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Retrospective Study: Serum Hemoglobin, Erythrocyte, and Creatinine Profiles in Chronic Kidney Disease Patients Following Hemodialysis

Mely Purnadianti[1*], Selviani Muhtadi[2]

[1]D3 Medical Laboratory Technology, Faculty of Health Technology and Management, Bhakti Wiyata Kediri Institute of Health Sciences, Kediri City, Indonesia
[2]D4 Medical Laboratory Technology, Faculty of Health Technology and Management, Bhakti Wiyata Institute of Health Sciences Kediri, Kediri City, Indonesia

*Email: yenny.armayanti@undiksha.ac.id

Abstract

Chronic kidney disease (CKD) is a progressive and irreversible pathological condition with multiple etiologies, leading to a gradual decline in kidney function. Hemodialysis is employed to eliminate metabolic waste products and specific toxins. This study aimed to evaluate the correlation between hemoglobin levels, erythrocyte count, and serum creatinine levels in CKD patients after undergoing hemodialysis therapy. A cross-sectional study with an analytical observational design was conducted on 25 patients selected through purposive sampling. Data were analyzed using Pearson's correlation test. The analysis revealed a strong positive correlation between hemoglobin levels and erythrocyte count (correlation coefficient $r = 0.932$; $p < 0.001$), indicating a statistically significant association. However, no significant correlation was observed between hemoglobin and creatinine levels ($r = 0.099$; $p = 0.636$), nor between erythrocyte count and creatinine levels. In conclusion, this study found a significant association between hemoglobin levels and erythrocyte count in CKD patients post-hemodialysis at Gambiran Hospital. However, no significant relationship was observed between hemoglobin or erythrocyte parameters and serum creatinine levels.

Keywords: Hemoglobin Levels, Erythrocyte Count, Creatinine Levels, Chronic Kidney Disease, Hemodialysis

1. Introduction

According to the 2023 Basic Health Research Report[1], the incidence of chronic kidney disease (CKD) in East Java continues to rise. In 2022, over 19,000 cases of kidney failure required hospital treatment, with Panti Waluya Hospital recording 4,180 patients undergoing hemodialysis in 2023. In the first quarter of 2024 alone, the Surabaya City Health Office reported 308 new cases of CKD, indicating an increasing trend in this region.[1]

Based on medical records at Gambiran Hospital, Kediri, 25 patients underwent hemodialysis between February 6 and 17, 2025. In chronic kidney disease, impaired kidney function reduces erythropoietin production, leading to decreased erythrocyte synthesis.[2] The diagnosis of CKD often involves evaluating serum creatinine and urea levels, both of which are key indicators of renal function. Creatinine, a nitrogenous waste product from muscle metabolism, correlates with both muscle mass and renal excretory capacity.[3]

Hemodialysis remains the primary therapeutic modality for CKD, operating via a semipermeable membrane that mimics nephron function by filtering metabolic waste and balancing fluids and electrolytes.[4] A successful hemodialysis session is often indicated by a reduction in serum creatinine levels; however, this response may vary depending on residual renal function and therapy duration.[5] Adherence to dialysis protocols is essential to prevent complications.[6]

Anemia is a common consequence of CKD due to erythropoietin deficiency, compounded by blood loss during dialysis.[7] This condition leads to clinical symptoms such as fatigue, nausea, and decreased consciousness, ultimately diminishing the patient's quality of life. Managing such systemic effects is crucial in improving patient outcomes and adaptation to functional limitations.[8]

This study aims to assess the correlation between hemoglobin levels, erythrocyte counts, and creatinine levels in hospitalized CKD patients who underwent hemodialysis at Gambiran Hospital in February 2025. The findings are expected to contribute to a better understanding of hematological and renal parameter changes following dialysis therapy.

2. Method

This study employed a cross-sectional design using purposive sampling. The inclusion criteria were: (1) patients diagnosed with chronic kidney disease (CKD) who had undergone hemodialysis for a minimum of 12 weeks before the study, (2) hospitalized (inpatient) patients, and (3) patients with a decreased glomerular filtration rate (GFR). The exclusion criteria included CKD patients with a history of complications such as heart disease, diabetes mellitus, anemia, HIV, poor general health conditions, and those with systolic or diastolic blood pressure exceeding 130/90 mmHg. In determining the minimum sample size, the Slovin's formula was used, and it was found that the minimum sample size is 23 samples. Hemoglobin and erythrocyte levels were analyzed using the flow cytometry method, while serum creatinine levels were measured using the Jaffe method. Flow cytometry was selected due to its impedance-based approach to calculating the number and size of blood cells by measuring changes in electrical resistance. It also utilizes laser beam technology for detailed analysis of individual blood cells, allows accurate hemoglobin quantification through spectrophotometry, enables multiparameter analysis across a wide range of blood components, and provides rapid and reliable results, thereby enhancing laboratory efficiency in patient diagnosis and health management. The Jaffe method was chosen for creatinine analysis as it relies on the absorption of light by compounds formed during the reaction between creatinine and alkaline picrate. The interaction of specific wavelengths of light with these compounds enables stable and consistent measurements. The reliability of the instruments used in this study was assessed using the Cronbach's alpha test, performed with IBM SPSS Statistics version 25. Correlation analyses were subsequently conducted using Pearson's correlation test. This study received ethical approval from the Ethics Committee of the Bhakti Wiyata Institute of Health Sciences, Kediri, Indonesia, on December 23, 2024 (Certificate No. 930/FTMK/EP/XII/2024).

3. Result

The total study population comprised 27 patients, of whom 25 met the inclusion criteria and were included in the final analysis reveals. Derived from the research data, that the characteristics of respondents based on age in the Clinical Laboratory installation of Gambiran Hospital Kediri City, The age distribution of respondents was as follows: 6 respondents (24%) aged 25–44 years, 13 respondents (52%) aged 45–64 years, and 6 respondents (24%) aged 61–75 years (Table 1).

Based on Figure 2, it can be seen that only 2 respondents (8%) had normal hemoglobin levels, while the remaining 23 respondents (92%) had abnormal hemoglobin levels.

Table 1 Characteristics of Respondents by Age

Age (y.o)	n	Percentage
25 - 44	6	24 %
45 - 60	13	52 %
61 - 75	6	24 %

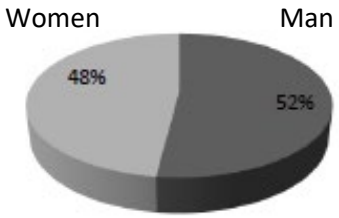

Figure 1. Characteristics of respondents by gender

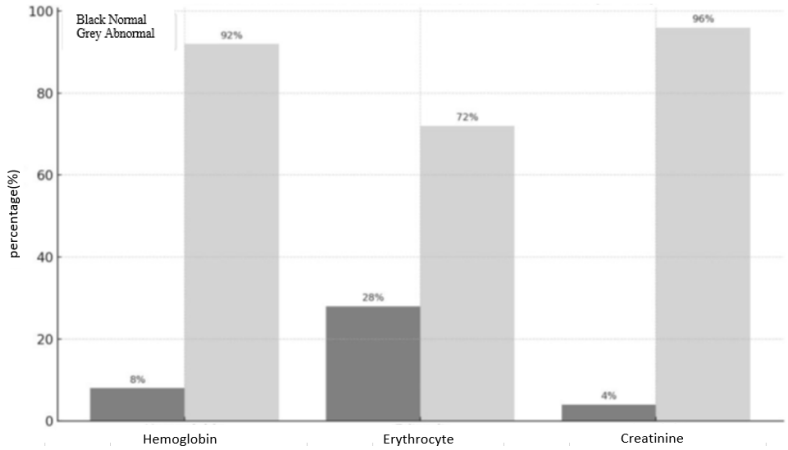

Figure 2. Characteristics of respondents based on hemoglobin levels, erythrocyte counts, and creatinine levels

Table 2. Pearson correlation test results for hemoglobin levels and erythrocyte count

Factor	Pearson Correlation	Sig. (2-tailed)	Total
Hemoglobin	.932	.000	25
Erythrocyte Count	.932	.000	25

Table 3. Pearson correlation test results for hemoglobin and creatinine levels

Factor	Pearson Correlation	Sig. (2-tailed)	Total
Hemoglobin	.099	.636	25
Creatinine levels	.099	.636	25

Table 4. Pearson correlation test results for erythrocyte count and creatinine levels

Factor	Pearson Correlation	Sig. (2-tailed)	Total
Erythrocyte count	.154	.464	25
Creatinine levels	.154	.464	25

Regarding erythrocyte counts, 7 respondents (28%) had normal levels, whereas 18 respondents (72%) showed decreased erythrocyte levels. As for creatinine levels, only 1 respondent (4%) had normal levels, while 24 respondents (96%) had elevated creatinine levels.

Pearson correlation analysis revealed a very strong positive correlation between hemoglobin levels and erythrocyte counts ($r = 0.932$, $p < 0.001$, Table 2). This indicates a statistically significant relationship, suggesting that an increase in erythrocyte count is associated with a corresponding increase in hemoglobin levels.

In contrast, the correlation between hemoglobin and creatinine levels was very weak ($r = 0.099$, $p = 0.636$, Table 3), indicating no statistically significant relationship. This suggests that there is no meaningful association between hemoglobin and creatinine levels in patients with chronic kidney disease (CKD).

Similarly, the correlation between erythrocyte count and creatinine levels was very weak ($r = 0.154$, $p = 0.464$, Table 4), indicating no statistically significant association. This suggests that there is no meaningful relationship between erythrocyte count and creatinine levels in patients with chronic kidney disease (CKD).

4. Discussion

The results showed that there were 12 male and 13 female respondents. Both genders have an equal risk of developing chronic kidney disease (CKD) requiring hemodialysis, with lifestyle factors playing a significant role.[7] However, these results differ from studies indicating that the prevalence of CKD is higher among women (59%).[3] This is supported by studies suggesting that the prognosis of CKD differs by gender: in women, it is more closely related to poor blood sugar control, while in men, it is linked to the inability to control proteinuria, often due to dietary habits.[16] Thus, both men and women can develop CKD and undergo hemodialysis, depending largely on lifestyle choices. The etiology of CKD is most commonly associated with hypertension.[11] Premenopausal women may benefit from estrogen, which acts as an antioxidant and increases high-density lipoprotein (HDL), offering protection against atherosclerosis.[9] Atherosclerosis, characterized by progressive narrowing and blockage of blood vessels, can impair renal perfusion, leading to kidney damage.[15] This damage elevates intraglomerular pressure, creating a vicious cycle that accelerates kidney failure and necessitates hemodialysis.[4]

The highest proportion of CKD cases was observed in the 45–64-year age group, consistent with the natural aging process and the accumulation of chronic conditions like hypertension and diabetes mellitus, the two leading causes of CKD.[10] This age group is particularly vulnerable due to physiological decline and prolonged exposure to uncontrolled comorbidities.

Only 2 respondents (8%) had normal hemoglobin (Hb) levels, while 23 respondents (92%) had decreased Hb levels. Normal Hb levels may result from effective erythropoietin (EPO) therapy, adequate nutritional intake, and regular hemodialysis sessions. Decreased Hb levels are primarily due to impaired EPO production by damaged kidneys, blood loss during dialysis, and nutritional deficiencies (iron, vitamin B12, and folate). Conversely, increased Hb levels may result from successful EPO and iron therapy, and improved nutritional status.[8]

Seven respondents (28%) had normal erythrocyte counts, while none showed elevated levels, and 18 respondents (72%) had decreased erythrocyte counts. This pattern reflects the common occurrence of anemia in

CKD patients, primarily caused by decreased erythropoietin production due to kidney damage. Anemia is common in CKD due to reduced EPO production, blood loss during dialysis, and dietary restrictions that limit iron and vitamin B12 intake. However, a small percentage maintained normal erythrocyte counts, likely due to appropriate therapy, absence of chronic bleeding, and good adherence to treatment.[2,5,7]

The mean creatinine level before hemodialysis was 2.89 mg/dL and increased to 3.37 mg/dL post-dialysis. This apparent rise may be attributed to creatinine rebound—the redistribution of creatinine from tissues into the bloodstream—and premature blood sampling. These factors reflect the limitations of dialysis in fully replicating kidney function.[12,9]

The strong positive correlation between hemoglobin and erythrocyte counts can be explained by their close physiological relationship. Hemodialysis may contribute to this correlation by reducing uremic toxins, which otherwise suppress erythropoiesis, thereby improving the body's response to erythropoietin (EPO) therapy. Additionally, the fluid removal during hemodialysis may increase plasma concentration, further enhancing both hemoglobin and erythrocyte levels.[18]

The lack of correlation between hemoglobin and creatinine levels suggests that these parameters reflect different aspects of CKD pathology. Hemoglobin levels are primarily affected by EPO production and nutritional status, while creatinine levels are markers of renal excretory function. Therefore, hemodialysis may effectively reduce creatinine without immediately improving hemoglobin levels, especially if factors such as inflammation or iron deficiency persist.[12,14] Similarly, the weak correlation between erythrocyte count and creatinine levels indicates that although kidney damage (reflected by high creatinine) leads to decreased EPO production and erythropoiesis, the erythrocyte count is also influenced by factors like blood loss during dialysis and nutrient deficiencies. Thus, erythrocyte reduction can occur independently of creatinine levels.[18] No significant relationships between hemoglobin or erythrocyte counts and creatinine levels in this study highlight that hemoglobin and creatinine operate via different mechanisms and reflect different aspects of CKD pathology.[19]

In this study, one respondent (code A624) demonstrated a significant drop in creatinine levels from 2.20 mg/dL to 0.78 mg/dL after dialysis, reaching normal limits. This may be attributed to optimal dialysis efficiency, residual renal function, low muscle mass, or early post-dialysis blood sampling.[13]

This study had several limitations, including a short duration, a small sample size, and limited cooperation from participants due to their health conditions, which restricted in-depth data collection. These factors may limit the generalizability and robustness of the findings.

5. Conclusion

This study found that hemoglobin levels are closely related to erythrocyte counts in patients with chronic kidney disease after undergoing hemodialysis. In contrast, no meaningful relationship was observed between hemoglobin or erythrocyte counts and creatinine levels. These findings suggest that while anemia parameters such as hemoglobin and erythrocyte counts are interrelated, they do not directly reflect kidney function as indicated by creatinine levels.

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