the predominant symptoms, followed by erythema (78.89%), fever (73.33%), and tissue necrosis (65.56%). Lower limb involvement was most common (54.44%), followed by perineal/genital involvement (24.44%). Kumar and Saxena (2026)[13] similarly reported lower-extremity involvement in 75% of patients. de Haan et al. (2025)[14] observed that 61% of patients initially presented with early-stage manifestations such as pain or erythema, emphasizing the diagnostic challenges associated with NSTIs.

Laboratory findings in the present study demonstrated leukocytosis in 64.44%, elevated C-reactive protein in 51.11%, and hyponatremia in 41.11% of patients. Microbiological cultures were positive in 80.00% of cases, with polymicrobial infections accounting for 43.33% and monomicrobial infections for 36.67%. In comparison, Lohawatcharagul et al. (2025)[15], in a retrospective study of 99 patients from Thailand, reported monomicrobial infections in 52.7%, polymicrobial infections in 14.0%, and negative cultures in 33.3%. These differences suggested geographical and population-related variations in the microbiological spectrum of NSTIs.

All patients in the present study underwent surgical debridement, with 61.11% requiring two or more procedures. ICU admission was required in 34.44%, skin grafting in 26.67%, and amputation in 10.00%. Lohawatcharagul et al. (2025)[15] reported an average of 3.06 debridements per patient and an amputation rate of 11.1%. Similarly, Nawijn et al. (2022)[16], in a multicenter study involving 160 patients, reported amputation in 13% and 30-day mortality in 14%. These findings were broadly comparable with the present study regarding major surgical outcomes.

In the present study, septic shock occurred in 23.33%, acute kidney injury in 21.11%, and multiorgan dysfunction in 15.56% of patients. In-hospital mortality was 15.56%. Kumar and Saxena (2026)[13] reported mortality of 14%, whereas de Haan et al. (2025)[14] observed in-hospital mortality of 21% and ICU admission in 83% of patients. Lohawatcharagul et al. (2025)[15] reported a lower mortality rate of 8.08%. Differences in mortality may reflect variations in disease severity, comorbidities, timing of intervention, and healthcare resources. Overall, these comparisons reinforced the importance of early recognition, prompt surgical debridement, appropriate antimicrobial therapy, and multidisciplinary management in improving NSTI outcomes.

CONCLUSION

Necrotizing soft tissue infections were associated with considerable morbidity and mortality, predominantly affecting middle-aged males and patients with underlying comorbidities, particularly diabetes mellitus. Pain, swelling, and lower limb involvement were the most common clinical manifestations, while polymicrobial infections constituted a substantial proportion of cases. Early recognition, prompt surgical debridement, appropriate

antimicrobial therapy, and intensive supportive care were essential components of management. Septic shock, acute kidney injury, and multiorgan dysfunction contributed to adverse clinical outcomes, with an in-hospital mortality rate of 15.56% in the dataset. These findings emphasized the importance of timely diagnosis and multidisciplinary management to improve patient outcomes.

LIMITATIONS

The present study was limited by its relatively small sample size of 90 patients and single-center design, which may restrict the generalizability of the findings. The observational nature of the study limited the ability to establish causal relationships between risk factors and clinical outcomes. Variations in disease severity, timing of presentation, and treatment approaches may have influenced patient outcomes. Additionally, the absence of long-term follow-up prevented assessment of functional recovery, recurrence, and long-term quality of life among survivors.

REFERENCES

1. Hakkarainen TW, Burkette Ikebata N, Bulger E, Evans HL. Moving beyond survival as a measure of success: understanding the patient experience of necrotizing soft-tissue infections. J Surg Res. 2014;192:143-149.
2. Stevens DL, Bryant AE. Necrotizing soft-tissue infections. N Engl J Med. 2017;377:2253-2265.
3. Suzuki H, Muramatsu K, Kubo T, Kawasaki M, Fujitani T, Tsukamoto M. Factors associated with mortality among patients with necrotizing soft tissue infections: an analysis of 4597 cases using the Diagnosis Procedure Combination Database. Int J Infect Dis. 2021;102:73-78.
4. Krieg A, Dizdar L, Verde PE, Knoefel WT. Predictors of mortality for necrotizing soft-tissue infections: a retrospective analysis of 64 cases. Langenbecks Arch Surg. 2014;399:333-341.
5. Sartelli M, Guirao X, Hardcastle TC. 2018 WSES/SIS-E consensus conference: recommendations for the management of skin and soft-tissue infections. World J Emerg Surg. 2018;13:58.
6. Cui Z, Lu S, Bai Y. Necrotizing soft tissue infection: clinical characteristics, diagnosis, and management of 32 cases in Beijing. J Int Med Res. 2021;49:3000605211018442.
7. Hua C, Urbina T, Bosc R, Parks T, Sriskandan S, de Prost N, et al. Necrotising soft-tissue infections. Lancet Infect Dis. 2023;23(3):e81-e94.
8. Madsen MB, Skrede S, Perner A. Patient's characteristics and outcomes in necrotising soft-tissue infections: results from a Scandinavian, multicentre, prospective cohort study. Intensive Care Med. 2019;45:1241-1251.
9. Sadasivan J, Maroju NK, Balasubramaniam A. Necrotizing fasciitis. Indian J Plast Surg. 2013;46:472-478.
10. Menon B, Krishna M, Galagali A, Mehrotra S. Necrotising soft tissue infection in the twenty-first century—a clinical and microbiological spectrum analysis. Indian J Surg. 2021;83:66-71.
11. Wong CH, Khin LW, Heng KS, Tan KC, Low CO. The LRINEC (Laboratory Risk Indicator for Necrotizing Fasciitis) score: a tool for distinguishing necrotizing fasciitis from other soft tissue infections. Crit Care Med. 2004;32:1535-1541.
12. Cribb BI, Wang MT, Kulasegaran S, Gamble GD, MacCormick AD. The SIARI score: a novel decision support tool outperforms LRINEC score in necrotizing fasciitis. World J Surg. 2019;43:2393-2400.
13. Kumar A, Saxena R. A Clinico-Pathological Study and Evaluation of Factors Associated With Poor Outcomes in Patients With Necrotizing Fasciitis in a Tertiary Care Hospital at Eastern India. Cureus. 2026 Jul 9;18(7):e112351.
14. de Haan J, Neeter LMFH, Suijker J, van Zuijlen PPM, Pijpe A, Meij-de Vries A, et al; NSTI Knowledge Collaborative Group. Characteristics, treatments, and outcomes of patients with necrotizing soft tissue infections: a Dutch multicenter cohort study. Eur J Trauma Emerg Surg. 2025 Oct 28;51(1):321.
15. Lohawatcharagul T, Jamjittrong S, Suenghataiphorn T, Kasemsantitham AA, Tangsirisatian P, Rojasavastera S, et al. Retrospective Study of Necrotizing Fasciitis: A Review of 99

Cases in a Tertiary Care Center in Eastern Thailand from 2022 to 2023. Open Forum Infect Dis. 2025 Jan 29;12(Suppl 1):ofae631.950.

16. Nawijn F, van Heijl M, Keizer J, van Koperen PJ, Hietbrink F. The impact of operative time on the outcomes of necrotizing soft tissue infections: a multicenter cohort study. BMC Surg. 2022 Jan 8;22(1):3.