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ORIGINAL RESEARCH

Impact of Diabetes on Clinical Characteristics and Prognosis in Sepsis: A Retrospective Study

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Background: Diabetes mellitus (DM) may alter the clinical trajectory of sepsis by modulating immune responses, infection patterns, and outcomes. This study aimed to assess the impact of diabetes on the clinical characteristics and prognosis of sepsis patients.

Methods: This retrospective included 256 adult sepsis patients admitted between January 2021 and December 2024. Based on diabetes status, patients were categorized into a diabetic group (n = 151) and a non-diabetic group (n = 105). Clinical features, laboratory parameters, infection types, and outcomes were compared. Prognostic factors in diabetic sepsis were assessed using Spearman correlation and logistic regression.

Results: Compared to non-diabetic patients, diabetic sepsis patients had higher rates of Escherichia coli infection (25.5% vs 10.6%, $\chi^2 = 8.450$, $p = 0.004$), fungal co-infection (23.84% vs 5.71%, $p = 0.004$), and urinary tract infections (45.03% vs 30.48%). Diabetic patients also had elevated Acute Physiology and Chronic Health Evaluation II (APACHE II) scores (13.4 ± 6.5 vs 10.7 ± 4.4, $t = 3.706$, $p < 0.001$), C-reactive protein (CRP) levels (median 0.45 vs 0.37 mg/dL, $Z = 4.506$, $p < 0.01$), and procalcitonin (PCT) levels (median 7.9 vs 3.7 ng/mL, $Z = 3.118$, $p < 0.05$), along with increased mortality (25.83% vs 15.24%, $\chi^2 = 4.117$, $p < 0.05$). Among diabetic patients, APACHE II score correlated with 28-day mortality ($r = 0.463$, $p < 0.001$) and was an independent predictor (OR = 1.177, 95% CI: 1.019–1.361, $p = 0.029$), whereas CRP and PCT were not independently associated with prognosis ($p > 0.05$).

Conclusion: Diabetic sepsis patients showed distinct microbiological profiles, more urinary and fungal infections, and poorer outcomes. While the APACHE II score was independently associated with 28-day mortality, its moderate correlation suggests a multifactorial interplay. These results support the potential utility of integrated prognostic models combining clinical scores and biomarkers.

Keywords: diabetes mellitus, sepsis, APACHE II score, inflammatory markers, mortality, multiple organ dysfunction syndrome

Introduction

Sepsis remains one of the leading causes of morbidity and mortality in critically ill patients worldwide, characterized by a systemic inflammatory response to infection, which can lead to organ dysfunction and failure. The complex pathophysiology of sepsis involves a dysregulated immune response, which triggers both systemic inflammation and an impaired immune response. In recent years, the role of comorbid conditions, particularly diabetes mellitus (DM), in influencing the clinical outcomes of patients with sepsis has gained considerable attention.[1,2] Diabetes, a metabolic disorder characterized by chronic hyperglycemia, is known to have widespread effects on various physiological systems, including immune function, endothelial integrity, and inflammatory responses, all of which are critical in the progression and outcome of sepsis. Therefore, understanding the impact of diabetes on the clinical characteristics and prognosis of sepsis is essential for optimizing the management of these patients.[3,4]

Diabetes mellitus is associated with several immune dysfunctions, such as impaired neutrophil function, decreased phagocytic activity, and altered cytokine production, which may increase susceptibility to infections.[5] Moreover, persistent hyperglycemia, which is characteristic of diabetes, contributes to endothelial dysfunction and amplifies the inflammatory response in sepsis. Elevated blood glucose levels are independently associated with poor outcomes in

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septic patients, including increased mortality, prolonged hospital stays, and a greater incidence of organ dysfunction.[6] The altered immune response in diabetic patients may not only predispose them to infections but also impair their ability to mount an effective immune defense, resulting in worse clinical outcomes in the context of sepsis.[7,8] The relationship between diabetes and sepsis is complex and multifactorial, warranting further investigation into its impact on clinical characteristics and prognosis.

Recent studies have highlighted the limitations of conventional diagnostic and prognostic tools in sepsis and other critical illnesses, underscoring the need for novel biomarkers. Metabolomics has emerged as a promising approach to identify clinically relevant biomarkers for sepsis and ARDS, offering rapid diagnostic and prognostic potential.[9] In pediatric populations, the lactate/albumin ratio has been shown to predict mortality in nosocomial infections, with the 24-hour measurement providing the greatest discriminatory value.[10] Similarly, procalcitonin (PCT) has demonstrated pathogen-related variability in sepsis, though its prognostic accuracy remains moderate.[11] Recent evidence further suggests that the procalcitonin-to-albumin ratio provides superior predictive value for mortality compared to PCT or albumin alone, offering a reliable composite biomarker.[12] Collectively, these findings emphasize the importance of integrating dynamic biomarker-based approaches to improve early risk stratification and guide individualized management in sepsis. This retrospective study aims to investigate the impact of diabetes on clinical characteristics and prognosis in patients with sepsis, with a particular focus on mortality and organ dysfunction. By elucidating these associations, our findings may provide valuable insights for the management of diabetic sepsis patients and contribute to more individualized therapeutic strategies.

Methods

Study Design

This retrospective study was conducted at our hospital to evaluate the impact of diabetes mellitus on the clinical characteristics and prognosis of patients with sepsis. The study was performed over a four-year period, from January 2021 to December 2024. A total of 256 sepsis patients were included in the study. Of these, 105 patients without diabetes were assigned to the control group, while 151 patients with diabetes were assigned to the observation group (Figure 1). The study adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for methodological rigor.[13] Informed consent was obtained from all subjects and/or their legal guardian(s). This study was rigorously reviewed and approved by our hospital's ethics committee and conducted according to established guidelines and the Declaration of Helsinki. All phases—from design and execution to data management and reporting are the highest ethical standards. Measures were taken to ensure confidentiality, including the anonymization of all personal identifiers before analysis, to safeguard participant privacy.

Inclusion and Exclusion Criteria

Inclusion Criteria

1) Age: Patients aged 18 years and older, both male and female, were included in the study.
2) Diagnosis of Sepsis: All patients must have been diagnosed with sepsis according to the Sepsis-3 criteria, which include evidence of infection and a sequential organ failure assessment (SOFA) score of ≥2.
3) Diabetes Mellitus: Diabetic patients were identified based on documented medical history of DM, either type 1 or type 2, or confirmed by a fasting blood glucose level ≥126 mg/dL or a hemoglobin A1c (HbA1c) level ≥6.5%.
4) Sepsis Onset: Patients must have developed sepsis during their hospitalization, with the onset of sepsis clearly documented within 48 hours after admission.
5) Availability of Clinical Data: Patients with complete medical records, including demographic information, clinical characteristics, laboratory test results, and outcomes, were included in the analysis.

Exclusion Criteria

1) Non-sepsis Diagnosis: Patients diagnosed with conditions other than sepsis, such as isolated systemic inflammatory response syndrome (SIRS) without infection, were excluded from the study.

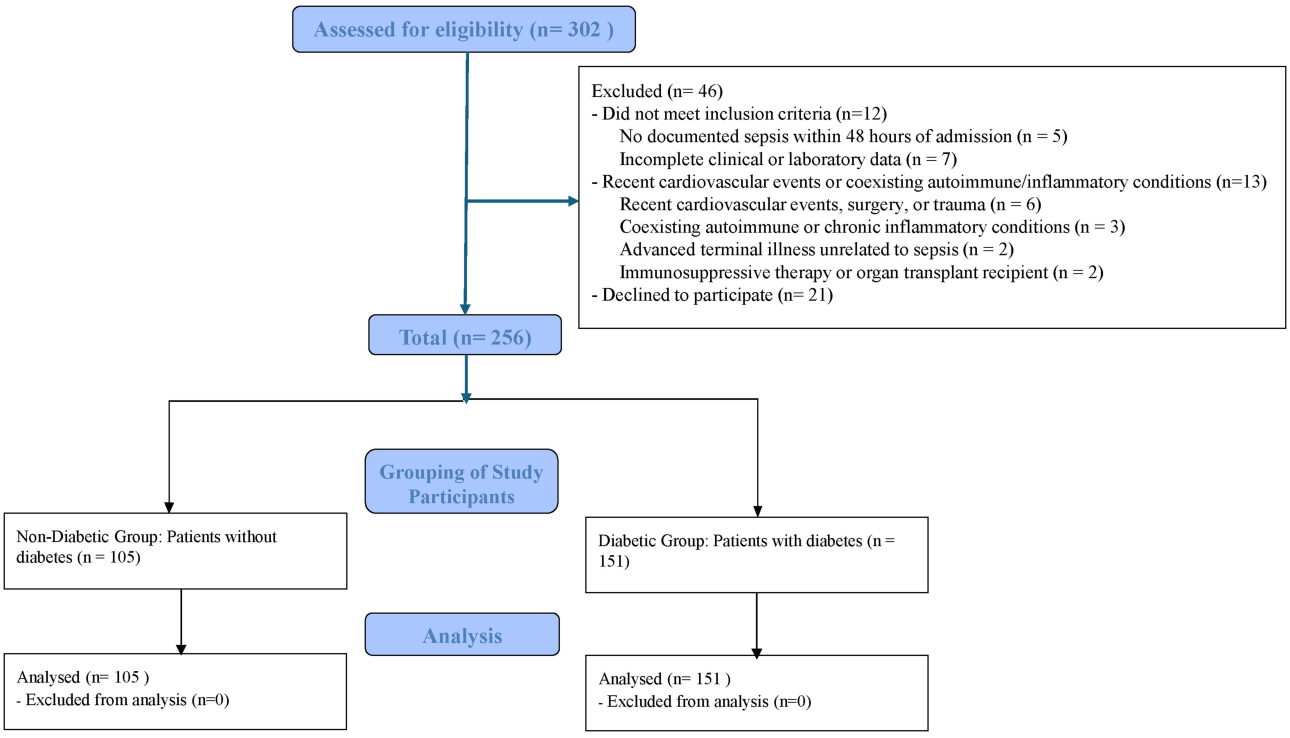

Figure 1 Flowchart of Patient Enrollment and Grouping.

2) Immunocompromised Status: Patients with primary or secondary immunodeficiencies, including those receiving immunosuppressive therapy (eg, steroids with a cumulative dose equivalent to prednisone ≥20 mg/day for more than 7 days, or the use of other immunosuppressive drugs such as calcineurin inhibitors, methotrexate, or biologic agents), or those undergoing organ transplantation, were excluded due to their distinct immune response to infection.
3) Severe End-Stage Disease: Patients with end-stage terminal diseases such as advanced cancer or chronic organ failure (liver failure, heart failure) not related to diabetes or sepsis were excluded.
4) Recent Surgery or Trauma: Patients who had undergone major surgery or trauma within the preceding 30 days prior to sepsis onset were excluded to minimize confounding due to surgical or traumatic stress.

Data Collection and Outcome Measures

In this study, various clinical and laboratory parameters were collected from all enrolled patients to assess their clinical characteristics and prognosis. On the second day of hospitalization, fasting blood glucose (Glu), hemoglobin A1c (HbA1c), C-reactive protein (CRP), PCT, white blood cell count (WBC), lymphocyte count, alanine aminotransferase (ALT), aspartate aminotransferase (AST), blood urea nitrogen (BUN), and serum creatinine (Cr) were measured. These parameters were selected based on their clinical relevance to inflammation, organ function, and sepsis-related metabolic derangements.

These samples included sputum, midstream clean-catch urine, and pus from infected wound sites. For patients with suspected pulmonary infections, sputum samples were carefully selected to minimize contamination. In such cases, less contaminated specimens were prioritized, such as bronchial lavage fluid, suction catheter aspirates, and sputum collected following morning mouth rinsing. For all patients presenting with fever (≥38.5°C), two blood samples were collected for laboratory analysis.

To evaluate the severity of illness at the time of admission, the worst values within the first 24 hours were used to calculate the Acute Physiology and Chronic Health Evaluation II (APACHE II) score. Additionally, the occurrence of multiple organ dysfunction syndrome (MODS) was recorded, along with patient outcomes to determine prognosis.

Invasive procedures were defined as any of the following performed during the hospital stay for sepsis management: mechanical ventilation, central venous catheterization, urinary catheterization, abscess or fluid drainage, and feeding tube placement.

All patients received clinical care according to standardized hospital guidelines. Glycemic control strategies aimed to maintain blood glucose levels between 7.8 and 10.0 mmol/L using continuous or intermittent insulin infusion therapy, adjusted according to regular glucose monitoring. Initial empiric antibiotic therapy consisted of broad-spectrum antibiotics administered immediately upon sepsis diagnosis, followed by timely adjustments based on microbiological culture and sensitivity results. The sepsis management protocol adhered strictly to the Surviving Sepsis Campaign guidelines, which included early fluid resuscitation, targeted hemodynamic stabilization, vasopressor administration, and comprehensive supportive care for organ dysfunction. These clinical practices were consistently applied to all included patients, although individualized variations occurred based on clinical judgment and patient-specific considerations.

Pathogen Detection

Specimens were collected from all patients and sent to the laboratory for pathogen culturing. Bacterial identification was performed using the VITEK 2 Compact automated microbial analysis system, which is part of the laboratory's diagnostic center. In cases where fungal hyphae were observed under microscopy, and antifungal treatment was found to be effective, fungal infection was considered as a co-infection.

Statistical Analysis

Statistical analyses were performed using SPSS version 17.0 software. Prior to analysis, all data underwent normality testing and homogeneity of variance assessments. For normally distributed continuous data, results are expressed as mean ± standard deviation (SD), while categorical data are presented as frequencies and percentages. Univariate analysis was conducted using the *t*-test for continuous variables and the chi-square (χ^2) test for categorical variables. Multivariate analysis was performed using Spearman correlation analysis and logistic regression. For non-normally distributed continuous data, results are presented as median (interquartile range) [M(Q)]. Comparisons between groups for these variables were conducted using the rank-sum test. A p-value of less than 0.05 was considered statistically significant.

Results

Bacterial Species, Infection Sites, and Infection Types in Diabetic and Non-Diabetic Sepsis Patients

The comparison between diabetic and non-diabetic sepsis patients revealed notable differences in bacterial species, infection sites, and infection types. In terms of bacterial species, Klebsiella was the most prevalent in both groups, though non-diabetic patients had a higher proportion (36.42%) compared to diabetic patients (24.00%). Diabetic patients had a significantly higher incidence of Escherichia coli (25.50%) than non-diabetic patients (10.60%). Although both groups had similar proportions of Acinetobacter baumannii (16.00% vs 15.89%), non-diabetic patients showed a higher rate of Pseudomonas aeruginosa (7.95%) compared to diabetic patients (4.50%) (Table 1).

Table 1 Bacterial Species and Composition Ratios Between the Diabetic and Non-Diabetic Groups [Strains, (%)]

Group	Klebsiella	Acinetobacter baumannii	P. aeruginosa	M. morganii	E. coli	Staphylococcus	Enterococcus	Others
Diabetic Group	48 (24.00%)	32 (16.00%)	9 (4.50%)	16 (8.00%)	51 (25.50%)	10 (5.00%)	26 (13.00%)	8 (4.00%)
Non-Diabetic Group	55 (36.42%)	24 (15.89%)	12 (7.95%)	12 (7.95%)	16 (10.60%)	9 (5.96%)	10 (6.62%)	13 (8.61%)
Chi-Squared (χ^2)	6.405	0.001	1.817	0.001	12.371	0.155	10.413	3.250
p-value	0.011**	0.978	0.178	0.986	<0.001***	0.694	0.001***	0.071

Notes: **p < 0.01, ***p < 0.001.
Abbreviations: P. aeruginosa, Pseudomonas aeruginosa; M. morganii, Morganella morganii; E. coli, Escherichia coli.

Regarding infection sites, non-diabetic patients exhibited a higher prevalence of respiratory infections (47.62%) compared to diabetic patients (36.42%), while diabetic patients showed a higher incidence of urinary infections (45.03%) compared to non-diabetic patients (30.48%). The rates of skin and soft tissue infections were comparable between groups, but diabetic patients had a lower proportion of "Others" infection sites (2.65%) compared to non-diabetic patients (8.57%) (Table 2).

In terms of infection types, diabetic patients had a higher proportion of fungal co-infections (23.84%) compared to non-diabetic patients (5.71%). Non-diabetic patients exhibited a higher percentage of single bacterial infections (79.05%) compared to diabetic patients (65.56%), while the latter had a higher incidence of composite bacterial infections (34.44%) than non-diabetic patients (20.95%) (Table 3).

Clinical Characteristics and Prognosis in Diabetic and Non-Diabetic Sepsis Patients

The comparison of clinical characteristics between diabetic and non-diabetic patients with sepsis revealed several significant differences. Diabetic patients, with an average age of 67.5 years, had notably higher HbA1c levels (8.46%) compared to the non-diabetic group (3.58%), reflecting poorer glycemic control. Inflammatory markers, including CRP and PCT, were elevated in the diabetic group, suggesting a more pronounced inflammatory response. The APACHE II score, which indicates the severity of illness, was higher in diabetic patients, further indicating more severe sepsis. Diabetic patients also had higher glucose levels (10.8 mmol/L) compared to their non-diabetic counterparts (4.9 mmol/L). In terms of outcomes, the mortality rate was significantly higher in diabetic patients (25.83% vs 15.24%), and a greater proportion developed multiple organ dysfunction syndrome (31.13% vs 15.24%). Diabetic patients exhibited higher WBC counts (12.1 ± 4.7 vs 11.9 ± 3.5 $\times 10^9$/L; t = 0.37, p = 0.711) and similar lymphocyte counts (1.2 ± 0.5 vs 1.1 ± 0.6 $\times 10^9$/L; t = 1.449, p = 0.149) compared to non-diabetic patients. Hepatic function markers were comparable between groups, with ALT levels of 44 ± 33 vs 43 ± 21 U/L (t = 0.27, p = 0.784) and AST levels of 49 ± 27 vs 48 ± 19 U/L (t = 0.33, p = 0.744). Renal function parameters also showed no significant differences: BUN of 9.8 ± 3.5 vs 9.5 ± 2.8 mmol/L (t = 0.76, p = 0.466) and Cr of 110 ± 38 vs 109 ± 30 μmol/L (t = 0.23, p = 0.822) (Table 4).

Table 2 Infection Sites and Composition Ratios Between the Diabetic and Non-Diabetic Groups [Cases, (%)]

Group	Cases	Respiratory System	Digestive System	Urinary System	Skin and Soft Tissue	Others
Diabetic Group	151	55 (36.42%)	8 (5.30%)	68 (45.03%)	16 (10.60%)	4 (2.65%)
Non-Diabetic Group	105	50 (47.62%)	6 (5.71%)	32 (30.48%)	8 (7.62%)	9 (8.57%)
Chi-Squared (χ^2)	–	3.209	0.021	5.513	0.646	4.507
p-value	–	0.073	0.885	0.019*	0.422	0.034*

Note: *p < 0.05.

Table 3 Infection Types and Composition Ratios Between the Diabetic and Non-Diabetic Groups [Cases, (%)]

Group	Cases	Single Bacterial Infection	Composite Bacterial Infection	Fungal Co-Infection	No Pathogen Detected
Diabetic Group (n=151)	151	99 (65.56%)	52 (34.44%)	36 (23.84%)	12 (7.95%)
Non-Diabetic Group (n=105)	105	83 (79.05%)	22 (20.95%)	6 (5.71%)	9 (8.57%)
Chi-Squared (χ^2)	–	–	5.480	8.450	0.032
p-value	–	–	0.019*	0.004**	0.858

Notes: *p < 0.05, **p < 0.01. Composite bacterial infection refers to the isolation of two or more different bacterial species from clinical specimens obtained from the same patient during the same infectious episode. Single bacterial infection indicates isolation of a single bacterial species. Fungal co-infection indicates concurrent detection of fungal pathogens alongside bacterial pathogens.

Correlation Between Clinical Indicators and 28-Day Prognosis in Diabetic Sepsis Patients

The correlation analysis between clinical indicators and 28-day prognosis in diabetic sepsis patients demonstrated that the APACHE II score exhibited the highest correlation with prognosis ($r = 0.463$, $p < 0.001$). CRP ($r = 0.377$, $p = 0.003$) and PCT ($r = 0.346$, $p = 0.004$) also showed significant correlations. MODS was significantly correlated with prognosis ($r = 0.368$, $p = 0.003$). No significant correlations were observed for glucose ($r = 0.098$, $p = 0.442$) or HbA1c ($r = 0.165$, $p = 0.216$) (Table 5 and Figure 2).

Logistic Regression Analysis of Risk Factors for Mortality in Diabetic Sepsis Patients

The logistic regression analysis included age, sex, Glu, glycated hemoglobin (HbA1c), CRP, PCT, MODS, and APACHE II score as covariates to assess their association with 28-day mortality in diabetic sepsis patients. The analysis identified age (OR = 1.042, 95% CI: 1.002–1.084, $p = 0.040$) and APACHE II score (OR = 1.177, 95% CI: 1.019–1.361, $p = 0.029$) as significant predictors of mortality. Other variables—including sex (OR = 1.32, 95% CI: 0.84–2.08, $p = 0.233$), Glu (OR = 1.05, 95% CI: 0.95–1.17, $p = 0.378$), HbA1c (OR = 1.07, 95% CI: 0.96–1.20, $p = 0.295$), CRP (OR = 1.021, 95% CI: 0.928–1.129, $p = 0.668$), PCT (OR = 1.1, 95% CI: 0.979–1.229, $p = 0.115$), and MODS (OR = 1.702, 95% CI: 0.342–8.421, $p = 0.510$)—were not significantly associated with mortality (Table 6).

Multivariate Prognostic Model Analysis

In addition to mortality-focused regression analysis, we explored a multivariate logistic regression model incorporating APACHE II score, CRP, and PCT to assess their predictive value for 28-day prognosis (survival vs non-survival and presence vs absence of MODS). The integrated model demonstrated that the APACHE II score remained the strongest independent predictor (OR = 1.165, 95% CI: 1.012–1.342, $p = 0.032$), while CRP (OR = 1.018, 95% CI: 0.926–1.121, $p = 0.661$) and PCT (OR = 1.083, 95% CI: 0.975–1.205, $p = 0.135$) did not reach statistical significance. The overall model yielded an acceptable discriminatory capacity (AUC = 0.74), suggesting that combining these markers may offer some incremental prognostic information, although APACHE II alone retained the dominant predictive role.

Discussion

This study provides important clinical insights by systematically comparing microbiological profiles, infection sites, and outcomes between diabetic and non-diabetic sepsis patients. Our findings reveal that diabetic patients exhibit a distinct pathogen distribution, including a higher prevalence of Escherichia coli and fungal co-infections, which may inform empiric antimicrobial strategies. The elevated levels of inflammatory markers and higher APACHE II scores in diabetic patients underscore their greater disease severity and support the use of these parameters for early risk stratification. Mechanistically, chronic hyperglycemia contributes to immune dysfunction by impairing neutrophil function, promoting oxidative stress, and activating pro-inflammatory pathways that compromise endothelial integrity. The accumulation of advanced glycation end-products (AGEs) further exacerbates inflammation through RAGE-mediated signaling, leading to increased vascular permeability and tissue injury. These pathophysiological changes help explain the heightened vulnerability and worse outcomes observed in diabetic patients with sepsis, emphasizing the need for optimized glycemic control and tailored therapeutic approaches.[14,15]

One of the most notable differences between diabetic and non-diabetic sepsis patients was the composition of bacterial species. While Klebsiella remained the most common pathogen in both groups, its prevalence was higher among non-diabetic patients (36.42% vs 24.00%). In contrast, diabetic patients exhibited a significantly increased incidence of Escherichia coli infections (25.50% vs 10.60%), likely reflecting their greater susceptibility to urinary tract infections.[16,17] The diabetic group also had a markedly higher proportion of fungal co-infections (23.84% vs 5.71%), consistent with prior reports associating diabetes with fungal infections due to impaired innate immunity and hyperglycemic microenvironments. Differences in infection sites further support distinct pathophysiological profiles between the groups. Diabetic patients showed a higher prevalence of urinary infections (45.03% vs 30.48%), possibly driven by glycosuria-induced bacterial growth and urinary stasis.[18,19] Conversely, respiratory infections were more

Table 4 Comparison of Clinical Indicators Between the Diabetic and Non-Diabetic Groups

Group	Sex (Male/ Female)	Age (years, mean ± SD)	HbA1c (%, mean ± SD)	CRP [mg/dL, median (Q1, Q3)]	PCT [ng/mL, median (Q1, Q3)]	APACHE II (score, mean ± SD)	Glu (mmol/L, mean ± SD)	Mortality [n, (%)]	MODS (n)	Invasive Procedures (n)	WBC (10^9/L, mean ± SD)	Lymphocyte (10^9/L, mean ± SD)	ALT (U/L, mean ± SD)	AST (U/L, mean ± SD)	BUN (mmol/L, mean ± SD)	Cr (μmol/L, mean ± SD)
Diabetes (n=151)	74/77	67.5 ± 6.0	8.46 ± 2.72	0.45 (0.16, 4.30)	7.9 (2.05, 13.5)	13.4 ± 6.5	10.8 ± 3.6	39 (25.83%)	47 (31.13%)	37 (24.50%)	12.1 ± 4.7	1.2 ± 0.5	44 ± 33	49 ± 27	9.8 ± 3.5	110 ± 38
Non-Diabetes (n=105)	51/54	66.9 ± 6.3	3.58 ± 1.09	0.37 (0.14, 3.18)	3.7 (1.55, 9.98)	10.7 ± 4.4	4.9 ± 1.6	16 (15.24%)	16 (15.24%)	16 (15.24%)	11.9 ± 3.5	1.1 ± 0.6	43 ± 21	48 ± 19	9.5 ± 2.8	109 ± 30
χ^2/t/Z value	0.004	0.771	17.60	4.506	3.118	3.706	15.74	4.117	8.426	3.239	0.370	1.449	0.274	0.327	0.731	0.225
P-value	0.945	0.441	<0.001	<0.01**	<0.05*	<0.001**	<0.001**	<0.05**	<0.01*	0.072**	0.711	0.149	0.784	0.744	0.466	0.822

Notes: *p < 0.05, **p < 0.01.

Abbreviations: HbA1c, Glycated Hemoglobin; CRP, C-reactive Protein; PCT, Procalcitonin; APACHE II, Acute Physiology and Chronic Health Evaluation II; MODS, Multiple Organ Dysfunction Syndrome; Glu, Glucose; WBC, White Blood Cell Count; ALT, Alanine Aminotransferase; AST, Aspartate Aminotransferase; BUN, Blood Urea Nitrogen; Cr, Creatinine.

Table 5 Correlation Between Various Indicators and 28-Day Prognosis in Diabetic Sepsis Patients

Indicator	r Value	P value
Glu	0.098	0.442
HbA1c	0.165	0.216
PCT	0.346	0.004
CRP	0.377	0.003
APACHE II score	0.463	<0.001
MODS	0.368	0.003

Abbreviations: Glu, Glucose; HbA1c, Glycated Hemoglobin; PCT, Procalcitonin; CRP, C-reactive Protein; APACHE II, Acute Physiology and Chronic Health Evaluation II; MODS, Multiple Organ Dysfunction Syndrome.

common in non-diabetic patients (47.62% vs 36.42%), which may reflect differences in pathogen exposure, pulmonary defense mechanisms, or comorbidity profiles. These findings suggest that diabetic status not only alters host immunity but may also influence pathogen distribution and infection localization, underscoring the need for stratified antimicrobial strategies in diabetic sepsis.[20]

In terms of clinical characteristics, diabetic patients exhibited significantly higher HbA1c levels (8.46% vs 3.58%), reflecting poor long-term glycemic control. Inflammatory markers, including CRP and PCT, were also elevated, indicating an amplified systemic inflammatory response. These observations are consistent with the concept that chronic hyperglycemia contributes to immune dysregulation, endothelial dysfunction, and exaggerated cytokine release in sepsis.[21] The APACHE II score, a composite measure of illness severity, was significantly higher in diabetic patients (13.4 ± 6.5 vs 10.7 ± 4.4), reflecting more severe organ dysfunction at presentation. Importantly, diabetic patients experienced worse outcomes, including higher mortality (25.83% vs 15.24%) and a greater incidence of multiple organ

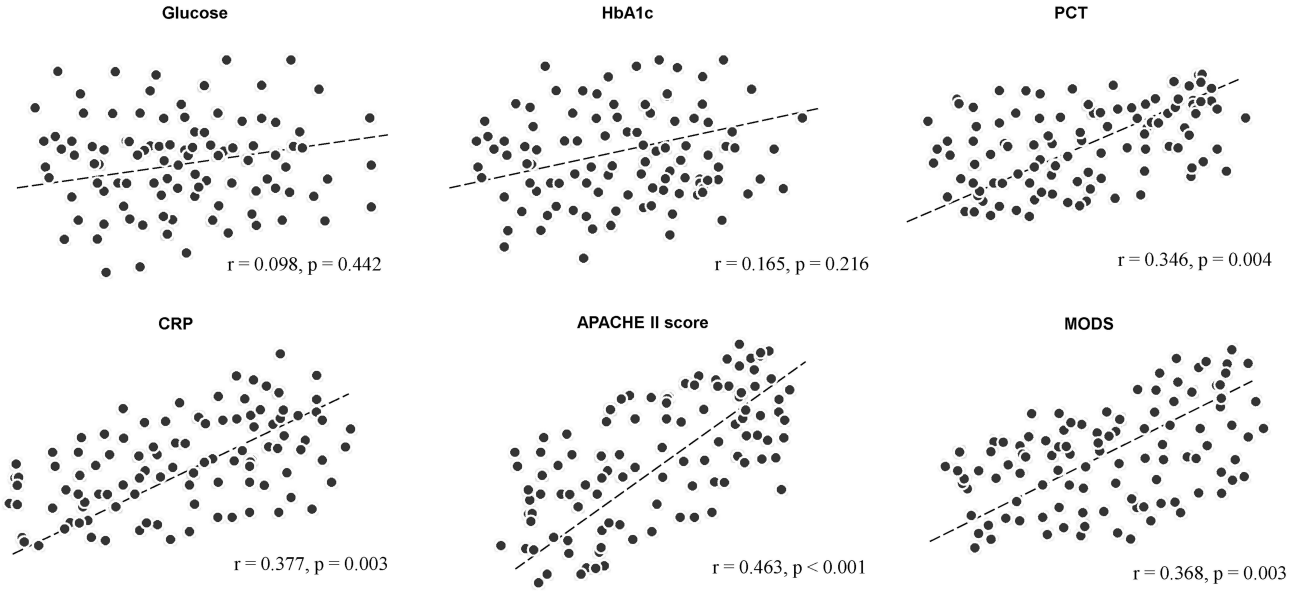

Figure 2 Spearman correlation analyses between six baseline clinical indicators and 28-day prognosis in diabetic sepsis patients are presented as scatter plots with smoothing lines. Glucose (Glu) demonstrated no significant association (r = 0.098, p = 0.442), nor did glycated hemoglobin (HbA_1c; r = 0.165, p = 0.216). In contrast, procalcitonin (PCT; r = 0.346, p = 0.004), C-reactive protein (CRP; r = 0.377, p = 0.003), and Multiple Organ Dysfunction Syndrome score (MODS; r = 0.368, p = 0.003) each exhibited moderate positive correlations with 28-day prognosis, while the Acute Physiology and Chronic Health Evaluation II score (APACHE II) showed a strong positive correlation (r = 0.463, p < 0.001).

Abbreviations: Glu, glucose; HbA_1c, glycated hemoglobin; PCT, procalcitonin; CRP, C-reactive protein; APACHE II, Acute Physiology and Chronic Health Evaluation II; MODS, Multiple Organ Dysfunction Syndrome.

Table 6 Logistic Regression Analysis of Risk Factors for Mortality in Diabetic Sepsis Patients

Factors	β Value	Wald Value	OR Value	95% CI for OR	P-value
Age (years)	0.041	4.21	1.042	1.002–1.084	0.040
Sex (male)	0.276	1.42	1.32	0.84–2.08	0.233
Glu (mmol/L)	0.053	0.78	1.05	0.95–1.17	0.378
HbA1c (%)	0.068	1.1	1.07	0.96–1.20	0.295
CRP	0.021	0.157	1.021	0.928–1.129	0.668
PCT	0.095	2.372	1.1	0.979–1.229	0.115
MODS	0.532	0.421	1.702	0.342–8.421	0.510
APACHE II score	0.163	4.827	1.177	1.019–1.361	0.029

Abbreviations: Glu, Glucose; HbA1c, Glycated Hemoglobin; CRP, C-reactive Protein; PCT, Procalcitonin; MODS, Multiple Organ Dysfunction Syndrome; APACHE II, Acute Physiology and Chronic Health Evaluation II.

dysfunction syndrome (31.13% vs 15.24%). These findings align with existing literature suggesting that diabetes exacerbates sepsis severity and impairs recovery through a combination of metabolic derangements, immune suppression, and pro-inflammatory states.[22,23]

The correlation analysis between clinical indicators and 28-day prognosis demonstrated that the APACHE II score had the strongest association with prognosis in diabetic sepsis patients ($r = 0.463$, $p < 0.001$). Although this value did not exceed 0.7, indicating only a moderate correlation strength, it nonetheless reflects a consistent relationship between disease severity and prognosis. Both CRP ($r = 0.377$, $p = 0.003$) and PCT ($r = 0.346$, $p = 0.004$) also exhibited statistically significant but moderate correlations with prognosis, supporting their role as markers of systemic inflammation but suggesting that they alone may not fully capture the complexity of sepsis outcomes.[24,25] Glucose and HbA1c levels were not significantly associated with prognosis ($r = 0.098$, $p = 0.442$ and $r = 0.165$, $p = 0.216$, respectively), highlighting their limited predictive value for short-term sepsis outcomes. This finding may reflect the inherent differences between chronic glycemic control and acute glycemic variability in the context of sepsis. HbA1c primarily reflects long-term glycemic status over the preceding 2–3 months, which does not necessarily capture acute fluctuations in glucose levels during critical illness. Similarly, a single fasting glucose measurement at admission may not adequately represent dynamic changes in glucose homeostasis throughout the disease course. Prior studies have suggested that acute glucose variability, rather than chronic glycemic control, exerts a stronger impact on immune function, endothelial integrity, and sepsis outcomes. Hyperglycemia during sepsis is often multifactorial, influenced not only by baseline diabetes but also by stress-induced hormonal and inflammatory responses. Therefore, the absence of prognostic significance for baseline glucose and HbA1c in our study underscores the need to evaluate dynamic indices such as time-in-target range, glycemic excursions, or stress hyperglycemia ratio in future investigations to more accurately capture the impact of glycemic status on sepsis outcomes.

Logistic regression analysis reaffirmed the APACHE II score as a significant independent predictor of 28-day mortality in diabetic sepsis patients (OR = 1.177, $p = 0.029$), highlighting its value in assessing illness severity. In contrast, CRP, PCT, and MODS did not reach statistical significance in the adjusted model, underscoring the multifactorial pathophysiology of sepsis and the limitations of relying solely on individual biomarkers for prognostication.[26,27] Furthermore, neither glucose nor HbA1c levels were associated with mortality, which may reflect the limited predictive value of static glycemic indicators in acute septic states. HbA1c, as a marker of chronic glycemic control, may not adequately capture the impact of acute glucose variability—a factor increasingly recognized for its prognostic importance but not assessed in this study. To enhance predictive capacity, we constructed a multivariate model integrating APACHE II, CRP, and PCT. Although the combined model demonstrated acceptable discrimination (AUC = 0.74), only the APACHE II score remained an independent predictor, while inflammatory markers contributed minimally. These findings reinforce the primacy of comprehensive severity scoring systems over isolated laboratory values in mortality prediction. Nonetheless, future research incorporating dynamic glycemic metrics and novel biomarkers may further refine risk stratification models for diabetic patients with sepsis.

Several recent studies have explored the relationship between diabetes and sepsis risk or prognosis using various clinical markers and modeling approaches. Lin et al[28] constructed a nomogram to predict sepsis risk in diabetic foot patients based on variables such as HbA1c, CRP, and albumin, reporting high diagnostic performance (AUC = 0.919). While consistent with our findings that hyperglycemia and inflammation are associated with adverse outcomes, their model focused on a specific population (diabetic foot), whereas our study evaluates a broader sepsis cohort, allowing generalization across diverse infection types. Sun et al[29] demonstrated the predictive utility of NLR and PNI in diabetic foot ulcer–related sepsis. In contrast to their focus on nutritional and hematologic indices, our study integrates organ dysfunction scores (APACHE II) and microbial profiles, offering a more comprehensive framework for prognostication in diabetic sepsis. Takahashi et al[30] investigated inflammatory markers in hyperglycemic emergencies and found CRP superior to PCT for predicting bacteremia in DKA/HHS. While our findings similarly showed limited prognostic value for PCT, we extend these observations to a sepsis population with or without diabetes and identify APACHE II as a more robust independent predictor. Pandey et al[31] applied metabolomics to uncover disease-specific metabolic shifts in septic shock patients with comorbidities including diabetes. Although their approach elucidates mechanistic insights, it lacks clinical risk stratification. Our study bridges this gap by correlating clinical markers, infection patterns, and outcomes, emphasizing the relevance of integrating microbiologic and physiologic parameters for individualized management. Taken together, while prior studies have addressed components of diabetic sepsis, our research offers a unique, comprehensive analysis combining pathogen distribution, infection site variation, inflammatory markers, and organ dysfunction severity. This integrated approach enhances understanding of how diabetes modifies sepsis trajectory and reinforces the value of composite clinical scoring over isolated biomarkers for mortality prediction.

This study has several limitations. First, the single-center and retrospective design may introduce selection bias and limit the generalizability of the findings. Additionally, due to the limited sample size, we were unable to perform propensity score matching or multivariable adjustment, thereby limiting the ability to draw causal inferences. Second, logistic regression analysis was conducted exclusively in diabetic sepsis patients in alignment with the study's predefined objective. While this approach allowed for subgroup-specific insights, future investigations should compare prognostic indicators between diabetic and non-diabetic populations to provide a more comprehensive understanding of diabetes-related risk modifications. Third, although invasive procedures were recorded, they were not included in the prognostic models. This decision was based on the recognition that the need for such interventions is strongly influenced by initial illness severity and clinical judgment. Larger multicenter studies with standardized treatment data are needed to evaluate their independent prognostic value. Fourth, the proposed mechanistic explanations are based on biological plausibility but remain hypothetical. These associations should be validated in prospective studies with temporal analyses or in mechanistic investigations. Fifth, fungal co-infections were not stratified in detail, which may have led to an underestimation of their impact on sepsis severity among diabetic patients. Furthermore, the present analysis did not account for dynamic glycemic measures, specific therapeutic regimens, or patient-level variations in microbiome composition and genetic background, all of which may influence disease progression and outcomes. Future research should prioritize multicenter, prospective designs with larger and more diverse populations to enhance external validity and statistical robustness. Standardized collection of data on comorbidities, invasive interventions, and treatment strategies will be essential. In addition, the incorporation of advanced risk stratification tools may help personalize treatment approaches and improve outcomes in diabetic patients with sepsis.

Conclusions

This study highlights key differences in microbiological profiles, infection sites, and clinical outcomes between diabetic and non-diabetic sepsis patients. Diabetic patients demonstrated a higher prevalence of Escherichia coli and fungal co-infections, more urinary tract infections, and worse clinical outcomes, including increased mortality and MODS incidence. Although the APACHE II score was identified as the strongest independent predictor of 28-day mortality, its correlation with prognosis was only moderate. This underscores the multifactorial pathophysiology of sepsis, suggesting that no single indicator is sufficient for accurate risk stratification. Our findings support the integration of comprehensive clinical scoring systems with biomarker data to improve individualized prognostic assessment in diabetic

patients with sepsis. Future prospective studies are needed to validate these findings and explore additional dynamic predictors of outcome.

Data Sharing Statement

The datasets generated and analyzed during this study are not publicly available but can be obtained from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of Ningbo Medical Center Lihuili Hospital. All study procedures complied with ethical standards from both institutional and national research committees, adhering to the 1964 Helsinki declaration and subsequent amendments. Informed consent was secured from all participants or their legal guardians.

Consent for Publication

Written informed consent for publication was obtained from all patients and/or their families included in this retrospective analysis.

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Disclosure

The authors declare that they have no competing interests in this work.

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