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Pretransfusion Hemoglobin Level and Pattern of Iron Chelation of the Transfusion Dependent Thalassemia Patients

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ABSTRACT

Background: Thalassemia is a common hereditary blood disorder in Bangladesh, requiring regular blood transfusions and iron chelation therapy to manage its complications and improve life quality. **Objective:** The study aimed to evaluate the pretransfusion hemoglobin levels, the pattern of iron chelation therapy, and the associated complications in transfusion-dependent thalassemia patients. **Methods:** This hospital-based cross-sectional descriptive study was conducted over six months (November 2016 to April 2017) at Rajshahi Medical College Hospital, with 75 transfusion-dependent thalassemia patients. Data were collected through structured questionnaires from patients' parents, and statistical analysis was performed using SPSS (version 16) to assess means, standard deviations, and p-values. **Results:** The average age of the patients was 7.7±2.3 years, with 57.33% in the 5-10 years age group. The first blood transfusion occurred at 2.5 years. The mean number of blood transfusions was 52.48±23.90 units. Serum ferritin levels were elevated (mean 3638.74±2567.79 ng/ml), and pretransfusion hemoglobin was low (7.2±1.56 gm/dl). Only 9.33% received regular chelation therapy, and 74.67% did not use any form of chelation. Statistical analysis revealed that patients with facial dysmorphism had significantly lower hemoglobin (6.32 gm/dl, p=0.03) and higher serum ferritin (4774.46 ng/ml in stunted patients). Patients with >50 transfusions had a higher serum ferritin level. Additionally, a longer duration of chelation therapy showed a lower serum ferritin level. **Conclusion:** This study indicates that thalassemia patients often receive transfusions irregularly and exhibit delayed chelation therapy initiation. Most patients fail to adhere to regular chelation despite elevated serum ferritin levels.

Keywords: Thalassemia, Pretransfusion Hemoglobin, Iron Chelation, Serum Ferritin, Blood Transfusion

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INTRODUCTION

Thalassemia is a group of inherited blood disorders characterized by defective hemoglobin synthesis, leading to chronic anemia and requiring lifelong management through blood transfusions and iron chelation therapy. It is one of the most common congenital hematological conditions globally, with an especially high prevalence in Mediterranean, Middle Eastern, Southeast

Asian, and South Asian populations. In Bangladesh, thalassemia remains a significant public health challenge, particularly for transfusion-dependent thalassemia patients. Despite its high prevalence, the country lacks a national registry for thalassemia, and there is insufficient government intervention to implement preventive measures or public education programs. The absence of such programs exacerbates the incidence of thalassemia, and a significant percentage of the population remains unaware of the condition's genetic implications and management strategies [1]. Thalassemia is particularly prevalent in Bangladesh, with an estimated 6,000 to 7,000 new cases born annually. Hb E beta-thalassemia, a compound genetic disorder involving a mutation in the beta-globin gene in conjunction with the Hb E mutation, accounts for nearly 85% of all thalassemia cases in the country. The carrier rate for Hb E in Bangladesh is approximately 6.1%, while the beta-thalassemia trait occurs in about 4.1% of the population. These figures reflect a broad regional variation, indicating that thalassemia is not uniformly distributed across the country but is more prevalent in certain areas. Without proper prenatal screening and genetic counseling, many individuals continue to marry within high-risk populations, leading to a rise in thalassemia births [2].

Thalassemia is inherited in an autosomal recessive manner, with patients needing two copies of the defective gene to develop the disease. The two most significant forms of thalassemia are β-thalassemia major and β-thalassemia intermedia. β-thalassemia major, the most severe form, leads to transfusion-dependent anemia and requires regular blood transfusions for survival. In contrast, β-thalassemia intermedia typically involves milder symptoms and may not require blood transfusions but still necessitates management to avoid complications [3]. The pathophysiology of thalassemia involves a deficiency in the production of the beta-globin chain of hemoglobin, which results in an imbalance between the alpha- and beta-globin chains in the red blood cells. This imbalance leads to the ineffective production of hemoglobin and the premature destruction of red blood cells, a process called hemolysis. This deficiency contributes to severe anemia and a number of other clinical manifestations, including jaundice, splenomegaly, and facial deformities due to the expansion of bone marrow [4]. In thalassemia major, patients exhibit progressive hemolytic anemia, leading to profound weakness, pallor, and growth retardation. The bone marrow compensates for the reduced red blood cell production by increasing erythropoiesis, leading to marrow expansion and bone deformities. The resultant hypoxia further exacerbates the severity of anemia and the ineffective erythropoiesis, leading to hepatomegaly and splenomegaly. These patients also experience delays in growth and puberty due to the chronic anemia and lack of oxygen supply to tissues, which further highlights the importance of early intervention [5].

The cornerstone of managing transfusion-dependent thalassemia is regular blood transfusion. Transfusions aim to maintain an adequate hemoglobin level, suppress the body's erythropoiesis, and reduce the complications arising from ineffective hematopoiesis. The frequency and volume of blood transfusions are adjusted to maintain a pretransfusion hemoglobin level between 9–10.5 gm/dl and post-transfusion hemoglobin levels should not exceed 14–15 gm/dl. This management approach helps prevent the detrimental effects of anemia, including stunted growth, organ damage, and bone deformities. However, blood transfusions are not without complications [6]. One of the most significant complications of chronic blood transfusions is iron overload. Each unit of packed red blood cells contains approximately 200 mg of iron, and with regular transfusions, patients accumulate excessive iron in various organs, including the liver, heart, and endocrine glands. The body has no natural mechanism to excrete excess iron, and if left unchecked, iron deposition in these organs can lead to serious complications, including heart failure, liver cirrhosis, and endocrine dysfunctions such as hypothyroidism and diabetes mellitus. This condition, known as transfusional hemosiderosis, is a major contributor to mortality in thalassemia patients [7]. To prevent the detrimental effects of iron overload, iron chelation therapy is employed.

Chelation therapy binds free iron in the bloodstream and facilitates its excretion via the urine or feces. Several chelating agents have been developed over the years, including deferoxamine (intravenous), deferasirox (oral), and deferiprone (oral). Deferoxamine, the first-line chelator, has been in use for decades, but newer oral agents like deferasirox and deferiprone have gained popularity due to their convenience and improved patient compliance. The goal of iron chelation therapy is to maintain the serum ferritin level below 1000 ng/ml to prevent iron-induced organ damage [8]. Iron overload occurs when the body's iron stores exceed its capacity for

safe storage. In thalassemia, the excessive iron deposited in the tissues primarily affects the liver and heart, leading to organ dysfunction. The mechanism by which iron induces tissue damage involves the generation of free radicals, particularly hydroxyl radicals, through the Fenton reaction. These radicals attack cellular structures, including membranes, mitochondria, and DNA, resulting in oxidative stress and cellular apoptosis. As iron accumulates, it saturates the plasma iron-binding protein transferrin, leading to an increase in non-transferrin-bound iron (NTBI), which is highly reactive and exacerbates tissue damage [9]. The long-term management of thalassemia major requires a combination of blood transfusions and iron chelation therapy. The advent of iron chelation therapy has significantly improved the prognosis of transfusion-dependent thalassemia patients, enabling them to live longer, healthier lives. However, iron overload remains a challenge, and achieving optimal management of transfusion therapy and iron chelation is crucial for improving survival and quality of life. The goal is to reduce iron accumulation, prevent organ damage, and ensure that patients maintain a high quality of life despite the ongoing need for transfusions and chelation [10].

Aims and Objective

The aim of this study is to evaluate the pretransfusion hemoglobin levels and the pattern of iron chelation therapy in transfusion-dependent thalassemia patients. The specific objectives include assessing serum ferritin levels, documenting the frequency of blood transfusions, and identifying common complications associated with the condition.

MATERIALS AND METHODS

Study Design

This study was a hospital-based, cross-sectional descriptive study conducted in the Paediatric Inpatient Department of Rajshahi Medical College Hospital (RMCH). The study aimed to evaluate transfusion-dependent thalassemia patients, focusing on their pretransfusion hemoglobin levels, patterns of iron chelation therapy, serum ferritin levels, frequency of blood transfusions, and common complications. The research was conducted over six months, from November 2016 to April 2017. A structured questionnaire was used for data collection, and the results were analyzed using SPSS (version 16.0). This design was chosen to provide a snapshot of the clinical characteristics and management practices related to transfusion-dependent thalassemia in the hospital setting.

Inclusion Criteria

The study included children aged between 2 to 12 years who were diagnosed with transfusion-dependent thalassemia. Both male and female patients were eligible for inclusion. Furthermore, patients who had received blood transfusions more than 10 times during their clinical management were also considered eligible. These criteria were selected to ensure the study population comprised individuals who have had a consistent history of blood transfusions, thereby providing a valid sample for the study's objectives.

Exclusion Criteria

Patients diagnosed with thalassemia before the age of 2 were excluded from the study, as their clinical presentation and management may differ from older children. Non-transfusion-dependent thalassemia patients were also excluded, as the study focused on those who rely on regular transfusions for survival. Additionally, patients who presented with other significant comorbid conditions that could influence the study's variables were excluded to maintain a homogeneous group focused on thalassemia management.

Data Collection

Data collection was performed using a structured questionnaire designed to gather relevant clinical information regarding the patients' hemoglobin levels, transfusion history, iron chelation patterns, and complications. Interviews were conducted face-to-face with the parents or caregivers of the patients to collect accurate and detailed responses. The data were gathered by trained research assistants, who ensured consistency and clarity in recording the responses. All responses were recorded in the data collection sheets for subsequent analysis.

Data Analysis

The collected data were input into SPSS version 16.0 for statistical analysis. Descriptive statistics, including mean, standard deviation, and frequency distributions, were used to summarize the clinical data. The study's

variables, including hemoglobin levels, serum ferritin, and transfusion frequencies, were analyzed using appropriate statistical tests to assess relationships and determine any significant patterns or correlations. A p-value of <0.05 was considered statistically significant. The results of the analysis helped draw conclusions about the clinical management and complications of transfusion-dependent thalassemia in the patient cohort.

Procedure

The study commenced with a thorough review of the patient records in the Pediatric Inpatient Department of RMCH. After obtaining ethical approval and informed consent from the parents or caregivers of the patients, data collection began. Trained research assistants administered face-to-face interviews, following a structured questionnaire to ensure consistency in the responses. Each interview was carefully conducted to capture accurate data on the patients' transfusion history, pretransfusion hemoglobin levels, iron chelation therapy, and any complications associated with the disease. The patients' serum ferritin levels were recorded through laboratory tests, and the frequency of transfusions was obtained from medical records. All data were entered into SPSS version 26.0 for analysis. The data were scrutinized for any inconsistencies or missing information. Once data collection was completed, statistical analysis was performed to identify trends and relationships between the variables, allowing for a comprehensive understanding of transfusion-dependent thalassemia management in the study population. The findings from the study provided valuable insights into the clinical outcomes and management practices for thalassemia patients at RMCH. Follow-up procedures were set to ensure that all patients received proper counseling regarding the importance of regular transfusion and chelation therapy.

Ethical Considerations

The study adhered to ethical guidelines, ensuring that informed written consent was obtained from the parents or guardians of all participants. Participants were assured of their right to withdraw from the study at any time without consequence. Confidentiality of patient data was maintained throughout the study, and ethical approval was obtained from the Institutional Review Board (IRB) of Rajshahi Medical College Hospital. The study was conducted with respect for the patients' rights and welfare.

RESULTS

This section provides a detailed analysis of the clinical, demographic, and therapeutic variables related to transfusion-dependent thalassemia patients, along with statistical analysis using frequency, percentage, p-values, and mean values. The study aims to evaluate key factors including demographic characteristics, serum ferritin levels, chelation therapy adherence, transfusion schedules, and clinical outcomes among the 75 enrolled patients.

Table 1: Demographic Characteristics of Patients

Patients' Characteristics	Mean ± SD	Range	Percentage (%)
Age (in years)	7.696 ± 2.3	2-12	100%
Male	42		56%
Female	33		44%
Weight (kg)	20.35 ± 6.95	11.7-40.0	
Height (cm)	116.57 ± 15.55	82-145	
Age at first BT (months)	31.79 ± 18.66	7-60	
Unit of BT	52.48 ± 23.90	10-120	
Age of start chelation (months)	55.156 ± 22.913	12-90	
Serum Ferritin (ng/ml)	3638.74 ± 2567.79	1130-10305	
Hemoglobin (gm/dl)	7.204 ± 1.563	3.6-10.6	

The mean age of the patients was 7.696 ± 2.3 years. There was a slightly higher number of male patients (56%) compared to females (44%). The mean age at the first blood transfusion was 31.79 ± 18.66 months. The pre-transfusion

hemoglobin level was low (7.204 ± 1.563 gm/dl), and the mean serum ferritin level was elevated (3638.74 ± 2567.79 ng/ml), indicating significant iron overload in these patients.

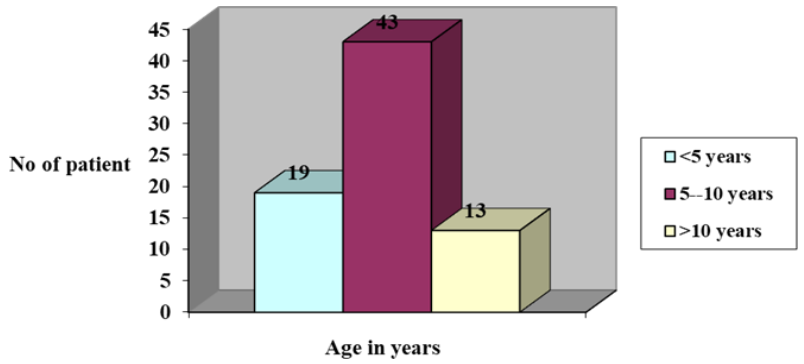

Figure 1: Distribution of Age of Patients

The age distribution shows that the majority of patients (57.33%) were in the 5-10 years age group, followed by 25.33% in the <5 years group and 17.33% in the >10 years group. This is consistent with the typical presentation of thalassemia, where symptoms often manifest at an early age.

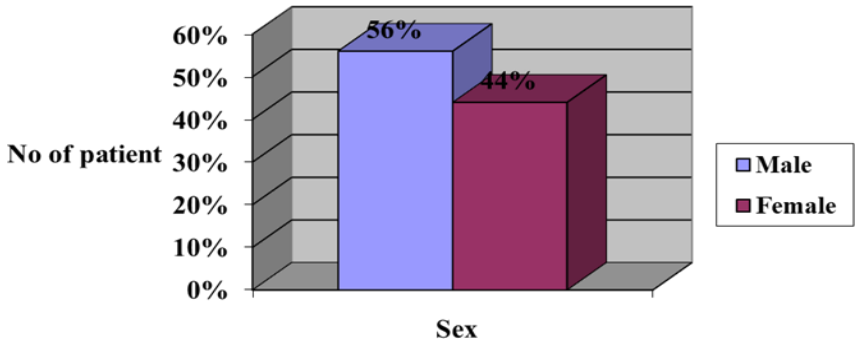

Figure 2: Distribution of Sex of Patients

The bar diagram shows that 56% patients are male and females are 44%. The males are more.

Table 2: Family History of Thalassemia with Socioeconomic Condition

Family History	Number	Percentage (%)
No family history of thalassemia	67	89.33
Family history of thalassemia	8	10.67
Socioeconomic Condition		
Low/poor	24	32.00
Middle class	37	49.33
Rich	14	18.67
Total	75	100.00

The study found that 89.33% of the patients had no family history of thalassemia, while 10.67% had a positive family history. This indicates that thalassemia often occurs sporadically, and carrier screening and genetic counseling are essential to reduce the incidence of affected births. The majority of patients (49.33%) were

from middle-class families, followed by 32% from low-income families and 18.67% from affluent families. This suggests that thalassemia affects a broad socioeconomic spectrum, although it is more common among middle- and low-income households.

Table 3: Interval of Blood Transfusion

Interval in Weeks	Number	Percentage (%)
3-4	19	25.33
5-6	53	70.67
7-8	3	4.00
Total	75	100.00

The majority of patients (70.67%) received blood transfusions every 5-6 weeks, while 25.33% received transfusions at 3-4-week intervals. A small percentage (4.00%) had transfusions every 7-8 weeks, indicating that most patients were not adhering to regular transfusion schedules.

Table 4: Frequency Distribution of Chelation Therapy Use

Type of Chelation	Frequency	Percentage (%)
No chelation	56	74.67
Regular use of chelation	7	9.33
Irregular use of chelation	12	16.00
Total	75	100.00

A significant majority of patients (74.67%) did not use any form of chelation therapy, while 9.33% used chelation regularly, and 16.00% used it irregularly. This low adherence to chelation therapy is concerning, given the high risk of iron overload and associated complications.

Table 5: Relation of Anemia (Hb) Status with Serum Ferritin

Hb (gm/dl)	Number	Mean Serum Ferritin (ng/ml)	P-Value
> 9.5	8	2857.73	0.05
7-9.5	37	3359.84	
< 7	30	4251.17	
Total	75		

This table demonstrates that patients with lower hemoglobin levels (<7 gm/dl) had significantly higher serum ferritin levels (4251.17 ng/ml) compared to those with higher Hb levels (>9.5 gm/dl). The p-value of 0.05 indicates a statistically significant relationship between low Hb and high serum ferritin.

Table 6: Relation of Hemoglobin with Facial Dysmorphism

Facial Dysmorphism	Number	Hemoglobin (gm/dl)	P-Value
Present	37	6.32	0.03
Absent	38	7.43	
Total	75		

Patients with facial dysmorphism had significantly lower hemoglobin levels (6.32 gm/dl) compared to those without facial dysmorphism (7.43 gm/dl), with a p-value of 0.03, indicating a statistically significant association between facial dysmorphism and low hemoglobin.

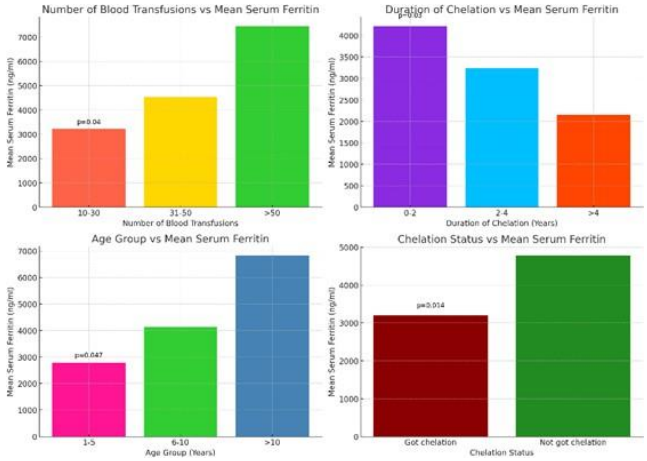

Figure 3: Association Between Clinical Variables and Serum Ferritin Levels in Transfusion-Dependent Thalassemia Patients

As the number of blood transfusions increased, so did the serum ferritin level, with patients who received more than 50 transfusions having significantly higher serum ferritin levels (7460.00 ng/ml) compared to those who received fewer transfusions. The p-value of 0.040 indicates a statistically significant correlation. Patients who received longer durations of chelation therapy (>4 years) had significantly lower serum ferritin levels (2151.46 ng/ml) compared to those who received shorter durations of chelation therapy. The p-value of 0.03 indicates that longer chelation duration is associated with better management of iron overload. Serum ferritin levels were significantly higher in older children, with patients in the >10 years group having a mean level of 6836.77 ng/ml, compared to 4138.45 ng/ml in the 6-10 years group and 2790.11 ng/ml in the 1-5 years group. The p-value of 0.047 indicates a statistically significant relationship between age and iron overload.

Table 7: Relation of Serum Ferritin with Chelation

Chelation Status	Number of Patients	Mean Serum Ferritin (ng/ml)	P-Value
Got chelation	19	3208.34	0.014
Not got chelation	56	4788.79	
Total	75		

Patients who received chelation therapy had significantly lower serum ferritin levels (3208.34 ng/ml) compared to those who did not receive chelation (4788.79 ng/ml). The p-value of 0.014 indicates a statistically significant difference in ferritin levels between those who received chelation and those who did not.

DISCUSSION

The study enrolled 75 transfusion-dependent thalassemia patients with a mean age of 7.696 ± 2.3 years. The distribution of age was similar to studies conducted in other parts of Bangladesh and India, where the majority of patients were under 10 years of age. For instance, a study at Bangabandhu Sheikh Mujib Medical University (BSMMU) found a similar age range, with a mean age of 7.5 years, and another study in Chittagong noted that the median age of diagnosis was around 6 years. This is consistent with the fact that thalassemia often manifests in early childhood, with symptoms becoming more pronounced after the age of 2 [11]. Our study found that most respondents (57.33%) were in the 5-10 years age group, highlighting the early onset and chronic nature of the disease. In terms of gender distribution, this study showed a slight male predominance (56%), which is consistent with other studies in the region. For example, a study in Egypt reported a male predominance of 62.6%, and studies in Pakistan also show a higher percentage of male thalassemia patients. However, the differences in gender distribution across various studies are often not statistically significant, as noted in a study from Chittagong, where male and female predominance was found to be statistically insignificant ($p > 0.05$) [12].

Family History and Socioeconomic Status

This study found that 89.33% of patients had no family history of thalassemia, with only 10.67% having a positive family history. The absence of a family history in the majority of cases highlights the importance of carrier screening and genetic counseling, as thalassemia is an autosomal recessive disorder. In the present study, the low percentage of patients with consanguineous parental marriages (14.67%) also indicates the importance of genetic counseling in preventing the birth of affected children. A similar study in Jammu and Kashmir, India, showed a higher prevalence of positive family history (44.4%) in Muslim communities, suggesting cultural and regional differences in thalassemia inheritance patterns. The study also noted a higher prevalence of consanguinity in thalassemia patients, which is consistent with other findings from South Asia, where consanguineous marriages are more common [13]. Regarding socioeconomic status, most of the patients in this study were from middle-class families (49.33%), followed by low-income families (32%) and affluent families (18.67%). This distribution reflects a pattern seen in other studies in South Asia, where thalassemia is most prevalent in middle- and low-income groups. A study in Bangladesh showed no significant relationship between socioeconomic status and thalassemia incidence, further emphasizing the widespread impact of this disease across various economic strata [14].

Transfusion Requirements and Pre-transfusion Hemoglobin Levels

In our study, the pre-transfusion hemoglobin level was 7.204 ± 1.563 gm/dl, which is considered low. A significant percentage (49.33%) of patients were moderately anemic, with hemoglobin levels between 7-9 gm/dl. This is consistent with studies from India, where patients with thalassemia major commonly present with hemoglobin levels below 8 gm/dl. A study conducted in Western India found that 53.5% of thalassemia patients had a hemoglobin level of less than 10 gm/dl, indicating a similar severity of anemia in transfusion-dependent thalassemia patients [15]. The need for regular blood transfusions is evident in our study, where the mean number of blood transfusions was 52.48 ± 23.90 units per patient. The mean age of first blood transfusion in our study was 31.79 ± 18.66 months, which is similar to findings from a study in India, where transfusion was typically initiated between 2 and 3 years of age. Early initiation of blood transfusions is crucial in managing the complications of thalassemia, as delayed transfusion therapy can lead to severe anemia, growth retardation, and organ damage. However, in our study, only 25.33% of patients were receiving regular transfusions, suggesting that many patients were not following the recommended transfusion schedule. This is a concern, as irregular transfusions may lead to an increase in iron overload and worsen clinical outcomes [16].

Clinical Manifestations: Growth, Dysmorphism, and Organ Involvement

In terms of clinical manifestations, the study found that facial dysmorphism was present in 49.33% of patients, and 54.67% exhibited stunting. These findings align with those from a study in Bihar and UP, India, where 52% of thalassemia patients showed facial dysmorphism and stunting. This is a common feature of thalassemia due to chronic anemia and bone marrow expansion, which affects bone development and growth. Hepatomegaly and splenomegaly were observed in 85.33% and 85.34% of patients, respectively. These findings are consistent with the results of a study conducted in Egypt, where 74% of thalassemia patients had splenomegaly and 65% had hepatomegaly. The presence of these symptoms is indicative of the compensatory mechanisms in the body in response to chronic anemia and ineffective erythropoiesis [17].

Iron Overload and Chelation Therapy

Iron overload remains one of the most critical complications in transfusion-dependent thalassemia patients. In this study, the mean serum ferritin level was 3638.74 ± 2567.79 ng/ml, which is significantly higher than the normal range. A study in India reported similar results, with a mean serum ferritin level of 3112 ng/ml in transfusion-dependent thalassemia patients. This high level of ferritin indicates severe iron overload, which is a consequence of regular blood transfusions and the inability of the body to excrete excess iron. Iron accumulation in organs such as the heart, liver, and endocrine glands can lead to organ dysfunction and failure if not properly managed. Despite the high prevalence of iron overload, our study found that 74.67% of patients did not use any form of chelation therapy, and only 9.33% used chelation therapy regularly. This finding is concerning, as inadequate chelation therapy is associated with a higher risk of iron-induced organ

damage. A similar study in Western India found that 67% of patients were receiving chelation therapy, but only 2% of them had adequate chelation (serum ferritin <1000 ng/ml). This highlights the gap in treatment adherence and the need for better patient education and healthcare management to ensure that patients receive appropriate and consistent chelation therapy [18].

Relationship Between Serum Ferritin and Clinical Outcomes

Our study also examined the relationship between serum ferritin levels and various clinical parameters, including hemoglobin levels, facial dysmorphism, and the number of transfusions received. Table 6 shows that patients with lower hemoglobin levels (<7 gm/dl) had significantly higher serum ferritin levels (4251.17 ng/ml) compared to those with higher hemoglobin levels (>9.5 gm/dl). This finding is consistent with studies that have demonstrated a positive correlation between the severity of anemia and the degree of iron overload in thalassemia patients. Additionally, facial dysmorphism was found to be associated with lower hemoglobin levels, further supporting the notion that more severe anemia leads to more pronounced physical deformities [19]. Furthermore, Table 8 shows that patients who had received more than 50 transfusions had significantly higher serum ferritin levels (7460 ng/ml) compared to those who received fewer transfusions (3225.53 ng/ml). This is consistent with the known relationship between the number of blood transfusions and the accumulation of iron in the body. A study in India reported similar findings, where patients with a higher number of transfusions had significantly higher serum ferritin levels, further emphasizing the importance of managing iron overload through effective chelation therapy [20].

Iron Chelation Therapy: Efficacy and Adherence

The study revealed a critical issue regarding the adherence to iron chelation therapy, with only 9.33% of patients using it regularly. This low adherence to therapy is concerning, as it can lead to severe iron overload and the associated risks of organ damage. A study in Western India found that only 2% of thalassemia patients on chelation therapy had adequate control of iron overload, as indicated by their serum ferritin levels. Non-compliance with chelation therapy is a known barrier to optimal management in thalassemia patients, and improving adherence is essential to prevent long-term complications such as heart failure, liver cirrhosis, and endocrine disorders. In this study, patients who received chelation had significantly lower serum ferritin levels compared to those who did not receive chelation. This highlights the importance of regular and effective chelation therapy in managing iron overload and preventing the toxic effects of excess iron in the body. However, the fact that a majority of patients are not adhering to the prescribed chelation regimen underscores the need for better healthcare education and patient support programs to improve treatment compliance and outcomes [21].

CONCLUSION

This study revealed that many transfusion-dependent thalassemia patients at Rajshahi Medical College Hospital do not receive blood transfusions regularly, leading to suboptimal pre-transfusion hemoglobin levels. Moreover, most patients do not adhere to recommended iron chelation therapy, despite having elevated serum ferritin levels. For those who do undergo chelation, it is often started late and used irregularly. These findings underscore the need for consistent monitoring, early intervention, and improved adherence to transfusion and chelation protocols to prevent long-term complications and improve patient outcomes.

Recommendations

Maintain pre-transfusion hemoglobin levels above the recommended threshold for better quality of life.

Initiate regular and early iron chelation therapy for all transfusion-dependent thalassemia patients.

Regularly monitor hemoglobin and serum ferritin levels for effective management.

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