Journal of Inflammation Research

Dovepress
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ORIGINAL RESEARCH

The Diagnostic and Prognostic Value of Procalcitonin and High-Sensitivity C-Reactive Protein in Early-Stage Burn Sepsis: A Retrospective Cohort Study

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Objective: To evaluate procalcitonin (PCT), high-sensitivity C-reactive protein (hs-CRP), and interleukin-6 (IL-6) for early diagnosis and prognosis of burn sepsis.

Methods: A retrospective cohort study included 159 critically ill burn patients (2021–2024) divided into burn sepsis group (n=72) and non-sepsis group (n=87). Clinical data were analyzed to evaluate the biomarkers' diagnostic value. Sepsis patients were further grouped by outcome (mortality/survival) to explore biomarkers' relationship with severity and prognosis.

Results: Compared with the non-sepsis group, the sepsis group had significantly higher early PCT and hs-CRP ($P < 0.05$), with no significant differences in IL-6, white blood cell (WBC) count, or body temperature. Multivariate logistic regression identified PCT and hs-CRP as independent diagnostic factors. Their areas under the receiver operating characteristic (ROC) curve were 0.802 and 0.768, respectively; combined areas under the curve (AUC) was 0.821, all higher than those of body temperature, WBC, and IL-6 (0.536, 0.536, 0.579; $P < 0.05$). In sepsis patients, PCT was positively correlated with creatinine ($r=0.625$, $R^2=0.362$; $P < 0.05$). Mortality subgroup had higher early PCT, hs-CRP, and IL-6 ($P < 0.05$), but these were not independent mortality risk factors.

Conclusion: PCT and hs-CRP are useful for early burn sepsis diagnosis, with combined detection improving efficacy. Body temperature, WBC, and IL-6 have limited diagnostic value. Elevated PCT may relate to acute kidney injury. Early biomarker levels correlate with sepsis severity but have limited prognostic value.

Keywords: procalcitonin, high-sensitivity C-reactive protein, interleukin-6, burn sepsis, diagnosis, prognosis

Background

Sepsis is a common clinical complication in burn patients and a leading cause of mortality among critically ill burn victims.[1] Currently, a consensus exists that early detection, early diagnosis, and early intervention are crucial for the treatment of sepsis and for reducing its mortality. In patients with extensive burns, the systemic inflammatory response and hypermetabolic state can mimic and mask underlying sepsis, making the diagnosis of sepsis in burn patients particularly challenging.[2]

Although the four existing diagnostic criteria for burn-related sepsis[3–6] have been validated with clinical data and demonstrate good applicability, they involve numerous and complex parameters. Moreover, under severe burn conditions,

https://doi.org/10.2147/JIR.S571738
Received: 23 November 2025
Accepted: 22 February 2026
Published: 18 March 2026

traditional diagnostic indicators such as elevated heart rate, respiratory rate, body temperature, and white blood cell count are often unreliable.[7] Early clinical symptoms in burn patients are typically subtle and easily overlooked until obvious clinical events, such as severe shock, occur. This oversight can delay antibiotic therapy, ultimately contributing to increased incidence and mortality of burn-related sepsis.[8] Furthermore, widely accepted diagnostic guidelines for sepsis require pathogen confirmation.[9,10] However, using current culture techniques may take several days, potentially leading to delays in diagnosis and treatment.

The utilization of readily available biomarkers to facilitate timely and accurate diagnosis would be highly beneficial for burn sepsis.[11] Procalcitonin (PCT), a 116-amino acid peptide precursor of calcitonin, has been described as one of the most promising biomarkers for bacterial infection.[12] While PCT has been extensively studied in burn patients, the associated clinical findings have yielded conflicting results.[13,14] Moreover, the significance of PCT as an indicator of systemic infection in severely burned patients remains controversial.[15] High-sensitivity C-reactive protein (hs-CRP) is an acute-phase reactant that increases during inflammatory states,[16] and has been widely studied in the fields of cardiovascular disease and neonatal bacterial infections. Regarding its relationship with sepsis, relevant studies have indicated that hs-CRP may serve as a valuable marker for assessing disease severity in pediatric patients and demonstrates moderate diagnostic utility.[17] However, few studies have reported on the diagnostic value of hs-CRP specifically in burn sepsis.

Interleukin-6 (IL-6) is a pivotal inflammatory cytokine that plays a significant role in immune signaling and the activation of inflammatory pathways.[18] Research by Borden et al indicated that IL-6 is closely associated with the inflammatory response triggered by microbial invasion.[19] Furthermore, significantly elevated serum IL-6 levels have been correlated with an increased risk of mortality in sepsis.[20,21] Nevertheless, findings regarding the predictive value of IL-6 for burn sepsis remain contentious across studies.[22,23] In clinical practice, PCT, hs-CRP, and IL-6 are easily accessible biomarkers with low detection costs, making them feasible for use even in many resource-limited settings. To promote early diagnosis and treatment of sepsis in critically ill burn patients, thereby reducing mortality risk and rates, it is valuable to investigate the diagnostic and prognostic utility of these three biomarkers in relation to sepsis.

Methods

Study Design

This retrospective study collected clinical data from patients with burn sepsis admitted to the Department of Burn Surgery at the Second Affiliated Hospital of Kunming Medical University between 2021 and 2024. The study protocol was approved by the hospital's Ethics Committee, and no personal information of any patient was disclosed during the research.

The inclusion criteria were as follows: (1) Age ≥ 18 years, regardless of gender; (2) Patients with severe burns or greater, defined as total burn area greater than or equal to 31%, or third-degree burn area greater than or equal to 11%, or accompanied by moderate to severe inhalation injury;[24] (3) Burn etiology was thermal injury, including flame burns, hot liquid scalds, contact burns, and steam burns; (4) Availability of recorded blood test results within the initial two hours of admission to the burn ward.

The exclusion criteria were as follows: (1) Severe combined injuries or multiple trauma, defined as: craniocerebral injury (GCS < 13), severe thoracoabdominal trauma requiring surgery, pelvic or long bone fractures requiring fixation, or Injury Severity Score (ISS) > 15; (2) Pre-existing severe comorbidities or major organ dysfunction, including: including: diabetes, hypertension, heart disease, chronic kidney disease, chronic liver disease, active malignancy, long-term immunosuppressive therapy, or immunodeficiency disorders; (3) Readmission due to causes related to the same burn wound, including: staged reconstructive surgery, recurrence of wound infection/sepsis, or treatment interruption followed by readmission; (4) Incomplete clinical data; (5) Patients with electrical burns, chemical burns, or radiation burns; (6) Other conditions judged by ≥2 investigators to significantly compromise study quality.

In our burn unit, serum levels of PCT, hs-CRP and IL-6 are routinely measured as part of the standardized admission laboratory panel for all critically ill burn patients. This protocol is implemented to enable early detection of systemic inflammation and infection, consistent with institutional practices previously described in studies supporting the utility of these biomarkers in high-risk populations,[25–28] thereby ensuring systematic assessment and minimizing selection bias.

Additionally, venous blood samples were collected within 2 hours of admission to the burn unit for all enrolled patients. Following sample submission, standardized testing for PCT, hs-CRP, and IL-6 levels was performed. This blood collection timing is an integral part of our hospital's standardized admission protocol for critically ill burn patients, ensuring all patients undergo biomarker testing within an early and relatively uniform post-burn time window. This approach minimizes biological variability arising from sampling time differences.

Inhalation injury was diagnosed based on fiberoptic bronchoscopy findings, combined with clinical history and physical signs. All patients with suspected aspiration injury underwent fiberoptic bronchoscopy upon admission. Bronchoscopic diagnostic criteria included: mucosal hyperemia, edema, erosion, necrosis, soot deposition, or intraluminal soot residue. Inhalation injury was recorded as a key clinical variable and adjusted for in baseline comparisons and multivariate regression analyses.

Data were extracted from electronic medical records using a standardized case report form. The following variables were collected: Demographics: age, gender. Burn characteristics: burn index, TBSA, inhalation injury, Tracheal intubation situation. Clinical parameters: body temperature (T), heart rate (HR), respiratory rate (R), mean arterial pressure (MAP), Glasgow Coma Scale (GCS), Modified Early Warning Score (MEWS), SOFA score. Laboratory biomarkers: PCT, hs-CRP, IL-6, white blood cell count (WBC), neutrophil percentage (NEUT%), platelet count (PLT), total bilirubin (TBIL), creatinine, lactate, glucose, and PaO_2/FiO_2 ratio. Outcomes: development of sepsis, in-hospital mortality.

A total of 159 eligible critically ill burn patients were included in this study. Based on the Sepsis-3 diagnostic criteria, the patients were divided into two groups for analysis: the burn sepsis group (n = 72) and the burn non-sepsis group (n = 87). The Sepsis-3 criteria define sepsis as a suspected or confirmed infection accompanied by an acute increase in the Sequential Organ Failure Assessment (SOFA) score of ≥ 2 points.[3] According to the outcomes of the burn sepsis patients, they were further classified into a deceased group and a survival group. Clinical data were statistically analyzed to investigate the relationships of PCT, hs-CRP, and IL-6 with the severity and prognosis of critically ill burn sepsis patients.

Statistical Analysis

Data collection and recording were performed using Microsoft Excel 2016. Statistical analyses were conducted using IBM SPSS Statistics version 26.0 (SPSS Inc., Chicago, IL, USA) and MedCalc version 22.019. Normally distributed quantitative data were expressed as mean ± standard deviation ($\bar{x} \pm s$), while non-normally distributed data were presented as median and interquartile range [M (P25~P75)]. For comparisons between two groups, the independent samples *t*-test was used if data followed a normal distribution and homogeneity of variance was met; if normality was met but variance was uneven, the t′-test was applied; otherwise, the Mann–Whitney *U*-test was employed. Categorical data were expressed as rates [n (%)], and group comparisons were performed using the chi-square test or Fisher′s exact test, as appropriate. After assessing multicollinearity, multivariate binary logistic regression analysis was conducted to identify factors associated with the study outcomes.

Receiver operating characteristic (ROC) curve analysis was used to evaluate the diagnostic performance of clinical indicators. The Youden index was applied to determine the optimal cutoff values for diagnostic markers. The Z-test was employed to compare differences in the areas under the curve (AUC). Spearman′s correlation coefficient was used to assess correlations between clinical indicators: an absolute correlation coefficient (r) value of 0.8–1.0 indicated a very strong correlation; 0.6–0.8, a strong correlation; 0.4–0.6, a moderate correlation; 0.2–0.4, a weak correlation; and 0.0–0.2, a very weak or negligible correlation. Additionally, univariate linear regression analysis was performed to illustrate linear relationships between clinical indicators. A two-tailed p-value < 0.05 was considered statistically significant for all analyses.

Results

Comparison of Baseline Characteristics

The study included 159 critically ill burn patients: 72 (45%) in the sepsis group and 87 (55%) in the non-sepsis group. No significant differences were found between groups in age, gender, burn index, GCS score, PaO_2/FiO_2 ratio, T, HR, R, and

MAP (P > 0.05), indicating good comparability. Significant differences were observed in MEWS, hs-CRP, PCT, TBIL, creatinine, lactate, presence of inhalation injury, and rate of tracheal intubation (P < 0.05). No significant differences were found in IL-6, WBC, NEUT%, PLT, and blood glucose (P > 0.05). The in-hospital mortality rate was significantly higher in the sepsis group compared to the non-sepsis group (P < 0.05). (See Table 1).

Analysis of Factors Associated with Burn Sepsis Diagnosis

Multicollinearity Diagnostics

The eight significantly different variables (MEWS, hs-CRP, PCT, TBIL, creatinine, lactate, inhalation injury, tracheal intubation) underwent collinearity diagnosis. Tolerance values were all less than 1 but greater than 0.1, and variance inflation factors (VIF) were all less than 10 (Table 2), indicating no significant multicollinearity.

Table 1 Comparison of Baseline Characteristics of the Patients

	Sepsis Group (n = 72)	**Non-Sepsis Group (n = 87)**	**Z/χ^2/t**	**p−value**
Age (years)	48 (37~55)	42 (34~51)	−1.504	0.133
Gender (n,%)				
Male	61 (84.7%)	65 (74.7%)	2.40	0.121
Female	11 (15.3%)	22 (25.3%)		
Burn Index (%)	49.3 (25~79.5)	44 (35.5~56.5)	−1.272	0.203
GCS	15 (15~15)	15 (15~15)	−1.008	0.314
PO_2/FiO_2 (mmHg)	296±117	331±109	−1.969	0.051
T (°C)	37.2 (36.9~37.8)	37.3 (37~37.8)	−0.784	0.433
HR (beats/min)	109 (98~130)	114 (100~124)	−0.564	0.573
R (times/min)	22 (21~23)	22 (21~22)	−1.329	0.184
MAP (mmHg)	83 (74~87)	84 (79~88)	−0.658	0.511
MEWS	5 (4~7)	4 (3~5)	−3.556	<0.001
hs-CRP (mg/L)	57.2 (28.5~117.1)	10 (1.4~33.8)	−5.81	<0.001
PCT (ng/mL)	4.77 (1.14~17.66)	0.42 (0.13~1.56)	−6.536	<0.001
IL-6 (pg/mL)	166.8 (72.1~415.4)	131.9 (59.1~272.5)	−1.702	0.089
WBC (10^9/L)	17.5 (11.2~29.5)	21.2 (14.7~27.6)	−0.775	0.438
NEUT (%)	84.9 (77.3~88)	86.5 (81.4~89.4)	−1.9	0.057
PLT (10^9/L)	271 (101~409)	243 (152~320)	−0.31	0.757
TBIL (umol/L)	24.4 (13.9~36.3)	19.1 (13.8~27.9)	−2.047	0.041
Glucose (mmol/L)	7.6 (6.2~9.9)	7.5 (5.9~9.5)	−0.542	0.588
Creatinine (umol/L)	97 (71~140)	77 (61~97)	−3.101	0.002
Lactic acid (mg/L)	3.2 (1.6~5.6)	2.1 (1.2~4)	−2.991	0.003
Inhalation injury [n(%)]	41 (56.9%)	32 (36.8%)	6.45	0.011
Tracheal intubation [n(%)]	36 (50%)	23 (26.4%)	9.373	0.002
Mortality [n(%)]	32 (44.4%)	4 (4.6%)	35.713	<0.001

Table 2 Results of the Multicollinearity Test

Factor	**Tolerance (Tol)**	**Variance Inflation Factor (VIF)**
MEWS	0.702	1.424
hs-CRP	0.876	1.142
PCT	0.624	1.601
TBIL	0.695	1.439
Creatinine	0.626	1.598
Lactic acid	0.692	1.444
Inhalation injury	0.496	2.017
Tracheal intubation	0.457	2.189

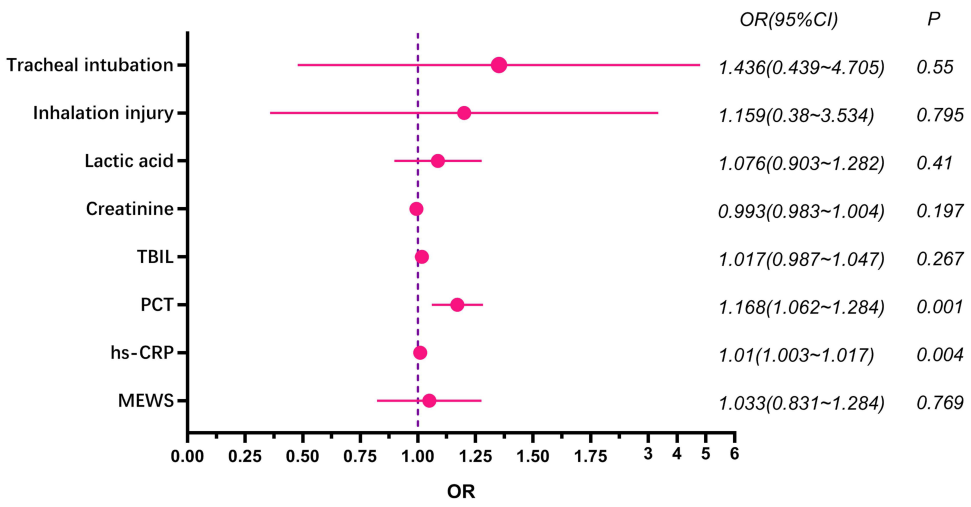

Figure 1 Results of the binary logistic regression analysis.

Multivariate Logistic Regression Analysis

Multivariate binary logistic regression analysis of the eight variables identified only PCT (OR 1.168, 95% CI: 1.062~1.284, P=0.001) and hs-CRP (OR 1.01, 95% CI: 1.003~1.017, P=0.004) as independent factors significantly associated with the diagnosis of burn sepsis (Figure 1).

ROC Curve Analysis for Burn Sepsis Diagnosis

ROC curve analysis was performed for T, WBC, IL-6, hs-CRP, PCT, and the combined hs-CRP+PCT indicator. The AUC values for T, WBC, and IL-6 were 0.536, 0.536, and 0.579, respectively ($P > 0.05$). For hs-CRP and PCT, the AUC values were 0.768 and 0.802, with sensitivities of 81.94% and 69.44%, specificities of 65.52% and 79.31%, and optimal cut-off values of >22.47 mg/L and >1.76 ng/mL, respectively ($P < 0.05$). The combined hs-CRP+PCT indicator had an AUC of 0.821, sensitivity of 77.78%, and specificity of 78.16% ($P < 0.05$). The diagnostic performance (AUC) of the combined indicator was not significantly different from PCT alone ($P > 0.05$) but was significantly better than T, WBC, IL-6, and hs-CRP alone ($P < 0.05$). PCT performed significantly better than T, WBC, and IL-6 ($P < 0.05$) but not significantly better than hs-CRP alone ($P > 0.05$). Hs-CRP performed significantly better than T, WBC, and IL-6 ($P < 0.05$). (See Table 3 and Figure 2).

Correlation Analysis of Early PCT and Hs-CRP with Other Clinical Indicators in Burn Sepsis Patients

Correlation Analysis of Early PCT

PCT levels showed significant positive correlations with burn index (r=0.36, R^2=0.083, P=0.014), HR (r=0.409, R^2=0.158, P<0.001), R (r=0.29, R^2=0.1, P=0.007), MEWS score (r=0.361, R^2=0.157, P<0.001), IL-6 (r=0.41,

Table 3 ROC Curve Analysis of the Predictive Model for Burn Sepsis Diagnosis

Factor	AUC	Cut-Off	Sensitivity (%)	Specificity (%)	Youden's Index	95% CI	p−value
T	0.536	≤36.9	29.17	81.61	0.108	0.455~0.615	0.441
WBC	0.536	≤19.58	58.33	58.62	0.17	0.455~0.615	0.453
IL-6	0.579	>262.5	40.28	74.71	0.15	0.498~0.656	0.086
hs-CRP	0.768 [a]	>22.47	81.94	65.52	0.475	0.695~0.831	<0.001
PCT	0.802 [bc]	>1.76	69.44	79.31	0.488	0.731~0.861	<0.001
hs-CRP + PCT [#]	0.821 [de]	>0.35	77.78	78.16	0.559	0.752~0.877	<0.001

Notes: [#]The logistic regression equation is defined by the regression coefficients (β) as follows: Logit(p) = −1.434 + 0.01 * hs-CRP + 0.153 * PCT. [a]hs-CRP vs T/WBC/IL-6, P<0.05; [b]PCT vs hs-CRP, P>0.05; [c]PCT vs T/WBC/IL-6, P<0.05; [d]hs-CRP+PCT vs PCT, P>0.05; [e]hs-CRP+PCT vs T/WBC/IL-6/hs-CRP, P<0.05.

https://doi.org/10.2147/JIR.S571738

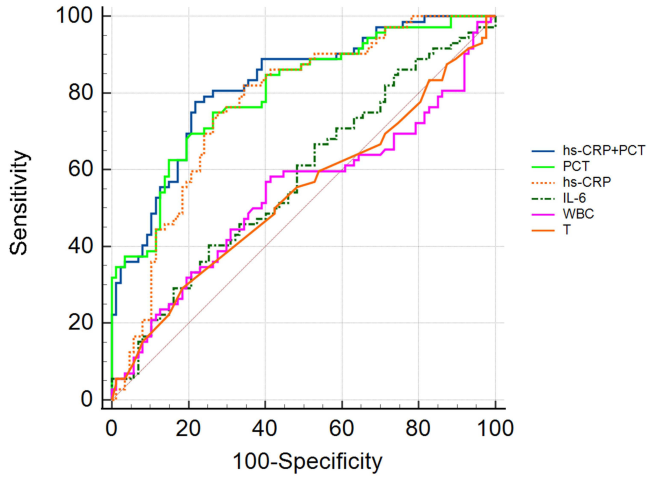

Figure 2 ROC curve analysis.

R^2=0.158, P<0.001), WBC (r=0.308, R^2=0.092, P=0.035), TBIL (r=0.325, R^2=0.139, P=0.008), creatinine (r=0.625, R^2=0.362, P<0.001), and lactate (r=0.391, R^2=0.06, P=0.038). (Details would be in Table 4 and Figure 3).

Correlation Analysis of Early Hs-CRP

Hs-CRP levels correlated with PaO_2/FiO_2 (r=−0.33, R^2=0.09, P<0.05), T (r=0.334, R^2=0.15, P<0.05), HR (r=0.276, R^2=0.067, P<0.05), R (r=0.274, R^2=0.049, P<0.05), IL-6 (r=0.257, R^2=0.164, P<0.05), WBC (r=−0.409, R^2<0.001, P=0.932, ns), and NEUT% (r=−0.328, R^2=0.055, P<0.05). The relationships with PaO_2/FiO_2, NEUT%, and WBC were negative, while those with T, HR, R, and IL-6 were positive. The correlation with WBC was not statistically significant. (Details would be in Table 5 and Figure 4).

Table 4 Correlation Analysis Between PCT Levels and Clinical Indicators in Burn Sepsis Patients

	Correlation Coefficient (r)	**p−value**
Burn Index (%)	0.36	0.002
GCS	−0.049	0.681
PO_2/FiO_2	−0.076	0.527
T (°C)	−0.062	0.607
HR	0.409	<0.001
R	0.29	0.013
MAP	−0.2	0.093
MEWS	0.361	0.002
hs-CRP	0.217	0.066
IL-6	0.41	<0.001
WBC	0.308	0.009
NEUT%	0.225	0.057
PLT	0.205	0.084
TBIL	0.325	0.005
Glucose	0.08	0.504
Creatinine	0.625	<0.001
Lactic acid	0.391	0.001
Inhalation injury	0.208	0.08
Tracheal intubation	0.211	0.075

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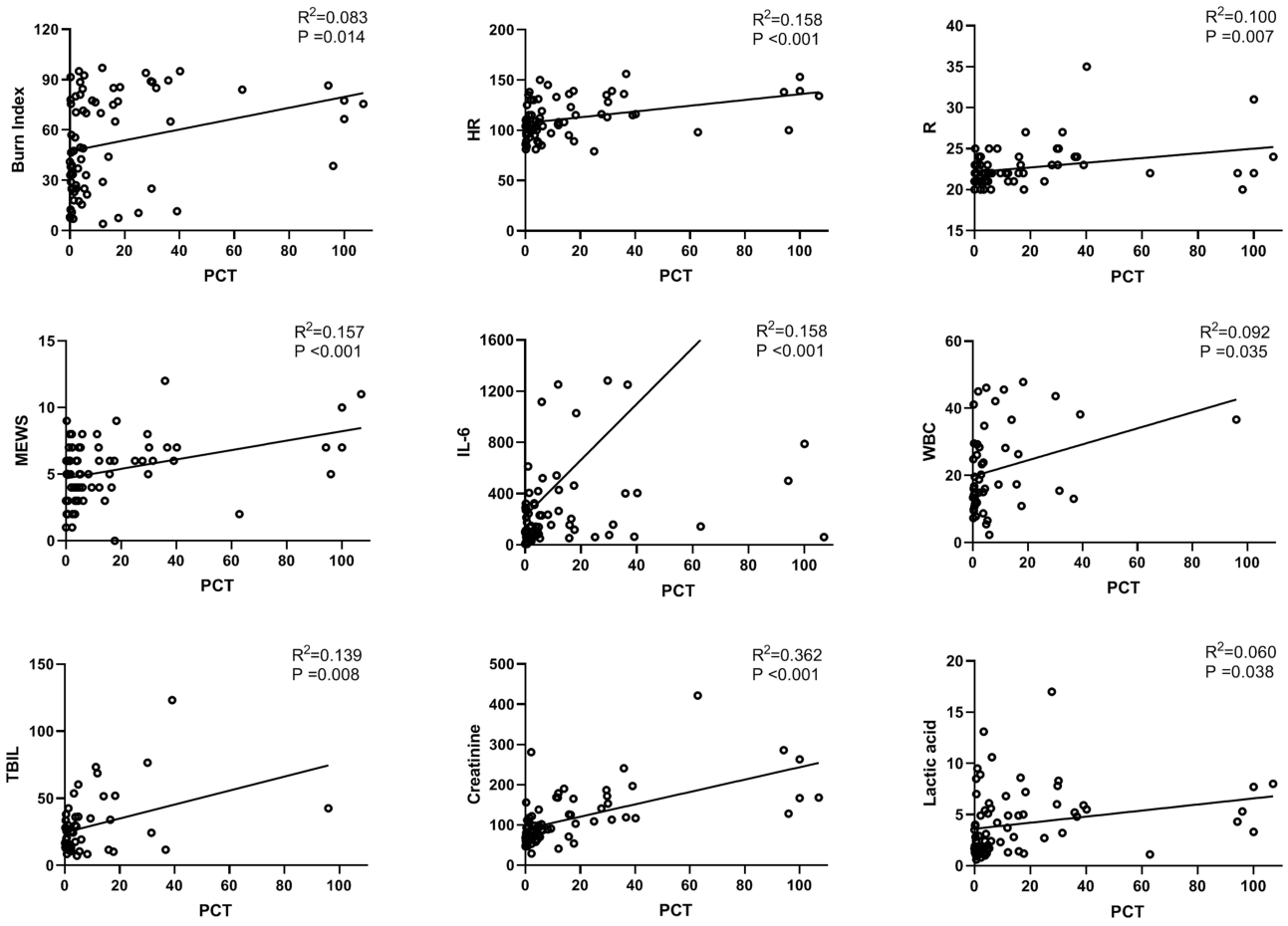

Figure 3 Univariate linear regression analysis of PCT.

Analysis of Early PCT, Hs-CRP, IL-6 Levels and Prognosis in Burn Sepsis Patients

Comparison of Baseline Characteristics (Sepsis Subgroups)

Within the burn sepsis group (n=72), patients were divided into a death group (n=32, 44%) and a survival group (n=40, 56%). Univariate analysis showed significant differences ($P < 0.05$) in burn index, SOFA score, R, MEWS score, hs-CRP, PCT, IL-6, TBIL, creatinine, lactate, proportion with inhalation injury, and proportion with tracheal intubation, all being

Table 5 Correlation Analysis Between Hs-CRP Levels and Clinical Indicators in Burn Sepsis Patients

	Correlation Coefficient (r)	**p−value**
Burn Index (%)	0.117	0.327
GCS	−0.072	0.55
PO_2/FiO_2	−0.33	0.005
T (°C)	0.334	0.004
HR	0.276	0.019
R	0.274	0.02
MAP	0.065	0.585
MEWS	0.16	0.18

(*Continued*)

https://doi.org/10.2147/JIR.S571738

Table 5 (Continued).

	Correlation Coefficient (r)	p−value
IL-6	0.257	0.029
WBC	−0.409	<0.001
NEUT%	−0.328	0.005
PLT	−0.19	0.11
TBIL	−0.132	0.268
Glucose	−0.175	0.141
Creatinine	0.038	0.752
Lactic acid	0.084	0.484
Inhalation injury	0.037	0.757
Tracheal intubation	0.171	0.151

higher in the death group. No significant differences were found in age, gender, GCS score, PaO_2/FiO_2, T, HR, MAP, WBC, NEUT%, PLT, or blood glucose (P > 0.05). (See Table 6).

Analysis of Prognostic Factors in Burn Sepsis

Multicollinearity diagnosis for the factors significant in univariate analysis showed no multicollinearity issues. Subsequent multivariate logistic regression analysis indicated that burn index, SOFA score, R, MEWS, hs-CRP, PCT,

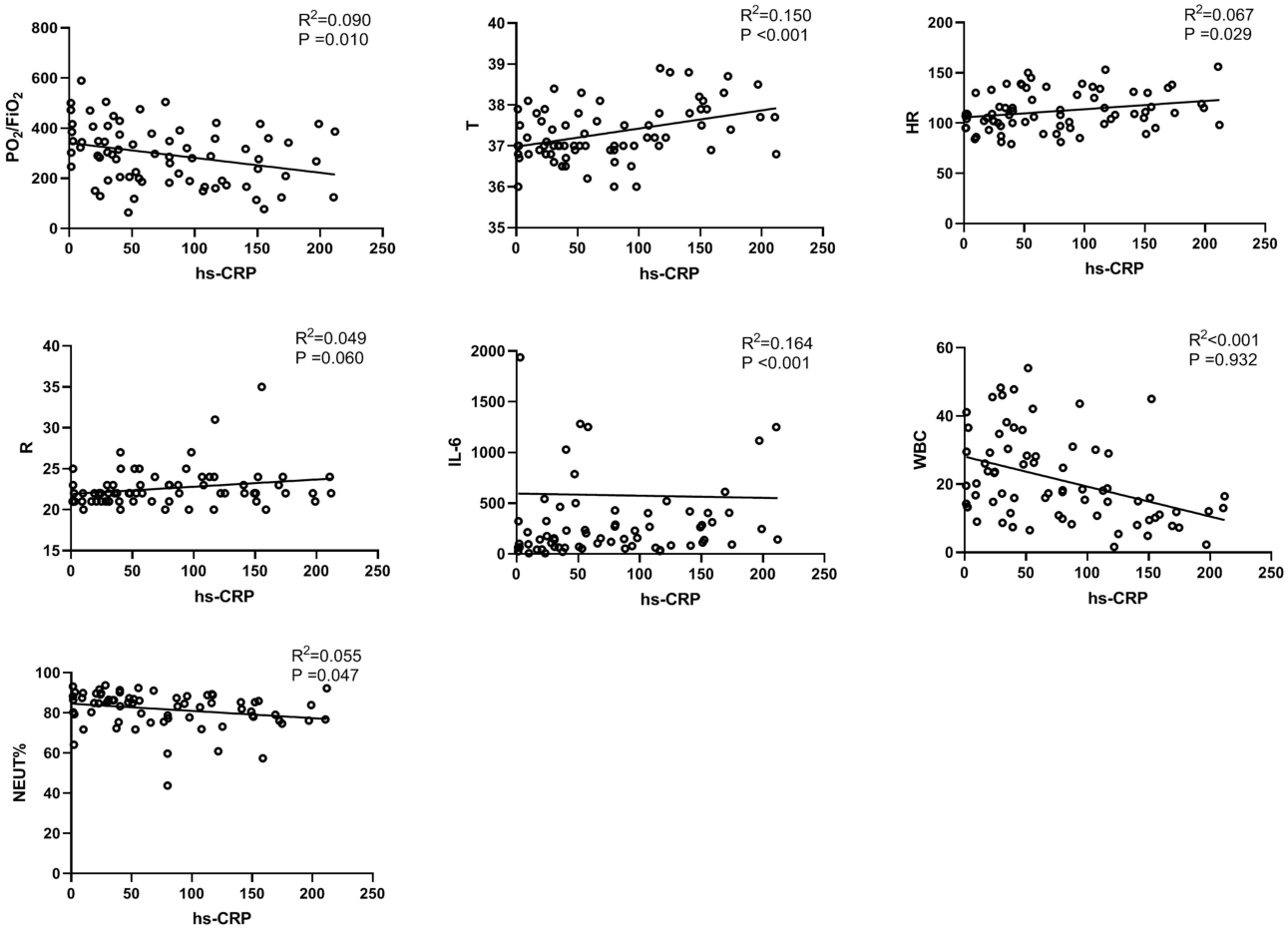

Figure 4 Univariate linear regression analysis of hs-CRP.

Table 6 Comparison of Baseline Characteristics Between Non-Survivors and Survivors in Burn Sepsis

	Non-Survivors (n = 32)	**Survivors (n = 40)**	**Z/χ^2/t/fisher**	**p−value**
Age (years)	48 (40~54)	48 (32~56)	−1.06	0.289
Gender (n,%)				
Male	27 (84.4%)	34 (85%)		1.00
Female	5 (15.6%)	6 (15%)		
Burn Index (%)	77.3 (34.5~88.9)	38.3 (24.6~63)	−3.293	0.001
GCS	15 (15~15)	15 (15~15)	−0.744	0.457
SOFA	8±3	5±3	4.38	<0.001
PO_2/FiO_2 (mmHg)	269±119	318±113	−1.797	0.077
T (°C)	37 (36.8~37.5)	37.5 (36.9~37.9)	−1.429	0.153
HR (beats/min)	116±20	109±18	1.592	0.116
R (times/min)	22 (22~25)	22 (21~23)	−2.06	0.039
MAP (mmHg)	79±15	84±10	−1.653	0.105
MEWS	6±2	4±2	3.84	<0.001
hs-CRP (mg/L)	87.7 (40.3~135.9)	45.5 (19.4~114.2)	−2.266	0.023
PCT (ng/mL)	16.67 (5.41~34.83)	2.25 (0.6~4.85)	−4.261	<0.001
IL-6 (pg/mL)	362.3 (155.6~968.8)	105.5 (63.9~259.6)	−3.547	<0.001
WBC (10^9/L)	17.9 (10.4~30.3)	17.1 (11.6~29.1)	−0.045	0.964
NEUT (%)	84.2 (78~87.2)	84.9 (76.3~89.3)	−0.561	0.575
PLT (10^9/L)	277 (134~491)	244 (96~385)	−0.595	0.552
TBIL (umol/L)	31.2 (17.5~46.8)	18.6 (13.1~33.1)	−2.425	0.015
Glucose (mmol/L)	7.3 (6.3~9.9)	7.6 (6~10)	−0.402	0.687
Creatinine (umol/L)	118 (91~171)	79 (61~111)	−3.576	<0.001
Lactic acid (mg/L)	5 (2.8~7.6)	1.9 (1.3~4.2)	−3.667	<0.001
Inhalation injury [n(%)]	25 (78.1%)	16 (40%)	10.539	<0.001
Tracheal intubation [n(%)]	22 (68.8%)	14 (35%)	8.1	0.004

IL-6, TBIL, creatinine, lactate, inhalation injury, and tracheal intubation were not independent factors associated with mortality in burn sepsis patients (Figure 5).

Discussion

Early diagnosis and timely therapeutic intervention for burn sepsis can effectively mitigate disease progression and improve patient survival rates. However, the signs and symptoms of burn sepsis are non-specific and often mimic those of various other disorders, making early diagnosis challenging. Furthermore, currently established diagnostic criteria have limited ability to identify sepsis in its initial stages. Studies have demonstrated that prospective diagnosis using clinical markers recorded within the first 48 hours can reliably predict the development of early sepsis prior to definitive clinical confirmation.[11,13] In this study, we investigated the value of three biomarkers—PCT, hs-CRP, and IL-6—both individually and in combination, for the early diagnosis of burn sepsis, and further explored their predictive value for mortality.

Value of PCT, Hs-CRP, and IL-6 in Diagnosing Early Burn Sepsis

PCT has been extensively studied as a marker associated with infection and sepsis and is effectively utilized in clinical practice. PCT, the prohormone of calcitonin, is a 116-amino acid peptide encoded by the CALC-1 gene. It is primarily produced by thyroid neuroendocrine cells, and its expression in non-endocrine tissues is suppressed under normal physiological conditions. Bacterial infection promotes the transcription of the CALC-1 gene in non-endocrine cells, leading to a peak in PCT levels within the first 20 hours post-infection.[29] In 1993, Assicot et al first reported elevated serum PCT levels in burn patients, suggesting an association with the progression of infection, sepsis, and septic shock.[30]

https://doi.org/10.2147/JIR.S571738

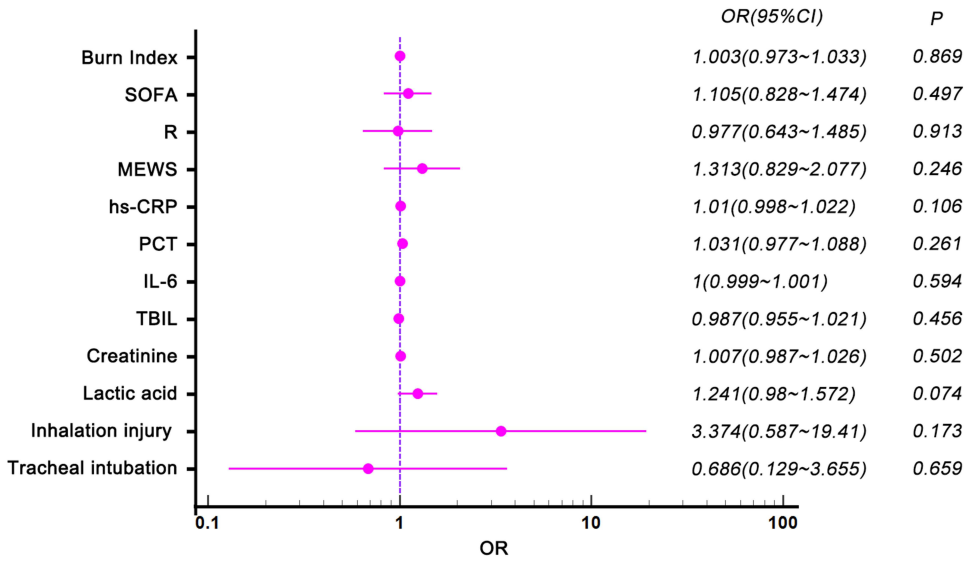

Figure 5 Multivariate logistic regression analysis of prognostic factors in burn sepsis.

Research by Xu et al also indicated that markedly elevated PCT levels in the early phase of severe burns could, to some extent, predict subsequent burn-related sepsis.[31] Furthermore, some clinical studies have explicitly stated that serum PCT levels can serve as an early indicator of septic complications in severely burned patients.[11,32,33] In contrast, some study results showed no association between PCT levels and sepsis in adult burn patients.[14,15,34] However, our findings revealed that serum PCT concentrations were significantly higher in patients with early burn sepsis compared to non-septic patients, with an optimal diagnostic threshold of 1.76 ng/mL, which is largely consistent with the results reported by Tan et al.[35]

Synthesizing the existing research on the predictive and diagnostic value of serum PCT concentration in burn sepsis patients, its advantages and reliability are evident. Two meta-analyses indicated that serum PCT is a useful biomarker for early diagnosis;[36,37] the confidence intervals for sensitivity and specificity encompass our results, although the reported AUC values were slightly higher than ours. A systematic review and meta-analysis concluded that PCT is a meaningful biomarker for the early diagnosis of burn sepsis,[11] and the 95% CIs for sensitivity, specificity, and AUC included our findings. The globally recognized guidelines from the Surviving Sepsis Campaign recommend considering a PCT increase $\geq$ 2 ng/mL from baseline as a trigger for diagnosing burn sepsis, although this recommendation lacks robust evidential support.[10] Moreover, comparative studies on the roles of PCT and CRP in sepsis diagnosis generally indicate the superiority of PCT.[38,39] Therefore, our results are highly reliable, suggesting that PCT holds significant value for the early diagnosis of burn sepsis.

CRP is an acute-phase protein closely associated with systemic inflammatory states. CRP has also been studied in sepsis; research by Gülhan et al showed that elevated CRP levels (≥6 mg/dL) are a risk factor for sepsis in pediatric burn patients.[40] Furthermore, a meta-analysis conducted by Tan et al demonstrated the diagnostic utility of CRP for sepsis in adult burn patients, albeit with slightly lower accuracy and specificity than PCT.[41] hs-CRP, measured using high-sensitivity detection technology, allows for efficient monitoring of low CRP concentrations, significantly enhancing detection capability. Current research on the relationship between hs-CRP and sepsis is more common in neonates, primarily because newborns cannot produce sufficient quantities of acute-phase proteins. Studies by Abdollahi et al[42] and Ganesan et al[43] showed that hs-CRP levels were significantly higher in the neonatal sepsis group compared to the control group. Related studies also indicate that hs-CRP levels are significantly elevated in adult sepsis patients compared to non-sepsis groups, but its diagnostic value is not high.[44]

Research specifically on hs-CRP and burn sepsis is currently scarce. Xu et al only reported that serum hs-CRP levels were significantly higher in burn sepsis patients compared to a control group with infection alone but did not elucidate its diagnostic value for burn sepsis.[45] Our results show that hs-CRP levels were significantly higher in the early critical burn

sepsis group than in the non-sepsis group, and it possessed a moderate degree of diagnostic value, with an optimal threshold of 22.47 mg/L, and sensitivity, specificity, and AUC of 81.94%, 65.52%, and 0.768, respectively. Although the optimal threshold in our study differs from previous CRP studies,[46,47] results such as sensitivity and AUC fall within the 95% CI of the meta-analysis results by Li et al[11] The target population of this study is burn patients, who differ pathophysiologically from non-burn sepsis patients to some extent. Furthermore, current reports on hs-CRP in the field of burns are few, and high-quality data are lacking. The optimal diagnostic threshold for hs-CRP from our study should only serve as a clinical reference; we believe that larger-sample, multicenter, prospective clinical data are needed to better determine a cutoff value.

Current related studies have reported that measuring PCT or CRP levels alone is valuable for the early diagnosis of burn sepsis.[11,46,48] Our results also indicate that PCT and hs-CRP can be useful biomarkers for the early diagnosis of adult burn sepsis. Although the diagnostic capabilities of the two did not show a statistically significant difference, they were far superior to those of body temperature, WBC, IL-6, and other indicators. What would be the effect of combining these two markers on diagnostic efficacy? Several related non-burn sepsis studies suggest that the combined use of PCT and CRP can improve the accuracy of sepsis diagnosis, but further research is needed to confirm these findings.[49,50] However, reports on whether combining PCT and hs-CRP improves the diagnostic capability for burn sepsis are scarce. Our results show that combined detection somewhat enhanced diagnostic capability, bringing both sensitivity and specificity to a more balanced and satisfactory level. Statistical results indicated that the diagnostic capability of the combined hs-CRP+PCT test, while not significantly different from PCT alone, was significantly better than that of T, WBC, IL-6, or hs-CRP alone. Given that hs-CRP and PCT are readily available markers early in burn patients and that the diagnostic performance of their combination is satisfactory, they can be used together in clinical practice as a reference for the early diagnosis of burn sepsis.

Severe burns are typically accompanied by an inflammatory response, leading to the activation of inflammatory pathways and an increase in various cytokines, including pro-inflammatory cytokines (TNF-α, IL-6, IL-8) and anti-inflammatory cytokines (IL-10).[51] The potential of these cytokines for the early diagnosis of post-burn sepsis has been investigated. Compared to burn patients without signs of sepsis, serum IL-6 is significantly elevated in septic burn patients, but study results have been unable to establish the diagnostic value of IL-6.[23,45] However, one non-burn sepsis clinical study showed that IL-6 has good diagnostic value for it.[22] Currently, the diagnostic value of IL-6 remains controversial. Our results showed no significant difference in early IL-6 levels between the critical burn sepsis group and the critical burn non-sepsis group. The AUC value of the ROC curve was only 0.579, and the diagnostic sensitivity was merely 40.28%, indicating low diagnostic efficacy.

In clinical practice, we also find that IL-6 is an unstable factor, susceptible to significant fluctuations due to varying degrees of trauma. The instability of IL-6 in burn serum may be related to the multiple inflammatory pathways it mediates; evidence suggests IL-6 amplifies inflammation and participates in tissue damage and cell death.[52] Moreover, studies have shown that IL-6 levels can exhibit rapid and wide fluctuations following burn injury, influenced by factors such as burn depth, timing of measurement, and concurrent interventions, which may limit its reliability as a stable early diagnostic marker in this population.[53,54] The altered internal environment in critically ill burn patients, along with changes in the coagulation, respiratory, digestive, and circulatory systems, likely exacerbates this instability. Therefore, we conclude that IL-6 has limited value for the early diagnosis of burn sepsis, and high-quality studies are still needed to validate this conclusion.

Body temperature (T) and white blood cell count (WBC) remain the most commonly used indicators and basis for infection diagnosis in clinical practice due to their simple measurement, speed, and low cost. In critically ill burn sepsis patients, body temperature may not only be elevated but can also be decreased in some patients. Our results showed no significant difference in early body temperature between the critical burn sepsis group and the non-sepsis group. The AUC value for temperature was only 0.536, significantly lower than that for indicators like hs-CRP and PCT. Therefore, although temperature is a commonly used clinical indicator, its diagnostic accuracy is relatively low, and it has limited reference value when used alone for early burn sepsis, which is consistent with the findings of other studies.[7,33] Regarding the diagnostic value of WBC for burn sepsis, numerous studies have also shown that WBC is not a reliable indicator for infection and early burn sepsis diagnosis.[7,11,33,46] Our results also show that the AUC value for WBC in

diagnosing burn sepsis was only 0.536, with both sensitivity and specificity below 60%, indicating it is not a valuable diagnostic indicator. However, in clinical practice, WBC remains a worthwhile reference indicator for infection.

Relationship Between PCT, Hs-CRP, IL-6 and Disease Severity and Prognosis in Burn Sepsis

PCT not only provides guidance for the diagnosis of burn sepsis but also offers some indication of its severity.[31] The pathophysiological progression of sepsis is primarily characterized by organ dysfunction; therefore, impairment of various organ functions also indicates the severity of sepsis.[2,3,55] In this study, we analyzed the correlation between PCT levels and other clinical indicators in burn sepsis patients. PCT levels correlated with indicators reflecting organ function such as HR, respiratory rate (R), MEWS score, IL-6, WBC, total bilirubin (TBIL), creatinine, and lactate. Linear correlation regression analysis showed positive correlations, all of which were statistically significant. The results suggest that PCT levels can, to some extent, reflect the degree of organ dysfunction in burn sepsis patients. Notably, PCT showed a strong correlation with creatinine levels (r=0.625), indicating it might reflect the severity of acute kidney injury (AKI) in these patients. Related studies also show that PCT levels are associated with the severity of septic AKI and may play a role in the process of septic kidney injury; it is worth noting that impaired renal function itself can affect PCT clearance.[56] In clinical application, a low PCT level in a septic patient can also be an effective indicator to rule out a high risk of developing AKI.[57]

Data from Mokline et al showed that in burn sepsis patients, the peak serum PCT levels in non-survivors far exceeded the baseline levels for sepsis diagnosis; this change was closely related to sepsis severity, showing a positive linear correlation.[32] Another study also indicated that persistently elevated PCT levels serve as an early warning for increased patient mortality.[58] Research by Xu et al showed that elevated early PCT levels could predict the occurrence of sepsis within 60 days post-injury and were significantly associated with patient mortality, suggesting it might be a potential early severity indicator.[31] In our study, univariate analysis showed that PCT levels were significantly higher in the mortality group among burn sepsis patients. However, in multivariate regression analysis, PCT was not a statistically significant independent factor associated with mortality. Therefore, we conclude that PCT levels in the early stage cannot provide an early warning for the prognosis of burn sepsis patients. Our findings are consistent with those of Zu et al, namely that early PCT has low predictive value for the prognosis of burn sepsis.[59] However, Kim et al reported that serum PCT levels within 48 hours post-burn, particularly between 14–24 hours, are a useful prognostic indicator for mortality in sepsis patients.[60] The main reason for this discrepancy may be the difference in sample sizes between the two studies, which influences the results to some extent. Additionally, burn patients in different studies have varying disease characteristics, such as differences in burn severity and complications, which also affect the outcomes. Therefore, the significance of the trend in early PCT levels for understanding the prognosis of critically ill burn sepsis patients requires further investigation.

Reportedly, CRP levels rise within 12–24 hours of onset, remain high for 20–72 hours, and return to baseline within 3–7 days.[61] Research by Lobo et al found that high CRP in non-burn ICU patients was associated with organ failure and increased risk of death.[62] Another study also indicated that elevated CRP showed good consistency with organ function damage in non-burn sepsis patients.[63] CRP levels have some guiding significance for disease progression and injury severity; related studies have verified that CRP shows an increasing trend in non-burn sepsis, severe sepsis, and septic shock.[64] So, what is the value of hs-CRP in assessing disease severity and prognosis in burn sepsis patients? This study showed that in burn sepsis patients, hs-CRP only correlated with clinical indicators such as PO2/FiO2, body temperature, HR, R, IL-6, WBC, and NEUT%. It showed negative linear correlations with PO2/FiO2, NEUT%, and WBC, and positive linear correlations with T, HR, R, and IL-6, indicating that hs-CRP does not adequately reflect changes in organ function related to sepsis.

In this study, we compared hs-CRP levels between the mortality and survival groups of burn sepsis patients. Univariate analysis showed that hs-CRP levels were significantly higher in the mortality group. However, in multivariate regression analysis, hs-CRP was not an independent factor associated with poor prognosis in burn sepsis. Therefore, we believe that hs-CRP levels in the early stagecannot provide a warning for the prognosis of burn sepsis patients. Our

results are similar to two previous studies, both suggesting that early CRP levels have limited prognostic value in burn sepsis patients.[59,65] Furthermore, Yu et al used the CRP-to-albumin ratio to predict sepsis and prognosis in severe burn patients, concluding that this ratio is an independent risk factor for sepsis and prognosis in severe burns.[66] Therefore, given the limited early warning value of hs-CRP alone, it could be considered as an auxiliary predictive tool for prognosis research.

Currently, most studies indicate that IL-6 levels are indicative of disease severity in non-burn sepsis patients and suggest that IL-6 has high value in predicting mortality.[21,67] However, some studies still show that IL-6 cannot predict mortality in non-burn sepsis patients.[68,69] The pathophysiological conditions and organ functional status differ between burn sepsis and non-burn sepsis patients. What is the value of IL-6 for disease severity and prognosis in critically ill burn sepsis patients? Related research shows that serum IL-6 levels correlate with burn severity.[53] Our results showed that early IL-6 levels were significantly elevated in the sepsis mortality group. However, multivariate regression analysis indicated that IL-6 was not an independent factor associated with poor prognosis in burn sepsis. The results of this study are consistent with two previous clinical studies.[22,70] Therefore, we believe that IL-6 levels in the early stagecannot provide a warning for the prognosis of burn sepsis patients. Currently, data on IL-6 and burn sepsis prognosis are limited, and larger-sample, multicenter, high-quality trials are still needed for further exploration.

In this study, besides the three biomarkers PCT, hs-CRP, and IL-6 being significantly elevated in burn sepsis patients, other observed indicators such as burn index, SOFA score, R, MEWS score, TBIL, creatinine, lactate, the proportion of inhalation injury, and the proportion of tracheal intubation were also significantly increased. After performing multivariate logistic regression analysis, no independent factors associated with mortality in burn sepsis patients were identified. The analysis suggests that this may be due to the limited sample size included, which ultimately led to the failure to identify independent factors. Therefore, future clinical studies with larger sample sizes are warranted to further verify these findings.

Strengths and Limitations

The primary strength of this study lies in its focus on the critical early window for diagnosing and treating burn sepsis, along with the practical comparison of three readily available biomarkers (PCT, hs-CRP, IL-6) against traditional indicators, within a strictly defined and uniformly implemented blood sampling time window. Patient stratification using the Sepsis-3 criteria enhanced the modernity and diagnostic accuracy of grouping, while the exploration of combined PCT and hs-CRP indices offered new perspectives for improving diagnostic efficacy. Furthermore, this study preliminarily examined their relationship with disease severity and prognosis, providing a basis for understanding the potential role of these markers in the comprehensive management of burn sepsis.

However, this study has several limitations. The retrospective design may introduce selection bias and confounding factors, and relies on the completeness of medical records. The single-center design and the inclusion of only critically ill burn patients limit the generalisability of the study conclusions and the proposed cutoff values in different institutions and in patients with mild-to-moderate burns. In addition, the established diagnostic thresholds for PCT and hs-CRP lack external validation and need to be confirmed in future by larger, multicenter prospective studies. The limited sample size in the prognostic analysis of sepsis subgroups may have weakened the statistical power to identify independent prognostic factors.

Conclusion

Serum PCT and hs-CRP may serve as valuable biomarkers for the early diagnosis of burn sepsis, with optimal diagnostic thresholds of >1.76 ng/mL and >22.47 mg/L, respectively. No significant difference was observed in the diagnostic performance between serum PCT and hs-CRP; however, their combined detection further improved diagnostic efficacy. In contrast, body temperature, WBC, and IL-6 levels demonstrated limited utility for early diagnosis of burn sepsis. Furthermore, PCT levels correlated with multiple indicators of burn sepsis diagnosis, and elevated PCT may represent a risk factor for acute kidney injury in burn sepsis patients. Although early serum levels of PCT, hs-CRP, and IL-6 were associated with the severity of burn sepsis, their prognostic value for predicting outcomes was relatively low.

Data Sharing Statement

All authors agree to share data from this study, which are available by contacting the corresponding author upon reasonable request, Email: liuxiaobodlfy@sina.com.

Ethics Approval and Consent to Participate

The study has been approved by the Ethics Committee of Kunming Medical University, and the name of the Ethics Committee is: The Second Affiliated Hospital of Kunming Medical University; the Ethics Approval Number is: Review-PJ-Ke-2023-305. The study was conducted according to the Declaration of Helsinki, and written informed consent was obtained from all participants.

Author Contributions

All authors contributed to the preparation of this work. Specifically, G.X.Y: Conceptualization, Funding Acquisition, Writing - original draft, Project Administration, Writing - Review & Editing; Z.F.C: Data Curation, Formal Analysis, Writing - original draft, Project Investigation, Writing - Review & Editing; S.S.Z: Data Curation, Formal Analysis, Writing - original draft, Formal Analysis, Investigation; Z.Q.W: Formal Analysis, Investigation, Methodology, Resources, Writing - original draft; C.Z: Formal Analysis, Writing - original draft, Methodology, Resources, Software; T.Q: Writing - original draft, Resources, Software, Validation, Investigation; S.Q.D: Investigation, Software, Validation, Writing - original draft, Formal Analysis; X.W: Investigation, Software, Validation, Writing - original draft, Formal Analysis; X.L.W: Visualization, Investigation, Methodology, Writing - original draft, Software; Q.J.C: Visualization, Investigation, Methodology, Resources, Writing - Review & Editing; X.B.L: Data Curation, Formal Analysis, Writing - original draft, Project Investigation, Writing - Review & Editing; W.J.L: Conceptualization, Funding Acquisition, Writing - original draft, Project Administration, Writing - Review & Editing. All authors had final responsibility for the decision to submit. All authors gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

This work was supported by the construction project of clinical medical discipline team in the First Affiliated Hospital of Dali University (Project Approval Number DFYYB2025015).

Disclosure

All authors declare that they have no potential competing interests; no other relationships or activities that could affect the submitted work.

References

1. Manning J. Sepsis in the burn patient. *Crit Care Nurs Clin North Am*. 2018;30(3):423–430. doi:10.1016/j.cnc.2018.05.010
2. Nielson CB, Duethman NC, Howard JM, et al. Burns: pathophysiology of systemic complications and current management. *J Burn Care Res*. 2017;38(1):e469–e481. doi:10.1097/BCR.0000000000000355
3. Singer M, Deutschman CS, Seymour CW, et al. The third international consensus definitions for sepsis and septic shock (Sepsis-3). *JAMA*. 2016;315(8):801–810. doi:10.1001/jama.2016.0287
4. Greenhalgh DG, Saffle JR, Holmes JHT, et al. American burn association consensus conference to define sepsis and infection in burns. *J Burn Care Res*. 2007;28(6):776–790. doi:10.1097/BCR.0b013e3181599bc9
5. Mann-Salinas EA, Baun MM, Meininger JC, et al. Novel predictors of sepsis outperform the American burn association sepsis criteria in the burn intensive care unit patient. *J Burn Care Res*. 2013;34(1):31–43. doi:10.1097/BCR.0b013e31826450b5
6. Yizhi P, Jing C, Zhiqiang Y, et al. Diagnostic criteria and treatment protocol for post-burn sepsis. *Crit Care*. 2013;17(1):406. doi:10.1186/cc11912
7. Lavrentieva A, Kontakiotis T, Lazaridis L, et al. Inflammatory markers in patients with severe burn injury. What is the best indicator of sepsis? *Burns*. 2007;33(2):189–194. doi:10.1016/j.burns.2006.07.001
8. Garnacho-Montero J, Ortiz-Leyba C, Herrera-Melero I, et al. Mortality and morbidity attributable to inadequate empirical antimicrobial therapy in patients admitted to the ICU with sepsis: a matched cohort study. *J Antimicrob Chemother*. 2008;61(2):436–441. doi:10.1093/jac/dkm460
9. Shime N, Nakada TA, Yatabe T, et al. The Japanese clinical practice guidelines for management of sepsis and septic shock 2024. *J Intensive Care*. 2025;13(1):15. doi:10.1186/s40560-025-00776-0
10. Greenhalgh DG, Hill DM, Burmeister DM, et al. Surviving sepsis after burn campaign. *Burns*. 2023;49(7):1487–1524. doi:10.1016/j.burns.2023.05.003

11. Li AT, Moussa A, Gus E, et al. Biomarkers for the early diagnosis of sepsis in burns: systematic review and meta-analysis. *Ann Surg*. 2022;275(4):654–662. doi:10.1097/SLA.0000000000005198
12. Rowland T, Hilliard H, Barlow G. Procalcitonin: potential role in diagnosis and management of sepsis. *Adv Clin Chem*. 2015;68:71–86.
13. Ren H, Li Y, Han C, et al. Serum procalcitonin as a diagnostic biomarker for sepsis in burned patients: a meta-analysis. *Burns*. 2015;41(3):502–509. doi:10.1016/j.burns.2014.08.019
14. Paratz JD, Lipman J, Boots RJ, et al. A new marker of sepsis post burn injury?* *Crit Care Med*. 2014;42(9):2029–2036. doi:10.1097/CCM.0000000000000400
15. Seoane L, Pértega S, Galeiras R, et al. Procalcitonin in the burn unit and the diagnosis of infection. *Burns*. 2014;40(2):223–229. doi:10.1016/j.burns.2013.11.018
16. Luo B, Sun M, Huo X, et al. Two new inflammatory markers related to the CURB-65 score for disease severity in patients with community-acquired pneumonia: the hypersensitive C-reactive protein to albumin ratio and fibrinogen to albumin ratio. *Open Life Sci*. 2021;16(1):84–91. doi:10.1515/biol-2021-0011
17. Liu GB, Cui XQ, Wang ZB, et al. Detection of serum procalcitonin and hypersensitive C-reactive protein in patients with pneumonia and sepsis. *J Biol Regul Homeost Agents*. 2018;32(5):1165–1169.
18. Van Snick J. Interleukin-6: an overview. *Annu Rev Immunol*. 1990;8(1):253–278. doi:10.1146/annurev.iy.08.040190.001345
19. Borden EC, Chin P. Interleukin-6: a cytokine with potential diagnostic and therapeutic roles. *J Lab Clin Med*. 1994;123(6):824–829.
20. Uusitalo-Seppälä R, Koskinen P, Leino A, et al. Early detection of severe sepsis in the emergency room: diagnostic value of plasma C-reactive protein, procalcitonin, and interleukin-6. *Scand J Infect Dis*. 2011;43(11–12):883–890. doi:10.3109/00365548.2011.600325
21. Miguel-Bayarri V, Casanoves-Laparra EB, Pallás-Beneyto L, et al. Prognostic value of the biomarkers procalcitonin, interleukin-6 and C-reactive protein in severe sepsis. *Med Intensiva*. 2012;36(8):556–562. doi:10.1016/j.medin.2012.01.014
22. Tocu G, Mihailov R, Serban C, et al. The contribution of procalcitonin, C-reactive protein and interleukin-6 in the diagnosis and prognosis of surgical sepsis: an observational and statistical study. *J Multidiscip Healthc*. 2023;16:2351–2359. doi:10.2147/JMDH.S422359
23. Pileri D, Accardo Palombo A, D'Amelio L, et al. Concentrations of cytokines IL-6 and IL-10 in plasma of burn patients: their relationship to sepsis and outcome. *Ann Burns Fire Disasters*. 2008;21(4):182–185.
24. Huang J, Chen Y, Guo Z, et al. Prospective study and validation of early warning marker discovery based on integrating multi-omics analysis in severe burn patients with sepsis. *Burns Trauma*. 2023;11:tkac050. doi:10.1093/burnst/tkac050
25. Ding X, Yang D, Ke C, et al. Value of evaluating procalcitonin kinetics in diagnosis of infections in patients undergoing laparoscopic radical cystectomy. *Medicine*. 2017;96(42):e8152. doi:10.1097/MD.0000000000008152
26. Huang X, Huang L, Zhao S, et al. Predictive significance of admission-day blood routine-derived indices for 30-day mortality risk in elderly patients with bacterial pneumonia. *Int J Gen Med*. 2025;18:1295–1309. doi:10.2147/IJGM.S501744
27. Li LL, Yang YQ, Qiu M, et al. The clinical significance of neutrophil-lymphocyte ratio in patients treated with hemodialysis complicated with lung infection. *Medicine*. 2021;100(29):e26591. doi:10.1097/MD.0000000000026591
28. Wu Y, Wang G, Huang Z, et al. Diagnostic and therapeutic value of biomarkers in urosepsis. *Ther Adv Urol*. 2023;15:17562872231151852. doi:10.1177/17562872231151852
29. Schneider HG, Lam QT. Procalcitonin for the clinical laboratory: a review. *Pathology*. 2007;39(4):383–390. doi:10.1080/00313020701444564
30. Assicot M, Gendrel D, Carsin H, et al. High serum procalcitonin concentrations in patients with sepsis and infection. *Lancet*. 1993;341(8844):515–518. doi:10.1016/0140-6736(93)90277-N
31. Xu L, Jin J, Wu G, et al. Elevated serum procalcitonin early after extensive burn: influencing factors and clinical significance. *Burns*. 2021;47(6):1399–1407. doi:10.1016/j.burns.2020.12.010
32. Mokline A, Garsallah L, Rahmani I, et al. Procalcitonin: a diagnostic and prognostic biomarker of sepsis in burned patients. *Ann Burns Fire Disasters*. 2015;28(2):116–120.
33. Cabral L, Afreixo V, Santos F, et al. Procalcitonin for the early diagnosis of sepsis in burn patients: a retrospective study. *Burns*. 2017;43(7):1427–1434. doi:10.1016/j.burns.2017.03.026
34. Yiğit E, Demir Yiğit Y. Diagnostic importance of serum C-reactive protein and procalcitonin in sepsis after burn. *Int J Burns Trauma*. 2021;11(5):391–396.
35. Tan J, Li N, Gong Y, et al. Procalcitonin kinetics early after severe burn injury and its value in diagnosis of sepsis. *Burns*. 2021;47(8):1802–1809. doi:10.1016/j.burns.2021.02.024
36. Chen Z, Turxun N, Ning F. Meta-analysis of the diagnostic value of procalcitonin in adult burn sepsis. *Adv Clin Exp Med*. 2021;30(4):455–463. doi:10.17219/acem/131755
37. Zhang YJ, Guo ZH, Ming ZG, et al. Meta-analysis of the diagnostic value of serum procalcitonin for burn sepsis in adults. *Eur Rev Med Pharmacol Sci*. 2023;27(15):7188–7200. doi:10.26355/eurrev_202308_33292
38. Wacker C, Prkno A, Brunkhorst FM, et al. Procalcitonin as a diagnostic marker for sepsis: a systematic review and meta-analysis. *Lancet Infect Dis*. 2013;13(5):426–435. doi:10.1016/S1473-3099(12)70323-7
39. Uzzan B, Cohen R, Nicolas P, et al. Procalcitonin as a diagnostic test for sepsis in critically ill adults and after surgery or trauma: a systematic review and meta-analysis. *Crit Care Med*. 2006;34(7):1996–2003. doi:10.1097/01.CCM.0000226413.54364.36
40. Gülhan B, Kanık Yüksek S, Hayran M, et al. Infections in pediatric burn patients: an analysis of one hundred eighty-one patients. *Surg Infect*. 2020;21(4):357–362. doi:10.1089/sur.2019.010
41. Tan M, Lu Y, Jiang H, et al. The diagnostic accuracy of procalcitonin and C-reactive protein for sepsis: a systematic review and meta-analysis. *J Cell Biochem*. 2019;120(4):5852–5859. doi:10.1002/jcb.27870
42. Abdollahi A, Shoar S, Nayyeri F, et al. Diagnostic value of simultaneous measurement of procalcitonin, interleukin-6 and hs-CRP in prediction of early-onset neonatal sepsis. *Mediterr J Hematol Infect Dis*. 2012;4(1):e2012028. doi:10.4084/mjhid.2012.028
43. Ganesan P, Shanmugam P, Sattar SB, et al. Evaluation of IL-6, CRP and hs-CRP as early markers of neonatal sepsis. *J Clin Diagn Res*. 2016;10(5):Dc13–17. doi:10.7860/JCDR/2016/19214.7764
44. Sui YD, Xin WN, Feng LL. Comparison of the clinical application values of PCT, hs-CRP and SAA detection in the early diagnosis of sepsis. *Pak J Med Sci*. 2020;36(7):1683–1687. doi:10.12669/pjms.36.7.2544

45. Xu C, Zhou G, Wang X, et al. Correlation analysis of serum miR-21 and miR-210 with hs-CRP, TNF-α, IL-6, and ICAM-1 in patients with sepsis after burns. *Burns*. 2022;48(3):633–638. doi:10.1016/j.burns.2021.05.026
46. Cakır Madenci Ö, Yakupoğlu S, Benzonana N, et al. Evaluation of soluble CD14 subtype (presepsin) in burn sepsis. *Burns*. 2014;40(4):664–669. doi:10.1016/j.burns.2013.08.024
47. Wineberg D, Moore R, Kruger D. Procalcitonin and bacterial sepsis in burn patients in South Africa. *J Surg Res*. 2020;246:490–498. doi:10.1016/j.jss.2019.09.040
48. Egea-Guerrero JJ, Martínez-Fernández C, Rodríguez-Rodríguez A, et al. The utility of C-reactive protein and procalcitonin for sepsis diagnosis in critically burned patients: a preliminary study. *Plast Surg*. 2015;23(4):239–243. doi:10.1177/229255031502300412
49. Ruan L, Chen GY, Liu Z, et al. The combination of procalcitonin and C-reactive protein or presepsin alone improves the accuracy of diagnosis of neonatal sepsis: a meta-analysis and systematic review. *Crit Care*. 2018;22(1):316. doi:10.1186/s13054-018-2236-1
50. Zeng G, Chen D, Zhou R, et al. Combination of C-reactive protein, procalcitonin, IL-6, IL-8, and IL-10 for early diagnosis of hyperinflammatory state and organ dysfunction in pediatric sepsis. *J Clin Lab Anal*. 2022;36(7):e24505. doi:10.1002/jcla.24505
51. Finnerty CC, Herndon DN, Przkora R, et al. Cytokine expression profile over time in severely burned pediatric patients. *Shock*. 2006;26(1):13–19. doi:10.1097/01.shk.0000223120.26394.7d
52. Kishimoto T. Interleukin-6: from basic science to medicine--40 years in immunology. *Annu Rev Immunol*. 2005;23(1):1–21. doi:10.1146/annurev.immunol.23.021704.115806
53. Hager S, Foldenauer AC, Rennekampff HO, et al. Interleukin-6 serum levels correlate with severity of burn injury but not with gender. *J Burn Care Res*. 2018;39(3):379–386. doi:10.1097/BCR.0000000000000604
54. Jeschke MG, Gauglitz GG, Kulp GA, et al. Long-term persistance of the pathophysiologic response to severe burn injury. *PLoS One*. 2011;6(7):e21245. doi:10.1371/journal.pone.0021245
55. Dvorak JE, Ladhani HA, Claridge JA, Claridge JA. Review of sepsis in burn patients in 2020. *Surg Infect*. 2021;22(1):37–43. doi:10.1089/sur.2020.367
56. Meisner M, Lohs T, Huettemann E, et al. The plasma elimination rate and urinary secretion of procalcitonin in patients with normal and impaired renal function. *Eur J Anaesthesiol*. 2001;18(2):79–87. doi:10.1097/00003643-200102000-00004
57. Nie X, Wu B, He Y, et al. Serum procalcitonin predicts development of acute kidney injury in patients with suspected infection. *Clin Chem Lab Med*. 2013;51(8):1655–1661. doi:10.1515/cclm-2012-0822
58. Luzzani A, Polati E, Dorizzi R, et al. Comparison of procalcitonin and C-reactive protein as markers of sepsis. *Crit Care Med*. 2003;31(6):1737–1741. doi:10.1097/01.CCM.0000063440.19188.ED
59. Zu H, Li Q, Huang P, et al. Therapeutic value of blood purification and prognostic utilities of early serum procalcitonin, C reactive protein, and brain natriuretic peptide levels in severely burned patients with sepsis. *Cell Biochem Biophys*. 2015;72(1):259–263. doi:10.1007/s12013-014-0446-y
60. Kim HS, Yang HT, Hur J, et al. Procalcitonin levels within 48 hours after burn injury as a prognostic factor. *Ann Clin Lab Sci*. 2012;42(1):57–64.
61. Gabay C, Kushner I. Acute-phase proteins and other systemic responses to inflammation. *N Engl J Med*. 1999;340(6):448–454. doi:10.1056/NEJM199902113400607
62. Lobo SM, Lobo FR, Bota DP, et al. C-reactive protein levels correlate with mortality and organ failure in critically ill patients. *Chest*. 2003;123(6):2043–2049. doi:10.1378/chest.123.6.2043
63. Castelli GP, Pognani C, Meisner M, et al. Procalcitonin and C-reactive protein during systemic inflammatory response syndrome, sepsis and organ dysfunction. *Crit Care*. 2004;8(4):R234–242. doi:10.1186/cc2877
64. Póvoa P, Coelho L, Almeida E, et al. C-reactive protein as a marker of infection in critically ill patients. *Clin Microbiol Infect*. 2005;11(2):101–108. doi:10.1111/j.1469-0691.2004.01044.x
65. Xu Y, Jin X, Shao X, et al. Valuable prognostic indicators for severe burn sepsis with inhalation lesion: age, platelet count, and procalcitonin. *Burns Trauma*. 2018;6:29. doi:10.1186/s41038-018-0132-1
66. Yu Y, Wu W, Dong Y, et al. C-reactive protein-to-albumin ratio predicts sepsis and prognosis in patients with severe burn injury. *Mediators Inflamm*. 2021;2021(1):6621101. doi:10.1155/2021/6621101
67. Jekarl DW, Lee SY, Lee J, et al. Procalcitonin as a diagnostic marker and IL-6 as a prognostic marker for sepsis. *Diagn Microbiol Infect Dis*. 2013;75(4):342–347. doi:10.1016/j.diagmicrobio.2012.12.011
68. Nader D, Abdelmaseeh M, Al Sharif R, et al. Serum level of MicroRNA 15a and interleukin 6 as biomarkers for sepsis in critically Ill Patients. *Egypt J Immunol*. 2023;30(3):162–170. doi:10.55133/eji.300316
69. Yu B, Chen M, Zhang Y, et al. Diagnostic and prognostic value of interleukin-6 in emergency department sepsis patients. *Infect Drug Resist*. 2022;15:5557–5566. doi:10.2147/IDR.S384351
70. Zhou H, Tu JJ, Huang Y, et al. Changes in serum contents of interleukin-6 and interleukin-10 and their relation with occurrence of sepsis and prognosis of severely burned patients]. *Zhonghua Shao Shang Za Zhi*. 2012;28(2):111–115.