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CHRONIC INFLAMMATION MAY DECREASE TRANSFUSION EFFECTIVENESS: EVALUATION OF TRANSFUSION PERFORMANCE IN HEMODIALYSIS PATIENTS

Minoue Kuum Marc Germain[1*], Bidi Abada Protais Le Roi[2], Gisèle Atsang à Kiki[3], Temdie Guemmogne Joel Romeo[4], Kada Sanda Antoine[5] and Biwole Sida Magloire[2]

[1]Department of Psychology, Faculty of Letters and Social Sciences, P.O. Box 3132 Douala, University of Douala, Cameroon.
[2]Department of Biological Sciences, Higher Institute of Medical Technology (ISTM), P.O. Box 188 Yaounde, Cameroon.
[3]Department of Biological Sciences, Faculty of Science, P.O. Box 814 Maroua, University of Maroua, Cameroon
[4]Department of Biological Sciences, Faculty of Sciences, P.O Box 454 Ngaoundere, University of Ngaoundere, Cameroon.
[5]Department of Biological Sciences, Faculty of Sciences, P.O. Box 39 Bambili Bamenda, University of Bamenda, Cameroon.

***Corresponding Author: Minoue Kuum Marc Germain**

Department of Psychology, Faculty of Letters and Social Sciences, P.O. Box 3132 Douala, University of Douala, Cameroon. **DOI:** https://doi.org/10.5281/zenodo.18480235

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ABSTRACT

Chronic renal failure (CRF) is defined as the progressive loss of the kidneys' ability to perform their functions. Anaemia in patients with chronic renal failure is a direct consequence of several interdependent pathophysiological mechanisms. Transfusion of blood cell components is frequent in the therapeutic arsenal; it is globally safe or even very safe. The objective of this study was to evaluate transfusion performance in haemodialysis patients at Yaounde General Hospital and to assess the actual effectiveness of blood transfusions in the management of anaemia associated with chronic kidney failure. An observational, analytical and prospective study was conducted between October 2024 to July 2025 on 70 hemodialysis patients. Hemoglobin levels before and 48 hours after transfusion were compared to determine transfusion efficiency. The study population included 70 patients, comprising 50 men and 20 women, with a sex ratio of 2.5 in favour of men, representing 71.4% males and 28.6% females, with a mean age of 49.4 ±19.8 years. Haemodialysis patients with a dialysis time of between 0 and 2 years were the most represented (23/70) at 32.9%. The mean Hb gain was +1.237 dl ± 0.46 g/dL and the mean gain per transfusion was 0.94g/dl, with a significantly higher response in males (p=0.05). The median change in haemoglobin level was 0.9 g/dl. This may indicate moderate or heterogeneous efficacy in response to transfusion. The number of transfused units was the main determinant of haemoglobin gain. Blood transfusion effectively improves hemoglobin levels in hemodialysis patients. Individualized post-transfusion follow-up is essential to optimize transfusion performance and minimize risks.

KEYWORDS: Hemodialysis, Anemia, Blood transfusion, Transfusion performance, Chronic inflammation, Hemoglobin.

INTRODUCTION

Chronic inflammation, common in haemodialysis patients, leads to inflammatory anaemia characterised by inadequate erythropoietin production, iron retention in the reticuloendothelial system, and resistance to the action of erythropoiesis-stimulating agents (ESAs).[1,2] The WHO defines anaemia as a haemoglobin (Hb) level below 12g/dl in women or below 13g/dl in men.[3] It is a public health problem affecting approximately 7.6% of the general population and is estimated to affect 60 to 80% of patients with chronic kidney disease (CKD).[4] The recommended therapeutic goal is to achieve an Hb

level of 10 to 11.5 g/dL in order to avoid both the risks associated with severe anaemia and those associated with excessive correction.[5] However, their high cost, side effects (hypertension, thrombosis, resistance to treatment) and controversy surrounding their cardiovascular safety in certain patients make their use complex, particularly in contexts with limited resources.[6,7] In iterative dialysis, as in CRF, anaemia is mainly due to a decrease in renal production of erythropoietin (EPO), to which may be added a decrease in the lifespan of red blood cells, blood loss, trace element deficiencies or chronic inflammation.[8] The main cause therefore remains the reduction in the synthesis of erythropoietin (EPO), a glycoprotein hormone produced by the peritubular interstitial cells of the renal cortex, which stimulates the production of red blood cells in the bone marrow. Anemia is a common and severe complication among haemodialysis patients. Blood is a vital medical resource that is sourced from primarily nonremunerated donations. Anemia is one of the most frequent and disabling complications in patients with chronic kidney disease (CKD) undergoing hemodialysis. According to the World Health Organization (WHO), it is defined as a decrease in hemoglobin (Hb) level below 13 g/dL in men and 12 g/dL in women.[3] In dialysis patients, anemia is multifactorial, mainly resulting from decreased erythropoietin production by damaged kidneys, but also from frequent blood losses, nutritional deficiencies, and chronic inflammation associated with end-stage renal disease.[8,9] Anemia significantly affects the quality of life of hemodialysis patients. It is associated with severe fatigue, reduced exercise capacity, impaired cognitive function, exacerbation of left ventricular hypertrophy, and increased cardiovascular mortality.[10,11] Effective management of anemia is therefore essential to improve prognosis and quality of life in hemodialysis patients. Among the available therapeutic options, erythropoiesis-stimulating agents (ESAs) remain the first-line treatment in most cases. However, their high cost, limited accessibility in resource-poor settings, and certain contraindications lead many centers to continue relying on blood transfusion.[10, 12] Although transfusion allows rapid correction of haemoglobin levels, it also carries risks, including alloimmunization, transfusion reactions, iron overload, and transmission of infectious agents.[13,14] The effectiveness of a transfusion is generally assessed by the increase in haemoglobin (Hb) levels within 24 to 48 hours after the infusion. In a stable adult, an increase of 1 g/dL of Hb is expected for each unit of packed red blood cells transfused.[15] The effectiveness of a transfusion does not depend solely on the amount of blood administered. Several individual, biological and transfusion-related parameters can modulate the post-transfusion response in terms of haemoglobin gain. These factors are particularly important in haemodialysis patients, due to their biological vulnerability and specific therapeutic context.[12] However, in haemodialysis patients, this response may be altered by several factors, including chronic inflammation, secondary hyperparathyroidism, or recurrent blood loss during dialysis sessions.[2,16] The survival of red blood cells is also reduced in uraemic patients, from approximately 120 days to 60–80 days, probably due to increased oxidative stress and alterations in the erythrocyte cell membrane[17], Studies have shown that transfusion responses are often below normal in haemodialysis patients. For example, a study conducted in Yaoundé revealed an average post-transfusion increase in Hb of only 0.8 ± 0.3 g/dL after two units of RBC, indicating a partial and suboptimal response.[18] The post-transfusion response may be influenced by the volume and quality of the transfused products, particularly the storage life of RBCs, which affects their viability.[19], or the patient's nutritional status, particularly folate or vitamin B12 deficiencies, which disrupt erythropoiesis[20], see the presence of chronic systemic inflammation, common in dialysis, which limits the effectiveness of erythropoiesis and potentiates erythrocyte loss[1] and ferritin levels and transferrin saturation, which modulate the utilisation of available iron.[5] Repeated transfusions increase the risk of erythrocyte alloimmunisation, an immunological phenomenon whereby the patient develops antibodies against antigens in the Rh, Kell, Duffy and Kidd systems.[21,22] These antibodies can cause rapid destruction of transfused red blood cells and significantly reduce post-transfusion Hb gain.[23] Patients who have received multiple transfusions, particularly women who have had several pregnancies, are at greater risk of developing anti-erythrocyte antibodies, thereby complicating the search for compatible RBCs.[24] Chronic inflammation, common in haemodialysis patients, leads to inflammatory anaemia characterised by inadequate erythropoietin production, iron retention in the reticuloendothelial system, and resistance to the action of RAS.[1,2] The presence of comorbidities such as diabetes, chronic infections (tuberculosis, HIV), or secondary hyperparathyroidism may also negatively affect transfusion performance.[25,26] In addition to EPO deficiency, haemodialysis patients often have iron deficiency, which is essential for reticulocyte haemoglobinisation. This deficiency may be absolute (depletion of iron stores) or functional (iron present but unavailable for erythropoiesis due to chronic inflammation).[27] Inflammation, which is common in haemodialysis, leads to an increase in hepcidin, a liver hormone that blocks intestinal iron absorption and its mobilisation from liver stores.[16,27] Furthermore, repeated haemodialysis leads to significant blood loss, estimated at between 1 and 3 g of iron per year, due to frequent blood sampling, losses during dialysis and gastrointestinal bleeding secondary to uraemia or anticoagulant use.[27,28] The survival of red blood cells is also reduced in uraemic patients, falling from around 120 days to 60–80 days, probably due to increased oxidative stress and alterations in the erythrocyte cell membrane.[17] Finally, nutritional deficiencies (folic acid, vitamin B12), secondary hyperparathyroidism, and certain types of aluminium poisoning can also contribute to anaemia.[11,29] All these factors contribute to a picture

of chronic anaemia, often severe, requiring multidimensional management and rigorous monitoring. In Africa, the actual burden of CKD is presumed to be high but remains unknown due to the lack of national registries and high-quality studies. However, estimates suggest an overall prevalence of 15.8% for stages 1 to 5 of CRC, and 4.6% for stages 3 to 5 in the general population. These rates vary between regions, with higher prevalences in sub-Saharan Africa compared to North Africa.[30] A study conducted in Algeria in 2003 states that CRF is a highly prevalent condition characterised, in its terminal stage, by high morbidity and mortality rates.[31] In Cameroon, a study published by the Cameroon Tribune newspaper reveals that approximately 13% of the adult population suffers from chronic kidney disease. Approximately 1,000 people are on permanent dialysis, nearly 10% of whom are children.[32] In Cameroon, anaemia is extremely common among haemodialysis patients, with a prevalence of over 80% according to several hospital studies.[33,34] This situation can be explained by the advanced stage of kidney disease at the time of diagnosis, limited access to specialist care, and delays in treating chronic anaemia.[35] In public centres, transfusion remains the most accessible treatment, often replacing erythropoiesis-stimulating agents (ESAs), which are prohibitively expensive for most patients.[36] The majority of Cameroonian patients undergoing haemodialysis are treated in public hospitals, where the cost of care remains partially subsidised. However, blood products are not always covered, forcing patients to purchase blood units from transfusion centres or through informal networks, thereby increasing the risk of unsafe transfusions.[3,37] A study conducted in Douala revealed that 64% of haemodialysis patients who received transfusions had paid for their own blood products, with no guarantee of extended compatibility.[38] This socio-economic context has a direct impact on the quality and regularity of transfusion care. Although improving, Cameroon's transfusion system still faces several challenges: a shortage of donors, frequent shortages of blood products, a lack of extensive phenotyping, and a shortage of staff trained in immunohematology.[39] These deficiencies increase the risk of complications, such as alloimmunisation and delayed transfusion reactions, especially in patients who receive multiple transfusions, such as those undergoing haemodialysis.[40] Furthermore, biological monitoring after transfusion is rarely performed within 24-48 hours due to a lack of reagents or standardised protocols.[18] This complicates the assessment of transfusion performance in nephrology units. The management of anaemia therefore relies heavily on transfusions that are sometimes empirical, performed without a complete iron status assessment or systematic post-transfusion evaluation.[41] The lack of national protocols for evaluating transfusion effectiveness is an obstacle to improving practices. In most centres, haemoglobin levels are only measured in cases of marked clinical symptoms (extreme fatigue, hypotension), and not systematically after transfusion.[42] In low-income countries such as Cameroon, blood transfusion remains a common practice in dialysis patients due to limited financial access to ESAs and insufficient monitoring of iron status.[18,33] However, transfusion performance in terms of effective hemoglobin increase remains poorly documented in our context. Interest of this study was to evaluate transfusion performance among hemodialysis patients at the Yaoundé General Hospital and show the influence of chronic inflammation on the effectiveness of transfusion.

MATERIAL AND METHODS

Study type, setting, and period

This was a prospective observational and analytical study conducted among hemodialysis patients at the Yaoundé General Hospital, over a period of nine months from October 2024 to July 2025.

Sampling and administrative procedures

We collected and analyzed a total of 70 samples from hemodialysis patients aged 18 to 60 years. It consisted solely of adults (≥18 years) on chronic hemodialysis for three months and who had received at least one blood transfusion during their treatment. Authorization was obtained from the ethics committee of the Yaoundé General Hospital, as well as ethical approval No. 5065CEIUdo/07/2025/M from the Institutional Ethics Committee of the University of Douala.

METHODOLOGY

The study was a cross-sectional, observational and analytical study conducted in the hemodialysis unit of Yaoundé General Hospital over a period of nine months from October 2024 to July 2025, involving only chronic hemodialysis patients receiving transfusion therapy as part of their treatment. The inclusion criteria were: adult patients (≥18 years old) undergoing chronic hemodialysis for at least three months, and undergoing at least one complete blood count (CBC). In addition, patients who had received at least one blood transfusion during their treatment and were able to give their consent and agree to participate in the study. Cases of hemodialysis for acute renal failure (ARF) and patients who did not have a CBC were excluded from the study. In addition, patients on dialysis with a condition treated by blood transfusion (sickle cell disease), patients who refused to participate in the study, and patients who suffered from hemorrhage were also excluded. A questionnaire was used to collect data such as age, sex, medical history (comorbidities), number of transfused units, and duration on dialysis. Whole blood was drawn twice: before transfusion and 48 hours after transfusion, into EDTA tubes. All samples were placed in a mixer for 15 minutes to ensure proper homogenization. A BIOBASE BK-5000 hematology analyzer (2022 model) was used to measure hemoglobin levels before and after transfusion.

Statistical Analysis

Statistical tests were performed using SPSS 2022. Tables and figures were created using Microsoft Word 2019 and Microsoft Excel 2019.

RESULTS

The present study, whose overall objective was to evaluate transfusion efficacy in haemodialysis patients by analysing changes in post-transfusion haemoglobin levels at Yaoundé General Hospital, was conducted over a period of nine months from October 2024 to July 2025. The study population included 50 men (71.4%) and 20 women (28.6%), giving a sex ratio of 2.5, with a mean age of 49.4 ± 19.8 years. The majority (43.75%) were aged between 31 and 41 years. Haemodialysis patients with hypertension and diabetes were the most represented (24/70) 34.4%. Haemodialysis patients with a dialysis time of between 0 and 2 years were the most, either (23/70) 32.9%.

The mean hemoglobin gain after transfusion was 1.23±0.46 g/dL. A significant difference was observed according to sex ($p<0.05$), with men showing a better response than women. In our study, the average change in haemoglobin level was 1.24 g/dL. The standard deviation in haemoglobin levels before and 48 hours after transfusion was 0.46, indicating that the response to transfusion was relatively uniform. The median change in haemoglobin levels is 0.90 g/dL. This may indicate moderate or heterogeneous efficacy in response to transfusion. The average gain per transfused unit was 0.94 g/dL.

Associated factors influencing transfusion response

Table 1: Overview of associated factors influencing transfusion response.

Variation in HB Gender	Δ HB <1	Δ HB ≥1	P – Value
Male	11(22%)	39(78%)	
Female	09(45%)	11(55%)	0.05

Age group

Table 2: Distribution by age.

Variation in HB Age group	Δ HB <1	Δ HB ≥1	P – Value
[0-20[	01	04	
[20-40[	06	16	
[40-60[	05	15	0.96
60≥	08	15	

Comorbidities

Table 3: Distribution according to comorbidities.

Variation in HB Comorbidities	Δ HB <1	Δ HB ≥1	P – Value
None	01	04	
Diabetes			
Hypertension	06	16	
Hypertension/Diabetes	05	15	0.95
Heart failure	08	15	

Dialysis time

Table 3: Distribution according to dialysis time.

Variation in HB Dialysis time	Δ HB <1	Δ HB ≥1	P – Value
[0-3[	06	17	
[3-6[	04	16	
[6-9[	06	13	0.97
9≥	04	04	

No significant differences were found according to age, dialysis duration, or comorbidities. The number of transfused blood units remained the main factor influencing hemoglobin gain. No significant differences were found according to age, dialysis duration, or comorbidities. The number of transfused blood units remained the main factor influencing haemoglobin gain. The median change in haemoglobin levels would indicate moderate or heterogeneous efficacy in response to transfusion.

DISCUSSION

This study evaluated transfusion performance in hemodialysis patients at the Yaoundé General Hospital by analyzing hemoglobin evolution before and 48 hours after transfusion. Among the 70 patients included, males were predominant (71.4%), with a sex ratio of 2.5. The mean hemoglobin gain was 1.237 ± 0.46 g/dL, confirming moderate but effective transfusion performance. This value is consistent with Goodnough and Panigraphi[43], who reported an average Hb gain of 1-1.5 g/dL in hemodialysis patients in the United States.[44] Similarly, a study in Senegal by Diouf et al.[45] found an average gain of 1.28 g/dL, almost identical to ours.[46] In contrast, a study conducted in Egypt by El-Husseiny et al.[47] on 120 patients reported a lower gain of 0.90 g/dL, possibly due to a higher prevalence of inflammatory comorbidities or underuse of adjuvant treatments such as erythropoietin.[48] A statistically significant difference was found between sexes ($p=0.05$), with males showing a better response. This aligns with Locatelli et al.[49], who suggested better transfusion sensitivity in men due to more stable iron reserves.[27] However, a Canadian study by Hebert et al.[50] found no significant sex-related differences, highlighting the importance of local context.[16] Comorbidities did not significantly influence transfusion response ($p=0.97$). Patients without comorbidities or with isolated hypertension had slightly higher Hb gain. Conversely, more severe comorbidities (diabetes, heart failure) may reduce transfusion response, consistent with Fishbane et al.[5], who noted that chronic inflammation may decrease transfusion effectiveness.[51] Finally, dialysis duration showed no significant association with Hb gain, in line with Cote et al.[52], who reported that dialysis vintage minimally influences transfusion response when overall care is well structured.[28] These discrepancies highlight the need to complement transfusion approaches with a more detailed biological evaluation including ferritin, reticulocyts and CRP. In summary, this study addresses a crucial issue in the management of haemodialysis

patients, namely the effectiveness of blood transfusions, an aspect that is often overlooked in routine practice. Furthermore, few local studies have focused on transfusion performance as measured by changes in Hb levels before and after transfusion in haemodialysis patients, which gives this work considerable scientific interest. Furthermore, the study is based on authentic clinical data from patients followed at the HGY, which reinforces the validity and relevance of the results. However, the results of this research may contribute to the improvement of transfusion protocols in nephrology units in Cameroon. In short, this local study is consistent with international findings and reinforces the idea that transfusion, although occasional, remains an effective tool in the management of anaemia in haemodialysis, provided that it is governed by well-defined protocols adapted to the local context.

CONCLUSION

Blood transfusion remains an effective strategy for correcting anaemia in haemodialysis patients. The findings of this study emphasize the importance of systematic post-transfusion monitoring and individualized anemia management. Standardizing transfusion protocols, ensuring continuous staff training, and strengthening follow-up procedures are essential to improving the quality of care. The assessment of transfusion performance in hemodialysis patients at Yaoundé General Hospital, conducted as part of this study, provided a better understanding of the actual effectiveness of blood transfusions in the management of anemia associated with chronic renal failure. Blood transfusions aim to quickly correct severe or symptomatic anemia, particularly in patients who are refractory or non-responsive to erythropoiesis-stimulating agents (ESAs), or those with acute hemorrhage. This study shows that the effectiveness of a transfusion does not depend solely on the amount of blood administered. Several individual, biological and transfusion-related parameters can modulate the post-transfusion response in terms of hemoglobin gain. Blood transfusion remains an effective strategy for correcting anemia in hemodialysis patients. The findings of this study emphasize the importance of systematic post-transfusion monitoring and individualized anemia management. Standardizing transfusion protocols, ensuring continuous staff training and strengthening follow-up procedures are essential to improving the quality of care.

ETHICAL CONSIDERATIONS

No conflict of interest declared.

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