

ORIGINAL ARTICLE

Assessment of blood parameters for accurate
sepsis diagnosisSamaa Asaad Hameed, Thikra Adnan Jawad Banimusleum, and Zahraa Isam
Jameel*

Department of Biology, Faculty of Science, Al-Qasim Green University, Al-Qasim, Babil, Iraq

Abstract

Background: Sepsis is a life-threatening medical emergency characterized by an exaggerated inflammatory response by the immune system to infection, which triggers a damaging cascade of events in the body's tissues and organs. While all cases of sepsis originate from an infection, the main danger of the condition lies in excessive inflammation, which can result in organ failure and severe hypotension known as septic shock. **Aim:** This case-control study compared patients with sepsis with healthy individuals for demographics and key hematological parameters, with further analyses stratified by gender. **Methods:** A total of 150 subjects were recruited, with an equal proportion of males and females, and were classified as either patients with sepsis or controls. The study population was found to be mostly from rural areas with a high prevalence of diabetes mellitus and a significant proportion of subjects who were smokers. The values of complete blood count, a set of parameters including white blood cell count, lymphocyte count, red blood cell count, hemoglobin, and platelet count, were analyzed for differences between groups using *t*-test and analysis of variance. **Results:** Compared with the control group, sepsis patients showed significant differences in hematological parameters. Additionally, several specific hematological abnormalities were noted among individuals with sepsis compared to those who were healthy, such as anemia, marked lymphopenia, and evidence of leukocytosis. Both lymphocytes and platelets, which are indicative of the immune response, were differentially regulated by gender. **Conclusion:** There was a high prevalence of chronic risk factors among the sepsis group. Sepsis involves chronic risk factors, distinct hematological impairments, and gender-specific regulation of lymphocytes and platelets. **Relevance for patients:** Understanding these changes in blood parameters and gender differences can improve early sepsis detection and individualized care.

*Corresponding author:

Zahraa Isam Jameel
(zahraa.isam@science.uoqasim.
edu.iq)

Citation: Hammeed SA,
Banimusleum TAJ, Jameel ZI.
Assessment of blood parameters
for accurate sepsis diagnosis. *J Clin
Transl Res*.
doi: 10.36922/JCTR026250057

Received: June 16, 2026**Revised:** June 27, 2026**Accepted:** July 6, 2026**Published online:** August 3, 2026

Copyright: © 2026 Author(s).
This is an Open-Access article
distributed under the terms of the
Creative Commons AttributionNon-
Commercial 4.0 International (CC
BY-NC 4.0), which permits all
non-commercial use, distribution,
and reproduction in any medium,
provided the original work is
properly cited.

Publisher's Note: AccScience
Publishing remains neutral with
regard to jurisdictional claims in
published maps and institutional
affiliations.

Keywords: Sepsis; Hematological parameters; Statistical Package for Social Sciences; Risk factors

1. Introduction

Sepsis is a complex condition that occurs when the body's response to infection is impaired, leading to an uncontrolled inflammatory response and subsequent immunosuppression. It occurs as a complication of infections affecting individuals in the community and healthcare settings, especially in intensive care units (ICUs)¹, where it is the most

prevalent cause of death, making up more than 50% of ICU deaths.² Sepsis is considered a global health problem with significant economic impact.³ Hence, early identification of sepsis is critical to facilitate prompt treatment and prevent adverse outcomes, including mortality.⁴ For every hour that therapy is delayed, there is an approximately 7%–10% increase in sepsis-associated mortality. However, early diagnosis of sepsis remains challenging because its signs and symptoms are nonspecific. Consequently, numerous studies have investigated biomarkers to facilitate the early identification of patients at high risk of sepsis.^{5–8}

Compared with other diseases, sepsis has a very diverse set of causes and mechanisms of action.⁹ Most sepsis cases are caused by Gram-negative bacteria, whereas Gram-positive bacteria constitute a close second. In addition to bacteria, parasites and fungi can also cause sepsis, although to a lesser degree. The culprit goes undetected in around a third of cases. Ideally, there are two stages in the pathophysiology of sepsis. The first stage is defined by the production of pro-inflammatory cytokines and a severe inflammatory reaction to infection. While almost 60% of patients make a full recovery, 30% enter the late phase, which is marked by immunosuppression.¹⁰ Here, the innate and adaptive immune systems work together to form the immune response. When protecting the body from harmful invaders, the innate immune system is the initial line of defense. As an anti-infective, it works quickly and is not selective. Part of the body's natural defenses consists of cells called eosinophils, basophils, and phagocytic cells, including white blood cells (WBCs) and monocytes.

A pathogen-specific antigen response is mediated by interactions with innate immune cells and is carried out by the adaptive immune system, which comprises B and T lymphocytes. Restoring immunological homeostasis and limiting post-infection inflammation and tissue damage are both facilitated by the adaptive immune response. A strong inflammatory reaction known as the “cytokine storm” occurs during sepsis when pathogen-associated molecular patterns and danger-associated molecular patterns activate innate immune cells. These cells release pro-inflammatory cytokines. An overreaction to inflammation can harm cells and tissues, which in turn can cause dysfunction in multiple organs. Sepsis also leads to immunosuppression through dysfunction of the adaptive immune response, thereby increasing the likelihood of infections.^{11–15}

Hemodynamic variables can be easily calculated using a patient's hemogram. Various hematological variables have been associated with sepsis, including the neutrophil-to-lymphocyte ratio (NLR), mean platelet volume, red cell distribution width, and platelet distribution width.¹⁶ Although various investigations have shown that

C-reactive protein, WBC count, and neutrophil count are useful predictors for bacteremia, NLR has been shown to be useful for discriminating bloodstream-infected and non-BSI bloodstream-infected patients.^{17,18}

As sepsis is a systemic inflammatory condition, we hypothesized that hematological parameters could reflect changes associated with the onset of nosocomial sepsis. Complete blood count parameters may therefore serve as useful diagnostic tools. Complete blood count testing offers several advantages: it is widely available across healthcare facilities, provides a rapid turnaround time, is cost-effective, and is relatively simple to perform. It is also commonly ordered as an initial test at all facilities, including the emergency department and ICU. It acts as a first-line diagnostic tool.^{19–22} The objective of this study was to determine the relationship between sepsis and blood indices to enable early diagnosis.

2. Methods

2.1. Patient recruitment and data collection

The current study included 75 patients diagnosed with nosocomial sepsis between July 2025 and December 2025 in hospitals in Babylon province, as well as 75 healthy individuals as controls. The researchers used medical records to complete the data collection on education level, presence of diabetes and hypertension, age, gender, and smoking habits.

2.2. Exclusion criteria

There were certain criteria for exclusion from the study including (i) patients who have received any type of antibiotic treatment; (ii) patients with compromised immune systems (e.g., those receiving chemotherapy or those who were human immunodeficiency virus/acquired immunodeficiency syndrome positive); (iii) patients diagnosed with autoimmune diseases or cancers; and (iv) patients who are currently pregnant, to avoid any physiological changes associated with pregnancy that may have an impact on the microbial colonization process. Additionally, children under 10 years of age were also excluded from the study. Finally, samples that were determined to be of poor quality (due to poor collection technique, transportation method, and/or time in excess of that specified for processing) were excluded; therefore, reliable methods of bacterial isolation and identification could be employed to ensure accurate results.

2.3. Ethical approval information

The clinicopathological data for both the patient and control groups were derived from their respective hospital records. The experiments conducted in this study complied

with the ethical principles established in the Declaration of Helsinki for research involving human subjects. The Institutional Review Board at the Al-Qasim Green University approved the study.

2.4. Sepsis diagnosis

Sepsis refers to life-threatening organ failure (dysfunction) due to an unregulated immune response to an infection. An infection can usually be confirmed by sufficient combined clinical, laboratory, and radiological evidence, together with positive microbiological cultures (from blood, sputum, urine, or other appropriate sites), obtained prior to the initiation of appropriate antibiotic therapy, where possible. Organ dysfunction was assessed using the Sequential Organ Failure Assessment (SOFA) score, which was also used to diagnose sepsis if a patient's SOFA score increased by ≥ 2 points above his/her baseline (assumed to be 0 unless previously documented). The SOFA score was calculated across all of its six individual components (respiratory function, coagulation, liver, cardiovascular, neurological, and renal function) within a 48-h period before the onset of the suspected infection to 24 h after the onset of the suspected infection, including all microbiological data, pathogen characterization, and antibiotic susceptibility data.

2.5. Statistical analysis

We used one-way analysis of variance in the Statistical Package for Social Sciences software version 22 to compare group means, and descriptive statistics, the chi-square test, the Fisher's test, and the paired *t*-test were employed for data analysis. The Kolmogorov–Smirnov test was used to ascertain whether the data distribution was normal. A significant result was defined as a *p*-value less than 0.05.

3. Results

Table 1 provides a concise overview of the study population's demographic and clinical characteristics at baseline (*N* = 150). Gender, age range, frequency of common health issues, and lifestyle characteristics were among the important variables presented. To provide a comprehensive view of the cohort's makeup, all statistics are shown as raw counts and percentages (%) of the overall sample. This case-control study of sepsis included 150 participants: 75 patients and 75 healthy controls.

Sepsis is characterized by systemic inflammation, which is expected to result in distinct hematological alterations compared with the normal physiological state. As shown in Table 2, the sepsis group exhibited a twofold increase in WBC counts compared with controls, indicating significant leukocytosis. Leukocytes, or WBCs,

are a diverse group that includes monocytes, lymphocytes, and granulocytes, which include neutrophils, eosinophils, and basophils. Its absolute value or percentage form is equally valid. Compared with the relative value (%), the absolute value of the WBC count is more informative and clinically relevant, as it reflects the medullary reaction to inflammatory stimuli. By comparing these two values, the WBC population that contributes most actively to the inflammatory response can be identified, helping to narrow down potential underlying causes.

The comparative hematological analysis presented in Table 3 demonstrates substantial alterations in systemic hematological parameters associated with sepsis, with distinct patterns observed between genders. The most prominent disturbance is severe lymphopenia, which was significantly more pronounced in both male and female sepsis patients compared with their respective healthy controls (*p* < 0.0001).

4. Discussion

Due to its complexity, sepsis remains a major unresolved global health challenge. Early diagnosis and timely administration of appropriate treatment are crucial, particularly within the first hour of hospital admission, before the onset of organ failure symptoms. Clinicians recognize that rapid diagnosis of sepsis remains challenging. Clinical assessments and analytical data serve as the foundation for diagnosis. Among available methods, blood cultures remain the gold standard; however, they have several limitations, including prolonged turnaround time, a high false-negative rate, and susceptibility to pre-analytical factors.^{23–26}

Compared to individuals who have normal blood pressure, individuals who have high blood pressure have a significantly higher prevalence of sepsis (72.0% vs. 28.0 %) ($\chi^2 = 4.48$; *p* < 0.00001), demonstrating that hypertension is the primary risk factor for the development of sepsis in these individuals. The increased odds of developing sepsis among individuals with hypertension have a well-documented biological basis. Compared with individuals with normal blood pressure, those with hypertension had 5.00-fold higher odds of developing sepsis (95% confidence interval [CI]: 2.51–10.58). As a result of chronic hypertension, the presence of systemic infection can result in the development of multiple problems within the cardiovascular system, including endothelial dysfunction, oxidative stress, and an increased inflammatory state that can alter microvascular function, ultimately resulting in an elevation of the severity of the infection, organ failure, and sepsis.²⁴ In addition, research has demonstrated that the presence of hypertension is an independent predictor of

Table 1. Main features of the study population

Variable	Subjects	Control	<i>p</i> -value	χ^2	Odds ratio (95% CI)
Gender					
Male	42	40	0.74	0.32	1.11 (0.58–2.11)
Female	33	35			
Education level					
Up to high school	45	49	0.499	0.46	1.26 (0.65–2.44)
Beyond high school	30	26			
Age					
<50 years	28	30	0.73	0.33	0.89 (0.46–1.72)
>50 years	47	45			
Disease severity scores					
Severe infection	50	12	0.005*	0.45	0.5 (0.03–0.9)
None severe infection	25	63			
Septic shock					
Present	25	0	0.003	0.26	0.9 (0.2–1.8)
Absent	50	75			
Smoking					
Yes	50	55	0.62	0.48	1.21 (0.56–2.62)
No	25	20			
Diabetes mellitus					
Yes	54	22	0.009*	2.60	6.2 (1.24–4.63)
No	21	53			
Hypertension					
Yes	52	23	<0.00001*	4.48	5.16 (2.51–10.58)
No	50	25			

Note: *indicates significance. Data presented as *n* (%).

Abbreviation: CI: Confidence interval.

acute kidney injury in patients with sepsis. Acute kidney injury is one of the most common complications of severe sepsis, and serves as a negative prognostic indicator for survival from sepsis.²⁵

The rate of diabetes mellitus among patients with sepsis (72%) is significantly higher than in control patients (28%) ($\chi^2 = 2.60$; $p = 0.009$). The odds of developing sepsis in individuals with diabetes were approximately 6.2-fold higher than in those without diabetes (OR = 6.2; 95% CI: 1.24–4.63). This statistic supports the vast literature on the acquired immunologic deficiency that characterizes diabetes mellitus. The negative impact of hyperglycemia and insulin resistance has been well documented across multiple immune pathways, thereby increasing susceptibility to infections and sepsis. Examples of affected

immune system pathways include neutrophil chemotaxis, phagocytosis, intracellular bactericidal activity and adaptive responses from T-lymphocytes. Overall, these findings indicate the substantial risks of complications and mortality in individuals with diabetes mellitus and sepsis, and underscore the necessity for vaccination programs and strict glycemic control.²⁶

Educational attainment is often used as an indicator of the socioeconomic status and health literacy of an individual. In our study group, 40.0% of individuals with sepsis attained education above the high school level while the figure was 34.7% for the control group. However, the difference was not statistically significant ($\chi^2 = 0.46$; $p = 0.499$), and the odds ratio for sepsis with higher education was 1.26 (95% CI: 0.65–2.44), indicating no

strong protective or harmful effect. Although many latest Mendelian randomization studies report an established protective relationship between education duration and sepsis incidence²⁷, we fail to confirm the findings, which could be explained by unobserved confounders or discrepancies in our study population.

Several factors did not show statistically significant associations with sepsis risk: gender ($p = 0.74$) and age (<50 years vs ≥ 50 years; $p = 0.73$). The null associations between gender and age merit some consideration in this smaller cohort; both gender and age continue to be well-established suite risk factors for developing sepsis and poor outcomes across larger population-based cohort studies (i.e.,). The lack of significance for age may be due to either the relatively younger age distribution of the sample or the use of 50 years of age as the cut-point, thereby potentially hiding more gradual or non-linear relationships between older age for both advancing (versus sudden) or developing sepsis.

When specific microorganisms invade the body, they can trigger a systemic inflammatory response known as sepsis. Patients with sepsis often have poorer prognoses when excessive systemic inflammation occurs due to immune dysregulation.²⁷ The prognosis and survival of patients with sepsis depend critically on prompt diagnosis. During a systemic inflammatory response, marked alterations in WBC counts may occur, including neutropenia and relative lymphocytopenia.²⁸ The NLR, which can be readily calculated from complete blood cell counts, is a widely used marker of systemic inflammation.

Elevated NLR has been associated with serious conditions, including bacteremia and sepsis, reflecting the severity of the inflammatory response.²⁹⁻³⁰

Many studies indicate that atypical neutrophilia is strongly mediated by granulocyte-colony-stimulating factor and interleukin-6, which act as potent chemoattractants released during inflammation, as well as by bone marrow production and “demargination”.³⁰ At the same time, marked relative lymphopenia was observed. Although absolute lymphopenia may provide greater specificity, relative lymphopenia remains one of the most validated indicators of sepsis-induced immunoparesis. This, however, is largely due to marked lymphocyte apoptosis mediated by inflammatory mediators such as tumor necrosis factor alpha and corticosteroids, resulting in the “immune paralysis” stage and susceptibility to secondary infection.³¹ This group also exhibited normocytic, normochromic anemia, with a low mean red blood cell count. Along the same lines, hemoglobin was low. Both of the latter two might indicate inflammatory anemia, with reduced iron uptake resulting from hepatic hepcidin released as a precursor/surrogate in response to interleukin-6 stimulation, leading to accelerated erythropoiesis and reduced red blood cell lifespan.³¹ Of immense interest is the fact that the group exhibited thrombocytosis as opposed to thrombocytopenia, which may indicate that this group may still be in its reactive form as a precursor/state/symptom of sepsis, with platelets acting as a paradigm of the latter. Interleukin-6 is also a strong stimulant of platelets.³²

Table 2. Blood parameters among the study groups

Blood parameters	Study groups		<i>p</i> -value	Unpaired <i>t</i> -test
	Sepsis patients	Control		
WBC ($10^3/\mu\text{L}$)	15.49 $\pm$ 5.86	6.84 $\pm$ 1.53	0.0001*	8.02
LYM ($10^3/\mu\text{L}$)	14.29 $\pm$ 3.97	29.50 $\pm$ 8.01	0.001*	8.77
RBCs ($10^6/\mu\text{L}$)	3.69 $\pm$ 0.77	4.60 $\pm$ 0.61	0.00001*	4.97
HGB (g/dL)	10.17 $\pm$ 2.15	13.29 $\pm$ 1.57	<0.0001*	6.35
PLT ($10^3/\mu\text{L}$)	333.50 $\pm$ 127.00	213.01 $\pm$ 58.48	0.0023*	3.18

Note: *indicates significance. Data presented as mean $\pm$ standard deviation.

Abbreviations: HGB: Hemoglobin; LYM: Lymphocyte; PLT: Platelet; RBCs: Red blood cells; WBC: White blood cell.

Table 3. Blood parameters among the study groups, stratified by gender

Blood parameters	Study groups				<i>p</i> -value	<i>F</i> -statistics	Odds ratio (95% CI)
	Male sepsis patients	Female sepsis patients	Male control	Female control			
WBC ($10^3/\mu\text{L}$)	10.95 $\pm$ 3.37	10.17 $\pm$ 4.02	7.07 $\pm$ 1.70	6.91 $\pm$ 1.75	0.0019*	7.48	1.12 (0.26–2.62)
LYM ($10^3/\mu\text{L}$)	6.30 $\pm$ 1.93	15.23 $\pm$ 2.19	26.34 $\pm$ 7.42	32.45 $\pm$ 7.00	0.000*	58.77	3.16 (2.51–11.52)
RBCs ($10^6/\mu\text{L}$)	3.89 $\pm$ 0.19	3.52 $\pm$ 0.61	5.18 $\pm$ 0.46	4.29 $\pm$ 0.44	1.08	16.37	2.11 (1.51–9.58)
HGB (g/dL)	10.80 $\pm$ 2.57	9.62 $\pm$ 1.61	14.76 $\pm$ 1.26	12.52 $\pm$ 1.11	1.24	22.46	1.16 (4.51–13.00)
PLT ($10^3/\mu\text{L}$)	315.58 $\pm$ 169.78	216.42 $\pm$ 91.84	208.36 $\pm$ 60.67	211.20 $\pm$ 55.48	0.04*	2.94	7.12 (2.51–12.58)

Note: *indicates significance. Data presented as mean $\pm$ standard deviation.

Abbreviations: CI: Confidence interval; HGB: Hemoglobin; LYM: Lymphocyte; PLT: Platelet; RBCs: Red blood cells; WBC: White blood cell.

A low red blood cell count is a hallmark of sepsis, which may result from a number of processes affecting red blood cell survival or production.³³ Infection, inflammation, functional iron deficiency, or reduced erythropoietin synthesis could all lead to decreased red blood cell production. In addition, red blood cell loss during sepsis can be caused by both preexisting clinical diseases like cancer, liver disease, or renal impairment and new-onset multiple organ dysfunction, especially in the hepatic and renal systems. Hypoadrenalism, dietary deficiencies, pathogen-associated hemolysis, and disseminated intravascular coagulation are other variables. Red blood cell counts tend to drop in addicts due to volume resuscitation-induced hemodilution. Last but not least, surgical operations, gastrointestinal tract bleeding, or repeated phlebotomy can all cause blood loss. An estimated 24–41 mL of blood is lost every day due to blood withdrawal.³³ Alterations to red blood cells caused by pathogens and immune reactions may explain their reduced survival time. Indeed, rheology (viscosity, aggregation, and deformability) and red blood cell shape are significantly changed by sepsis. The reticuloendothelial system in the liver and spleen increases the clearance of altered RBCs, allowing them to be removed from circulation more quickly.³⁴ Thus, reduced red blood cell count is not a reliable indicator of sepsis diagnosis or prognosis.

Lymphocyte depletion is a hallmark of sepsis-induced immunoparalysis, resulting from extensive apoptosis of adaptive immune cells, which compromises the host's defense and is strongly associated with a heightened risk of secondary infections and mortality.³⁵ Simultaneously, leukocytosis was observed, with a significantly elevated WBC count in the sepsis groups ($p = 0.0019$). This represents the early hyperinflammatory stage of sepsis, mediated by a cascade of pro-inflammatory cytokines

such as tumor necrosis factor alpha and interleukin-6; the moderate elevation observed here, however, is consistent with the variable and frequently subnormal leukocyte response noted in many septic patients.³⁶

There was a statistically significant difference in platelet counts between the sepsis cohort and controls ($p = 0.04$, $F = 2.94$). There was a small reduction in platelet counts in patients with sepsis compared with controls (mean difference: $7.12 \times 10^3/\mu\text{L}$, 95% CI: 2.51–12.58). Male sepsis patients had a higher mean platelet count ($315.58 \pm 169.78 \times 10^3/\mu\text{L}$) than male controls ($208.36 \pm 60.67 \times 10^3/\mu\text{L}$), likely reflecting normal physiological variability. Both female sepsis ($216.42 \pm 91.84 \times 10^3/\mu\text{L}$) and control ($211.20 \pm 55.48 \times 10^3/\mu\text{L}$) patients had platelet counts within the normal range and did not exhibit significant thrombocytopenia. In response to the mechanisms of sepsis, the reduction observed in both males and females may narrow the gender difference due to systemic inflammation; however, based on differences noted within the male sepsis patient subgroup, no clinically significant thrombocytopenia was present among sepsis cases. These results indicate that platelets are a nonspecific marker of systemic inflammation and warrant further investigation into the utility of measuring platelet activation biomarkers for predicting outcomes in patients with sepsis.³⁷

Platelet activation occurs during sepsis due to a combination of factors, including direct contact between the pathogen and surface-expressed danger-associated molecular pattern receptors, activation of the coagulation system, the inflammatory response, and damage to endothelial tissue. Once activated, platelets perform multiple roles. Platelets that have been activated quickly clump together and display various surface receptors that either bind to and capture extracellular infections or facilitate clumping with surrounding platelets and WBCs.³⁶

In addition to signaling immune cells, releasing microbicide chemicals, and adding to inflammation, activated platelets aid in pathogen eradication. Lastly, platelets promote the development of monocytes and neutrophils into macrophages, a pro-inflammatory phenotype.³⁷

In the treatment of septic patients, the clinical monitoring of platelet count has become an invaluable tool. Platelet count has been shown to be an effective biomarker for the diagnosis and prognosis of sepsis.³⁷ Thrombocytopenia, a decrease in platelet count, is frequently observed in patients with septic shock; studies have shown incidence rates ranging from 20% to 70%.³⁸ The SOFA score includes platelet count as an essential criterion, emphasizing the relevance of these complete blood count parameters.³⁹ Sepsis and thrombocytopenia have been associated with adverse outcomes. It is commonly used to classify patients into three groups based on the degree of thrombocytopenia: mild thrombocytopenia with a platelet count $100\text{--}150 \times 10^3/\mu\text{L}$, moderate thrombocytopenia with a platelet count $50\text{--}100 \times 10^3/\mu\text{L}$, and severe thrombocytopenia with a platelet count $< 50 \times 10^3/\mu\text{L}$, with an increasing degree of severity and associated with higher rates and severities of adverse outcomes.⁴⁰ Importantly, platelet dynamics have been shown to better identify outcomes and mortality rates than static measurements and have provided vital information. Recovery, indicating return to normal levels, has been associated with an elevated risk of mortality and acute illness, while return-to-normal levels is associated with an increase in the possibility of an intensive care unit transfer.

The hematological profile further supports marked marrow suppression and anemia. These data, despite the apparent anomaly in the listed *p*-values, indicate highly significant *F*-statistics with clear reductions in mean red blood cell count and hemoglobin concentration in septic patients, reflecting the entity commonly referred to as anemia of critical illness. This is driven by inflammatory cytokines, most notably hepcidin, which inhibit iron mobilization and erythropoiesis, as well as by increased red cell destruction and phlebotomy-related blood loss.⁴¹ The results also show a significant disturbance in platelet dynamics ($p = 0.04$), with extreme variability and a marked elevation in males with sepsis. Platelet counts are among the more dynamic biomarkers in sepsis, with initial consumption and subsequent rebound thrombocytosis as common features reflecting a complex interplay among disseminated intravascular coagulation, inflammatory activation of platelets, and marrow stimulation.⁴² The strong gender difference in platelet response evident here may suggest further investigation of potential sex-based differences in coagulant and inflammatory pathways during sepsis. In summary, this tabulated data robustly

captures the dual hematological signature of sepsis: a profoundly dysregulated immune axis with contradictory lymphopenia and leukocytosis, coupled with impaired oxygen transport and highly variable platelet responses. These findings reinforce the complex pathophysiology of sepsis as a syndrome of simultaneous immune activation and failure, with emerging evidence of gender-specific phenotypic variations.

5. Conclusion

Sepsis has been the focus of global efforts aimed at reducing its burden and improving patient outcomes. Avoiding multi-organ dysfunction, reducing ICU hospitalizations, and improving patient prognoses are all ways sepsis prediction could reduce healthcare costs and save patients' lives. Due to the complexity and heterogeneity of sepsis, the optimal biomarker for the condition has not yet been identified and may not exist.⁴³ Therefore, clinicians can aid in its early detection through a thorough, comprehensive assessment based on laboratory and clinical results. There is significant promise in complete blood count parameters. Changes in complete blood count values, in particular, may serve as a warning to doctors, who should then perform more targeted tests to confirm a sepsis diagnosis. Clinicians may also find complete blood count values useful for assessing sepsis severity and tracking treatment efficacy.⁴⁴

Acknowledgments

None.

Funding

None.

Conflict of interest

The authors declare that they have no competing interests.

Author contributions

Conceptualization: All authors

Formal analysis: Zahraa Isam Jameel

Investigation: Zahraa Isam Jameel

Methodology: Zahraa Isam Jameel, Samaa Saad Hameed

Writing—original draft: All authors

Writing—review & editing: Zahraa Isam Jameel

Ethics approval and consent to participate

The clinicopathological data for both the patient and control groups were derived from their respective hospital records. The experiments conducted in this study complied with the ethical principles established in the Declaration of Helsinki for research involving human subjects. The

Institutional Review Board (IRB) at Al-Qasim Green University granted ethics approval to conduct the study (reference: qgec\632026). Each participant signed written informed consent to participate in the study.

Consent for publication

Each participant signed written informed consent to participate in the study. The participants were also made aware that the fully anonymized results would be submitted for publication and consented to publication.

Availability of data

All data analyzed have been presented in the paper.

References

1. 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
2. Hotchkiss RS, Monneret G, Payen D. Sepsis-induced immunosuppression: from cellular dysfunctions to immunotherapy. *Nat Rev Immunol*. 2013;13(12):862-874.
doi: 10.1038/nri3552
3. Pieracci FM, Barie PS. Diagnosis and management of iron-related anemias in critical illness. *Crit Care Med*. 2006;34(7):1898-1905.
doi: 10.1097/01.CCM.0000220495.10510.C1
4. Venkata C, Kashyap R, Farmer JC, Afessa B. Thrombocytopenia in adult patients with sepsis: incidence, risk factors, and its association with clinical outcome. *J Intensive Care*. 2013;1(1):9.
doi: 10.1186/2052-0492-1-9
5. Evans L, Rhodes A, Alhazzani W, *et al.* Surviving sepsis campaign: international guidelines for management of sepsis and septic shock 2021. *Intensive Care Med*. 2021;47(11):1181-1247.
doi: 10.1007/s00134-021-06506-y
6. Venkata C, Kashyap R, Farmer JC, Afessa B. Thrombocytopenia in adult patients with sepsis: incidence, risk factors, and its association with clinical outcome. *J Intensive Care Med*. 2013;1(1).
doi: 10.1186/2052-0492-1-9
7. Markwart R, Saito H, Harder T, *et al.* Epidemiology and burden of sepsis acquired in hospitals and intensive care units: A systematic review and meta-analysis. *Intensive Care Med*. 2020;46(8):1536-1551.
doi: 10.1007/s00134-020-06106-2
8. Langley RJ, Tsalik EL, van Velkinburgh JC, *et al.* An integrated clinico-metabolomic model improves prediction of death in sepsis. *Sci Transl Med*. 2013;5(195):195ra95.
doi: 10.1126/scitranslmed.3005893
9. Reinhart K, Daniels R, Kissoon N, Machado FR, Schachter RD, Finfer S. Recognizing Sepsis as a Global Health Priority—A WHO Resolution. *N Engl J Med*. 2017;377(5):414-417.
doi: 10.1056/NEJMp1707170
10. Shashikumar SP, Stanley MD, Sadiq I, *et al.* Early sepsis detection in critical care patients using multiscale blood pressure and heart rate dynamics. *J Electrocardiol*. 2017;50(6):739-743.
doi: 10.1016/j.jelectrocard.2017.08.013
11. Kataria Y, Remick D. Sepsis Biomarkers. *Methods Mol Biol*. 2021;2321:177-189.
doi: 10.1007/978-1-0716-1488-4_16
12. Agnello L, Bivona G, Parisi E, *et al.* Presepsin and Midregional Proadrenomedullin in Pediatric Oncologic Patients with Febrile Neutropenia. *Lab Med*. 2020;51(6):585-591.
doi: 10.1093/labmed/lmaa011
13. Bellia C, Agnello L, Lo Sasso B, *et al.* Mid-regional pro-adrenomedullin predicts poor outcome in non-selected patients admitted to an intensive care unit. *Clin Chem Lab Med*. 2019;57(4):549-555.
doi: 10.1515/cclm-2018-0645
14. Velissaris D, Zareifopoulos N, Karamouzos V, *et al.* Presepsin as a Diagnostic and Prognostic Biomarker in Sepsis. *Cureus*. 2021;13(5):e15019.
doi: 10.7759/cureus.15019
15. Rittirsch D, Flierl MA, Ward PA. Harmful molecular mechanisms in sepsis. *Nat Rev Immunol*. 2008;8(10):776-787.
doi: 10.1038/nri2402
16. Bone RC, Balk RA, Cerra FB, *et al.* Definitions for sepsis and organ failure and guidelines for the use of innovative therapies in sepsis. The ACCP/SCCM Consensus Conference Committee. American College of Chest Physicians/Society of Critical Care Medicine. *Chest*. 1992;101(6):1644-1655.
doi: 10.1378/chest.101.6.1644
17. Levy MM, Fink MP, Marshall JC, *et al.* 2001 SCCM/ESICM/ACCP/ATS/SIS International Sepsis Definitions Conference. *Intensive Care Med*. 2003;29(4):530-538.
doi: 10.1007/s00134-003-1662-x
18. Nedeva C, Menassa J, Puthalakath H. Sepsis: Inflammation Is a Necessary Evil. *Front Cell Dev Biol*. 2019;7:108.
doi: 10.3389/fcell.2019.00108
19. Brady J, Horie S, Laffey JG. Role of the adaptive immune

- response in sepsis. *Intensive Care Med Exp.* 2020;8(Suppl 1):20.
doi: 10.1186/s40635-020-00309-z
20. Pyo JY, Park JS, Park YB, Lee SK, Ha YJ, Lee SW. Delta neutrophil index as a marker for differential diagnosis between flare and infection in febrile systemic lupus erythematosus patients. *Lupus.* 2013;22(10):1102-1109.
doi: 10.1177/0961203313499957
21. Pyo JY, Ha YJ, Song JJ, Park YB, Lee SK, Lee SW. Delta neutrophil index contributes to the differential diagnosis between acute gout attack and cellulitis within 24 hours after hospitalization. *Rheumatology.* 2017;56(5):795-801.
doi: 10.1093/rheumatology/kew471
22. Saleem M, Cheema SM, Azam M. Hematological Scoring System for Early Diagnosis of Neonatal Sepsis. *J Rawalpindi Med Coll.* 2014;18(1). <https://www.journalrmc.com/index.php/JRMC/article/view/391>
23. Muthukumar N, Gowri V. To Enumerate the Nucleated Red Blood Cells in Neonatal Sepsis as an Early Response Element to Inflammation in Infection. *J Med Sci Clin Res.* 2018;6(10).
doi: 10.18535/jmscr/v6i10.205
24. BS V, Girish GN, Adhikari S, Hugara S. Evaluation of Septic Screen as a Diagnostic Tool for Neonatal Sepsis in a Tertiary Hospital at Mysore. *Sch J Appl Med Sci.* 2015;3(2):1005-1010.
doi: 10.36347/sjams.2015.v03i02.095
25. Elsayed M, Hassan A, Hashim A, Kasem Y. The role of Hematological Scoring System (HSS) in early diagnosis of Neonatal Sepsis. *Ann Neonatol J.* 2021;3(1):85-106.
doi: 10.21608/anj.2021.140120
26. Dey D, Sultana R, Ahmed W, Chowdhury MA, Akter F, Dasgupta S. Role of Hematological Score in Early Diagnosis of Neonatal Sepsis. *Chattagram Maa-O-Shishu Hosp Med Coll J.* 2020;18(2):45-48.
doi: 10.3329/cmshmcj.v18i2.47776
27. Khair KB, Rahman MA, Sultana T, *et al.* Role of Hematologic Scoring System in Early Diagnosis of Neonatal Septicemia. *Bangabandhu Sheikh Mujib Med Univ J.* 2011;3(2):62-67.
doi: 10.3329/bsmmuj.v3i2.7053.
28. Yusuf MM, Yasmeen BN, Chowdhury MAK. Evaluation of Hematological Scoring System (HSS) for Early Diagnosis of Neonatal Sepsis. *North Int Med Coll J.* 2016;7(2):135-138.
doi: 10.3329/nimcj.v7i2.29656
29. Ibrahim MMM, El-Sewefy DA, Ibrahim MJA, Pessar SA. Diagnostic Evaluation of Hematological Sepsis Score and Presepsin in Neonatal Sepsis. *Iran J Pediatr Hematol Oncol.* 2022;12(2):101-113.
doi: 10.18502/ijpho.v12i2.9075
30. Sawadkar MM, Dharwadkar A, Gore CR, Chandanwale S, Buch A. Hematological Scoring System and its Significance in Early Diagnosis of Neonatal Sepsis. *Sch J Pathol Med.* 2020;5(2):108-114.
doi: 10.36348/sjpm.2020.v05i02.012
31. Derbala S, Handoka N, Hasan B, El-Sayed H. Performance of the Hematological Scoring System for Early Diagnosis of Neonatal Sepsis in a Neonatal Intensive Care Unit of a Developing Country. *Infect Dis Trop Med.* 2017;3(4):e429.
32. Barman M, Das B. A Study of Validity of Haematological Parameters in the Diagnosis of Neonatal Sepsis. *Int J Curr Res.* 2016;6(3):532-535.
doi: 10.31729/jnma.488
34. Yadav SK, Yadav SP, Bhatta NK, Kanodia P, Singh RR, Khanal B. Risk factors for hospital acquired bloodstream infections in neonatal intensive care unit of B.P. Koirala Institute of Health Sciences, Nepal. *Sri Lanka J Child Health.* 2017;46(1):16-22.
doi: 10.4038/sljch.v46i1.8236
35. Effenberger-Neidnicht K, Hartmann M. Mechanisms of hemolysis during sepsis. *Inflammation.* 2018;41(5):1569-1581.
doi: 10.1007/s10753-018-0810-y
36. Vincent JL, Baron JF, Reinhart K, *et al.* Anemia and blood transfusion in critically ill patients. *JAMA.* 2002;288(12):1499-1507.
doi: 10.1001/jama.288.12.1499
37. Bateman RM, Sharpe MD, Singer M, Ellis CG. The Effect of Sepsis on the Erythrocyte. *Int J Mol Sci.* 2017;18(9):1932.
doi: 10.3390/ijms18091932
38. Guo L, Rondina MT. The Era of Thromboinflammation: Platelets Are Dynamic Sensors and Effector Cells During Infectious Diseases. *Front Immunol.* 2019;10:2204.
doi: 10.3389/fimmu.2019.02204
39. Assinger A, Schrottmaier WC, Salzmann M, Rayes J. Platelets in Sepsis: An Update on Experimental Models and Clinical Data. *Front Immunol.* 2019;10:1687.
doi: 10.3389/fimmu.2019.01687
40. Ma AC, Kubes P. Platelets, neutrophils, and neutrophil extracellular traps (NETs) in sepsis. *J Thromb Haemost.* 2008;6(3):415-420.
doi: 10.1111/j.1538-7836.2007.02865.x
41. Dewitte A, Lepreux S, Villeneuve J, *et al.* Blood platelets and sepsis pathophysiology: A new therapeutic prospect in

- critically ill patients? *Ann Intensive Care*. 2017;7(1):115.
doi: 10.1186/s13613-017-0337-7
42. Levi M. Platelets in Critical Illness. *Semin Thromb Hemost*. 2016;42(3):252-257.
doi: 10.1055/s-0035-1570080
43. Claushuis TA, van Vught LA, Scicluna BP, *et al*. Thrombocytopenia is associated with a dysregulated host response in critically ill sepsis patients. *Blood*. 2016;127(24):3062-3072.
doi: 10.1182/blood-2015-11-680744
44. Vardon-Bouines F, Gratacap MP, Groyer S, *et al*. Kinetics of mean platelet volume predicts mortality in patients with septic shock. *PLoS ONE*. 2019;14(10):e0223553.
doi: 10.1371/journal.pone.0223553