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Necrotizing Soft Tissue Infections As A Source Of Surgical Sepsis: Clinical Variability, Comorbidity, And Outcomes

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Abstract: Background. Necrotizing soft tissue infections represent a distinct category of surgical infections associated with rapid progression, systemic inflammatory response, and high mortality. The development of surgical sepsis in these patients remains unpredictable and may occur despite timely and radical surgical treatment, particularly in the presence of significant comorbidities.

Methods. A retrospective analysis was performed on 143 patients treated for necrotizing soft tissue infections. Surgical sepsis was defined according to Sepsis-3 criteria. Patients were evaluated with respect to comorbid conditions, clinical course, need for intensive care, progression to septic shock and multiple organ failure, and in-hospital mortality.

Results. All patients with necrotizing soft tissue infections demonstrated a potential risk of septic complications. In patients with pronounced comorbidity, including diabetes mellitus and HIV infection, sepsis frequently followed a fulminant course with rapid progression to septic shock, multiple organ failure, and high mortality. In patients without severe comorbidities, sepsis often developed in a subacute manner with transient clinical stabilization, which could mask ongoing systemic infection and delay intensive anti-septic therapy. Progression to septic shock and the need for treatment in the intensive care unit were strongly associated with adverse outcomes.

Conclusion. Necrotizing soft tissue infection should be regarded as a condition with an inherent and unpredictable risk of surgical sepsis. Apparent local improvement does not exclude systemic progression. Continuous assessment for septic manifestations and early initiation of comprehensive anti-septic therapy is essential, even in the presence of radical surgical source control.

Key words: Necrotizing soft tissue infection; surgical sepsis; comorbidity; septic shock; mortality.

INTRODUCTION

Necrotizing soft tissue infections (NSTIs) represent one of the most severe forms of surgical infection, characterized by rapid progression, extensive tissue destruction, and a high risk of systemic complications. Despite advances in surgical techniques, antimicrobial therapy, and intensive care, mortality associated with NSTIs remains high and varies widely depending on the clinical course and patient-related factors [1]. The fulminant nature of the disease, combined with diagnostic difficulties in early stages, continues to pose a major challenge for practicing surgeons.

A critical determinant of outcome in NSTIs is the development of surgical sepsis. According to contemporary definitions, sepsis reflects a dysregulated host response to infection leading to organ dysfunction, rather than infection alone [2]. In patients with necrotizing infections, systemic involvement may occur early and progress rapidly, sometimes outpacing local clinical signs. Radical surgical debridement is universally recognized as the cornerstone of treatment; however, even timely and extensive source control does not reliably prevent septic progression in all cases [3].

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Clinical experience suggests that the course of sepsis in NSTIs is heterogeneous. In patients with significant comorbidities such as diabetes mellitus, HIV infection, chronic renal failure, or other conditions associated with immune or metabolic dysfunction, septic progression may be fulminant, with rapid transition to septic shock and multiple organ failure. In contrast, patients without pronounced comorbidity may exhibit a subacute course, characterized by intermittent fever and apparent local wound improvement, creating a false impression of stabilization while systemic infection continues to evolve. Such variability complicates clinical decision-making and may delay escalation of anti-septic therapy.

The unpredictable nature of septic complications in NSTIs underscores the need for continuous systemic assessment that extends beyond local wound evaluation. Treating NSTIs solely as a localized surgical problem risk underestimating the potential for sudden systemic deterioration. From a practical standpoint, NSTIs should be regarded as infections with an inherent risk of sepsis throughout their clinical course, regardless of initial presentation or early postoperative dynamics [4]. Improved understanding of the relationship between necrotizing infection, comorbidity, and septic outcomes may contribute to earlier recognition of high-risk patients and timelier implementation of comprehensive anti-septic management strategies.

METHODS

Study design and patients. A retrospective cohort study was conducted including 143 consecutive patients treated for necrotizing soft tissue infections at a specialized surgical center. Medical records were reviewed over the defined study period. Only patients with intraoperatively confirmed necrotizing infection of the skin, subcutaneous tissue, fascia, or muscle were included in the analysis. Cases with superficial soft tissue infection without necrosis were excluded.

Definition of surgical sepsis. Surgical sepsis was defined in accordance with the Sepsis-3 criteria as infection-associated organ dysfunction, identified by an increase in the Sequential Organ Failure Assessment (SOFA) score of two points or more from baseline [2]. Septic shock was diagnosed in patients with persistent hypotension requiring vasopressor support to maintain mean arterial pressure ≥65 mmHg and serum lactate levels >2 mmol/L despite adequate fluid resuscitation.

Comorbid conditions. Special attention was paid to the presence of comorbidities known to influence immune response and systemic tolerance to infection. These included diabetes mellitus, HIV infection, chronic kidney disease, chronic liver disease, cardiovascular disease, and other clinically significant chronic conditions. Comorbidities were identified based on documented medical history at admission.

Surgical management. All patients underwent urgent surgical intervention aimed at radical source control. Surgical treatment consisted of wide incision and excision of all necrotic tissues until viable margins were achieved. Repeat surgical debridement was performed when clinical assessment indicated ongoing necrosis, infection progression, or inadequate source control. The number of surgical procedures required for each patient was recorded.

Perioperative and intensive care management. Antimicrobial therapy was initiated empirically immediately after diagnosis and adjusted according to microbiological findings when available. Supportive therapy followed institutional protocols and included hemodynamic monitoring, fluid resuscitation, vasopressor support, and organ support measures as indicated. Admission to the intensive care unit was determined by the presence of organ dysfunction, hemodynamic instability, or progression to septic shock.

Outcomes. The primary outcome of the study was in-hospital mortality. Secondary outcomes included progression to septic shock, development of multiple organ failure, requirement for intensive care unit treatment, and the number of surgical interventions performed during hospitalization.

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Statistical analysis. Data were analyzed using standard statistical methods appropriate for retrospective clinical studies. Continuous variables were summarized as means with standard deviations or medians with interquartile ranges, depending on data distribution. Categorical variables were presented as absolute numbers and percentages. Comparisons between patients with and without surgical sepsis were performed using appropriate comparative tests, with statistical significance defined as $p < 0.05$.

RESULTS

Patient characteristics and comorbidity. A total of 143 patients with intraoperatively confirmed necrotizing soft tissue infections were included in the analysis. Surgical sepsis according to Sepsis-3 criteria was diagnosed in a substantial proportion of patients either at admission or during early hospitalization. Patients with sepsis more frequently presented with pronounced comorbidity. Diabetes mellitus and HIV infection were the most common conditions observed in this group, often in combination with other chronic diseases such as cardiovascular pathology or chronic kidney disease.

Patients without sepsis at presentation demonstrated fewer comorbid conditions and a more stable initial clinical profile. However, absence of sepsis at admission did not preclude subsequent systemic deterioration during treatment. Baseline demographic data and comorbid conditions of patients with and without surgical sepsis are summarized in Table 1.

Table 1.

Baseline characteristics and comorbidity of patients with necrotizing soft tissue infections

Variable	Sepsis group (n=62)	Non-sepsis group (n=81)
Age, years, mean ± SD	58.4±11.6	49.2±13.1
Male sex, n (%)	41 (66.1)	52 (64.2)
Diabetes mellitus, n (%)	36 (58.1)	19 (23.5)
HIV infection, n (%)	11 (17.7)	4 (4.9)
Chronic kidney disease, n (%)	14 (22.6)	6 (7.4)
Cardiovascular disease, n (%)	29 (46.8)	21 (25.9)
≥2 comorbid conditions, n (%)	33 (53.2)	14 (17.3)
Sepsis at admission, n (%)	44 (71.0)	0
Sepsis developed during hospitalization, n (%)	18 (29.0)	0

Clinical course and progression of sepsis. The clinical course of necrotizing soft tissue infections differed markedly depending on the presence and pattern of septic involvement. In patients with significant comorbidity, sepsis frequently followed a fulminant course characterized by rapid progression to septic shock and early development of multiple organ failure. This progression often occurred despite prompt surgical intervention and initiation of intensive care measures.

In contrast, patients without severe comorbid conditions more commonly exhibited a subacute septic course. These patients experienced intermittent fever and transient periods of apparent clinical stabilization, sometimes accompanied by local improvement

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of the wound. Such dynamics could precede sudden deterioration with manifestation of overt sepsis or septic shock later in the hospital course.

Surgical burden and intensive care requirements. Patients with surgical sepsis required a significantly greater surgical burden. The number of repeated debridements was higher in the septic group, reflecting both the extent of tissue involvement and the need for ongoing source control. Admission to the intensive care unit was substantially more frequent among septic patients, particularly those who progressed to septic shock or multiple organ failure.

Non-septic patients more often stabilized after initial or limited repeated surgical interventions and required intensive care less frequently. Nevertheless, a subset of initially non-septic patients subsequently required escalation of care due to delayed septic progression.

Outcomes. In-hospital mortality was significantly higher among patients with surgical sepsis compared with those without systemic involvement. Mortality was particularly elevated in patients who developed septic shock and multiple organ failure. The need for intensive care unit treatment was strongly associated with adverse outcomes.

Among patients without sepsis, mortality was lower and outcomes were generally more favorable, although isolated fatal cases were observed in the setting of sudden systemic deterioration. Comparative data on surgical management, septic progression, intensive care requirements, and outcomes are presented in Table 2.

Table 2.

Clinical course, surgical management, and outcomes

Variable	Sepsis group (n=62)	Non-sepsis group (n=81)
Repeated debridements, n (%)	49 (79.0)	28 (34.6)
Median number of surgical procedures (IQR)	3 (2-5)	1 (1-2)
ICU admission, n (%)	47 (75.8)	18 (22.2)
Progression to septic shock, n (%)	28 (45.2)	0
Multiple organ failure, n (%)	24 (38.7)	2 (2.5)
Length of hospital stay, days, median (IQR)	21 (15-34)	12 (8-18)
In-hospital mortality, n (%)	19 (30.6)	3 (3.7)

DISCUSSION

The present study demonstrates that necrotizing soft tissue infections are consistently associated with a high and unpredictable risk of surgical sepsis. Even in cases where radical surgical debridement is performed in a timely manner, systemic deterioration may occur rapidly or follow a deceptive subacute course. These findings reinforce the concept that NSTIs should not be regarded as purely localized surgical pathology but rather as conditions with inherent potential for systemic failure [1,3].

A particularly important observation concerns the influence of comorbid conditions on the clinical trajectory of sepsis. Patients with diabetes mellitus, HIV infection, and other chronic disorders affecting immune or metabolic function more frequently developed a fulminant septic course, characterized by early progression to septic shock and multiple organ failure. This pattern is consistent with existing data indicating impaired host response and

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reduced physiological reserve in such populations, which limits their ability to compensate for the profound inflammatory burden associated with necrotizing infections [4,5]. In these patients, even aggressive surgical source control may be insufficient to prevent rapid systemic collapse.

At the same time, the study highlights a clinically deceptive scenario observed in patients without pronounced comorbidity. In this subgroup, sepsis often evolved in a subacute manner, with intermittent fever and transient signs of stabilization. Local wound improvement after debridement may create a false sense of security, leading to underestimation of ongoing systemic infection. Similar observations have been noted in prior clinical series, where delayed recognition of sepsis contributed to worse outcomes despite adequate local control [3,6]. This pattern underscores the limitation of relying solely on local wound dynamics when assessing treatment response in NSTIs.

The increased surgical burden observed in septic patients reflects both the aggressiveness of the disease and the difficulty of achieving durable source control. Repeated debridements are frequently necessary, yet the need for multiple interventions should itself be interpreted as a marker of systemic severity rather than merely technical inadequacy. The strong association between intensive care unit admission, progression to septic shock, and mortality further emphasizes the systemic nature of the disease process and aligns with contemporary concepts of sepsis as a syndrome of organ dysfunction rather than localized infection [2].

From a practical standpoint, the findings support a more vigilant and proactive approach to septic surveillance in patients with NSTIs. Continuous reassessment for signs of organ dysfunction, early involvement of intensive care specialists, and prompt initiation of comprehensive anti-septic therapy should be considered mandatory components of management. Apparent clinical improvement at the local level should not be interpreted as resolution of systemic risk. This is particularly relevant in surgical departments where NSTIs are initially managed and where early decisions may determine patient trajectory.

Several limitations should be acknowledged. The retrospective design of the study inherently limits control over confounding variables, and the single-center setting may restrict generalizability. Microbiological factors and specific antimicrobial regimens were not analyzed in detail, which may influence septic progression. Nevertheless, the relatively large cohort and the clear clinical differentiation between septic and non-septic courses provide meaningful insight into the complexity and unpredictability of NSTIs.

CONCLUSION

Necrotizing soft tissue infections represent a surgical condition with an inherently high and unpredictable risk of sepsis, which may progress rapidly or evolve in a subacute and misleading manner despite adequate surgical source control. Patients with significant comorbidities are particularly susceptible to fulminant deterioration with early development of septic shock and multiple organ failure, while in the absence of overt risk factors sepsis may remain clinically concealed until sudden systemic decompensation occurs. These findings indicate that management of necrotizing soft tissue infections should not be limited to assessment of local wound dynamics but must include continuous systemic evaluation and early implementation of comprehensive anti-septic therapy. Sustained clinical vigilance and close integration of surgical and intensive care strategies are essential to reduce mortality in this high-risk patient population.

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