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Predictive value of systemic immune inflammation index for infections caused by healthcare in pediatric patients hospitalized to the burn unit

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The Systemic Immune-Inflammation Index is a measurement of the systemic immune-inflammatory response (SII), which is used as both a diagnostic and predictive index for many diseases. Burns are a major public health problem among children. Infection caused by burns is the most important cause of mortality in children. In this study aims to investigate the predictive and diagnostic performance of SII for infection for pediatrics at the burn center and the causes of burns and responsible microorganisms and possible risk factors on infection. Data were collected retrospectively from 42 pediatric patients between 2013 and 2023 and analyzed in the burn center. Infected and uninfected burn patients were compared. Scalds were the most common cause of burns in both groups, (91.3%; 87%, respectively). The most frequently isolated microorganism was Pseudomonas aeruginosa (52,6%). Central venous catheter use was the biggest risk factor for infection (OR = 8,077; 95% CI 1,523 to 42,834). The AUC value demonstrated an acceptable diagnostic performance (AUC = 0,605; 95% CI 0,450 to 0,746) Similarly, the odds ratio suggested a potential relationship between SII and infection (OR = 2,057; 95% CI 0,489 to 8,657), but both failed to reach statistical significance. The results of this investigation indicate limited predictive and diagnostic utility for SII. CRP performed better diagnostically than SII (AUC = 0,877; 95% CI 0,747 to 0,955), suggesting that traditional inflammatory markers may still be a better way to predict infection in pediatric burns. Moreover, substantial disparities in hemoglobin levels, lymphocyte counts, CRP, and procalcitonin between infected and uninfected groups indicate that a multi marker strategy may prove more efficacious than dependence on a solitary index. While the SII showed a tendency to predict infection in pediatric burn patients, it did not achieve statistical significance in our research. These findings highlight the need for larger-scale studies to clarify the role of SII in infection prediction among pediatric burn patients. Further research with larger cohorts or multicenter studies could help determine whether SII has clinical utility in this population. Also, accurate identification of infectious agents, development of effective treatment strategies, avoidance of prophylactic antibiotic use, and strict adherence to isolation precautions will significantly reduce the risk of infection in centers where burn patients are followed up.

Keywords Systemic immune inflammation index, SII, Child, Infection, Burn, Burn center

Burn injuries, which are a significant public health problem, are unwanted traumas that are always at risk of occurring and can affect people of all age groups[1,2]. Childhood burns, in particular, account for more than half of all hospitalizations for burns in Europe. Although most deaths from childhood burns result from fire-related burns, scalds and contact burns are also major contributors to overall morbidity. Additionally, hot liquids, hot tap water, and steam are responsible for more than 75% of burns in young children[3]. Although most pediatric burns do not lead to severe clinical complications, severe burns have higher mortality rates compared to adults with similar burn injuries[4].

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The infected burn wound constitutes an important source for most cases of sepsis. The mortality rate due to sepsis in pediatric burn patients is still high[5]. The loss of skin integrity due to burns can allow microorganisms to enter the body, leading to life-threatening infections[6]. In deep burns, in particular, the healing ability of the skin is negatively affected due to damage to vascularization and resident cells[7]. While the burn surface is initially mostly sterile, it quickly becomes contaminated with microorganisms. Wound and soft tissue infections develop in the early stages of hospitalization, whereas bloodstream infections generally appear in later stages[8]. *Pseudomonas aeruginosa*, *Acinetobacter baumannii*, and *Methicillin-resistant Staphylococcus aureus* are among the most common bacteria responsible for infections[9]. In addition to thermal damage in burn patients, many factors such as invasive procedures, the presence of catheters, burn wound colonization, translocation of gastrointestinal microbiota, and prolonged hospitalization contribute to an increased risk of infection[10].

Routine blood examination is a regular monitoring practice after hospitalization in burn patients and is useful for the early diagnosis of various diseases. Particularly, complete blood counts are among simple, cost-effective, and practical diagnostic tools. Lymphocytes, neutrophils, platelets, and monocytes are closely associated with the immune response[4,10]. While complete blood count indices have shown strong associations with immunity and inflammation in various diseases in studies conducted on adult patients, the combined ratios of these blood parameters have been used as prognostic markers for solid tumors and inflammatory indices. Furthermore, they have been proposed as biomarkers to assist in risk classification and to determine the mortality of inflammatory diseases[5,11,12]. Recent studies have revealed that the neutrophil-to-lymphocyte ratio (NLR) and the lymphocyte-to-platelet ratio (LPR) play a significant role in assessing the prognosis and severity of extensive burn cases[13–15]. The systemic immune-inflammation index (SII), derived from lymphocyte, neutrophil, and platelet counts, is a novel inflammatory biomarker identified that is used to both diagnose and predict a several of medical situations. SII is a new and reliable parameter used to comprehensively measure the systemic immunity and inflammation levels of subjects[16]. Although the SII is widely used as a marker to predict systemic inflammation in adult burn patients, no studies on this subject have been reported in pediatric patients. For this reason, our primary aim is to evaluate the prognostic and diagnostic value of SII in children with burn injuries. Additionally, we aim to investigate the clinical characteristics, burn and infection causes, responsible microorganisms, infection parameters, and possible risk factors on infection of pediatric patients hospitalized in the burn unit in light of the literature.

Method

This retrospective cohort study included data from pediatric patients with burn injuries admitted to the Burn Unit of a tertiary hospital between January 1, 2013, and December 31, 2023. Information on clinical characteristics, laboratory test findings, and clinical outcomes of enrolled patients was obtained using the hospital information system (HIS). Inclusion criteria were pediatric patients between the ages of 0–18 years, hospitalization in the Burn Intensive Care Unit for at least 48 h and growth in cultures.Exclusion criteria included malignancies, concurrent chemotherapy, and immunosuppressive use, patients on drugs or blood products that affect complete blood count, patients over 18 years of age, and lack of necessary data. Inclueded patients were divided into two groups according to the presence of clinical infection: patients without infection, and patients with clinical infection.

Study covariates included age, gender, length of hospitalization (LOS), burn severity, burn type, burn location, burn percentage, interventions performed, infections acquired, and laboratory evaluations (White blood cells (WBC), C-reactive protein (CRP), neutrophil, platelet, lymphocyte, and procalcitonin) of pediatric patients admitted with nosocomial infections in the burn unit. Burn types were classified as flame burn and hot liquid burn. The average percentage of total body surface area of burn (TBSA) was obtained from patient information notes.

Primary outcome the SII was calculated from platelet (reference range: $150–400 \times 10^3/\mu L$), neutrophil (reference range: $1.8–6.98 \times 10^3/\mu L$) and lymphocyte (reference range: $1.26–3.35 \times 10^3/\mu L$) counts using the formula SII = platelet × neutrophil/lymphocyte counts[16]. SII was expressed as $\times 10^5/\mu L$. SII was used to analyze cases hospitalized in the burn unit and cases with nosocomial infections.

This study was conducted in accordance with the standards set by the Declaration of Helsinki and approved by the Clinical Research Ethics Committee of University the Toros (No. 2024-99; date: 23.05.2024). In addition, we confirm that this retrospective study adheres to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for reporting observational studies.

Statistical analysis

MedCalc trial version 23.0.1 was used for statistical analysis of the data. For numerical variables, normal distribution was checked by Shapiro Wilk test. Normally distributed quantitative variables were summarized with mean ± standard deviation, otherwise, median and interquartile range values were used. Categorical variables were summarized with number (n) and percentage (%) values. The means of independent groups were compared using the Student-t test and the medians were compared using the Mann-Whitney U test. Chi-square analysis was performed to check for independence or homogeneity in categorical variables. Since the SII range was very high, a logarithmic transformation in base 10 was applied, and calculated log (SII). Univariate logistic regression analysis was performed to determine the risk factors affecting infection, odds ratios and 95% confidence intervals were calculated. Odds ratios with confidence intervals not including the value "1" were considered statistically significant. The diagnostic performance of biomarkers and SII for infection was evaluated by ROC analysis. ROC curves were drawn and areas under the curve (AUC), cut-off values, sensitivity, specificity, positive, and negative predictive values and their 95 were calculated. In addition, AUC values of biomarkers were also compared by ROC analysis. AUC values were evaluated to between 0.6 and 1.0 to be significant, with 1.0 indicating the strongest association[17]. Statistical significance level $p < 0,05$ was accepted for all comparisons.

	Uninfected (*n* = 23)	Infected (*n* = 23)	$p^{*,\dagger}$
Age			
(Median (IQR), (wk)	46,0 (62,0)	80,0 (56,0)	**0,038***
Body surface area			
(Mean ± Sd)	22,3 ± 13,1	43,3 ± 9,1	**< 0,001***
LOS			
(Median (IQR) (d)	7,0 (11,0)	35,0 (29,0)	**< 0,001***
ICU length of stay			
Median (IQR) (d)	0,0(0, 0)	1,0 (24)	**< 0,001***
Gender, n (%)			
Girl	5 (21,7)	7 (30,4)	0,502†
Boy	18 (78,3)	16(69,6)	
Treatment, n (%)			
Medical Treatment + Dressing	23 (100,0)	10(43,5)	**< 0,001**†
Grafting	0 (0,0)	13(56,5)	
Type of burn, n (%)			
Scald burn	21(91,3)	20(87,0)	1,00†
Flame burn	2 (8,7)	3(13,0)	
TBSA%, n (%)			
<%30	19 (82,6)	1 (4,3)	**< 0,001**†
≥ %30	4 (17,4)	22 (95,7)	
Burn degree, n (%)			
Second degree	17 (73,9)	11 (47,8)	0,07†
Third degree	6 (26,1)	12 (52,2)	
CVC, n (%)			
Yes	2 (8,7)	10(43,5)	**0,007**†
No	21(91,3)	13(56,5)	
MV, n (%)			
Yes	0 (0,0)	3(13,0)	0,233†
No	23(100,0)	20(87,0)	

Table 1. Comparison of demographic characteristics and clinical findings of noninfected and infected patients. *$p^{\star}$ values were calculated by Student-t test or Mann Whitney test;$p^{\dagger}$-values were calculated by Chi-Squared or Fisher Exact test.*LOS: *Length of hospital stay;* ICU: *Intensive care unit;* TBSA%: *Average percentage of total body surface area of burn;* CVC: *Central venous catheter;* MV: *Mechanical ventilation*, ***d***: *day;* wk: *week;* IQR: *Interquartile range;* Sd: *Standard deviation*, n: *frequency.*

Results

In this study, a total of 26 pediatric patients hospitalized in the burn intensive care unit (ICU) of our tertiary care hospital were evaluated. The data of the uninfected and infected patient's demographic and clinical data were presented in Table 1. The median age of infected patients was significantly higher than non-infected patients (p^{*}<0,05). The majority patients were boy, 73.9% were boy and 26.1% were female. The gender distribution of the infected and uninfected was similar ($p^{\dagger}$>0,05). The proportion of uninfected patients receiving medical treatment and dressings was significantly higher than the proportion of infected patients receiving the same treatment ($p^{\dagger}$<0,05). On the other hand, only the infected patients were grafting. When the type of burn was analyzed, scalds were the most common cause in both groups with 91.3% and 87%, respectively. Flame Burns ranked second. But, there was no statistically significant difference between the groups in terms of burn etiology ($p^{\dagger}$<0,05). The proportion of infected patients with TBSA above 30% was statistically higher than the proportion of uninfected patients, while the proportion of uninfected patients with TBSA below 30% was statistically higher ($p^{\dagger}$<0,05). There were statistically significant relationships between infection status and CVC use ($p^{\dagger}$=0,007). The CVC usage proportion were higher in infected patients compared to uninfected patients. During the study period, the rate of ventilator use was recorded as 13% for only infected patients, but no case of ventilator-associated pneumonia was encountered. The mean body surface area of burn and median length of hospital and intensive care unit stays of infected patients were statistically significantly higher than uninfected patients (p^{*}<0,05).

The distribution of infected patients according to the breeding site is given in detail in Table 2. There was a statistically significant relatinship between the burn degree and breeding site ($p^{\dagger}$<0.05). In patients with second-degree burns, the proportions of growth in the blood (77,8%) was higher than the proportions of growth in the wound (12,5%). However, there was no statistically significant difference between the growth proportions in the catheter (50%) and the growth proportions in the wound and blood. In patients with third-degree burns,

	Breeding site				
	Wound	Blood	Catheter	Total	*p*-value
Type of burn					
Scald burn	5 (25,0)	9 (45,0)	6 (30)	20 (100)	0,247*
Flame burn	3 (100,0)	0 (0,0)	0 (0,0)	3 (100)	*NA*
Burn degree					
Second degree	1 (9,1)	7 (63,6)	3 (27,3)	11 (100)	**0,019**†
Third degree	7 (58,3)	2 (16,7)	3 (25,0)	12 (100)	
TBSA%					
<%30	0 (0,0)	0 (0,0)	1 (100)	1 (100)	*NA*
≥ %30	8 (36,4)	9 (40,9)	5 (22,7)	22 (100)	0,226*
The Microorganisms Isolated					
Gram-positive bacteria	0 (0,0)	1 (50,0)	1 (50,0)	2 (100)	*NA*
Gram-negative bacteria	8 (42,1)	7 (36,8)	4 (21,1)	19 (100)	0,259*
Candida species	0 (0,0)	1 (50,0)	1 (50,0)	2 (100)	*NA*

Table 2. Distribution of infected patients according to site of reproduction. *Data were summarized as n (%) all proportions were calculated from rows*. $p^{\star}$: *p* values were calculated by Chi-Squared test for homogenity. $p^{\dagger}$: *p* values were calculated by Chi-Squared test for independence. NA: Insufficient observed values prevented the calculation of *p*-values.

the growth proportions in the wound (87,5%) was higher than the growth proportions in the blood (22,2%). There was no statistically significant difference between the growth proportions in the catheter (50%) and the growth proportions in the wound and blood. (The proportions of burn degree were calculated from columns.) Distribution of type of burn, TBSA %, and the place of growth were homogeneous in the breeding site ($p^{\star}>0,05$).

The distribution of blood, wound, and central venous catheter culture samples obtained from our patients was homogenous, and, 39.1% of the blood, 34.8% of the wound, and 26.1% of the central venous catheter cultures were grown ($p^{*}>0,05$) in Table 3. The most frequently isolated microorganism was Pseudomonas aeruginosa ($p^{*}<0,05$). The microorganisms isolated according to the type of infection are presented in detail in Table 3.

Table 4 shows the distribution of blood parameters and SII for patient groups. The results of infected patients represent samples taken in the middle of the patient's ICU stay and when they did not show signs of infection. The Uninfected group includes the laboratory results of the day when samples were taken for microbiologic examination with suspicion of infection. Only hemoglobin mean, lymphocyte, CRP, and procalcitonin medians showed statistically significant differences between the infected and uninfected groups ($p^{*}<0,05$), while the other blood parameters, and SII did not show statistically significant differences in these groups ($p^{\star}>0,05$).

There was no statistically significant difference in the mean and/or median of blood parameters between burn degrees ($p^{*}>0.05$) (Table 5).

According to Table 1, CVC usage, body surface area and length of hospitalization are statistically significant risk factors for infection. CVC usage increases the risk of infection by 8.07 times (OR = 8,077; 95% CI 1,523 to 42,834). Each 1-unit increase in body surface area increases the risk of infection by 1,166 times (OR = 1,166; 95% CI 1,071 to 1,271) and each 1-day increase in length of hospitalization by 1.37 times (OR = 1,37; 95% CI 1,108 to 1,710). Each 1-unit increase in CRP increases the risk of infection by 1,492 times (OR = 1,492; 95% CI 1,128 to 1,972). Increases in Hb and lymphocytes decrease the risk of infection (respectively OR = 0,656, and 0,763; 95% CI 0,479 to 0,897 and 0,593 to 0,982). Factors that may affect the risk of infection are presented in detail in Table 6. According to Table 4, the SII is not a significant risk factor for infection. However, we evaluated and analyzed it as a clinical risk factor, and the result was not statistically significant (OR = 2,057;95% CI 0,489 to 8,657) (Table 6).

Table 7 shows the diagnostic performances of blood parameters and SII for infecion. According to ROC analysis result, the SII was not successful in diagnosing infection. AUC value was 0,605 ($p = 0,236$) for the SII (Table 7; Fig. 1).

In Fig. 1, especially CRP was observed to be very successful in distinguishing between infected and uninfected patients (AUC = 0,877; $p < 0,001$). Those with a CRP value > 0,31 can be considered infected. The sensitivity value for CRP was quite high, 91,30% and the specificity was 73,91%. After CRP, the other blood parameter was Hb (AUC = 0,725; $p = 0,009$). The specificity of Hb was very high (Sp = 95.65%). Those with a Hb value ≤ 10,4 can be considered infected. Although the diagnostic performance of lymphocytes was not as good as the others, but the sensitivity value was high, 86.96% (AUC = 0.679; $p = 0,02$). Furthermore, when comparing the AUC values of these blood parameters in Table 7, we have observed that CRP was more successful than the SII in the diagnosis of infection ($p^{\star}=0,001$). But it was not a significant difference between the SII and the Hb and lymphocyte (respectively $p^{\dagger}=0,397$; $p^{\ddagger}=0,510$) diagnostic performances'. Also, the difference between the AUC values of CRP and Hb is statistically significant ($p^{\S}=0,039$). This indicates that the discrimination of CRP is more successful than Hb. When CRP is compared with lymphocyte, it can be said that the discrimination of CRP is more successful than lymphocyte ($p^{\P}=0,033$). When Hb is compared with lymphocyte, the difference between AUC values is not statistically significant ($p^{\|}=0,663$). Their diagnostic performances is similar.

	n (%)	*p**
Reproduction Site		
Wound	8 (34,8)	
Blood	9 (39,1)	0,737
Catheter	6 (26,1)	
The Microorganisms Isolated		
Gram-positive	2 (8,7)	
Gram-negative	19 (82,6)	**< 0,0001**
Candida	2 (8,7)	
Gram-positive bacteria		
Staphylococcus aureus	2 (100)	–
Gram-negative bacteria		
P. aeruginosa	10 (52,6)	
Acinetobacter spp.	4 (21,1)	**0,006**
E. coli	3 (15,8)	
Serratia marcescens	1 (5,3)	
Klebsiella spp	1 (5,3)	
Candida species		
C.albicans	1 (50,0)	1,00
C. parapsilosis	1 (50,0)	

Table 3. Microorganisms isolated according to the site of infection. *p** values were calculated by Chi-Squared test for homogenity.

Discussion

Pediatric burns constitute a significant portion of all burn cases. However, most burn cases can be treated as outpatients[12]. In this study, we evaluated the demographic, clinical, and laboratory data and infection outcomes of pediatric patients hospitalized in the burn intensive care unit. Pediatric burns constitute a critical patient group associated with high morbidity and mortality. Deaths from burn trauma usually occur due to shock in the first hours and respiratory failure in the early period. Following the development of intensive care facilities and advances in burn treatment, deaths from burn shock and respiratory failure have decreased and infections have become the leading cause of death. The increase in survival time has made infections an important cause of morbidity and mortality. In pediatric burns, impaired immune response and loss of skin integrity increase the risk of infection. Infections account for a significant proportion of deaths in pediatric burns. This situation emphasizes the importance of preventive measures to prevent burns. In our study, the median age of infected patients was higher than that of uninfected patients ($p < 0.05$). The most common burn agent was liquids (89.1%) and most of our cases were scald burns. When the gender distribution of burn cases in the pediatric age group was examined, it was found that boys were exposed to burns more than girls in various studies[18,19]. 73.9% of the cases in our study were boys. Gender distribution was normal between the groups and there was no statistically significant difference. We do not think that age and gender are effective in the development of infection in pediatric burns. The mean body surface area and median length of hospital and intensive care unit stay of infected children were statistically significantly higher than non-infected children. High burn severity and surface area affect burn morbidity and recovery time. Advances in intensive care and surgical techniques have reduced morbidity and mortality, but prolonged intensive care length of stay. Both intensive care and total hospital stays of the patients in the infection group were found to be significantly longer than those in the non-infection group. Our findings are compatible with the literature[13,20]. Infections are an important cause of morbidity and mortality in burn patients. The risk of infection is high in these patients depending on factors such as the etiology of heat damage, invasive procedures performed, presence of a catheter, colonization of the burn wound, translocation of gastrointestinal microbiota, and prolonged hospitalization. In a study conducted in Turkey in which 63 burn patients were examined, the size of the burn surface area, the presence of urinary and central catheters, transfusion administration, and prolonged hospitalization were found to be associated with healthcare-associated infections[14]. In a prospective study of 71 burn patients from India, longer hospitalization, the presence of more central venous catheters, and high mortality were found in patients with infections[15,21]. In addition, the risk of sepsis was found to be higher in patients with large burn surface areas. In our study, the risk factors for patients with infection were similarly found to be the presence of a catheter, a high percentage of burns, and a long hospitalization period. As the burn surface area increases, the length of hospitalization increases, the interventional procedures performed on patients increase, and as a result, the risk of infection increases. In our study, surgical wound and bloodstream infections developed most frequently in the patients followed up. After burn injury, the skin surface becomes sterile, and within a few days, the flora starts to repopulate from the adjacent tissue. The burned skin surface contains coagulated protein and exudate, which facilitates the colonization of microorganisms. In addition, the skin barrier is lost and there are no leukocytes in the burned tissue. Therefore, virulent pathogens develop sometime after the burn injury. The leading bacteria in the bloodstream and burn wound infections are Staphylococcus aureus, Pseudomonas aeruginosa, and

	Uninfected ($n=23$)	Infected ($n=23$)	p-value
Hemoglobin, g/dL	12,17 ± 1,13	10,20 ± 2,84	**0,005***
WBC ($\times 10^3$ µL)	16,19 ± 5,43	15,34 ± 9,22	0,706*
Platelet ($\times 10^5$ µL)	3,98 ± 1,88	3,96 ± 1,35	0,961*
Lymphocyte ($\times 10^3$ /uL)	4,82 (5,51)	2,56 (2,07)	**0,038**†
Neutrophil ($\times 10^3$ µL)	8,93 (6,26)	9,26(13,41)	0,904†
CRP	0,31 (0,52)	5,51 (10,68)	< **0,001**†
Procalcitonin	0,01 (0,09)	7,00 (21,75)	< **0,001**†
SII ($\times 10^5$ µL)	8,18 (8,22)	13,2 (24,3)	0,223†
Log (SII)	5,87 ± 0,34	5,99 ± 0,48	0,331*

Table 4. Comparison of blood parameters of infected patients according to groups. SII: Systemic Immune Inflammation Index (Neutrophil * Lymphocyte/ Platelet). Log (SII): The base-10 logarithm of SII values; WBC: White blood cells; CRP: C-reactive protein; N: Neutrophil; P: Platelet; L: Lymphocyte. The data was summarized as mean ± sd or median (IQR). p*: p-values were calculated by Student-t test or Mann Whitney test. $p^{\dagger}$: p-values were calculated by Mann Whitney test.

	Second Degree ($n=11$)	Third degree ($n=12$)	p^{*}value
Hemoglobin, g/dL	9,95 ± 2,85	10,43 ± 2,85	0,696*
WBC ($\times 10^3$ µL)	16,46 ± 9,27	14,32 ± 9,46	0,589*
Platelets ($\times 10^5$ µL)	4,08 ± 1,41	3,79 ± 1,92	0,712*
Lymphocytes ($\times 10^3$ µL)	2,56 (2,20)	2,36 (2,30)	0,805†
Neutrophils ($\times 10^3$ µL)	13,91 (16,00)	8,68 (15,00)	0,424†
CRP	3,86 (11,38)	7,38 (13,76)	0,389†
Procalcitonin	9,10 (22,00)	5,15 (18,44)	0,498†
SII ($\times 10^5$ µL)	8,58 (10,3)	12,7 (12,9)	0,325†
Log (SII)	6,08 ± 0,53	5,92 ± 0,45	0,448*

Table 5. Comparison of blood parameters of infected patients according to burn degree. SII: Systemic Immune Inflammation Index (Neutrophil * Lymphocyte/ Platelet). Log (SII): The base-10 logarithm of SII values; WBC: White blood cells; CRP: C-reactive protein; N: Neutrophil; P: Platelet; L: Lymphocyte. The data was summarized as mean ± sd or median (IQR). p^{*}: p-values were calculated by Student-t test or Mann Whitney test. $p^{\dagger}$: p-values were calculated by Mann Whitney test.

Variables	OR	95% CI for OR (Lower-Upper)	*p-value
CVC	8,077	(1,523 – 42,834)	**0,014**
Burn degree	3,091	(0,895 – 10,672)	0,074
Body surface area	1,166	(1,071 – 1,271)	< **0,001**
LOS	1,376	(1,108-1,710)	**0,004**
CRP	1,492	(1,128-1,972)	**0,005**
Hemoglobin	0,656	(0,479-0,897)	**0,008**
Lymphocytes ($\times 10^3$ µL)	0,763	(0,593-0,982)	**0,036**
SII	2,057	(0,489-8,657)	0,325

Table 6. Factors that May affect the risk of infection according to univarite logistic regression analysis. LOS: Length of hospital stay; CVC: Central venous catheter; OR: Odds Ratio; CI confidence interval for OR. *p-values were calculated by Wald test statistics for logistic regression.

Escherichia coli in urinary tract infections. In addition, the incidence of Acinetobacter and Candida species is increasing[22,23]. In our study, Pseudomonas aeruginosa was found to be the leading microorganism in bloodstream infections and wound infections. The profile of microorganisms cultured in our patients with hospital infection is consistent with the literature. While gram-positive microorganisms are the causative agents in the early period, gram-negative microorganisms become dominant in the late period. This is because these agents cause infection in patients colonized with healthcare-related agents. The most common infectious agents in our study were gram-negative microorganisms. In a study examining 206 burn children, the rate of gram-positive microorganisms

	SII (x10^6)	CRP	Hemoglobin	Lymphocyte (×10^3)
Cut-off	> 1.28	> 0,31	≤ 10,4	≤ 4,52
AUC (95% CI)	0,605 (0,450- 0,746)	0,877 (0,747–0,955)	0,725 (0,525–0,809)	0,679 (0,573–0,846)
Se (95% CI)	52,17 (30,6–73,2)	91,30 (72,0–98,9)	60,87 38,5–80,3	86,96 (66,4–97,2)
Sp (95% CI)	82,61 (61,2–95,0)	73,91 (51,6–89,8)	95,65 (78,1–99,9)	52,17 (30,6–73,2)
PPV (95% CI)	75,00 (47,6–92,7)	77,8 (57,7–91,4)	93,3(68,1–99,8	64,5 (45,4–80,8)
NPV (95% CI)	63,30 (43,9–80,1)	89,5 (66,9–98,7)	71,0(52,0–85,8)	80,0 (51,9–95,7)
p value	p^*=0,001 $p^\dagger$ =0,397	$p^\S$ =0,039 $p^\P$ =0,033	$p^\parallel$ =0,663	$p^\ddagger$ =0,510

Table 7. Diagnostic performances of blood parameters and SII. AUC: The area under the ROC curve; CI: Confidence interval of 95%; Se: Sensitivity, Sp: Specificity, PPV: Positive predictive value; NPV: Negative predictive value; p value: p-value for pairwise comparison of the AUCs. p^*value obtained from the pairwise comparison of the AUC values between SII and CRP; $p^\dagger$ value obtained from the pairwise comparison of the AUC values between SII and Hemoglobin; $p^\ddagger$ value obtained from the pairwise comparison of the AUC values between SII and Lymphocyte; $p^\S$ value obtained from the pairwise comparison of the AUC values between CRP and Hemoglobin; $p^\P$ values obtained from the pairwise comparison of the AUC values between CRP and Lymphocyte; $p^\parallel$ values obtained from the pairwise comparison of the AUC values between Hemoglobin and Lymphocyte.

was found to be 66.4%[10]. However, similar to our study, other studies have shown that gram-negative microorganisms, especially Pseudomonas spp. and Acinetobacter spp., are more frequently isolated. Other gram-negative agents include Klebsiella spp. and E. coli[10,24]. In various clinical studies, the body surface area affected by burns in pediatric age group cases varies between 1% and 19%[25,26]. However, it has been reported that

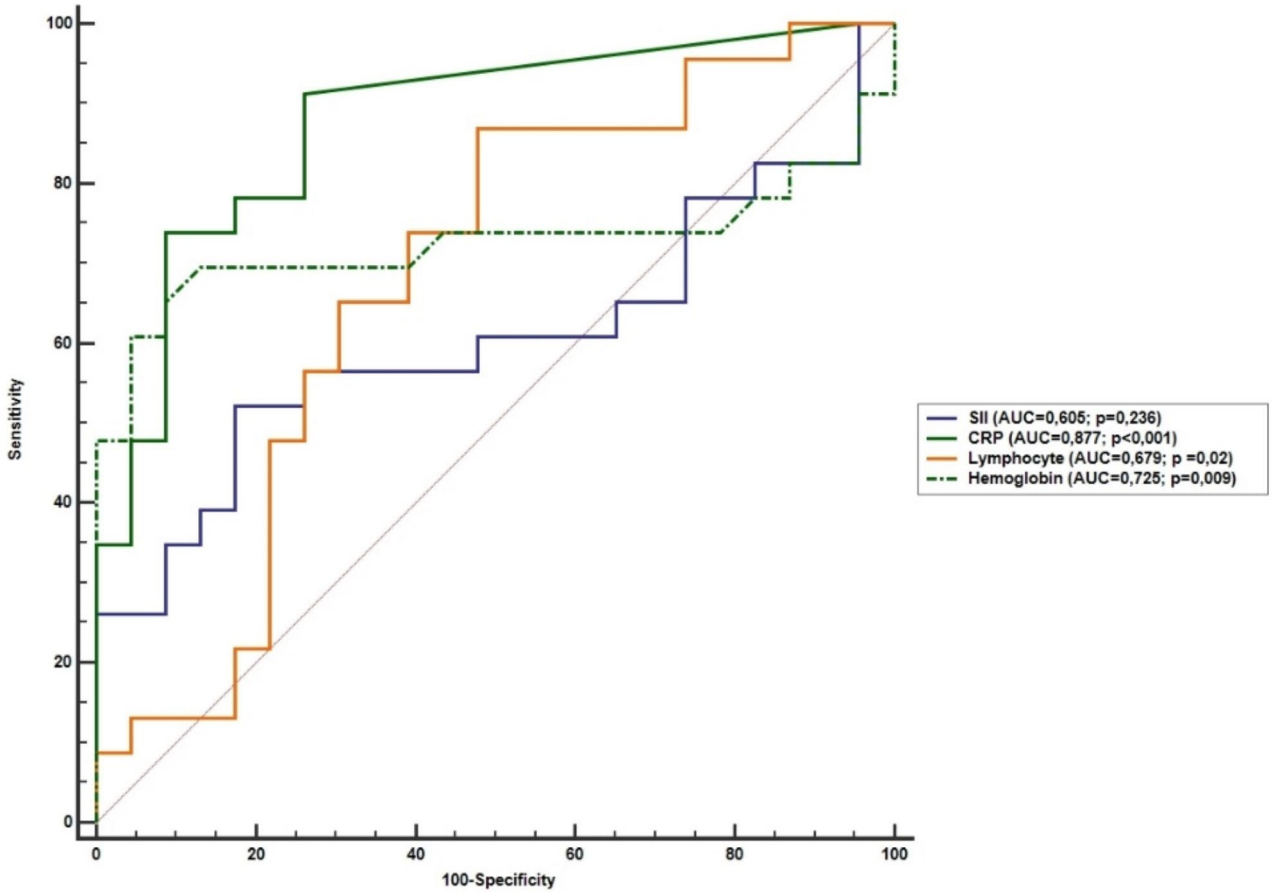

Fig. 1. ROC Curve of blood parameters that can be used to differentiate infected and non-infected burn patients. AUC: The Area Under the ROC curve; *p*: *p* value for AUC. SII: Systemic Immune Inflammation Index. CRP: C-reactive protein. Lymphocytes: Lymphocytes counts.

mortality and length of hospital stay increase as the body surface area affected by burns increases[26,27]. In our study, burn percentages of 30% and above were higher in infected patients than in non-infected patients, while those below 30% were higher in non-infected patients than in non-infected patients. The systemic inflammatory response in burn patients may be similar to the septic response. Identification of microorganisms in blood cultures is the gold standard for sepsis diagnosis, but culture results are obtained a few days after sampling. Therefore, the use of biomarkers is important. In our study, procalcitonin, CRP, and lymphocyte levels were significantly higher in the infected group. Median lymphocyte, CRP, and procalcitonin values showed statistically significant differences between infected and non-infected patients. Leukocytes create a physiological stress response, and this response is manifested by the proliferation of neutrophils and the decrease in lymphocytes. The main function of platelets is in the hemostasis and coagulation system, but in chronic inflammatory processes, an increase in the proliferation of megakaryocytic series and the resulting increase in platelet count is observed. The number of lymphocytes tends to decrease due to increased apoptosis. All of these values are collected as a single collection under parameter-based SII. In recent publications, it has been suggested that this value, which consists of whole blood parameters involved in the inflammation process, should be used as an inflammation indicator. In a study by Dey et al.[27], the collective effect of pro-inflammatory and pro-thrombotic cellular lines was taken into account in the calculation of new indices. Another biomarker widely mentioned in the current literature is SII, first described by Hu et al. in 2014 and calculated with the formula: SII = Platelet x Neutrophil/Lymphocyte. The potential utility of this index is based on the specific relationship between neutrophils, lymphocytes, and platelets, which play important roles in numerous inflammatory processes. The Systemic Immunity-Inflammation Index (SII) is an indicator obtained by multiplying the platelet count by the neutrophil count and dividing this value by the lymphocyte count[16]. In conclusion, although SII showed significant differences between groups in almost all the outcome measures evaluated, its usefulness as a single test is limited. When the SII value was examined in our study, no statistically significant difference was observed between the groups. In our study, the SII had limited discrimination power in the diagnosis of infection. Although it had high sensitivity (82.61%), it had moderate specificity (52.17%), indicating that it may miss infected patients. Also, according to the PPV (75%), the SII predicts infection correctly in three out of four cases. But the NPV of 63.3% suggests that a negative result can not confidently exclude infection. These findings indicate that SII alone may not be sufficient as a standalone diagnostic tool, and a multi-marker approach integrating more established inflammatory markers like CRP and procalcitonin may be more effective. Despite the lack of statistical significance, the odds ratio for SII (OR = 2.057) suggests a possible association with infection, although the wide confidence interval indicates variability. The most important limitation of our study is that it was conducted retrospectively in a single center. Although we performed a 10-year file review and used all samples ($n = 42$), the small sample size impacted the diagnostic and prognostic test results of SII. On the other hand, it is as a primary inflammatory biomarker that CRP demonstrated superior diagnostic performance in this study, despite the small sample size. SII has a potansiall marker for infection. Our findings suggest that while SII lacks statistical significance, it is potential as an independent diagnostic marker for infection in pediatric burn patients. For this reason, these findings highlight the need for larger, multicenter prospective studies to better define the role of SII and emphasize the importance of comprehensive infection prevention strategies in burn care settings.

In conclusion, strict adherence to isolation precautions in major burns will reduce the risk of infection. Early excision and early wound closure are also important. Each burn center should develop appropriate antibiotic strategies according to culture results and prophylaxis with broad-spectrum antibiotics should be avoided. The heterogeneity of the results and recommendations regarding infection in major burns is striking and further studies are needed on this subject.

Data availability

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

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Author contributions

In this article, BÖÖ . was responsible for conducting the basic research and a comprehensive literature review. Author BÖÖ ,M.T.Ş ,Ş.A Wrote the main text of the manuscript. BÖÖ,S.Ö M.E, and M.T.Ş ,managed the data collection processes. In the data analysis and interpretation phase, BÖÖ and M.T.Ş analyzed the data obtained and interpreted the results; in this process, BÖÖ ,SÖ and M.T.Ş played an important role in assessing the accuracy of the statistical analyses.In the process of writing and editing the manuscript, BÖÖ, S.Ö, Ş.A and M.E , and worked together to create the text, ensure the fluency of the language and the overall integrity of the manuscript. Finally, BÖÖ, M.T.Ş, and Ş.A verified the sources used, added references, and completed the final revision of the manuscript.Each author stood out in their area of expertise and made a unique contribution at different stages.

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Declarations

Competing interests

The authors declare no competing interests.

Ethics approval

This study was conducted in accordance with the standards set by the Declaration of Helsinki and approved by the Clinical Research Ethics Committee of University the Toros (No. 2024-99; date: 23.05.2024).

Informed consent

The requirement for informed consent was waived by Clinical Research Ethics Committee of University the Toros because of the retrospective nature of the study.

Additional information

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