



Correlation between hematological and biochemical parameters in patients with chronic disease

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Abstract

Chronic diseases rarely affect a single organ system, and routine blood tests often capture this multisystem burden. This narrative review examines how hematological indices (hemoglobin, red and white cell counts, and derived ratios such as the neutrophil-to-lymphocyte ratio, NLR) relate to biochemical markers (creatinine, glomerular filtration rate, calcium, bicarbonate, and C-reactive protein) in chronic disease, using chronic kidney disease (CKD) as the principal model. Literature from 2023 to 2026 was identified through targeted searches of open-access sources and supplemented with key earlier syntheses. Across studies, declining renal function tracked with lower hemoglobin and red cell counts, lower calcium and bicarbonate, and higher creatinine and inflammatory markers, although associations ranged from very strong (creatinine) to weak (calcium, C-reactive protein). NLR showed a consistent but modest association with mortality in hemodialysis and chronic obstructive pulmonary disease. Interpretation is limited by marked heterogeneity, varying cut-offs, small single-centre samples, and probable publication bias. The evidence supports reading hematological and biochemical results together, while cautioning that correlation does not establish causation or justify new thresholds without standardized validation. Multicentre longitudinal studies are needed.

Keywords: Hematological parameters, biochemical markers, chronic kidney disease, anemia, neutrophil-to-lymphocyte ratio, inflammation

Introduction

Chronic diseases such as kidney disease, diabetes, and chronic obstructive pulmonary disease (COPD) burden several organ systems at once, and routine blood tests often capture that burden. CKD is a useful model: it is estimated to affect 10% to 14% of the general population, and diabetes is the leading cause of progression to end-stage disease (Goyoneche Linares *et al.*, 2025) ^[4]. Because the kidney clears metabolic waste and produces erythropoietin, declining renal function alters serum chemistry and blood cell production together, while persistent inflammation adds a further layer of change (Valand *et al.*, 2026) ^[7].

Complete blood counts and chemistry panels are inexpensive and widely available, so understanding how their results move together has practical value for monitoring and risk assessment. This review asks three questions: how hematological and biochemical parameters relate to one another as chronic disease advances; whether leukocyte-derived indices add prognostic information; and what limits the current evidence. Answering these matters most in settings where advanced imaging or specialist assays are scarce, because a pattern recognized across several inexpensive tests can prompt earlier referral and treatment.

Review Approach

This is a narrative review, not a systematic one. In October 2026, open-access web sources and journal sites were searched using combinations of the terms hematological, biochemical, chronic kidney disease, hemodialysis, anemia, neutrophil-to-lymphocyte ratio, inflammation, and COPD. Studies from 2023 to 2026 were preferred, and earlier meta-analyses were retained where they framed recent findings. Only findings that could be checked against a source

abstract or text were extracted. No formal risk-of-bias tool was applied, so the review identifies patterns rather than pooled effects, and the small set of sources should be treated as illustrative.

Hematological–Biochemical Relationships in Chronic Disease

Anemia and Red Cell Indices

Anemia is the most visible hematological change in CKD. Its main drivers are reduced erythropoietin production, iron deficiency, and chronic inflammation (Valand *et al.*, 2026) ^[7]. In a cohort of 380 adults with CKD stages 1–5, roughly three-quarters had hemoglobin below 11 g/dL, and mean hemoglobin fell from 10.65 g/dL in early disease (stages 1–3) to 9.14 g/dL in advanced disease (stages 4–5). Estimated glomerular filtration rate (eGFR) correlated moderately with both hemoglobin ($r = .37$) and red cell count ($r = .37$). A smaller study of 100 patients likewise reported lower hemoglobin alongside shifts in the calcium–phosphorus product (Gupta, 2023) ^[5], and hemodialysis cohorts pooled in a recent meta-analysis had mean hemoglobin of about 10–11 g/dL (Vempati *et al.*, 2025) ^[8].

These findings fit the physiology. As nephron mass is lost, erythropoietin output falls, and inflammation and iron deficiency further restrict red cell production, so hemoglobin reflects several processes at once. That multi-causal origin helps explain why hemoglobin tracks eGFR only moderately even though anemia becomes more frequent and more severe in advanced stages (Valand *et al.*, 2026) ^[7].

Mineral, Acid–Base, and Waste-Product Markers

Biochemical markers track kidney function more tightly than blood counts do. In the same cohort, eGFR correlated

almost perfectly and inversely with serum creatinine ($r = -.94$), whereas correlations with calcium ($r = .21$) and bicarbonate ($r = .27$) were weak (Valand *et al.*, 2026) ^[7]. Advanced disease showed lower calcium and bicarbonate, which the authors linked to mineral–bone disorder and metabolic acidosis, while sodium, uric acid, and white cell count did not differ significantly between early and advanced stages. Among 100 CKD patients, the calcium–phosphorus product correlated negatively with calcium ($r = -.48$) and sodium ($r = -.31$) and positively with urea ($r = .56$) and creatinine ($r = .35$; Gupta, 2023) ^[5]. Table 1 summarizes the pattern.

Table 1: Correlation of eGFR with selected laboratory parameters in 380 CKD patients (adapted from Valand *et al.*, 2026) ^[7].

Parameter	Direction as eGFR declines	Correlation with eGFR
Serum creatinine	Higher	$r = -.94$ (very strong)
Hemoglobin	Lower	$r = .37$ (moderate)
Red blood cell count	Lower	$r = .37$ (moderate)
Bicarbonate	Lower	$r = .27$ (weak)
Calcium	Lower	$r = .21$ (weak)
C-reactive protein	Higher	$r = -.18$ (weak)
White cell count, sodium, uric acid	No clear change	Not significant

This gradient suggests that markers depending directly on filtration, such as creatinine, correlate strongly with eGFR, whereas markers shaped by several pathways, such as hemoglobin, correlate only moderately. For clinicians, this means a normal-looking hemoglobin does not exclude significant renal impairment, and a low hemoglobin should prompt a search for iron deficiency or inflammation rather than being attributed to kidney function alone.

Inflammation and Leukocyte Indices

Inflammation links the hematological and biochemical domains. In the CKD cohort above, C-reactive protein (CRP) rose as eGFR fell, though weakly ($r = -.18$; Valand *et al.*, 2026) ^[7]. Leukocyte subsets also shift: a cross-sectional study of 20 patients with end-stage CKD on hemodialysis found fewer classical and more non-classical monocytes (Goyoneche Linares *et al.*, 2025) ^[4], and a recent review tied leukocyte changes in end-stage disease to immune dysfunction, a pro-inflammatory state, and accelerated immune ageing (Bumbea *et al.*, 2024) ^[2]. The NLR, calculated from a routine differential count, condenses this picture into a single number. In patients on hemodialysis, NLR correlated with the uremic toxin indoxyl sulfate and predicted death (Lano *et al.*, 2022) ^[6], a direct bridge between a biochemical and a hematological marker.

Beyond the Kidney

The relevance of leukocyte indices extends beyond renal disease. A meta-analysis of 24 studies and 18,597 patients with COPD found that higher NLR was associated with higher all-cause mortality (pooled OR = 1.03, 95% CI ^[1.01, 1.06]), with better prediction in acute-exacerbation subgroups (Fang *et al.*, 2025) ^[3]. Evidence from diabetes and other chronic conditions was not examined in depth here, so conclusions about generalizability remain tentative.

The same meta-analytic literature notes that NLR has been explored in many other disorders, including cardiovascular, infectious, and malignant disease (Vempati *et al.*, 2025) ^[8], which underlines both its appeal as a general inflammatory marker and its lack of disease specificity.

Evidence on Effectiveness

Effectiveness here refers to how well these laboratory relationships support monitoring and prognosis. For prognosis, the strongest synthesis is a meta-analysis of 19 studies and 9,047 patients on chronic hemodialysis, in which NLR above 2.5 was associated with higher all-cause mortality (adjusted HR = 1.25, 95% CI ^[1.14, 1.37]) and cardiovascular mortality (adjusted HR = 1.24, 95% CI ^[1.02, 1.49]); pooled discrimination was AUC = 0.71, which the authors rated good but which still leaves considerable room for error (Vempati *et al.*, 2025) ^[8]. An earlier meta-analysis in CKD pointed in the same direction (Ao *et al.*, 2021).

For staging, the correlations in **Table 1** show that creatinine and eGFR convey largely the same information, while the weaker associations of hemoglobin and CRP suggest these markers reflect influences beyond filtration (Valand *et al.*, 2026) ^[7]. Importantly, a value that predicts outcomes is not necessarily a treatment target: Valand *et al.* noted that trials aiming for near-normal hemoglobin with high-dose erythropoiesis-stimulating agents did not clearly improve cardiovascular outcomes and may have raised risk.

Barriers and Challenges to Implementation

Several problems limit how far these findings can be applied. First, heterogeneity is large: the hemodialysis meta-analysis reported I^2 above 85% for all-cause mortality, and included studies used differing NLR cut-offs (Vempati *et al.*, 2025) ^[8]. Second, the same analysis found significant publication bias for all-cause mortality (Egger's $p = .0007$), so pooled estimates may be inflated. Third, many primary studies are small or single-centre. One enrolled only 20 patients (Goyoneche Linares *et al.*, 2025) ^[4], and the 380-patient cohort over-represented stage 5 disease, probably through referral patterns, and lacked comorbidity and medication data (Valand *et al.*, 2026) ^[7]. Some summary values in that report, such as mean blood urea nitrogen, appear implausible as printed and may reflect unit or entry inconsistencies.

Fourth, cross-sectional designs add a further limit, because they capture one moment and cannot show whether hematological change precedes or follows biochemical change. Fifth, confounders including infection, medications, and dialysis adequacy were rarely analyzed (Vempati *et al.*, 2025) ^[8]. Finally, NLR is non-specific, its reference values differ across ethnic groups, and its predictive value may weaken with age, all of which complicate fixed thresholds (Vempati *et al.*, 2025) ^[8].

Discussion and Implications

Taken together, the literature describes a layered relationship. Filtration-dependent biochemistry (creatinine, eGFR) changes in step with disease stage; hemoglobin, calcium, bicarbonate, and CRP shift in the same direction but with weaker coupling; and leukocyte ratios add modest prognostic information. This supports reading blood counts

and chemistry panels together: a falling hemoglobin accompanied by low bicarbonate and rising CRP says more about advanced disease than any single value. For practice, Valand *et al.* (2026) ^[7] recommend routine anemia and biochemical screening, especially from stage 3 onward, and NLR is best treated as a low-cost adjunct to, not a replacement for, established markers (Vempati *et al.*, 2025) ^[8]. Because the tests involved are routine, this approach is feasible even where resources are limited, although local reference ranges and laboratory standardization should be confirmed before any threshold is adopted.

For research, priorities include agreeing on standard NLR thresholds, using longitudinal rather than cross-sectional designs, reporting comorbidity and treatment data, and testing whether the same correlations hold in diabetes and other chronic conditions. This review has its own limits: it is narrative, drew on a small set of sources, and centres on kidney disease, so its statements about other chronic diseases rest mainly on one COPD meta-analysis. Because most evidence is correlational, no causal direction should be inferred.

Conclusion

In chronic kidney disease, hematological and biochemical parameters change together as function declines, with the strongest correlations among filtration-dependent markers and more moderate links to hemoglobin, red cell count, and inflammation. Leukocyte-based ratios such as NLR carry modest prognostic value in hemodialysis and COPD, but heterogeneity, publication bias, and small samples restrict firm thresholds. Taken together, the evidence favors integrated interpretation over reliance on any single test. Clinicians can reasonably interpret these results as a panel; researchers should prioritize multicentre, longitudinal studies with standardized definitions.

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