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# The Financial Toxicity of Anemia Management among Patients on Chronic Hemodialysis: A Cross-Sectional Study on Blood Transfusion Costs and Care Disruption in Douala, Cameroon

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## Abstract

**Background**: Chronic hemodialysis patients frequently require blood transfusions due to persistent anemia. However, in many sub-Saharan African settings, patients face substantial informal costs when sourcing blood products. These hidden, out-of-pocket expenses remain poorly quantified, limiting policymakers' ability to effectively address financial barriers to safe and timely transfusions. **Methods**: A cross-sectional survey was conducted among patients undergoing chronic hemodialysis at the two public hemodialysis facilities in Douala, Cameroon. A total of 168 patients were interviewed. Variables assessed included sociodemographic and economic characteristics, anemia management data, estimated cost per blood unit, impact on hemodialysis non-adherence, and perceived quality-of-life effects. Descriptive and bivariate analyses were performed. **Results**: A total of 168 (males 53%, n = 89) patients were included; the mean age was 49 ± 12 years. Low socio-economic status was prevalent (58.3%, n = 98) and 65.5% (n = 110) had a monthly income < US$200. Erythropoiesis stimulating agents (ESAs) were used by 69% of patients (n = 116), but compliance was suboptimal. Nearly half of the patients received ≥ 1

blood unit during the past 3 months (48.2%, n = 81), with most of them receiving ≥ 2 units per month (n = 46). The use of non-medical intermediaries was common (58%, n = 47), with a median fee of US$20 [IQR: 10 - 40]. Among patients utilizing replacement donors (n = 75), 88% (n = 66) relied on compensated individuals, with a median procurement cost of US$16 [IQR: 10 - 20] per donor. The median total estimated cost per blood unit was US$81.5 [IQR: 60 - 90]. Nonadherence was reported by 30.3% (n = 51) of patients and was mainly due to blood unavailability (43.1%, n = 22). It was significantly higher among patients transfused within the past 3 months compared to non-transfused peers (50.6% n = 41 vs 11.5% n = 10, $p < 0.001$). Transfusion requirements constituted a massive burden, manifesting as a structural barrier to medical care (44%, n = 74), altered quality of life (51.8%, n = 87), financial distress requiring personal loans (43%, n = 55), and acute psychological stress (37%, n = 62). **Conclusion**: Transfusion costs constitute a major and under-recognized barrier to timely access to blood among chronic hemodialysis patients in our setting. The combination of high out-of-pocket expenses with intermediary and donor payments is associated with increased socioeconomic vulnerability, hemodialysis nonadherence, and impaired quality of life.

## Keywords

Hemodialysis, Blood Transfusion, Economic Burden, Perceived Quality of Life, Cameroon

## 1. Background

Anemia is a pervasive complication among patients with kidney failure, particularly those undergoing maintenance hemodialysis (HD), with prevalence rates documented between 66% and 89% [1]-[7]. This multifactorial condition primarily results from deficient erythropoietin (EPO) production, though it is further compounded by impaired iron homeostasis, uremia-induced erythropoiesis suppression, shortened erythrocyte survival, and persistent systemic inflammation. While erythropoiesis-stimulating agents (ESAs) are considered the therapeutic gold standard—utilized by up to 90% of in-center HD patients in high-income nations [6]—blood transfusion remains the primary modality for anemia management in most resource-limited settings. Regional data highlight this reliance: in Yemen, 75.9% of patients require transfusions despite 70% having access to ESAs [7]. Similarly, in Cameroon, transfusion rates range from 42% to 82% [5] [8] [9], with an average monthly requirement of one to four blood units per patient.

In sub-Saharan Africa, blood transfusion is increasingly recognized as a vital component of the right to health, serving as a critical intervention for life-threatening conditions such as severe malarial anemia, obstetric hemorrhage, and trauma. However, transfusion services in this region are hampered by systemic vulnerabilities, including deficient infrastructure, shortages of skilled personnel, high rates of transfusion-transmissible infections, and low voluntary donation rates

[10]. These challenges are exacerbated by limited public awareness, cultural misconceptions, and spiritual beliefs that restrict the voluntary donor pool [11] [12]. Such governance gaps have inadvertently fostered an informal "black market," characterized by safety risks and prohibitive costs. In Cameroon, the supply chain is heavily dependent on family replacement donors or compensated intermediaries. Despite partial government subsidies, patients frequently face out-of-pocket costs between US$30 and US$45 per unit, depending on the facility [13].

For the maintenance HD population in Cameroon, these challenges impose a unique, cumulative burden. Unlike acute surgical emergencies, the recurring nature of renal anemia creates a chronic financial strain. In a setting where universal health coverage is still emerging, managing anemia complications remains a private expense. In Cameroon, the cost of transfusion-related care in HD ranges from US$159 to US$627 [5] [9], a staggering figure considering that most patients report monthly incomes below US$180 [5] [14]. This persistent economic pressure leads to "financial toxicity," where health expenditures jeopardize household survival and force agonizing trade-offs between basic necessities and life-sustaining therapy.

Beyond financial barriers, the logistical complexity of the replacement donation system introduces significant psychological and physical exhaustion. For patients already debilitated by uremia, the effort to mobilize donors or negotiate the informal market is taxing. While existing Cameroonian literature has documented the prevalence and clinical characteristics of renal anemia, empirical data linking socioeconomic and logistical barriers to dialysis delivery remain scarce. Notably, poverty has already been associated with a 4.3-fold increase in the risk of treatment nonadherence in this population [14]. It remains unclear how the intersection of socioeconomic status and acquisition costs of blood influences adherence to dialysis schedules. Quantifying these impacts is crucial for advocating for policies that integrate anemia management as a core pillar of renal replacement therapy rather than a peripheral cost. Consequently, this study sought to evaluate the economic burden of blood transfusion and its influence on adherence and perceived quality of life among hemodialysis patients in Douala, Cameroon.

## 2. Methods

### 2.1. Study Design and Setting

We conducted a multicenter, hospital-based, cross-sectional study over a 2-week period in January 2026. The study was carried out at the only two public hemodialysis (HD) facilities in Douala, the economic capital of Cameroon.

- The HD unit of the Douala General Hospital (DGH): Established in 1990, it is the oldest and largest center in the country. The unit operates from Monday to Sunday with four shifts per day, except on Sundays, which run two shifts. An on-site blood bank is available within the institution.
- The HD unit of the Laquintinie Hospital of Douala (LHD): Operational since 2023, this center runs four shifts per day from Monday to Sunday. An institutional blood bank is also available on site.

## 2.2. Participants and Sampling

All consenting adult patients (aged > 18 years) undergoing maintenance hemodialysis for more than 3 months were eligible for inclusion. We excluded patients with cognitive impairment, those unable to understand French or English, and "transient" patients who were regularly dialyzed at another HD facility outside the study sites.

During the study period, a total population of N = 414 patients on maintenance hemodialysis was registered across both centers (283 at DGH and 131 at LHD). To estimate the minimum sample size, we first applied Cochran's formula for an infinite population.

$$n_0 = \frac{Z^2 \cdot p \cdot (1-p)}{e^2} \tag{1}$$

where:

- $Z = 1.96$, corresponding to the 95% confidence interval.
- $e = 0.05$ represents the margin of error.
- $p = 0.82$ (82%) is the expected prevalence of blood transfusion in HD patients in Cameroon, based on previous data reported by Fouda *et al.* [8].

This yielded an initial sample size ($n_0$) of 226.8. We then applied the finite population correction formula:

$$n = \frac{n_0}{1 + \frac{n_0 - 1}{N}} \tag{2}$$

This determined a minimum required sample size of $n = 147$ patients.

Patients were approached in the waiting room before or after their dialysis session. We used consecutive sampling. A total of 225 patients were screened during the study period (DGH n = 138 and LHD n = 87). Of these, 56 were excluded: 11 were under 18 years old, 7 presented with cognitive impairment, 5 were transient patients, and 34 declined to participate. Ultimately, 168 patients (DGH n = 108 and LHD n = 60) were included in the final analysis (Figure 1).

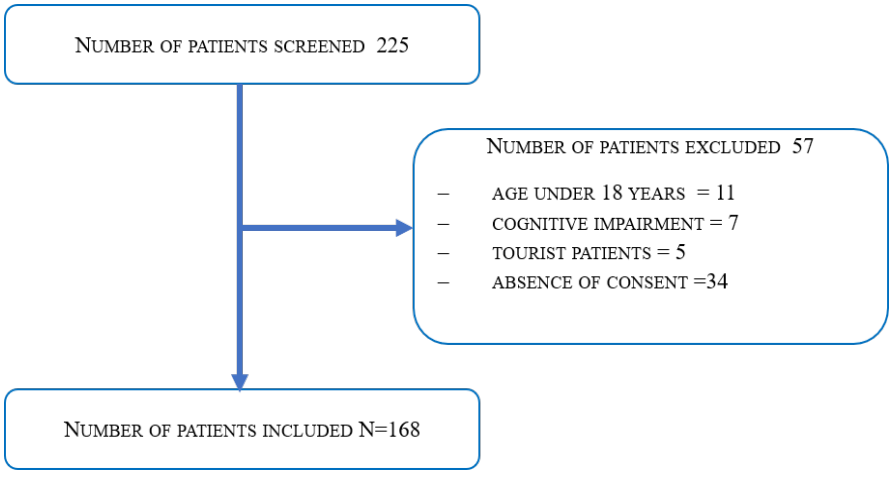


Figure 1. Flowchart of participants.

## 2.3. Data Collection Procedure

Data were collected through face-to-face interviews conducted immediately before or after the dialysis sessions using a pre-tested, standardized questionnaire. Medical records were reviewed concurrently to cross-check and complete clinical, logistical, and biological variables. The collected variables were categorized as follows:

- *Sociodemographic Characteristics*: Sex, age, area of residence, marital status, education level, and socioeconomic status (including monthly income and household wealth). The household wealth measurement was adapted from the World Bank Household Wealth Index, which assesses economic status based on a list of goods and services (housing quality, housing and vehicle ownership, water and electricity supply, number of persons per bedroom). A score (Si) was attributed to each asset, and the wealth index score was calculated using the formula

$$\text{Wealth index} = \Sigma Si + \left[\left(p/r - 1.84\right)/1.27\right] - 0.014$$

Where:

- $\Sigma Si$ = sum of the individual scores of each item.
- $p/r$ = number of persons per bedroom.

Percentile distribution was subsequently used to categorize participants into three socioeconomic strata.

Participants belonging to the lowest two quintiles were classified as poor households.

- Participants belonging to the highest quintiles correspond to wealthy households.
- Participants belonging to the 3rd and 4th quintiles correspond to intermediate households.

- *Hemodialysis and baseline clinical characteristics*: Blood group (ABO and Rh typing), hemodialysis vintage, type of vascular access (arteriovenous fistula or central venous catheter), and frequency of dialysis sessions per week.
- *Anemia Management*: The most recent pre-dialysis hemoglobin level, history of anemia therapies, utilization of ESAs along with the specific type used and compliance with prescriptions, and history of blood transfusions (number of blood units received during the past 3 - 6 months, average monthly requirements, type of blood product (whole blood vs. packed red blood cells)).
- *Logistical and financial burden of blood transfusion*: direct medical costs (estimated cost per blood unit, crossmatching fees), logistical parameters (use of an intermediary, type of replacement donor), and indirect costs (transportation expenses, estimated loss of earnings). The estimated loss of earnings was calculated using the formula: (Number of days of work lost × Monthly income)/30.
- *Perceived burden of transfusion*: Subjective impact on quality of life, financial strain, requirement to borrow money to afford blood products, and instances of missing scheduled HD sessions due to transfusion-related constraints. Sub-

jective impact on quality of life and psychological burden was evaluated using unvalidated perception questions based on a 3-point Likert scale.

- *Hemodialysis nonadherence*: Number of missed dialysis sessions during the past 3 months and the documented reasons for nonadherence.

The following definition was used:

- **Low socioeconomic (poverty)** was defined by a monthly income < $US200 associated with a poor household, or a monthly income < US$100 with an intermediate household.
- **Intermediate to high socioeconomic status** was defined by the absence of criteria for low socioeconomic status.
- **Total cost of blood transfusion:** corresponded to the cumulative financial sum paid for donor recruitment, non-medical intermediary fees, cross-matching, transportation expenses, and institutional blood bank processing fees.
- **Recent transfusion:** defined as a patient who has been transfused within the past 3 months.
- **Anemia** was defined as a hemoglobin level < 12 g/dl in women and < 13 g/dl in men.

### 2.4. Ethical Considerations

Administrative approvals were obtained from the institutional management boards of both the Douala General Hospital and the Laquintinie Hospital. The study was conducted in strict accordance with the ethical principles outlined in the Declaration of Helsinki. All participants provided written informed consent prior to enrollment, and data confidentiality was strictly maintained using anonymized identifiers.

### 2.5. Statistical Analysis

The data were analyzed using SPSS version 26. Continuous variables are expressed as medians with interquartile ranges (IQRs) or means with standard deviations (SDs), depending on the normality of the distribution. Categorical variables are presented as frequencies and percentages. Comparisons between groups were performed using Student's t-test or the Mann-Whitney U test for continuous data and the chi-square test or Fisher's exact test for categorical data. A two-sided p value < 0.05 was considered statistically significant.

## 3. Result

### 3.1. Sociodemographic and Economic Characteristics

Of the 225 patients screened, 168 were included. The male-to-female ratio was 1.12, with 53% (n = 89) males, and the mean age was 49 ± 12 years. The baseline socioeconomic indicators revealed widespread vulnerability (Table 1): 63.7% (n = 107) were unemployed, 65.5% (n = 110) reported a monthly income below US$200, and 69% (n = 116) had not attained a university-level education n. Furthermore, 65.5% (n = 110) of the patients were married. Poor households ac-

counted for 42.3% (n = 71) of the patients, and low socioeconomic status was identified in 58.3% (n = 98).

**Table 1.** Sociodemographic and economic characteristics.

| Variables | Frequency | Percentage |
|---|---|---|
| Sex (male) | 89 | 53 |
| Age (years) | | |
| [18 - 30[ | 14 | 8.3 |
| [30 - 40[ | 28 | 16.7 |
| [40 - 50[ | 46 | 27.4 |
| [50 - 60[ | 38 | 22.6 |
| ≥60 | 42 | 25 |
| Level of education | | |
| None | 3 | 1.7 |
| Primary | 24 | 14.3 |
| Secondary | 89 | 53 |
| University | 52 | 31 |
| Profession | | |
| Retired | 8 | 4.7 |
| Unemployed | 107 | 63.7 |
| Employed | 53 | 31.6 |
| Monthly income (US$) | | |
| <100 | 74 | 44 |
| [100 - 200[ | 36 | 21.4 |
| [200 - 400[ | 36 | 21.4 |
| [400 - 600[ | 10 | 6 |
| ≥600 | 12 | 7.2 |
| Household wealth | | |
| Poor | 71 | 42.3 |
| Intermediate | 66 | 39.3 |
| Wealthy | 31 | 18.4 |

### 3.2. Hemodialysis and Baseline Clinical Data

The predominant blood phenotypes within the study population were groups O+ (53.6%, n = 90) and A+ (21.4%, n = 36). The median hemodialysis vintage was 2 years [IQR: 1 - 4]. Most patients (98.8%, n = 166) underwent twice-weekly sessions, while only two patients (1.2%) received three sessions per week. Arteriovenous fistulas were the primary vascular access in 85.2% (n = 143) of cases. The mean hemoglobin level was 8.6 ± 0.77 g/dl, and 66% of patients had a hemoglobin

level below 10 g/dl (Table 2).

Table 2. Hemodialysis data and anemia management.

| Variables | Frequency | Percentage |
|---|---|---|
| Blood group | | |
| O+ | 90 | 53.6 |
| A+ | 36 | 21.4 |
| B+ | 35 | 20.8 |
| AB+ | 3 | 1.8 |
| O- | 1 | 0.6 |
| B- | 3 | 1.8 |
| Vascular access | | |
| Fistula | 143 | 85.2 |
| Catheter | 25 | 14.8 |
| Session per week | | |
| 2 | 166 | 98.8 |
| 3 | 2 | 1.2 |
| Hemoglobin level (g/dl) | | |
| <7 | 33 | 19.6 |
| [7 - 10[ | 78 | 46.4 |
| [10 - 12[ | 45 | 26.8 |
| ≥12 | 12 | 7.2 |
| Anemia management | | |
| Erythropoiesis stimulating agents | 116 | 69 |
| Recombinant erythropoietin | 109 | 65 |
| Intravenous Iron | 100 | 59.5 |
| Blood transfusion | | |
| During the past 6 months | 105 | 62.5 |
| During the past 3 months | 81 | 48.2 |
| ≥ 2 units/months | 46 | 27.4 |
| Use of non-medical intermediaries for blood (n = 81) | 47 | 58 |
| Use of donor (n = 75) | 75 | 44.6 |
| Family replacement | 9 | 12 |
| Financially compensated donor | 43 | 57.3 |
| Both | 23 | 30.7 |

### 3.3. Anemia Management and Transfusion Prevalence

Blood transfusion was the primary therapeutic modality for anemia management;

62.5% (n = 105) of the participants received at least one unit of blood during the preceding 6 months, culminating in an aggregate consumption of 438 blood units. More than a quarter of the patients (27.4%, n = 46) required a high transfusion burden of two or more blood units per month (Table 2).

Concerning ESAs, the use of recombinant EPO was reported by 65% (n = 109) of patients. However, among those prescribed EPO, only 62% (n = 68) reported therapeutic compliance, and 35.8% (n = 39) experienced persistent transfusion dependency. Intravenous (IV) iron therapy was administered to 59.5% (n = 100) of patients, with a self-reported compliance rate of 71% (n = 71); despite this, 42% (n = 42) required concurrent blood transfusion. Combined therapeutic regimens utilizing both EPO and IV iron were documented in 55.3% (n = 93) of patients, of whom 40.8% (n = 38) remained transfusion-dependent (Table 2).

### 3.4. Logistical and Financial Burden of Blood Transfusion

During the 3 months preceding the study, 48.2% (n = 81) of the patients were transfused, utilizing a total of 298 blood units (186 units of packed red blood cells and 112 units of whole blood) with a mean transfusion rate of 1.23 units per month per patient. To secure blood products, 58% (n = 47) of these transfused patients relied on non-medical intermediaries, incurring a median transactional fee of US$20 [IQR: 10 - 40] per transaction (Table 3).

The structural supply chain of blood relied heavily on replacement donation (92.6%, n = 75), within which financially compensated donors represented 57.3% (n = 43), family replacement donors accounted for 12% (n = 9), and a combination of both was utilized by 30.7% (n = 23). Most replacement donors (88%, n = 66) were compensated. At the DGH, blood units sourced from external institutional blood banks incurred an additional crossmatch verification fee of US$16 per unit. Aggregating all components, the median total cost per blood unit was US$81.5 [IQR: 60 - 90] (Table 3). Additionally, the process involved a median logistical time loss of 2 days [IQR: 1 - 3] per transfusion event and a median estimated loss of earnings of US$6.70 [IQR: 3.4 - 16.7].

Table 3. Cost of blood transfusion.

| Variables* | Median | IQR | Extremes |
|---|---|---|---|
| Cost of intermediaries | 20 | 10 - 40 | 10 - 42 |
| Financial compensation per donor | 16 | 10 - 20 | 10 - 40 |
| Cost of crossmatch | 16 | - | 0 - 16 |
| Cost of transport | 5.8 | 2 - 10 | 2 - 28 |
| Total cost per bag | 81.5 | 60 - 90 | 32 - 115 |
| Estimated loss of earnings | 6.7 | 3.4 - 16.7 | 1.7 - 80 |
| Time loss (day) | 2 | 1 - 3 | 0.5 - 6 |

*Estimated cost per unit of blood in US$.

### 3.5. Hemodialysis Nonadherence and Associated Drivers

Nearly one-third of the study population (n = 51, 30.3%) reported missing at least one scheduled hemodialysis session during the 3-month reference period (Table 4), resulting in a total of 83 missed sessions (mean of 1.62 ± 0.7 missed sessions per nonadherent patient).

Nonadherence was significantly more prevalent among patients categorized with low socioeconomic status compared to those in intermediate-to-high tiers (36.7% n = 36 vs 21.4% n = 15, p = 0.041).

Patients who underwent blood transfusion within the past 3 months also demonstrated a significantly higher rate of nonadherence compared to non-transfused peers (50.6% n = 41 vs 11.5% n = 10, p < 0.001).

Acute blood unavailability was identified as the principal reason for missing sessions, accounting for 43.1% (n = 22) of nonadherence. The frequency of this barrier did not differ significantly between low and intermediate to high socioeconomic brackets (47.2% in low, n = 17 vs 50% in intermediate to high, n = 5, p = 0.62). Vascular access complications (29.4%, n = 15), personal reasons (19.6%, n = 10), and transport constraints due to the 2025 post-electoral crisis (7.8%, n = 4) constituted the remaining documented causes (Table 4).

### 3.6. Patient-Perceived Burden and Quality of Life

The subjective and economic pressure of blood acquisition was widespread among the patients. To afford blood products, 43% (n = 55 of the 128 respondents) of the patients required personal loans. The necessity to borrow money was associated with recent transfusion history (54.3% in transfused, n = 38 vs 29.3% in non-transfused, n = 17; p = 0.004) but did not vary significantly across socioeconomic strata (44.3% in low, n = 31 vs 41.4% in intermediate to high, n = 24; p = 0.81). Among actively employed individuals (n = 53), 34% (n = 18) reported missing work explicitly due to transfusion-related logistics.

Blood availability was perceived as a definitive structural barrier to medical care by 44% (n = 74) of all respondents. This perception was tightly linked to recent transfusion exposure (66.7% in transfused, n = 54 vs 23% in non-transfused, n = 20; p < 0.001) but was uniform across socioeconomic groups (48% in low, n = 47 vs 38.6% in intermediate to high, n = 27; p = 0.22). Blood unavailability was also perceived as negatively impacting quality of life (51.8%, n = 87), especially among recently transfused patients (80.3% n = 61 vs 38.3% n = 26, p < 0.001), patients with poor household wealth (76% in poor, n = 54 vs 34% n = 33, in intermediate to wealthy, p < 0.001), and low socioeconomic group (63.2% n = 62 in low vs 35.7% n = 25 in intermediate to high, p < 0.004).

The majority of patients (62.4%, n = 103 of 165 respondents) reported that the direct cost of blood negatively impacted their quality of life, a perception significantly heightened among recently transfused patients (86.5% in transfused, n = 70 vs 38% in non-transfused, n = 33; p < 0.001), but comparable among socioeconomic strata (63.3% in low, n = 62 vs 58.6% in intermediate-to-high, n = 41; p =

0.53). Similarly, the administrative and logistical procedure to locate blood was perceived as an active burden by 48.2% (n = 77 of 160 respondents) of the patients, also correlating significantly with recent transfusion history (60.5% in transfused, n = 49 vs 36% in non-transfused, n = 28; p = 0.002), and comparable among socioeconomic groups (49.5% in low, n = 46 vs 46.3% in intermediate-to-high, n = 31; p = 0.68).

Overall, 54.2% (n = 91) of the participants categorized transfusion costs as entirely out-of-pocket, and 37% (n = 62) described the logistical pursuit of blood as an acute stressor characterized by fear of missing dialysis, fear of death, donor recruitment struggles, and prolonged waiting times. Conversely, 52.4% (n = 88) noted that financial liquidity and the utilization of intermediaries were the primary facilitators of blood availability (Table 4).

Table 4. Burden of blood transfusion.

| Variables | Frequency | Percentage |
|---|---|---|
| Reason for non-adherence (n = 51) | | |
| Blood availability | 22 | 43.1 |
| Vascular access | 15 | 29.5 |
| Personal | 10 | 19.6 |
| Transportation | 4 | 7.8 |
| Need to borrow money (n = 128) | 55 | 43 |
| Missing work (n = 53) | 18 | 34 |
| Burden on quality of life (n = 168) | | |
| No | 57 | 34 |
| Do not know | 24 | 14.2 |
| Yes | 87 | 51.8 |
| Barrier to medical care (n = 168) | | |
| No | 64 | 38 |
| Do not know | 30 | 18 |
| Yes | 74 | 44 |
| Impact of blood transfusion cost in my life (n = 165) | | |
| No | 40 | 24.3 |
| Do not know | 22 | 13.3 |
| Yes | 103 | 62.4 |
| Impact of procedure to find blood impacts my life (n = 160) | | |
| No | 47 | 29.3 |
| Do not know | 36 | 22.5 |
| Yes | 77 | 48.2 |

## 4. Discussion

Almost all patients in this study exhibited anemia (96.8%), a finding consistent with previous reports on kidney failure in Cameroon and other low-resource settings, where the documented prevalence ranges between 79% and 95% [3]-[5] [9] [15] [16]. Moderate anemia predominated, with a mean hemoglobin level of 8.6 ± 0.77 g/dl. This biological profile likely reflects the increased utilization of ESAs, which reached 69% (n = 116) in our population—a substantial increase compared to earlier Cameroonian cohorts [5] [8] [9]. However, clinical optimization remains severely constrained by cost, leading to widespread suboptimal dosing and therapeutic non-compliance. Specifically, the maximum prescribed dose of recombinant erythropoietin (EPO) did not exceed 10,000 IU/week, and only 40.5% of patients receiving ESAs achieved a target hemoglobin level greater than 10 g/dL. Consequently, at least one-third of patients on ESAs experienced persistent transfusion dependency. The direct impact of medication costs and reimbursement structures on blood transfusion frequency has been well documented globally; for instance, the 2011 Medicare reimbursement reforms in the United States similarly catalyzed an increased reliance on rescue blood transfusions among public insurance beneficiaries compared to commercially insured populations [17].

In the pre-ESA era in the United States, it was estimated that 10% to 20% of chronic dialysis patients required at least one blood unit within a 3-month period to prevent severe anemia [18]. In contrast, despite the contemporary availability of ESAs, 48.2% (n = 81) of the patients in our cohort required a blood transfusion within the 3-month reference period. This persistently high reliance on blood products in our setting is multifactorial and deeply rooted in local clinical complexities. It is likely driven by the high prevalence of kalaba chalk geophagia among Cameroonian hemodialysis patients [8] [19], intestinal helminth infestations, baseline autoimmune nephropathies (such as lupus nephritis), persistent chronic inflammation, and uremia-induced alloimmunization from cumulative polytransfusions. Additionally, structural limitations in dialysis frequency exacerbate this demand; recent studies have suggested higher EPO requirements among patients maintained on a twice-weekly hemodialysis schedule [20], which constitutes the reality for 98.8% (n = 166) of our cohort.

The resulting macro-logistical strain on the local health system is immense. Our findings reveal that transfused patients consumed an aggregate of 298 blood units over 3 months, indicating that public blood banks must dedicate approximately 100 units per month exclusively to the hemodialysis population in Douala. Within a supply system structurally dependent on replacement donation [10] [11], this continuous and predictable demand places an immense strain on institutional infrastructure. This systemic deficit inadvertently fosters commercial speculation and drives the expansion of a clandestine market, as heavily reflected in our data: 58% (n = 47) of transfused patients relied on non-medical intermediaries, and 88% (n = 66) relied on financed (compensated) replacement donors to secure blood products. Moreover, financial liquidity and the utilization of intermediaries

were considered by patients as the primary facilitators of blood availability.

This informal commercialization exposes a profound "subsidy paradox" within Cameroon's public health policy. The Cameroonian government has made commendable strides by subsidizing maintenance hemodialysis sessions, reducing the direct cost to an annual fee of approximately US$30 per patient. However, our financial tracking exposes a stark contrast: a single blood transfusion episode demands a median out-of-pocket expenditure of US$81.50 [IQR: 60 - 90]—nearly three times the annual subsidized cost of the maintenance hemodialysis sessions themselves. Given that 65.5% (n = 110) of our cohort survives on less than US$200 per month, a single anemic crisis consumes a catastrophic proportion of a household's monthly income. Consequently, the state's substantial investment in dialysis infrastructure is clinically neutralized because patients cannot afford the essential peripheral therapies required to safely tolerate and sustain the procedure. This gap strongly argues for an integrated healthcare policy where primary anemia therapies—specifically ESAs, IV iron, and screened blood products—are legally bundled directly into the standardized public dialysis subsidy package rather than being relegated to out-of-pocket private expenses.

Beyond inducing financial distress, our findings reveal that the management of chronic renal anemia acts as a primary catalyst for healthcare non-adherence and acute household financial instability. Nearly one-third of our cohort (30.3%, n = 51) reported missing essential hemodialysis sessions, with acute blood unavailability identified as the predominant driving factor (43.2%, n = 22). Crucially, this care disruption was not randomly distributed but was tightly coupled with low socioeconomic status ($p = 0.041$) and acute transfusion requirements ($p < 0.001$), exposing a structural failure in which survival is heavily dependent on personal wealth.

Furthermore, the association between recent transfusions and missed dialysis sessions (50.6% vs. 13%, $p < 0.001$) underscores a vicious clinical and economic cycle. Severe anemia induces profound physical asthenia, directly impairing productivity and the physical capacity to travel to dialysis centers. This collapse in earning capacity is clearly evidenced by our finding that 34% (n = 18) of actively employed patients missed work explicitly due to transfusion logistics, compounding a median estimated loss of earnings of US$6.70 [IQR: 3.4 - 16.7]. As household income declines, patient compliance with critical preventive therapies like recombinant EPO (65% usage, 62% compliance) or intravenous iron collapses due to cost. Substandard hemoglobin levels follow (<7 g/dl in 19.6% of patients), ultimately forcing patients back into the emergency room for acute decompensation, where they must secure commercialized transfusions that are vastly more expensive than maintenance ESA regimens. Poverty, therefore, does not merely predict non-adherence; it actively fuels a bio-economic loop where the poorest patients are systematically forced into unstable, financially ruinous, and potentially dangerous rescue therapies.

Ultimately, this compounding logistical and financial pursuit of blood imposes

a severe psychological tax, profoundly deteriorating the patients' subjective quality of life. More than half of the cohort (51.8%, n = 87) associated transfusion requirements with an altered quality of life, and 37% (n = 62) characterized blood acquisition as an acute psychological stressor defined by the constant fear of missing dialysis, fear of death, donor recruitment struggles, and prolonged hospital waiting times. This burden manifested economically through the collapse of savings and a widespread need to borrow money (43%, n = 55), an economic dependency that was significantly higher among recently transfused individuals (54.3% vs. 29.3%, p = 0.004). Perceived as a complex and stressful process, the administrative procedure to locate blood was also viewed as a definitive barrier to medical care by 44% (n = 74) of the patients. Transfusion dependencies not only increase financial precarity but also introduce chronic logistical anxiety, which may directly predispose this chronic patient population to secondary mental health comorbidities such as anxiety and depression.

Despite these compelling insights, this study has several limitations that must be acknowledged. First, the cross-sectional design over a tight 2-week window precludes the determination of long-term causal directions over extended clinical timelines. Second, the reliance on patient self-reports for granular financial data—such as transportation expenses, non-medical intermediary fees, and donor compensation—introduces a potential risk of recall bias. Lastly, because the study was conducted exclusively within the two public hemodialysis facilities in Douala, the logistical and financial dynamics documented here may differ from those in private healthcare institutions or other regional sectors of Cameroon.

## 5. Conclusion

Although the use of ESAs has increased, rescue blood transfusion remains frequent in our setting. It is associated with high out-of-pocket costs—nearly three times the annual subsidized cost of maintenance hemodialysis sessions—and relies heavily on an informal market driven by non-medical intermediaries and compensated replacement donors. This out-of-pocket expenditure directly increases hemodialysis non-adherence, exacerbates socioeconomic vulnerability, and impairs patients' quality of life. Consequently, integrated healthcare policies that bundle anemia management into standard renal care need to be implemented to mitigate the financial toxicity associated with blood product acquisition among hemodialysis patients in Cameroon.

## 6. Declarations

### 6.1. Ethics Approval and Consent to Participate

Administrative approvals were obtained from the institutional management boards of both the Douala General Hospital and the Laquintinie Hospital of Douala. The study was conducted in strict accordance with the ethical principles outlined in the Declaration of Helsinki. All participants provided written informed consent prior to enrollment, and data confidentiality was rigorously maintained

using anonymized identifiers.

### 6.2. Availability of Data and Materials

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

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## Author Contributions

HDFME, JYB, and RSK conceptualized the study, conducted the data analysis, interpreted the findings, and drafted the manuscript. LE, VG, and AGN developed the proposal, analyzed the data, and contributed to the manuscript writing. ENG engaged in editing and critically revising the drafts of the paper. All authors reviewed the final version of the manuscript and approved it for submission.

## Conflicts of Interest

The authors declare that they have no competing interests.

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