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Original Research

Could Blood Cell-Based Inflammatory Markers Be Used to Monitor Response to Biologic Therapy in Psoriasis?

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Abstract

Objectives: Despite extensive research, there is currently no specific biomarker that reliably and universally indicates treatment response in psoriasis. Multiple studies have evaluated systemic inflammation markers, including neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), monocyte-to-lymphocyte ratio (MLR), systemic immune-inflammation index (SII), and systemic immune response index (SIRI) in psoriasis patients. However, there are limited studies investigating changes in these markers with biologic therapy. The goal of this study was to investigate the impact of biologic therapy on parameters including NLR, PLR, MLR, SII, and SIRI in patients with psoriasis.

Methods: In this cohort study, we retrospectively evaluated 108 psoriasis patients who were on biological treatment, including interleukin (IL)17, IL23, and IL12/23 inhibitors, for a minimum of 12 weeks. We analyzed Psoriasis Area Severity Index (PASI) scores, complete blood count parameters, and C-reactive protein (CRP) levels both before and after 12 weeks of treatment.

Results: The NLR, PLR, MLR, SII, SIRI, and CRP values all demonstrated a significant decrease, regardless of the specific type of biologic agent (p=0.001, 0.007, 0.011, <0.001, <0.001 and <0.001, respectively). Furthermore, we observed a statistically significant but low correlation between the reduction in PASI scores and PLR, SII, and SIRI values (p=0.036, r=0.202; p=0.042, r=0.196; p=0.023, r=0.219, respectively).

Conclusion: The NLR, MLR, especially PLR, SII, and SIRI might be used as simple, convenient, and inexpensive laboratory markers to monitor the degree of inflammation and response to treatment after biologic therapy in daily practice.

Keywords: Biologic agents, platelet-to-lymphocyte ratio, psoriasis, systemic immune-inflammation index, systemic immune response index

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Psoriasis is a chronic inflammatory cutaneous disease, occurring in approximately 2-3% of the population. It is characterized by scaly erythematous papules and plaques that occur preferentially on the elbows, knees, trunk, and scalp.[1,2] Psoriasis-related inflammation extends beyond the skin. Increased levels of proinflammatory cytokines such as TNF-α, IFN-γ, IL17, IL22, and IL23 are found in the skin and serum of psoriasis patients.[3] These cytokines promote chronic subclinical systemic inflammation and are associated with an increased risk of cardio-cerebrovascular diseases, diabetes mellitus (DM), metabolic syndrome, inflammatory bowel disease, nonalcoholic fatty liver disease, and malignancy in psoriasis patients.[4] In recent times, complete blood count parameters have gained recognition as valuable biomarkers for a range of inflammatory conditions, primarily because of their widespread availabil-

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ity and cost-effectiveness. Earlier research has established that parameters like neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and monocyte-to-lymphocyte ratio (MLR) hold promise as markers of systemic inflammation, and they have been linked to the severity and prognosis of various conditions, including cardiovascular diseases (CVD), malignancies, and chronic inflammatory disorders like psoriasis and psoriatic arthritis (PsA).[5-12] The systemic immune-inflammation index (SII) and systemic immune response index (SIRI), relatively new inflammatory markers, have the potential to provide a comprehensive reflection of systemic inflammation compared with NLR or PLR alone.[13,14] They reflect the balance between the inflammatory response and immune status.[15] Initially, SII was identified as a prognostic marker with poor outcomes in patients with hepatocellular carcinoma.[16] In subsequent years, studies have determined that SII and SIRI are elevated in malignancies, CVD, and several infections, and they are relevant with an increased inflammatory response and potential adverse outcomes.[13-15,17-19] More recent research has indicated that SII is correlated with disease severity and activity in conditions such as psoriasis and PsA.[20,21]

The aims of this study were to evaluate the changes in NLR, PLR, MLR, SII, and SIRI values, which are systemic inflammation and CVD indicators, in psoriasis patients receiving biologic treatment and to determine the potential usefulness of these markers in evaluating the response to treatment.

Methods

Study Design and Patient Selection

In this single-center cohort study, a total of 108 patients with chronic plaque psoriasis who had undergone treatment with biologic agents for a minimum of 12 weeks between January 2022 and April 2023, were evaluated retrospectively.

Patients with a history of malignancy; systemic conditions like DM, CVD, kidney or liver diseases; inflammatory diseases; active infection; and cutaneous diseases other than psoriasis were excluded from the study.

Age, sex, disease duration, family history, scalp, nail, and joint involvement, the administered biologic agent, Psoriasis Area Severity Index (PASI) scores, neutrophil, lymphocyte, monocyte, and platelet counts, and NLR, PLR, MLR, SII, SIRI, and CRP values were recorded before and after treatment. The NLR, PLR, and MLR denote the number of neutrophils, platelets, and monocytes divided by the number of lymphocytes. The formulas for SII and SIRI are as follows:

SII = Platelet count × Neutrophil count / Lymphocyte count

SIRI = Monocyte count × Neutrophil count / Lymphocyte count

The administration of the biological agents in this study followed these protocols:

Ustekinumab (IL12/23 inhibitor): Initial two doses given four weeks apart, followed by a maintenance dose of 45 mg for patients with a weight below 100 kg or 90 mg for those weighing 100 kg or more, every 12 weeks.

Secukinumab (IL17 inhibitor): An initial dose of 300 mg administered once weekly for the first five weeks, followed by 300 mg maintenance doses every four weeks.

Ixekizumab (IL17 inhibitor): An initial dose of 160 mg, followed by 80 mg every two weeks until the 12th week.

Guselkumab (IL23 inhibitor): The first two doses given 100 mg each, four weeks apart, followed by 100 mg administered every eight weeks.

Risankizumab (IL23 inhibitor): The first two doses given 150 mg each, four weeks apart, and subsequently, 150 mg was given every 12 weeks.

Statistical Analysis

The statistical analyses were carried out utilizing SPSS software version 23.0 (SPSS, Chicago, IL, USA). To assess the normal distribution of variables, analytic methods such as the Kolmogorov-Smirnov and Shapiro-Wilk tests were employed. Continuous variables were presented as mean±standard deviation, while discrete variables were expressed as median (minimum-maximum). For comparing two means of dependent groups, the Paired Student's t-test was used. The Wilcoxon test was employed for comparing changes in non-normally distributed variables. Kruskal-Wallis test was applied to evaluate the difference between non-normally distributed numerical data among more than two groups. The Mann-Whitney U test was performed to test the significance of pairwise differences using Benforroni correction to adjust for multiple comparisons. The relationships between quantitative variables were evaluated using the Spearman correlation coefficient. A p-value of less than 0.05 was considered statistically significant.

Ethics Approval

The present study was conducted according to the Declaration of Helsinki and approved by the Clinical Research and Ethics Committee of Giresun Training and Research Hospital (Approval number: 09, date: 12.02.2023).

Results

One hundred and eight patients (51 female, 57 male) were enrolled in this study. The mean age was 48.18±13.58 years. Fourteen patients (13%) received ustekinumab, 25 patients (23.1%) received secukinumab, 23 patients (21.3%)

received ixekizumab, 26 patients (24.1%) received guselkumab, and 20 patients (18.5) received risankizumab. The clinical and demographic characteristics of the patients are indicated in Table 1.

Neutrophil count, platelet count, NLR, PLR, MLR, SII, SIRI, CRP values, and PASI scores were statistically lower after 12 weeks of treatment with biologic agents than values at baseline (p<0.001, p=0.005, 0.001, 0.007, 0.011, <0.001, <0.001, <0.001 and <0.001, respectively). No significant difference was found between pre-treatment and post-treatment lymphocyte and monocyte counts (p=0.089 and 0.052, respectively) (Table 2).

There was no statistically significant difference between the five different biological agents in terms of changes in NLR, PLR, MLR, SII, SIRI, and CRP levels before and after therapy (p>0.05). It was observed that patients receiving secukinumab had a significantly greater reduction in PASI scores compared to those receiving guselkumab and risankizumab (p=0.006, 0.008, respectively), whereas there was no significant difference between the other groups (Table 3).

When comparing 48 patients using IL17 inhibitors (secukinumab and ixekizumab) with 46 patients using IL23 inhibitors (guselkumab and risankizumab) in terms of laboratory parameters and changes in PASI, it was observed that in the IL17 inhibitor group, there was a statistically significant greater reduction in PASI score and NLR value compared to the IL23 inhibitor group (p=0.004, 0.036, respectively). However, no significant differences were identified in alterations of other parameters between the two groups (p>0.05).

There was a low but statistically significant correlation between the change in PASI scores and PLR, SII, and SIRI values (p=0.036, r=0.202; p=0.042, r=0.196; and p=0.023, r=2.219, respectively). However, no significant correlation has been detected between the change in CRP and NLR, PLR, MLR, SII, and SIRI values (p>0.05) (Table 4).

Table 1. Demographic and clinical characteristics of the patients.

Sex, M/F, (%)	57/51(52.78/47.2)
Age, years, mean±SD	48.18±14.58
Disease duration, years, median (min-max)	20 (2-52)
Age of onset, years, median (min-max)	26 (4-84)
Family history, P/A, (%)	57/51 (52.8/47.2)
Scalp involvement, P/A, (%)	82/26 (75.9/24.1)
Nail involvement, P/A, (%)	54/54 (50/50)
Psoriatic arthritis, P/A, (%)	28/80 (25.9/74.1)
Baseline PASI score, median (min-max)	13.6 (1.2-58.8)

M: male; F: female; P: present; A: absent; PASI: psoriasis area severity index; SD: standard deviation.

Discussion

Psoriasis is an inflammatory skin disease characterized by erythematous scaly plaques.[1] T lymphocytes, neutrophils, keratinocytes, dendritic cells and various cytokines such as TNF-α, IL1, IL12, IL17, IL22, and IL23 play an important role in pathogenesis. The systemic circulation of these cutaneous inflammatory cells and cytokines throughout the body results in systemic inflammation.[3] Recent studies have shown that individuals with psoriasis are at an increased risk of developing chronic inflammatory diseases due to increased and persistent systemic inflammation. In patients with psoriasis treated with biologics, studies have reported a reduction in systemic inflammatory parameters.[22,23]

Table 2. Baseline and 12th week Psoriasis Area and Severity Index scores and laboratory results of patients.

	Baseline	12th week	p
PASI score‡	13.6 (1.2-58.8)	0 (0-8.8)	<0.001
CRP (mg/L)‡	1.96 (0-30.14)	1.56 (0-11.28)	<0.001
Neutrophil count (x10^3/ml)‡	4.01 (2.04-11.8)	3.92 (1.39-6.7)	<0.001
Lymphocyte count (x10^3/ml)†	2.18±0.61	2.28±0.72	0.089
Platelet count (x10^3/ml)‡	246.5 (142-430)	239 (126-375)	0.005
Monocyte count (x10^3/ml)‡	0.46 (0.18-1.14)	0.45 (0.2-1.09)	0.058
NLR‡	2.01 (0.94-5.84)	1.79 (0.34-5.96)	0.001
PLR‡	115.88 (48.21-261.9)	112.1 (47.7-288.9)	0.007
MLR‡	0.22 (0.11-0.56)	0.21 (0.06-0.68)	0.012
SII‡	521.82 (189-2511.88)	469.7 (93.7-1878.44)	<0.001
SIRI‡	0.98 (0.36-2.88)	0.78 (0.14-4.16)	<0.001

Student t paired test used for parametric variables, Wilcoxon signed ranks test used for non-parametric variables. PASI: psoriasis area severity index; CRP: C-reactive protein; NLR: neutrophil-to-lymphocyte ratio; PLR: platelet-to-lymphocyte ratio; MLR: monocyte-to-lymphocyte ratio; SII: systemic immune-inflammation index; SIRI: systemic immune response index. †: mean±standard deviation, ‡: median (min-max).

Table 3. Changes of Psoriasis Area and Severity Index and laboratory results according to biologic agents.

	Biologic agent	Baseline	12th week	p
PASI‡	Ustekinumab	13.5 (2.7-30)	1.1 (0-8)	0.026
	Secukinumab	18.2 (5.4-58.8)	0 (0-1.8)	
	Ixekizumab	16.4 (1.2-42.3)	0 (0-8.8)	
	Guselkumab	12.5 (7.2-27)	0 (0-5.4)	
	Risankizumab	12.4 (7.2-29.8)	0.8 (0-4.8)	
CRP‡	Ustekinumab	6.09 (0.43-30.14)	2.96 (0.57-9.04)	0.934
	Secukinumab	2.55 (0-9.35)	2.04 (0-5.12)	
	Ixekizumab	3.55 (0.43-12.6)	2.61 (0.4-7.9)	
	Guselkumab	2.34 (0.22-11.63)	1.62 (0.12-5.35)	
	Risankizumab	3.79 (0.69-11.41)	3.24 (0-11.28)	
NLR‡	Ustekinumab	1.71 (0.94-3.01)	1.57 (0.8-2.64)	0.266
	Secukinumab	2.52 (1.17-5.84)	1.95 (0.34-4.53)	
	Ixekizumab	2.05 (1.13-3.47)	1.83 (0.76-3.73)	
	Guselkumab	2.09 (1.16-3.58)	2.1 (0.88-5.96)	
	Risankizumab	2.07 (1.44-3.17)	1.76 (0.74-2.79)	
PLR‡	Ustekinumab	110.01 (48.21-193.55)	101.52 (47.7-159.72)	0.957
	Secukinumab	138.21 (76.74-229.9)	128.75 (67.09-213.86)	
	Ixekizumab	122.08 (63.7-255.68)	110.9 (54.45-187.63)	
	Guselkumab	124.64 (61.74-207.41)	124.11 (74.02-288.9)	
	Risankizumab	122.47 (79.33-261.9)	108.58 (63.66-236.08)	
MLR‡	Ustekinumab	0.19 (0.12-0.31)	0.19 (0.12-0.29)	0.413
	Secukinumab	0.26 (0.14-0.56)	0.25 (0.06-0.58)	
	Ixekizumab	0.22 (0.11-0.42)	0.21 (0.09-0.37)	
	Guselkumab	0.26 (0.14-0.44)	0.22 (0.12-0.51)	
	Risankizumab	0.22 (0.15-0.4)	0.21 (0.07-0.35)	
SII‡	Ustekinumab	459.44 (189-1081.9)	400.56 (132.61-891.21)	0.542
	Secukinumab	652.21 (287.36-2511.88)	484.84 (93.69-1048.38)	
	Ixekizumab	526.58 (221.04-1042.4)	435.81 (178.06-913.03)	
	Guselkumab	537.9 (242.63-1139.1)	524.53 (238.22-1878.44)	
	Risankizumab	538.12 (301.43-872.14)	456.77 (227.06-1041.09)	
SIRI‡	Ustekinumab	0.69 (0.36-1.65)	0.65 (0.34-1.53)	0.245
	Secukinumab	1.08 (0.36-2.88)	0.74 (1.14-2.47)	
	Ixekizumab	0.87 (0.41-2.3)	0.86 (0.16-1.98)	
	Guselkumab	1.01 (0.4-2.24)	0.75 (0.4-2.04)	
	Risankizumab	1.06 (0.53-1.91)	0.9 (1.19-4.16)	

Kruskal-Wallis test used for analysis. PASI: Psoriasis Area and Severity Index; CRP: C-reactive protein; NLR: neutrophil-to-lymphocyte ratio; PLR: platelet-to-lymphocyte ratio; MLR: monocyte-to-lymphocyte ratio; SII: systemic immune-inflammation index; SIRI: systemic immune response index. ‡: median (min-max).

However, there are no suitable laboratory markers that can be used in daily practice to assess the degree of inflammation and response to therapy in psoriasis. NLR, PLR, MLR, SII and SIRI are novel whole blood cell-based biomarkers of systemic inflammation that correlate with disease severity and outcomes in patients with inflammatory diseases such as CVD, malignancies and chronic inflammatory diseases like psoriasis, and PsA.[5-12,16,20,21]

The systemic immune inflammation index and SIRI, newly developed markers of systemic inflammation, are considered more promising prognostic indices than other inflammatory indices in malignancies.[16] SII includes neutrophil, platelet, and lymphocyte counts, while SIRI includes neutrophil, monocyte, and lymphocyte counts. They reflect the balance between individual inflammatory and immune status.[17] In recent years, several studies have shown that the SII can also be used to predict the risk and severity of chronic inflammatory diseases such as psoriasis, PsA, rheumatoid arthritis, and CVD.[17,20,21,24]

Various studies have reported that the NLR, PLR, MLR, SII and SIRI are significantly higher in psoriasis patients and some of these studies have shown a correlation between

Table 4. The correlation between changes in laboratory parameters and changes in Psoriasis Area and Severity Index and C-reactive Protein.

	Change in PASI	Change in CRP
Change in NLR		
r	0.152	0.104
p	0.115	0.283
Change in PLR		
r	0.202*	0.171
p	0.036	0.076
Change in MLR		
r	0.176	0.187
p	0.068	0.052
Change in SII		
r	0.196*	1.164
p	0.042	0.09
Change in SIRI		
r	0.219*	1.172
p	0.023	0.074

Spearman test was used for analysis. PASI: Psoriasis Area and Severity Index; CRP: C-reactive protein; NLR: neutrophil-to-lymphocyte ratio; PLR: platelet-to-lymphocyte ratio; MLR: monocyte-to-lymphocyte ratio; SII: systemic immune-inflammation index; SIRI: systemic immune response index; r: correlation coefficient.* Correlation is significant at the 0.05 level.

these parameters and the clinical severity of psoriasis.[8-11,20,21,23,25] In a study comparing 477 psoriasis patients with 954 healthy controls, it was reported that NLR and PLR were significantly higher in psoriasis patients. However, there was no significant correlation between NLR, PLR, and the PASI scores.[8] In another study evaluating 49 patients with chronic plaque psoriasis and 47 controls, the NLR value was significantly higher in psoriasis patients, yet no significant correlation was observed between NLR and the severity of the disease.[11] Another study, which compared 94 psoriasis patients with 118 healthy controls, found that NLR, MLR, and CRP were significantly higher in psoriasis patients, and there was a significant correlation between PASI scores and NLR, PLR, MLR, and CRP.[10] A study by Asahina and colleagues also indicated that patients with high NLR and PLR values had higher PASI scores.[23] In a study comparing 171 psoriasis patients and 170 healthy controls, NLR, PLR, MLR, and SII values were higher in psoriasis patients ($p<0.001$) and in patients with moderate/severe psoriasis ($p=0.034$). A positive correlation was noticed between SII and PASI, which was more pronounced moderate-to-severe psoriasis patients ($p=0.13$, $r=0.16$). Therefore, the authors report that SII better reflects systemic inflammation in moderate-to-severe psoriasis.[20] In another study examining 71 psoriasis patients and 70 healthy controls, SII was significantly higher in psoriasis ($p<0.001$), and in patients with PASI score ≥ 4.5 ($p=0.007$).[21] According to Sugimoto et al.,[25] there was no statistical difference between psoriasis, PsA and controls in terms of NLR, PLR, MLR, SII, and SIRI ($p>0.05$). In this study, a positive correlation was found between these five inflammatory markers and PASI scores.

There are few studies evaluating the change in NLR, PLR, and SII, whereas there are no studies in the English literature examining the change in MLR and SIRI after biologic therapy.[23,26-28] In a study that analyzed 80 psoriasis patients receiving anti-TNFα treatment for one year, a significant decrease in NLR and PLR values was demonstrated in line with the reduction in PASI scores.[27] In another study, a significant decrease in NLR and PLR levels was observed after treatment in 186 psoriasis and 50 PsA patients assessed before and once during the first year of therapy (infliximab, adalimumab, ustekinumab), regardless of the type of biologic agent.[23] Similarly, in another study of 75 psoriasis patients examined before and after the third and sixth months of therapy, a statistically significant decrease in NLR, PLR, and CRP levels was observed, irrespective of the type of biologic used.[28] In a study evaluating 107 psoriasis patients using methotrexate and acitretin, and 102 patients using biologic therapy (26 adalimumab, 13 etanercept, 8 infliximab, 40 ustekinumab, 9 secukinumab, and 6 ixekizumab), a significant decrease in NLR, PLR, SII, and CRP values at 3 months compared to baseline was observed in all patients. No significant differences were found in the changes of NLR and PLR among the treatment regimens [26]. Consistent with the results of these studies, we observed in the current study that NLR, PLR, and CRP levels decreased significantly after 12 weeks of therapy, independent of the type of biologic agent. In this study, in which the changes in MLR and SIRI with biological therapy were evaluated for the first time, a significant decrease in MLR, SII, and SIRI values was observed, independent of the biologic. In our study, no significant differences were found among the treatment groups in terms of changes in laboratory parameters. However, it was observed that in patients receiving secukinumab, there was a significantly greater reduction in PASI score compared to those receiving guselkumab and risankizumab. Furthermore, when comparing patients receiving IL17 inhibitors with those receiving IL23 inhibitors, we observed a significantly greater reduction in PASI and NLR in IL17 inhibitor group. Consistent with our findings, it has been reported that in the short-term treatment (12-16 weeks), IL17 inhibitors are more effective than IL23 inhibitors in achieving PASI-75 response.[29]

Neutrophil-to-lymphocyte ratio, PLR, MLR, SII and SIRI are recognized as systemic inflammation markers in various diseases like DM, infections, malignancies and CVD.[5-7,13-19] It is known that chronic low-grade systemic inflamma-

tion is an important factor in the development of CVD.[30] Various publications have demonstrated an association between these parameters and CVD.[5,6,17,19,30,31] A systematic review and meta-analysis reported that elevated NLR levels are associated with cardiovascular and cerebrovascular events and could be used as an indicator of CVD.[31] In a recent cohort study following 42,875 adults for 20 years, SII and SIRI were found to be closely associated with cardiovascular mortality.[30] In our study, the significant reduction in these parameters point to the effectiveness of biological treatment in mitigating systemic inflammation and reducing cardiovascular risk in psoriasis patients, even within a short timeframe of 12 weeks.

In various studies, a correlation has been found between PASI and NLR, PLR, MLR, SII and SIRI.[9,10,20,25] In this study, we found that there was a weak but significant correlation between the reduction in PASI scores and the decrease in PLR, SII, and SIRI. Based on this result, we believe that PLR, SII, and SIRI could be useful laboratory parameters for assessing the response to biological treatment for psoriasis.

Retrospective design, being conducted in a single-center, the short patient follow-up period, and the absence of patients utilizing TNF-α inhibitors can be identified as limitations of this study.

Conclusion

In this study, in which the MLR and SIRI changes after biologic therapy were evaluated for the first time, our findings suggest that NLR, MLR, and particularly PLR, SII and SIRI values obtained from routine hemogram data can serve as cost-effective and readily accessible parameters. These parameters hold the potential for assessing the impact of biologic therapies on systemic inflammation and monitoring the treatment response in patients with psoriasis. Overall, our study provides evidence supporting the effectiveness of biologic agent therapy in reducing the risk of systemic inflammation in individuals with psoriasis. Comprehensive prospective studies with a larger number of patients, encompassing all biologic agents used in psoriasis treatment, and featuring a longer follow-up period are needed to support the utility and benefits of using these inflammatory parameters in evaluating the response to biologic treatment.

Disclosures

Ethics Committee Approval: The present study was conducted according to the Declaration of Helsinki and approved by the Clinical Research and Ethics Committee of Giresun Training and Research Hospital (Approval number: 09, date: 12.02.2023).

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Concept – S.K.; Design – S.K.; Supervision – I.D.O.; Materials – S.K., I.D.O., B.A.; Data collection &/or processing – S.K., I.D.O., B.A.; Analysis and/or interpretation – S.K., I.D.O.; Literature search – S.K.; Writing – S.K.; Critical review – I.D.O., B.A.

References

1. Singh R, Koppu S, Perche PO, Feldman SR. The cytokine mediated molecular pathophysiology of psoriasis and its clinical implications. Int J Mol Sci 2021;22:12793. [CrossRef]
2. Armstrong AW, Read C. Pathophysiology, clinical presentation, and treatment of psoriasis: a review. JAMA 2020;323:1945–60.
3. Mahil SK, Capon F, Barker JN. Update on psoriasis immunopathogenesis and targeted immunotherapy. Semin Immunopathol 2016;38:11–27. [CrossRef]
4. Takeshita J, Grewal S, Langan SM, Mehta NN, Ogdie A, Van Voorhees AS, et al. Psoriasis and comorbid diseases: epidemiology. J Am Acad Dermatol 2017;76:377–90. [CrossRef]
5. Ning P, Yang F, Kang J, Yang J, Zhang J, Tang Y, et al. Predictive value of novel inflammatory markers platelet-to-lymphocyte ratio, neutrophil-to-lymphocyte ratio, and monocyte-to-lymphocyte ratio in arterial stiffness in patients with diabetes: a propensity score-matched analysis. Front Endocrinol (Lausanne) 2022;13:1039700. [CrossRef]
6. Larmann J, Handke J, Scholz AS, Dehne S, Arens C, Gillmann HJ, et al. Preoperative neutrophil to lymphocyte ratio and platelet to lymphocyte ratio are associated with major adverse cardiovascular and cerebrovascular events in coronary heart disease patients undergoing non-cardiac surgery. BMC Cardiovasc Disord 2020;20:230. [CrossRef]
7. Portale G, Bartolotta P, Azzolina D, Gregori D, Fiscon V. Prognostic role of platelet-to-lymphocyte ratio, neutrophil-to-lymphocyte, and lymphocyte-to-monocyte ratio in operated rectal cancer patients: systematic review and meta-analysis. Langenbecks Arch Surg 2023;408:85. [CrossRef]
8. Wang WM, Wu C, Gao YM, Li F, Yu XL, Jin HZ. Neutrophil to lymphocyte ratio, platelet to lymphocyte ratio, and other hematological parameters in psoriasis patients. BMC Immunol 2021;22:64.
9. Nguyen HT, Vo LDH, Pham NN. Neutrophil-to-lymphocyte and platelet-to-lymphocyte ratios as inflammatory markers in psoriasis: a case-control study. Dermatol Reports 2022;15:9516. [CrossRef]
10. Aktaş Karabay E, Demir D, Aksu Çerman A. Evaluation of monocyte to high-density lipoprotein ratio, lymphocytes, monocytes, and platelets in psoriasis. An Bras Dermatol 2020;95:40–5.
11. Çerman AA, Karabay AE, Altunay Kİ. Evaluation of neutrophil-lymphocyte ratio and mean platelet volume in patients with psoriasis. Sisli Etfal Hastan Tip Bul [Article in Turkish] 2016;50:137–41.
12. Talmac MA, Ciftpinar T, Ozdemir MS, Yardimci AH, Gunay I, Kocadal NC. Can the combination of magnetic resonance ımaging, neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio predict the mass origin in ovarian masses? Sisli Etfal Hastan Tip Bul 2023;57:326–31. [CrossRef]

13. Geng Y, Zhu D, Wu C, Wu J, Wang Q, Li R, et al. A novel systemic inflammation response index (SIRI) for predicting postoperative survival of patients with esophageal squamous cell carcinoma. Int Immunopharmacol 2018;65:503–10. [CrossRef]
14. Xie QK, Chen P, Hu WM, Sun P, He WZ, Jiang C, et al. The systemic immune-inflammation index is an independent predictor of survival for metastatic colorectal cancer and its association with the lymphocytic response to the tumor. J Transl Med 2018;16:273.
15. Wang RH, Wen WX, Jiang ZP, Du ZP, Ma ZH, Lu AL, et al. The clinical value of neutrophil-to-lymphocyte ratio (NLR), systemic immune-inflammation index (SII), platelet-to-lymphocyte ratio (PLR) and systemic inflammation response index (SIRI) for predicting the occurrence and severity of pneumonia in patients with intracerebral hemorrhage. Front Immunol 2023;14:1115031. [CrossRef]
16. Hu B, Yang XR, Xu Y, Sun YF, Sun C, Guo W, et al. Systemic immune-inflammation index predicts prognosis of patients after curative resection for hepatocellular carcinoma. Clin Cancer Res 2014;20:6212–22. [CrossRef]
17. Ye Z, Hu T, Wang J, Xiao R, Liao X, Liu M, et al. Systemic immune-inflammation index as a potential biomarker of cardiovascular diseases: a systematic review and meta-analysis. Front Cardiovasc Med 2022;9:933913. [CrossRef]
18. Mangalesh S, Dudani S, Malik A. The systemic immune-inflammation index in predicting sepsis mortality. Postgrad Med 2023;135:345–51. [CrossRef]
19. Dziedzic EA, Gąsior JS, Tuzimek A, Paleczny J, Junka A, Dąbrowski M, et al. Investigation of the associations of novel inflammatory biomarkers-systemic inflammatory index (SII) and systemic inflammatory response index (SIRI)-with the severity of coronary artery disease and acute coronary syndrome occurrence. Int J Mol Sci 2022;23:9553. [CrossRef]
20. Yorulmaz A, Hayran Y, Akpinar U, Yalcin B. Systemic immune-inflammation index (SII) predicts increased severity in psoriasis and psoriatic arthritis. Curr Health Sci J 2020;46:352–7.
21. Dincer Rota D, Tanacan E. The utility of systemic-immune inflammation index for predicting the disease activation in patients with psoriasis. Int J Clin Pract 2021;75:e14101. [CrossRef]
22. Asahina A, Umezawa Y, Yanaba K, Nakagawa H. Serum C-reactive protein levels in Japanese patients with psoriasis and psoriatic arthritis: long-term differential effects of biologics. J Dermatol 2016;43:779–84. [CrossRef]
23. Asahina A, Kubo N, Umezawa Y, Honda H, Yanaba K, Nakagawa H. Neutrophil-lymphocyte ratio, platelet-lymphocyte ratio and mean platelet volume in Japanese patients with psoriasis and psoriatic arthritis: response to therapy with biologics. J Dermatol 2017;44:1112–21. [CrossRef]
24. Choe JY, Kim SK. Association between hematological indicesand disease activity in patients with rheumatoid arthritis treated with janus kinase inhibitors for 24 weeks. Medicina (Kaunas) 2022;58:426. [CrossRef]
25. Sugimoto E, Matsuda H, Shibata S, Mizuno Y, Koyama A, Li L, et al. Impact of pretreatment systemic inflammatory markers on treatment persistence with biologics and conventional systemic therapy: a retrospective study of patients with psoriasis vulgaris and psoriatic arthritis. J Clin Med 2023;12:3046. [CrossRef]
26. Albayrak H. Neutrophil-to-lymphocyte ratio, neutrophil-to-monocyte ratio, platelet-to-lymphocyte ratio, and systemic ımmune-ınflammation ındex in psoriasis patients: response to treatment with biological drugs. J Clin Med 2023;12:5452.
27. Najar Nobari N, Shahidi Dadras M, Nasiri S, Abdollahimajd F, Gheisari M. Neutrophil/platelet to lymphocyte ratio in monitoring of response to TNF-α inhibitors in psoriatic patients. Dermatol Ther 2020;33:e13457. [CrossRef]
28. An I, Ucmak D, Ozturk M. The effect of biological agent treatment on neutrophil-to-lymphocyte ratio, platelet-to-lymphocyte ratio, mean platelet volume, and C-reactive protein in psoriasis patients. Postepy Dermatol Alergol 2020;37:202–6. [CrossRef]
29. Bai F, Li GG, Liu Q, Niu X, Li R, Ma H. Short-term efficacy and safety of IL-17, IL-12/23, and IL-23 inhibitors brodalumab, secukinumab, ixekizumab, ustekinumab, guselkumab, tildrakizumab, and risankizumab for the treatment of moderate to severe plaque psoriasis: a systematic review and network meta-analysis of randomized controlled trials. J Immunol Res 2019;2019:2546161. [CrossRef]
30. Xia Y, Xia C, Wu L, Li Z, Li H, Zhang J. Systemic immune inflammation index (SII), system inflammation response index (SIRI) and risk of all-cause mortality and cardiovascular mortality: a 20-year follow-up cohort study of 42,875 US adults. J Clin Med 2023;12:1128. [CrossRef]
31. Angkananard T, Anothaisintawee T, McEvoy M, Attia J, Thakkinstian A. Neutrophil lymphocyte ratio and cardiovascular disease risk: a systematic review and meta-analysis. Biomed Res Int 2018;2018:2703518. [CrossRef]