RESEARCH ARTICLE

Evaluation of Patients with Hemophilia in Nineveh Governorate

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Ann Coll Med Mosul 2026; 48 (1):43-52.
Received: 31th Dec. 2025; Revised: 20th April 2026; Accepted: 11th May 2026.

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DOI: 10.33899/acmm.v48.i1.60338

ABSTRACT

Background: Hemophilia is the most common significant hereditary bleeding disease, resulting from a deficiency in clotting factor VIII (Hemophilia A) or factor IX (Hemophilia B). Deficiency of these coagulation factors will lead to prolonged bleeding. Hemophilia A is the most common type. Hemophilia is classified according to the coagulation factor level into mild, moderate, and severe disease.

Aims: To evaluate the clinical and laboratory characteristics of patients registered with hemophilia in the Nineveh hemophilia database, focusing on a representative cohort of 100 individuals.

Patients and methods: This study is a cross-sectional study, carried out in Nineveh governorate at Ibn-Sina Teaching Hospital and Al-Hadbaa Specialized Hospital between January and October 2025. As of 2025, there are 305 patients registered with hemophilia in Nineveh governorate, according to the National Hemophilia Registry. From this population, a cohort of 100 patients was recruited for detailed clinical and laboratory analysis. These patients underwent investigations that encompassed: complete blood count, coagulation study, which includes prothrombin time (PT), activated partial thromboplastin time (APTT), mixing study, factor assay, and Bethesda assay in addition to viral screen.

Results: Among the 100 hemophilia patients, hemophilia A patients form the majority (95%). The mean age (±SD) of enrolled patients was 14.74 (± 11.914) years. The first clinical presentation is bleeding, mostly after circumcision, while hemarthrosis was the most commonly encountered presentation throughout the course of the disease. The association between clinical characteristics and disease severity shows a significant statistical difference concerning the gum bleeding (P-value=0.018) and epistaxis (P-value=0.020). Patients having positive inhibitors form 15% of enrolled patients.

Conclusion: Our findings highlight a high prevalence of moderate hemophilia and joint morbidity in Nineveh, necessitating a dual strategy of standardized neonatal screening and home-infusion programs to bridge the gap between clinical intent and functional outcomes.

Keywords: Hemophilia A, hemophilia B, hemarthrosis, inhibitor.

INTRODUCTION

Hemophilia is an X-linked hereditary bleeding disease that results from a deficiency of blood clotting factors. Hemophilia A, resulting from a deficiency of coagulation factor VIII, and Hemophilia B, due to a deficiency of coagulation factor IX, both are the most common significant congenital bleeding disorders[1]. Hemophilia A (also known as Classic Hemophilia) is the second most common inherited bleeding disease after Von Willebrand disease (VWD) and the most prevalent type of hemophilia globally [2]. It is five times more prevalent than hemophilia B (also called Christmas disease) [2, 3]. Hemophilia A and B are the only hereditary bleeding disorders inherited as an X-linked pattern, with the affected gene situated on the long arm of the X chromosome [4]. Factor VIII (FVIII) is a crucial component of the coagulation cascade and plays a critical role in promoting and maintaining hemostasis following injury [5].

The successive activation of clotting factors, including zymogens and cofactors such as factor VIII (FVIII), drives the coagulation process and results in thrombin generation and fibrin clot formation [6].

Phenotypically, hemophilia patients are more likely to develop hemarthrosis (especially in the knee, ankle, and elbow joints), soft-tissue hematomas, bruising, retroperitoneal bleeding, intracerebral hemorrhage, and post-surgical bleeding [7]. These complications occur due to the reduced ability to form blood clots, making it harder for individuals with hemophilia to stop bleeding after injury or surgery [7]. The definition of a target joint varies, but it is typically one in which three or more spontaneous bleedings happen during a six-month period [8]. The most significant and difficult complication of replacement therapy using clotting factor concentrates in congenital hemophilia patients is the development of alloantibodies, also known as inhibitors.

These inhibitors reduce the effectiveness of treatment and make management more difficult by targeting and neutralizing the activity of the clotting factors implicated in the propagation phase of blood clotting, such as factor VIII (FVIII) in hemophilia A and factor IX (FIX) in hemophilia B [9]. Hemostasis is required to be evaluated using screening tests such as complete blood cell count, activated partial thromboplastin time (APTT), thrombin time (TT), prothrombin time (PT), and VWF:Ag assays. Prolonged APTT with normal PT and bleeding time is indicative of coagulation disorders, including hemophilia [10]. A prolonged screening test should be followed by an assessment of clotting factors to not only establish the definite diagnosis, but also to assess the severity of the condition and assist in monitoring replacement therapy [11]. Hemophilia can be treated by two regimes of therapy: Prophylaxis and on-demand replacement therapy. Prophylaxis is the administration of factor concentrates to avoid bleeding and joint damage, with the goal of preserving normal musculoskeletal function [12]. On-demand (or episodic) treatment includes infusing the deficient clotting factor during a bleeding episode to control hemorrhage [13]. Currently, recombinant factor therapy is the standard therapy in developed countries for severe Hemophilia A and Hemophilia B patients. This method has resulted in a significant increase in the quality of life for patients, notably by maintaining their normal musculoskeletal and joint function and decreasing the number of bleeding episodes and long-term consequences[14]. The formation of persistent inhibitory antibodies to factor VIII is a significant and costly complication of replacement therapy occurring in hemophilia patients, those hemophilia patients with inhibitory antibodies are mainly treated with bypassing agents (BPAs)[15], Immune tolerance induction (ITI) [16], and Emicizumab, which is a humanized bispecific monoclonal antibody that binds to and bridges factor X (FX) and activated factor IX (FIXa), essentially replacing the missing function of activated factor VIII (FVIII) [17]. While BPAs are FEIBA (factor VIII inhibitor-bypassing activity), an activated prothrombin complex concentrate (aPCC), and recombinant factor VIIa (rFVIIa), these agents are capable of bypassing the factor VIII–dependent step in the clotting cascade and enhance hemostasis by promoting thrombin generation [15]. In Nineveh governorate, there are many patients registered with hemophilia, but due to the post-war conditions, some data are lost or disrupted, so this study is essential now to establish a baseline for current healthcare needs.

This research aims to evaluate the clinical and laboratory characteristics of patients registered with hemophilia in the Nineveh hemophilia database, focusing on a representative cohort of 100 individuals.

PATIENTS AND METHODS

This cross-sectional study was executed in Nineveh governorate at Ibn-Sina Teaching Hospital and Al-Hadbaa Specialized Hospital between January 2025 and October 2025. As of 2025, there are 305 patients registered with hemophilia in Nineveh governorate, according to the National Hemophilia Registry. From this population, a cohort of 100 patients was recruited for detailed clinical and laboratory analysis.

Ethical Consideration

The Iraqi Board approved this study for Medical Specializations/ Scientific Council of Pathology by the Institutional Review Board – Research Project (Issue No. Path79, Date 31/10/2024) and by the Ministry of Health / Nineveh Health Department (Order NO.60245, Date 17/12/2024). The study was explained to all enrollers (also for the parents of pediatric patients), and verbal consents were obtained from all patients.

Clinical Assessment

A full history has been taken from all patients regarding the following: Patient's name, age, gender, age and site of first bleeding attack, family history of hemophilia or other bleeding disorders, clinical symptoms, and any recent attack of bleeding.

Inclusion Criteria

1. Patients diagnosed with hemophilia A or B based on clinical and laboratory evaluation.
2. All age groups.
3. Patients residing in Nineveh governorate.

Exclusion Criteria

Patients with Von Willebrand Disease or other bleeding diseases

Blood Sampling

Five milliliters (mls) of peripheral venous blood were collected from each patient using the venipuncture method. Two milliliters were transferred into a K3EDTA tube, gently inverted several times to ensure good mixing with the anticoagulant, and kept at room temperature to be used within one hour for complete blood count (CBC) analysis.

Another three milliliters are placed in a trisodium citrate tube, gently inverted several times to ensure mixing with the anticoagulant, then centrifuged for 15 minutes at 2000-2500g to separate plasma, to be used for PT, APTT, Mixing study, Factor assay, and Inhibitor assay.

Investigation

A fully automated hematology analyzer (Sysmex XN-350) is used to perform a CBC on all patient samples collected in EDTA tubes.

Coagulation tests

All investigations are carried out according to the standard procedures recommended by the manufacturer of each kit. These included

- PT: was performed manually using the BIO-TP kit from BIOLABO, France.
- APTT: was performed using the C.K. PREST kit (DAGNOSTICA STAGO S.A.S, France).
- One-stage assay of factor VIII: was performed using the STA-DEFICIENT VIII kit from DAGNOSTICA STAGO S.A.S, France.
- One-stage assay of factor IX was performed using the STA-DEFICIENT IX kit from DAGNOSTICA STAGO S.A.S, France.
- Bethesda assay was performed using STA-DEFICIENT VIII from DAGNOSTICA STAGO S.A.S. and included patients with recurrent bleeding episodes with no response to recombinant VIII treatment.

Viral Screen

This test was performed using Hepatitis B Surface Antigen (HBsAg), Hepatitis C Virus (HCV), Human Immunodeficiency Virus (HIV)/acquired immunodeficiency syndrome (AIDS) Rapid Test kit from Hightop, Biotech, China.

Statistical analysis

The statistical analysis was carried out using IBM SPSS Statistics for Windows, version 26.0. Armonk, NY: IBM Corp. (2019). Categorical variables were summarized as frequencies and percentages, while continuous variables were summarized as Mean ± Standard Deviation (SD). Chi-square test was utilized to evaluate the association between main clinical features and disease severity, as well as to determine the distribution of age at first presentation. Spearman's rho correlation was performed to evaluate the correlation between age at first presentation and target joint involvement. Kruskal-Wallis H test; post-hoc Dunn's test with Bonferroni correction were performed to compare hematological parameters across the three disease severity categories (Mild, Moderate, and Severe).

P-values < 0.05 were regarded as statistically significant.

RESULTS

In this study, 100 hemophilia patients were enrolled, 95 patients (95%) diagnosed with hemophilia A and 5 patients (5%) with hemophilia B. The age of patients ranges from 2 to 48 years, with a mean age of 14.74 ± 11.9 years. All patients in this study were males. The demographic data of patients included in this study are shown in Table **1**.

Table 1.
Demographic data of enrolled patients

Variable	Group	No. (%)
Age (Years)	1-10	39 (39.00)
	11-20	36 (36.00)
	21-30	13 (13.00)
	31-40	6 (6.00)
	41-50	6 (6.00)
Family history	Positive	63 (63.00)
	Negative	37 (37.00)
Consanguineous marriage	Present	64 (64.00)
	Absent	36 (36.00)

The patients' age at the first clinical presentation ranges from at birth to 13 years with a mean age of 1.717 ± 2.894 years (20.6 ±34.72 months). The age of first clinical presentation is significantly seen in the age of <1 year, with a P-value of 0.000 as shown in Table 2.

Table 2.
Age of first clinical presentation of enrolled patients

Age of first clinical presentation (Year)	No. (%)	P-value*
< 1	56 (56.00)	0.000*
1 – 10	40 (40.00)	
10 – 20	4 (4.00)	
Total	100 (100.00)	

***** Chi-Square test. P-value<0.05 is regarded statistically significant

The first clinical presentation of these patients was bleeding, mostly after circumcision, which occurred in 40 patients (40%), followed by umbilical cord bleeding and ecchymosis, while the lowest presentation was musculoskeletal bleeding, as shown in Table **3**

Table 3.
First clinical presentation of enrolled hemophilia patients

Clinical presentation	No. (%)
Circumcision	40 (40.00)
Umbilical cord bleeding	15 (15.00)
Ecchymosis	14 (14.00)
Post-trauma or surgery	13 (13.00)
Gum bleeding	8 (8.00)
Epistaxis	7 (7.00)
Musculoskeletal bleeding	3 (3.00)
Total	100 (100.00)

Disease severity ranges from mild, moderate, to severe disease, according to the coagulation factor level, with levels <1%, 1-5%, and >5% for severe, moderate, and mild disease, respectively. In this research, nearly half of the patients have moderate severity, with 48 patients,

forming 48%. The association between the main clinical features experienced by the enrolled patients throughout the disease course and the severity of the disease classified according to the coagulation factor level is illustrated in Table 4. There is a significant statistical association between disease severity and the clinical features experienced by the enrolled patients, specifically gum bleeding (P-value=0.018) and epistaxis (P-value=0.020), with the higher frequencies were of moderate severity, representing 19.1% and 11.8% respectively. Hemarthrosis, Ecchymosis, Hemoptysis, Scalp hematoma, Muscle hematoma, and Eye-associated bleeding showed no significant statistical differences. Out of 59 patients with hemarthrosis, there are 42 patients with target joint involvement; 11of them (26.1%) had involvement of multiple joints, and the knee joint was the most repeatedly affected (83.3%), followed by the ankle (9.5%) and elbow (7.2%) joints.

From these 42 patients with target joint involvement, 21 patients (50%) experienced their first bleeding attack at the age of <1 year, with a non-significant direct correlation between age at first presentation and the target joint involvement (P-value = 0.051) as shown in Table 5. Association between different hematological parameters (Hb, WBC, Platelet, PT, APTT, Factor level) and the disease severity was demonstrated in Table **6**, which shows that patients with mild disease have significantly (P-value = 0.000) higher hemoglobin compared to those with moderate and severe disease. APTT becomes more prolonged as severity increases, moderate and severe groups have no significant differences, but both significantly differ from the mild group (P-value = 0.000). Moreover, the factor level decreases sharply from mild to moderate and severe groups; with each group being significantly different from the others (P-value = 0.000). WBC, platelets, and PT are not affected by hemophilia severity.

Table 4.
Association between main clinical features and the disease severity

Clinical features	Severity of the disease according to the factor level			P-value*
	Mild (>5-45%)	Moderate (1-5%)	Severe (<1%)	
	(n=23)	(n=48)	(n=29)	
	No. (%)	No. (%)	No. (%)	
Hemarthrosis (n=59)	12(44.4)	27(39.7)	20(54.1)	0.057
Gum bleeding (n=21)	5(18.5)	13(19.1)	3(8.1)	0.018
Muscle hematoma (n=17)	5(18.5)	7(10.3)	5(13.5)	0.467
Ecchymosis (n=14)	3(11.2)	6(8.8)	5(13.5)	0.607
Epistaxis (n=11)	2(7.4)	8(11.8)	1(2.7)	0.020
Scalp hematoma (n=6)	0(0.0)	5(7.4)	1(2.7)	0.102
Eye-associated bleeding (n=3)	0(0.0)	2(2.9)	1(2.7)	0.564
Hemoptysis (n=1)	0(0.0)	0(0.0)	1(2.7)	------

*Chi-square test. P-value < 0.05 is regarded statistically significant

Table 5
Correlation between age at first presentation and target joint involvement

Age at first presentation (Year)	No. of patients	Percentage %	Target joints' involvement only		R- value	P-value*
			No. of patients	Percentage %		
< 1	56	56.00	21	50.00	0.949	0.051
1 – 10	40	40.00	20	47.60		
10 – 20	4	4.00	1	2.40		
Total	100	100.00	42	100.00		

* Spearman's rho correlation. P-value < 0.05 is regarded statistically significant

Table 6
Association between different hematological parameters (Hb, WBC, Platelet, PT, APTT, Factor level) and the disease severity.

Hematological Parameters	Disease severity according to the factor level			P-value*
	Mild (>5-45%)	Moderate (1-5%)	Severe (<1%)	
	(n=23) Median (IQR)	(n=48) Median (IQR)	(n=29) Median (IQR)	
Hb g/dl	13.00 (10.9-13.6) A	10.6 (9.1-11.47) B	9.3 (7.95-10.15) B	0.000
WBC *10^9/L	7.9 (6.5-8.7)	8.25 (6.72-9.52)	7.9 (6.7-9.75)	0.436
Platelet *10^9/L	375.0 (298.0-390.0)	366.50 (300.25-412.50)	367.0 (320.50-394.0)	0.583
PT (sec)	14.0 (13.0-15.0)	14.0 (13.0-15.0)	13.5 (13.0-14.0)	0.189
APTT (sec)	57.0 (52.0-69.0) A	81.5 (63.25-90.0) B	94.0 (72.0-101.5) B	0.000
Factor level (%)	9.0 (7.0-17.0) A	2.0 (1.22-3.15) B	0.7 (0.5-0.8) C	0.000

* Kruskal-Wallis H test; post-hoc Dunn's test with Bonferroni correction. Different letters (A, B, C) show significant differences between severity groups ($p<0.05$). Values are displayed as Median (Interquartile Range). Interquartile Range represent 25th–75th Percentile.
P-value < 0.05 is regarded statistically significant

A statistically significant negative correlation (P-value=0.005) was found between FVIII level and APTT; APTT prolongs as FVIII level decreases, and so increases severity of hemophilia A. (Fig 1). The relationship between FIX level and APTT was also inversely proportional, although not statistically significant (P-value = 0.178), as APTT increases with decreasing level of FIX, and so increasing severity of hemophilia B, as shown in Fig 2. The incidence of chronic viral infection among enrolled patients is 3%, and all of them are of hepatitis C viral infection; there were no hepatitis B or HIV infections. Most patients receive prophylactic treatment (70%) while 30% receive treatment on demand. The regime and type of treatment received by patients with hemophilia included in this research are shown in Table **7**.

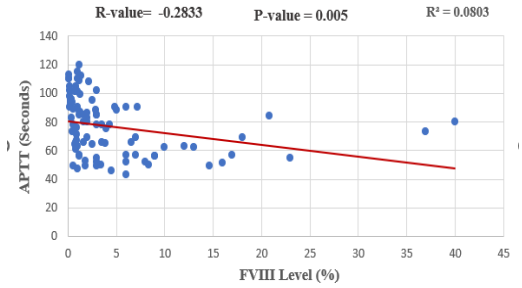

Fig 1. Correlation between FVIII level and APTT

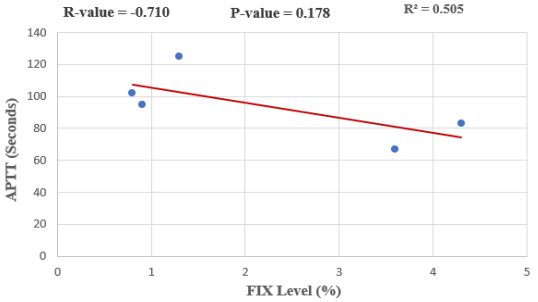

Fig 2. Correlation between FIX level and APTT

Table 7
Regime and type of treatment received by hemophilia patients

Type of hemophilia	Regime of treatment		Type of treatment			
	On demand No. (%)	Prophylaxis No. (%)	Recombinant factor only No. (%)	Recombinant factor and cryoprecipitate No. (%)	Recombinant factor & FFP No. (%)	Emicizumab No. (%)
Hemophilia A	29 (29.0)	66 (66.0)	57 (57.0)	12 (12.0)	11 (11.0)	15 (15.0)
Hemophilia B	1(1.0)	4 (4.0)	4 (4.0)	0 (0.0)	1 (1.0)	0 (0.0)
Total	30 (30.0)	70 (70.0)	61 (61.0)	12 (12.0)	12 (12.0)	15 (15.0)

Recombinant clotting factor was administered to 61% (57% of HA and 4% of HB) of patients as the primary treatment modality. The remaining patients required adjunctive therapy with cryoprecipitate or fresh frozen plasma (FFP) in addition to factor replacement. Among enrolled patients, inhibitors to factor VIII were identified in 15 patients (15%), all of them with hemophilia A. But, notably, no inhibitors were observed among patients with hemophilia B.

DISCUSSION

By evaluating 100 patients with hemophilia, this study provides a valuable understanding of the epidemiological profiles, clinical characteristics, treatment evaluation, and complications of patients with hemophilia in Nineveh governorate. Among the enrolled patients, there are 95 hemophilia A patients (95%) and 5 hemophilia B patients (5%). Other studies [18,21] reported comparable results, confirming the predominance of hemophilia A. The mean age (± SD) of these patients was 14.74 (±11.914) years. This is comparable to other national studies [18, 22], while it's lower than that observed in other studies [23] in which the mean age is 27.85 (±1.65) years. In concordance with our results, other research [22], reported that the highest age group was 1-10 years, but disagrees with other studies [24, 25], in which the highest age group is >10 years. These discrepancies in age distributions and the relative rarity of elderly hemophiliacs in our locality can be related to the fact that many mild cases remain undiagnosed, while many others with severe disorders die early as a result of inadequate therapy [26]. Due to the X-linked recessive inheritance of the disease, all patients in this study were males, which is concordant with other regional and national researches [23, 25, 27], but it disagrees with other research [19] in which a small percentage of patients were females (1.8%), such rare instances are due to homozygosity (two identical hemophilia alleles) in a female, which most commonly happens due to cousin marriage in a hemophilia family, when the father is having hemophilia and the mother being a heterozygote by inheritance [19].

Because hemophilia is a hereditary disorder, the majority of our patients presented with a positive family history (63%); these results are comparable to several other studies [19, 22, 25]. The presence of patients with no family history (37%) can be attributed to many causes, such as spontaneous de novo mutations, silent carriers, mosaicism, and undiagnosed previous generations [25].

The observed 64% percentage of consanguinity in this study is comparable with other research [29], though it exceeds the 50.2% to 55.5% range identified in other Iraqi governorates [18, 19]. From a clinical perspective, consanguinity does not inherently increase the incidence of X-linked disorders, but it creates 'carrier-dense' groups. This clustering complicates genetic counseling by increasing the likelihood of multiple affected siblings and asymptomatic female carriers within a single extended family, thereby placing a higher long-term socioeconomic and emotional burden on these family units [28, 30]. The mean age (±SD) of the first bleeding attack that led to the diagnosis in our study is 20.6 (±34.7) months. This is higher than the mean age of 4.4 (±24.2) months and 21.45 ± (6.59) months observed in other studies [18, 23], respectively. This variation might be caused by the wide range of patients' ages at diagnosis [18]. Our findings showed that more than half of the patients (56%) experienced their first clinical presentation, which led to the diagnosis of the disease within the first year of life. This is consistent with other regional and international studies [21, 27], but contrasts with other studies [24], which reported a later diagnostic window, with the higher percentage of patients (48.1%) being identified between the ages of 1 and 5 years. This variation can be caused by differences in the clinical severity of the cases studied, as severe hemophilia typically manifests earlier in life through neonatal complications or post-circumcision bleeding, whereas mild to moderate cases may remain undetected until the child becomes more physically active [20]. In agreement with several regional reports [19, 23, 24, 31], moderate deficiency is the most prevalent type. This distribution contrasts with other studies [18, 22, 27], where severe deficiency is the most common type. The increased percentage of patients having moderate

severity in our vicinity could be attributable to the type of FVIII mutations causing the disease or some unidentified modifier agents among people in the region [31]. This predominance of moderate deficiency also carries significant clinical implications. Unlike severe hemophilia, which is characterized by frequent spontaneous bleeds, moderate hemophilia typically manifests as bleeding following minor trauma or surgery. This shift in severity distribution influences our treatment strategy, moving from the intensive continuous prophylaxis required for severe cases toward a more tailored treatment approach. Clinically, this necessitates rigorous patient education on injury prevention and the implementation of 'on-demand' factor replacement protocols for minor traumas and surgical procedures to prevent long-term joint morbidity [12]. The most frequent first clinical presentation leading to diagnosis in this study was prolonged bleeding following circumcision, observed in 40% of patients. This is consistent with several other studies [20, 22, 24]. This is due to the fact that in Muslim countries, circumcision is a crucial ritual and one of the most common surgical procedures carried out in males, including those with hemophilia. Also, the high incidence of post-circumcision bleeding underscores the role of this procedure as a primary diagnostic indicator in our region, necessitating standardized hematological assessment for infants at risk [32]. Hemarthrosis is the most frequent sign of hemophilia [33], and is identified as the most common clinical manifestation in our study, arising in 59% of patients. This is comparable to the results observed in other researches [26, 33]. In this study, 42% of patients have target joint involvement, and there is a direct correlation between age at first presentation and target joint involvement (P-value=0.051). which align with the findings in another study [22], where a statistically significant direct correlation between age at initial presentation and target joint involvement (P-value=0.049) was established. Similar joint-related morbidity has been documented in other studies [18, 19].

The most frequently affected joint in our study is the knee joint (83.3%), which is comparable to several other researches [20, 31, 34]. This may be related to the fact that there is weight-bearing at the knees and ankles, so they bleed more frequently than the shoulders and hips, which are well supported [35]. The prevalence of hemarthrosis and target joint involvement highlights the clinical transition from acute bleeding to chronic arthropathy. This high burden of joint disease (particularly in weight-bearing joints like the knee) demonstrates that traditional on-demand therapy may be insufficient for our cohort [13]. These results advocate for a management shift toward early prophylaxis and specialized physiotherapy to mitigate the long-term risk of physical disability and improve overall functional outcomes [12]. Statistical analysis revealed a highly significant association between APTT and the disease severity (P-value=0.000). This finding is consistent with another study [36], in which the prolonged APTT is significantly associated with disease severity (P-value < 0.001). About chronic viral infection, 3% of patients in our study tested positive for hepatitis C infection, while no cases of hepatitis B or HIV infections were identified. These results align with findings from other reports [19], although some studies [22] have reported slightly higher rates of HCV (4.4%) and a minimal incidence of HIV (1.1%) infection; the absence of HBV remains a common finding across these studies. The clinical landscape of hemophilia management in this region is characterized by high levels of viral safety, likely driven by the integration of rigorous blood product screening and the increasing availability of recombinant factors. The low prevalence of HCV may be attributed to previous periods of limited therapeutic factor concentrates, leading to exposure to blood and plasma-derived products during therapy. Conversely, the total absence of HBV cases could be related to the availability of the Hepatitis B vaccine. The low prevalence of HCV and the absence of HBV and HIV infections in our study provide a critical assessment of the safety of hemophilia management in our region. These results validate the efficacy of current blood product screening and the national HBV vaccination program. Clinically, the presence of HCV necessitates regular monitoring and access to modern antiviral therapies for the affected minority. Furthermore, these findings reinforce the necessity of prioritizing recombinant factor concentrates to entirely eliminate the risk of transfusion-transmitted infections and ensure long-term patient safety [37].

In this study, 70% of patients were prescribed prophylactic treatment, while 30% received on-demand therapy. This distribution aligns with recent global data [38], which indicates that prophylactic treatment has become the standard of care for 100% of pediatric patients and 20% of adults in Iraq. This represents a significant advancement from the 45% national average reported in 2016 [39], and places Nineveh prescription rates on parallel with emerging global trends in countries such as the United Kingdom (93% for pediatrics), Japan (95% for pediatrics), and Malaysia (80% for both age groups) [37].

However, our study contrasts with other reports [18, 21, 22], where on-demand therapy was the predominant treatment modality. The higher rate of enrollment in prophylactic protocols in our study compared to other studies likely reflects recent improvements in the national supply chain, clinical guidelines, and the availability of recombinant factor concentrates.

This also suggests an increased clinical intent toward prophylaxis; a significant challenge remains regarding functional adherence. Although 70% are officially enrolled in prophylactic protocols, a majority of these patients demonstrate suboptimal adherence. This

discrepancy is often driven by the high treatment burden of frequent infusions, which is further influenced by patients' perception of prophylaxis, acceptance, and symptoms, as well as their capability to perform prophylaxis, which is affected by understanding and skill [40].

In our study, 15% of hemophilia patients develop inhibitors. This is comparable to the studies in other Iraqi governorates [19, 22, 24].

However, these findings are slightly higher than the 21.8% reported in another study [21].

The prevalence of inhibitors is known to vary globally, a phenomenon that can be attributed to several intersecting factors. These include patient-specific variables such as genetic predispositions, ethnicity, and individual immune responses, as well as treatment-related factors including the type of the product used, intensity and duration of therapy, and the specific sensitivity of the diagnostic assays employed for inhibitor detection [21].

CONCLUSIONS

Our findings highlight a high prevalence of moderate hemophilia and joint morbidity in Nineveh, necessitating a dual strategy of standardized neonatal screening and home-infusion programs to bridge the gap between clinical intent and functional outcomes.

Acknowledgment

We would like to express our appreciation to the Hematology department in AL-Hadbaa Specialized Hospital and Ibn Sina Teaching Hospital for their help and support.

Conflict of Interest

No conflict of interests is declared.

Funding

The authors declare that no funds, grants, or other support were received during the preparation of this manuscript

Authors contribution

All authors have contributed substantially to this research, with individual contributions detailed below:
Abdulazeez ZS: Conceptualization, Data curation, Resources, Investigation, Writing - original draft.
Kashmoola MA: Visualization, Methodology, Validation, reviewing, and editing, Supervision.
All authors have read and approved the final version of the manuscript and take full responsibility for its content.

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