EAS Journal of Radiology and Imaging Technology
Abbreviated Key Title: EAS J Radiol Imaging Technol
ISSN: 2663-1008 (Print) & ISSN: 2663-7340 (Online)
Published By East African Scholars Publisher, Kenya

OPEN ACCESS

Volume-8 | Issue-2 | Mar-Apr-2026 | DOI: https://doi.org/10.36349/easjrit.2026.v08i02.002

Original Research Article

Assessment of Biochemical and Hematological Changes Following Repeated Blood Transfusion in a Tertiary Hospital in North East Nigeria

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Article History
Received: 24.12.2025
Accepted: 20.02.2026
Published: 10.03.2026

Journal homepage:
https://www.easpublisher.com

Quick Response Code

Abstract: ***Background*:** Repeated blood transfusion remains a cornerstone in the management of chronic hematological disorders but is associated with significant biochemical and hematological alterations, including iron overload, hepatic dysfunction, and electrolyte imbalance. ***Objective*:** To assess biochemical and hematological changes associated with repeated blood transfusion among patients attending a tertiary hospital. ***Methods*:** This hospital-based comparative cross-sectional study involved 120 participants comprising 80 patients who had received ≥3 blood transfusions in the preceding 12 months and 40 age- and sex-matched controls with ≤1 transfusion. Hematological parameters were analyzed using an automated hematology analyzer, while biochemical assays were performed using standard spectrophotometric methods. Data were analyzed using SPSS version 25. Independent t-test, Pearson correlation, and linear regression were applied. A p-value <0.05 was considered statistically significant. ***Results:*** Repeatedly transfused patients had significantly higher mean serum ferritin (486.3 ± 162.5 ng/mL vs 168.4 ± 72.1 ng/mL; p<0.001), ALT, AST, bilirubin, and potassium levels compared to controls. Serum calcium was significantly lower in transfused patients (p=0.02). Serum ferritin showed a strong positive correlation with transfusion frequency (r=0.64, p<0.001). ***Conclusion*:** Repeated blood transfusion is associated with significant biochemical and hematological alterations, particularly iron overload and hepatic dysfunction. Routine laboratory monitoring is recommended for early detection and prevention of transfusion-related complications.

Keywords: Blood Transfusion, Ferritin, Iron Overload, Biochemical Changes, Hematological Parameters.

INTRODUCTION

Repeated blood transfusion is essential in the management of chronic hematological disorders but is associated with iron overload and metabolic complications [1]. Iron accumulation following transfusion has been linked to hepatic dysfunction, oxidative stress, and endocrine abnormalities [2, 3]. This study assessed biochemical and hematological changes associated with repeated blood transfusion.

Blood transfusion is a critical therapeutic intervention in the management of chronic anemia, sickle cell disease, thalassemia, malignancies, and perioperative blood loss [4]. Despite its benefits, repeated transfusion predisposes patients to iron overload due to the absence of a physiological iron excretory mechanism [5].

Each unit of packed red blood cells contains approximately 200–250 mg of elemental iron, which progressively accumulates in transfusion-dependent patients [6]. Iron overload results in oxidative stress, hepatic injury, and cardiovascular complications [7].

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Serum ferritin is widely used as a surrogate marker of body iron stores and has been shown to correlate with transfusion burden [8]. However, ferritin is also an acute-phase reactant influenced by inflammation and liver disease [9]. Repeated blood transfusion has also been associated with alterations in liver enzymes, bilirubin, electrolytes, and hematological indices due to hemolysis, citrate toxicity, and red cell storage lesions [10, 11].

Routine laboratory monitoring of transfusion-related complications remains suboptimal in many low- and middle-income settings [12]. This study therefore assessed biochemical and hematological changes following repeated blood transfusion to support evidence-based monitoring protocols [13].

MATERIALS AND METHODS

The study was a hospital-based comparative cross-sectional study conducted in the Departments of Chemical Pathology and Haematology of a tertiary hospital in North East, Nigeria, from January to June 2025 [14]. Patients aged five years and above who had received three or more blood transfusions in the preceding 12 months were recruited [15].

Hematological parameters were analyzed using an automated hematology analyzer, while biochemical assays were performed using standard spectrophotometric techniques [16, 17]. Data analysis was carried out using SPSS version 25, employing independent *t*-tests, Pearson correlation, and linear regression [18].

RESULTS

A total of 120 participants were enrolled in the study, comprising 80 repeatedly transfused patients and 40 controls. There was no statistically significant difference in age or sex distribution between both groups ($p>0.05$).

Table 1: Socio-Demographic and Clinical Characteristics of Participants

Variable	Transfused (n=80)	Controls (n=40)	*p*-value
Age (years), mean ± SD	24.6 ± 8.3	23.9 ± 7.8	0.64
Male, n (%)	46 (57.5)	22 (55.0)	0.79
Female, n (%)	34 (42.5)	18 (45.0)	
Mean number of transfusions/years	6.8 ± 2.1	0.9 ± 0.3	<0.001

Table 2: Comparison of Biochemical Parameters between Transfused Patients and Controls

Parameter	Transfused (Mean ± SD)	Controls (Mean ± SD)	*p*-value
Serum Ferritin (ng/mL)	486.3 ± 162.5	168.4 ± 72.1	<0.001
Serum Iron (µmol/L)	28.9 ± 9.4	17.6 ± 6.2	0.002
TIBC (µmol/L)	38.2 ± 10.1	52.6 ± 11.8	0.001
ALT (U/L)	42.6 ± 18.2	26.1 ± 9.4	0.001
AST (U/L)	48.7 ± 21.6	28.3 ± 10.2	<0.001
Total Bilirubin (µmol/L)	29.4 ± 11.6	16.8 ± 6.3	0.002
Sodium (mmol/L)	137.6 ± 4.2	139.1 ± 3.8	0.08
Potassium (mmol/L)	5.1 ± 0.6	4.4 ± 0.4	0.01
Calcium (mmol/L)	2.05 ± 0.18	2.21 ± 0.14	0.02

Table 3: Comparison of Hematological Parameters between Groups

Parameter	Transfused (Mean ± SD)	Controls (Mean ± SD)	*p*-value
Hemoglobin (g/dL)	9.2 ± 1.6	10.8 ± 1.4	0.01
Packed Cell Volume (%)	28.1 ± 4.9	33.4 ± 4.1	0.02
Total WBC ($\times 10^9$/L)	7.4 ± 2.1	6.9 ± 1.8	0.31
Platelet Count ($\times 10^9$/L)	312 ± 96	286 ± 88	0.27
Mean Corpuscular Volume (fL)	92.4 ± 8.1	86.3 ± 6.7	0.03

Table 4: Correlation between Transfusion Frequency and Iron Indices in Transfused Patients

Parameter	Correlation coefficient (*r*)	*p*-value
Serum Ferritin	0.64	<0.001
Serum Iron	0.48	0.002
Transferrin Saturation	0.52	0.001

Table 5: Linear Regression Analysis Showing Predictors of Iron Overload

Variable	β-coefficient	Standard Error	*p*-value
Number of transfusions/years	0.61	0.08	<0.001
ALT (U/L)	0.29	0.11	0.01
Age (years)	0.12	0.09	0.18

Repeatedly transfused patients had significantly higher serum ferritin, liver enzyme activities, bilirubin levels, and potassium concentrations compared with controls [19]. Serum calcium levels were significantly lower in transfused patients [20].

A strong positive correlation was observed between serum ferritin levels and transfusion frequency, indicating progressive iron accumulation with increasing transfusion exposure [21].

DISCUSSION

The present study demonstrates that repeated blood transfusion is associated with significant biochemical and hematological alterations. Elevated serum ferritin levels observed among transfused patients are consistent with findings from previous studies on transfusion-related iron overload [22].

The elevation of alanine aminotransferase, aspartate aminotransferase, and bilirubin suggests hepatic involvement secondary to iron deposition and chronic hemolysis [23]. Electrolyte disturbances, particularly hyperkalemia and hypocalcemia, may be explained by red cell storage lesions and citrate toxicity associated with transfused blood products [24].

These findings underscore the importance of routine biochemical and hematological surveillance in transfusion-dependent patients to prevent long-term complications [25, 26].

CONCLUSION

Repeated blood transfusion is associated with iron overload, hepatic dysfunction, electrolyte imbalance, and altered hematological indices. Regular laboratory monitoring should be integrated into the standard care of chronically transfused patients [27].

Acknowledgements

I acknowledge and appreciate the role of the following individuals.

Mallam Shamsuddeen, Mallam Sadiq and Mallam Bello for their technical support.

Mallam Rabiu for his indispensable assistance with the statistical analysis.

Conflict of Interest: There was no conflict of interest.

Funding: No external funding received.

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Cite This Article: Atiku GM, Hadiru Goni M, Kawu Y A, Talba H, Kunduli Y, Othman N, Tukur R.A, Ngamdu H.S, Musa A, Tikau H.I, Aliyu U.D, Kukawa YM (2026). Assessment of Biochemical and Hematological Changes Following Repeated Blood Transfusion in a Tertiary Hospital in North East Nigeria. *EAS J Radiol Imaging Technol, 8*(2), 31-33.