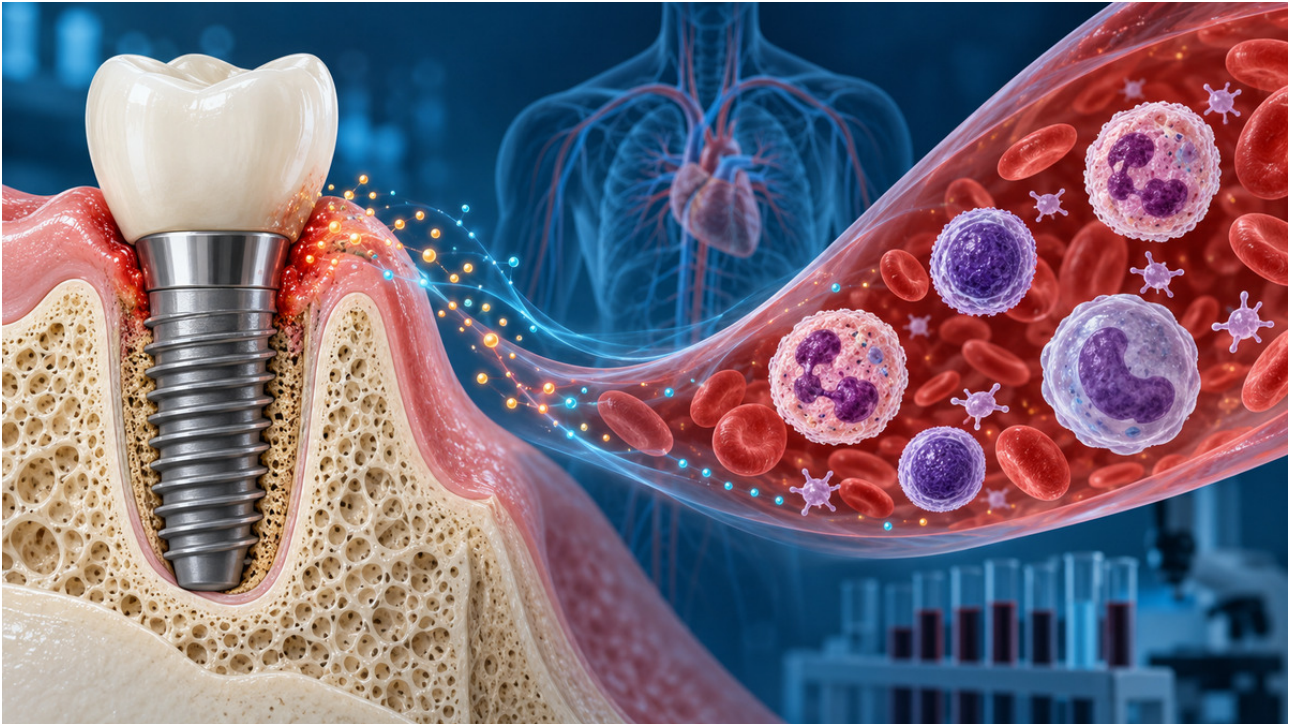


Reading Inflammation in the Blood: CBC-Derived Indices in Peri-implant Disease

Complete blood count ratios, composite inflammatory indices and their responsible interpretation in peri-implant care



Core message: NLR, PLR, MLR, SII, SIRI and AISI/PIV summarize relationships among circulating blood-cell populations. They may describe systemic inflammatory background, but they do not identify the implant as the source and do not diagnose peri-implantitis.

Educational material for dental students, postgraduate trainees and academic teachers

From complete blood count to composite indices

A complete blood count provides absolute or relative values for leukocyte populations and platelets. Composite indices reorganize these routine measurements into ratios or products. The calculation is simple; interpretation is not. Every value remains influenced by the biological and analytical conditions that affected the original cell counts.

Component	Principal biological context	Interpretive limitation
Neutrophils (NEU)	Rapid innate response, microbial defence, proteolytic and oxidative activity.	Increase is common in acute infection, stress, trauma and corticosteroid exposure.
Lymphocytes (LYM)	Adaptive immunity and immune regulation.	Reduction can reflect stress, medication, acute illness or immune dysfunction.
Monocytes (MON)	Circulating precursors of macrophages and osteoclast-lineage cells; chronic inflammatory signalling.	Affected by infection, inflammatory disease, haematological conditions and recovery states.
Platelets (PLT)	Haemostasis, endothelial interaction, leukocyte communication and thrombo-inflammation.	Counts change with inflammation, iron status, medication and haematological disorders.
White blood cells (WBC)	Total circulating leukocyte burden.	A broad signal that does not show which cell population drives the change.

Why ratios are used

Ratios can reveal a shift between cell populations even when total WBC remains within the laboratory reference interval. For example, simultaneous neutrophilia and lymphopenia increase NLR more than either change alone. Composite indices add monocytes or platelets to represent a wider inflammatory and thrombo-inflammatory profile.

An index is a transformation of the CBC, not a separate test. Inspect the component counts before interpreting the final number.

Formulas and reporting conventions

Index	Formula	Cell populations represented
NLR	NEU / LYM	Neutrophil predominance relative to lymphocytes
PLR	PLT / LYM	Platelet activity relative to lymphocytes
MLR	MON / LYM	Monocytic component relative to lymphocytes
SII	$PLT \times NEU / LYM$	Platelet-neutrophil axis relative to lymphocytes
SIRI	$NEU \times MON / LYM$	Neutrophil-monocyte axis relative to lymphocytes
AISI / PIV	$NEU \times MON \times PLT / LYM$	Combined neutrophil, monocyte and platelet profile relative to lymphocytes

Use absolute counts and consistent units

NEU, LYM and MON should be absolute counts reported in the same unit, commonly $\times 10^9/L$. PLT should be taken from the same blood sample and its unit must be documented. NLR, PLR and MLR are ratios. Composite indices depend on the numerical units entered, so results from differently scaled inputs cannot be compared without conversion.

Nomenclature is not fully standardized

AISI is commonly expanded as aggregate index of systemic inflammation. PIV is commonly expanded as pan-immune-inflammation value. Both labels are often used for the same mathematical structure: $NEU \times MON \times PLT / LYM$. Publications may use different abbreviations, scaling factors or transformations. The formula and input units should therefore be reported explicitly.

Reference intervals and cut-offs

General laboratory reference intervals apply to the component counts, not automatically to the derived index. There are no universally accepted diagnostic thresholds for peri-implantitis for NLR, PLR, MLR, SII, SIRI or AISI/PIV. A value should not be labelled normal or abnormal solely by importing a cut-off from oncology, cardiology or another disease population.

Reproducibility rule: report the formula, unit convention, sampling time, clinical context and all component counts alongside the calculated index.

Simple ratios: NLR, PLR and MLR

Neutrophil-to-lymphocyte ratio (NLR)

$$\text{NLR} = \text{NEU} / \text{LYM}$$

NLR rises with higher neutrophils, lower lymphocytes, or both. It integrates two directions of immune change but does not distinguish their cause.

NLR is the most widely discussed CBC-derived inflammatory ratio. In peri-implant research it may be used to describe systemic inflammatory background or to explore associations with disease severity and treatment response. It remains nonspecific and cannot localize inflammation to the peri-implant tissues.

Platelet-to-lymphocyte ratio (PLR)

$$\text{PLR} = \text{PLT} / \text{LYM}$$

PLR combines platelet count with lymphocyte count and may reflect an inflammatory-platelet profile.

Platelets participate in haemostasis, endothelial signalling and leukocyte communication. PLR may change in inflammatory, vascular, metabolic and haematological conditions. An increased PLR should prompt inspection of both PLT and LYM rather than an assumption of oral inflammation.

Monocyte-to-lymphocyte ratio (MLR)

$$\text{MLR} = \text{MON} / \text{LYM}$$

MLR emphasizes the balance between circulating monocytes and lymphocytes.

Monocytes connect peripheral blood with tissue macrophage biology and osteoclast-lineage pathways. MLR may be of interest in chronic inflammatory research, but its value is also altered by many systemic and haematological conditions.

The denominator matters. A ratio can increase because the numerator rises, because lymphocytes fall, or because both events occur. These mechanisms are not clinically equivalent.

Composite indices: SII, SIRI and AISI/PIV

Systemic immune-inflammation index (SII)

$$\text{SII} = \text{PLT} \times \text{NEU} / \text{LYM}$$

SII adds platelet count to the neutrophil-lymphocyte relationship and is often interpreted as a combined immune-inflammatory and platelet signal.

Systemic inflammation response index (SIRI)

$$\text{SIRI} = \text{NEU} \times \text{MON} / \text{LYM}$$

SIRI combines neutrophil and monocyte counts relative to lymphocytes and emphasizes innate and monocytic components.

AISI / pan-immune-inflammation value (PIV)

$$\text{AISII/PIV} = \text{NEU} \times \text{MON} \times \text{PLT} / \text{LYM}$$

This four-component index increases when several numerator components rise together or when lymphocytes decrease.

Aggregation increases information and sensitivity to confounding

Composite indices can separate patients who have the same NLR but different monocyte or platelet counts. The same mathematical aggregation also makes the result more sensitive to unrelated infections, medication effects, systemic disease and preanalytical variation. A large numerical value is not evidence that the index is biologically superior or diagnostically more specific.

Research use

These indices are best suited to hypothesis testing, risk modelling and longitudinal analysis when case definitions, blood sampling, confounder adjustment and statistical validation are prespecified. Their added value should be compared against simpler measures such as CRP, WBC and NLR rather than assumed from formula complexity.

More components do not guarantee better performance. A composite index requires external validation, calibration and clinically meaningful decision thresholds.

Worked calculation from one CBC

The following values are a simplified numerical example and are not a diagnostic case. All leukocyte subsets and platelets are entered using the same laboratory convention of $\times 10^9/L$.

CBC component	Value
NEU	$5.6 \times 10^9/L$
LYM	$1.4 \times 10^9/L$
MON	$0.7 \times 10^9/L$
PLT	$280 \times 10^9/L$

Index	Substitution	Result
NLR	$5.6 / 1.4$	4.0
PLR	$280 / 1.4$	200
MLR	$0.7 / 1.4$	0.50
SII	$(280 \times 5.6) / 1.4$	1120
SIRI	$(5.6 \times 0.7) / 1.4$	2.8
AISI / PIV	$(5.6 \times 0.7 \times 280) / 1.4$	784

Interpretation of the example

The calculations demonstrate a neutrophil-predominant pattern relative to lymphocytes, with additional contribution from monocytes and platelets in the composite indices. The values do not establish the anatomical source, duration or clinical importance of the inflammatory signal. Interpretation requires the laboratory reference ranges for the component counts, symptoms, medical history, medication use, timing of sampling and repeat measurements when appropriate.

What should be checked before comparison

- Were both samples analysed by the same laboratory method and reported in the same units?
- Was the patient free from acute infection, fever, recent surgery, trauma or intense exercise?
- Were systemic disease control, smoking and medication exposure comparable?
- Did the index change because of NEU, MON or PLT elevation, LYM reduction, or a combination?
- Does the change correspond to clinical and radiographic findings around the implant?

Do not diagnose from the arithmetic. The formula calculates a profile; the clinical assessment determines its relevance.

Peri-implant disease and systemic inflammatory markers

Peri-implantitis is diagnosed from peri-implant clinical inflammation and progressive supporting bone loss. Blood findings are not part of the primary diagnostic definition. Observational evidence nevertheless suggests that some patients with peri-implantitis have higher circulating inflammatory markers than controls.

Current evidence

A systematic review and meta-analysis reported higher serum CRP, IL-6 and WBC counts in peri-implantitis groups. The included studies were limited in number, and CRP estimates showed very high heterogeneity. A cross-sectional biochemical study also reported higher WBC counts in peri-implantitis after adjustment for periodontitis history. These observations support an association with systemic inflammatory burden, not proof that the implant lesion caused the blood changes.

Evidence level	Reasonable interpretation	Claim to avoid
Local diagnosis	Bleeding and/or suppuration, probing findings and progressive radiographic bone loss define the clinical problem.	A blood index diagnoses peri-implantitis.
Cross-sectional association	Groups with peri-implantitis may differ in circulating inflammatory markers.	The oral lesion caused the systemic result.
Longitudinal trend	Standardized repeated CBC data may describe change over time.	Every reduction after treatment is a treatment effect.
Predictive modelling	An index may contribute to a multivariable risk model after validation.	A single universal cut-off applies to all patients and settings.

Shared determinants

Smoking, diabetes, obesity, cardiovascular disease, periodontitis, infection, medication and health behaviour can influence both peri-implant disease and blood-cell profiles. These factors can create or amplify an association even when the peri-implant lesion is not the sole driver of systemic inflammation.

Association, prediction and causation are different questions. Each requires a different study design and a different level of evidence.

Clinical and research interpretation

Clinical examination comes first

Assess bleeding on probing, suppuration, probing depths, plaque control, prosthetic cleansability and radiographic bone-level change. Blood indices should be considered only after the local clinical situation has been defined.

Exclude competing explanations

Acute infection, fever, recent dental or medical procedures, trauma, dehydration, smoking, sleep loss, intense exercise, corticosteroids, immunosuppressive therapy, non-steroidal anti-inflammatory drugs, haematological disorders and chronic inflammatory diseases can change one or more CBC components.

Standardize serial sampling

For longitudinal use, document the laboratory, analyser, collection time, fasting status when relevant, recent procedures, active symptoms and medication changes. Compare like with like. A trend is interpretable only when the measurement conditions and clinical context are sufficiently stable.

Step	Action	Output
1. Local assessment	Clinical peri-implant examination and comparative imaging.	Diagnosis and local disease activity.
2. CBC review	Check NEU, LYM, MON, PLT and WBC individually.	Identification of the component driving the index.
3. Context review	Record acute illness, systemic diseases, smoking, medication and recent procedures.	Competing explanations and confounders.
4. Calculation	Apply predefined formulas with consistent units.	Reproducible NLR, PLR, MLR, SII, SIRI and AISI/PIV.
5. Interpretation	Integrate local findings, blood results and longitudinal information.	Supportive context, not an independent diagnosis.

Clinical and biological synthesis

- CBC-derived indices summarize relationships among circulating immune cells and platelets.
- The component counts explain why an index changed and should always accompany the final value.
- No universal peri-implantitis-specific cut-off has been established for these indices.
- Blood results may describe systemic inflammatory background but do not localize the source.
- Their strongest current role is research, standardized monitoring and carefully validated risk modelling.

Primary treatment endpoints remain local: reduction of inflammation and suppuration, improvement in pathological probing findings, arrest of progressive bone loss and restoration of maintainability.

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Interpretive note

Reference ranges, thresholds and predictive performance vary by population, laboratory, disease setting and statistical method. The indices described here are supportive research and monitoring variables; they are not validated stand-alone diagnostic tests for peri-implantitis.

Educational use and limitations

This material presents the biological rationale, formulas and responsible interpretation of CBC-derived inflammatory indices. It does not replace an individual clinical examination, medical assessment or interpretation by the laboratory and treating physician.

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