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Deferoxamine injection practice assessment and common administration errors among adult thalassaemia patients

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ABSTRACT

Background: Thalassaemia is a hereditary blood disorder characterised by defective globin chains, which results in haemolysis and impaired erythropoiesis. Routine blood transfusion is required, which may lead to iron overload in a long run. Deferoxamine (DFO) provides effective iron chelation in thalassaemia patients, however, challenges were faced among patients, especially in ensuring proper drug administration techniques. **Objective:** The study aim is to describe the current DFO administration practice, common administration errors, patient compliance towards iron chelation therapy and to identify factors associated with serum ferritin levels. **Methods:** A cross-sectional study among adult thalassaemia patients was done from January 2019 until November 2020. Patients were assessed for DFO injection practices and compliances. A DFO score was used to assess steps of dilution and administration of DFO, categorised as good (score 75-100%), satisfactory (score 60-74%), and fail (score <60%). Compliance was assessed using a validated 7-questions survey; a score of less than 27 marks dictated non-compliance. A multivariate linear regression was used to identify factors associated with high serum ferritin level (>1000 µg/L). **Results:** Twenty-four patients were included in the study. For administration practice, 79.2% were able to administer independently. Abdomen was the most favoured injection site and most patients administered DFO at night. Although 75% of the patients had a good DFO score, DFO administration errors persist. The compliance rate was low (29.2%), and majority reported more than 4 times per month of missed doses. Working status (4664.13, 95% CI 1609.41-7718.86, p=0.005) and frequent missed dose (1152.39, 95% CI 382.18-1922.6, p=0.005) were identified as factors associated with serum ferritin level, controlling for other factors. **Conclusion:** DFO administration errors persist among thalassaemia patients. Patients who are working and non-compliant were identified to be associated with high serum ferritin level. Effective counselling method may be needed to properly educate patients on DFO administration and improve patients' compliance.

INTRODUCTION

Thalassaemia is a hereditary blood disorder characterised by defective synthesis of globin chains, namely α and β globin chains which function as oxygen carrier in the haemoglobin [1]. The absence of haemoglobin subunit α or β synthesis will cause imbalance of the globin chains which results in haemolysis and impaired erythropoiesis [2]. Approximately 240 million people worldwide who are detected as β-thalassaemia heterozygous and approximately 200,000 people are annually born as homozygotes [3]. The highest prevalence of β-thalassaemia is reported in Cyprus, Sardinia, and Southeast Asia. It is also common in populations of Middle East, Central Asia, African heritage and Indian Subcontinent [4]. Lately, thalassaemia is also common in Europe, South America, North Central, and Australia due to worldwide migration [5]. Thalassaemia patients often req uire routine blood transfusion as part of mainstaytherapy in managing thalassaemia. Frequent

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transfusion subsequently may lead to iron overload due to gradual iron accumulation over the time, since the naturally occurring physiological mechanism of iron removal is impaired. Therefore, life-long treatment of iron chelation therapy is necessary in thalassaemia patient to prevent mortality and morbidity associated with iron accumulation in the body [6].

Iron overload causes devastating effects towards organ functions. Iron accumulation can be toxic to most of human tissues in the body and may cause complications such as cardiomyopathy, liver cirrhosis, stunted growth and endocrine abnormalities [7]. One of the means to monitor iron status is by measuring serum ferritin. Ferritin is a protein substance that encapsulates the iron stores in the body. However, serum ferritin is a non-specific marker, which can be elevated in various clinical conditions such as malignancy, iron overload, arthritis, and hemophagocytic lymphohistiocytosis [8]. In the absence of inflammation, the ferritin concentration is positively correlated with total iron stores [9].

Serum ferritin is relatively inexpensive and widely available in healthcare facilities, which makes it a preferred marker among clinicians to monitor iron stores. Several studies had demonstrated an association between serum ferritin level and clinical outcome. A study found that high serum ferritin was a significant predictor for cardiac mortality [10]. Another study found that serum ferritin of ≤1000 ng/mL was significantly associated with lower incidence of heart failure and prolonged survival [11]. A Cochrane review was reported on the accuracy of ferritin concentrations towards detection of iron deficiency and iron overload. The study concluded that blood ferritin concentration was reasonably sensitive in detecting iron deficiency, however for iron overload, it is very low certainty that high serum ferritin was sensitive for iron overload [12]. Nevertheless, serum ferritin is still relevant in the current practice, as suggested by recent study which mentioned that serum ferritin is a good predictor for hepatic iron overload in TDT [13].

Deferoxamine (DFO) is the oldest standard iron chelation therapy in managing iron overload. It is administered through subcutaneous or intravenous infusion, typically 8–12 hours per day for 5–7 days per week [14]. This medication works by protecting the cell from iron mediated toxicity in two ways which are through removal of excess iron as well as neutralization of free iron in the body. Long term chelation by DFO has proven to improve functional complication due to iron accumulation such as liver fibrosis, arrhythmias and abnormalities detected by echocardiogram. However, it might not be effective to reverse the complications due to extensive tissue damage, like frank diabetes, hypothyroidism and myocardial sclerosis [15]. Introduction of DFO has provide a longer and better quality of life of thalassaemia patients in comparison to few decades ago whereby patients died even before or during adolescence due to various complications. However, there are several limitations on DFO administration. The time-consuming nature of DFO administration has imposed several restrictions on patient's life including work, social activities, sleep, and emotional well-being especially in adult patient. This leads to suboptimal compliance which in turn increases risk of iron overload complications and poor prognosis [6, 16]. Furthermore, repeated daily administration of DFO may cause emotional burden as well as economic burden in patients who cannot afford such therapy.

Oral iron chelators such as Deferasirox (DFX) is expensive which causing accessibility issue [17]. DFX is one of the iron chelators that allows once daily administration, which is convenient to patients. A report showed that patients who received DFX had a significantly higher rate of compliance compared to those who were treated with DFO, however it was not shown to improve patient satisfaction [18]. There were several reports that prove the efficacy of DFX in reduction of serum ferritin, liver iron concentration (LIC) [19-22], as well as improvement in cardiac magnetic resonance imaging T2* (MRI T2*) [23]. However, the cost of drug remains a concern among healthcare professionals.

In clinical practice, DFO is self-administered at home. On the first encounter, patients were taught on subcutaneous injection technique, administration, and handling of DFO. Most of the thalassaemia patients, particularly those transfusion-dependent thalassaemia (TDT) was already started on DFO during childhood. As a result, they might be still dependent on their caretakers when they grew up. In thalassaemia clinic, patients were periodically assessed on the injection techniques to ensure proper administration of the medication. However, there is a paucity of information on how patients prepare and administer DFO at home, and some of the administration errors might not be encountered by the healthcare providers. Based upon our literature search, there are no studies that thoroughly describe DFO administration practice and identify common administration errors among thalassaemia patients. Some of the studies reported mainly on the compliance of DFO but did not elaborate specifically on the administration technique [14, 16, 24, 25]. Therefore, it is crucial to identify the current DFO self-administration practice among thalassaemia patients at home. Besides compliance, administration techniques are also important to ensure success of medication therapy. In this study, besides identifying the current DFO administration practices among thalassaemia patients and common errors made during administration have also been studied. In addition, patient compliance towards iron chelation therapy and factors associated with high serum ferritin levels were also investigated.

METHODS

Study Design

This is a cross-sectional study, including all adult thalassaemia patients using DFO as iron chelators from Thalassaemia Medication Adherence Clinic (TMTAC) in Hospital Tengku Ampuan Afzan (HTAA) Kuantan. Potential samples were screened using Pharmacy Information System (PhIS). Data were traced from January 2019 until November 2020 and a registry was generated from the system. Patients were identified during thalassaemia clinic follow-up.

We used Raosoft Sample Size Calculator for sample size calculation [26]. According to Malaysian Thalassaemia Registry Report, there were a total of 2084 patients who were on DFO therapy in Malaysia [27]. However, based on the registry in Pahang, only 95 patients were on DFO therapy [28]. With margin of error (E) set at 0.05 and response rate (r) set at 0.5, the minimum sample size of 77 is needed to represent the state. However, we did not perform a multicentre study, hence inadequate samples.

Purposive sampling method was used. This is a population study, all identified patients were included. After the initial screening, a total of 40 patients were included in the registry. All adult thalassaemia patients who were followed-up in adult thalassaemia clinic and prescribed with DFO from January 2019 until November 2020 were included. Patients who were not on DFO for more than 6 months and newly started DFO for less than a month were excluded. Data collection form was used to collect patient characteristics, details of DFO administration, and patient compliance assessment.

There were two main parts in the data collection. First part was patient characteristics, DFO injection practices and DFO dilution steps. The second part was a validated questionnaire for compliance assessment, adapted from Ramli et al. [29]. The interview session was conducted for 10-15 minutes. Informed consent was obtained from the patients. The interview of DFO administration practice at home was carried out according to the checklist in Thalassaemia Medication Adherence Clinic (TMTAC) Protocol, Ministry of Health (MOH) Malaysia.

Questions asked including drug dose, frequency, DFO injection independence, dilution of drugs, injection site, injection technique, needle handling, DFO machine settings, infusion duration and steps taken prior administration. DFO dilution steps was adapted from DFO administration guide by Northern California Comprehensive Thalassaemia Centre [30]. Patients were asked to describe on step-by-step approach in DFO administration, each of the correct step were given 1 mark. There were 15 steps in total, and total marks were calculated as percentages. The scores were defined as good (score 75-100%),

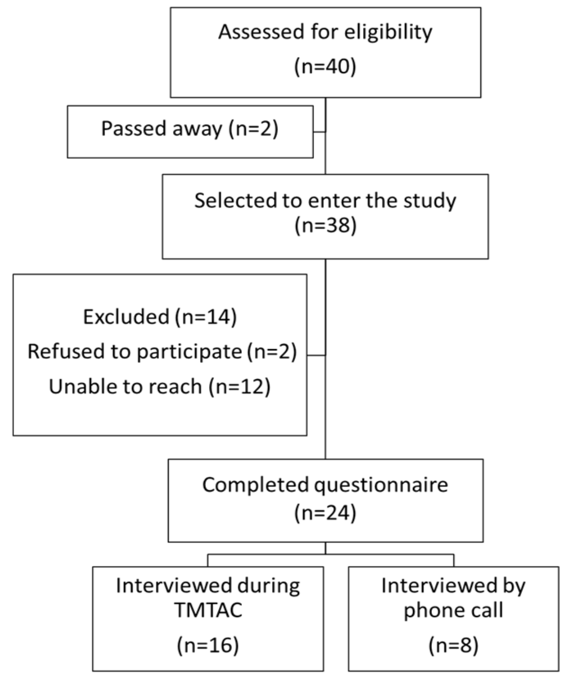

Figure I. Study Flow.

satisfactory (score 60-74%), and fail (score <60%). No validation was involved, as the guide was only for checklist purpose to assess patient's knowledge in DFO administration.

The second part was compliance assessment. For this part, a validated questionnaire consisting of seven questions was given, and patients were required to answer all seven questions. The questionnaire was validated in previous study, mentioning that it has good internal consistency and reliability [29]. Patient compliance was assessed based on the answers provided, and scores were calculated. Patients were considered compliant to medications when the compliance score obtained was at least 27 out of 28. For patients whose clinic appointment falls outside of data collection period, the session was completed through a phone call. Figure I outlined the flow of study.

Ethical Approval and Consent to Participate

This study had obtained ethical approval from the Head of Medical Department, the Hospital Director, and the National Medical Research and Ethics Committee (MREC) of the Ministry of Health (MOH) Malaysia. The study was conducted in compliance with ethical principles outlined in the Declaration of Helsinki and Malaysian Good Clinical Practice (GCP).

Statistical Analysis

The study data were analysed using the SPSS statistical software version 25. Descriptive statistics were used for demographic data. All categorical data were presented as

Table I. Patient demographic data. TDT, transfusion-dependent thalassaemia. [a]Mann-Whitney U test, [b]Fisher's Exact test.

Variables	Compliance		Statistical Test	p Value
	Yes (n=7)	No (n=17)		
Median age, years (IQR)	22 (21 to 43)	25 (23 to 28.5)	-0.383[a]	0.702
Gender, n (%)				
Male	2 (28.6)	6 (35.3)	0.101[b]	1.00
Female	5 (71.4)	11 (64.7)		
Median Weight, kg (IQR)	45.5 (41.25 to 49.75)	50.4 (45.5 to 57.4)	-1.508[a]	0.132
Working Status, n (%)				
Yes	2 (28.6)	8 (47.1)	0.697[b]	0.653
No	5 (71.4)	9 (52.9)		
Median Income, RM (IQR)	600 (0 to 2225)	600 (0 to 1875)	-0.25[a]	0.802
Education, n (%)				
Secondary and below	3 (42.9)	6 (40)	0.016[b]	1.00
Tertiary and above	4 (57.1)	9 (60)		
Diagnosis, n (%)				
B-Thalassaemia Major	1 (14.3)	4 (23.5)	2.262[b]	0.495
Hb E β-Thalassaemia	5 (71.4)	12 (70.6)		
HbH Constant Spring	1 (14.3)	0 (0)		
Splenectomy, n (%)				
Yes	5 (71.4)	10 (58.8)	2.246[b]	0.193
No	2 (28.6)	6 (35.5)		
TDT, n (%)				
Yes	7 (100)	15 (88.2)	0.457[b]	1.00
No	0 (0)	1 (5.9)		

Table II. Iron overload status and total iron chelators used. IQR, interquartile range; MRI T2*, magnetic resonance imaging T2*. aMann-Whitney U test, bFisher's Exact test, *significance at <0.05.

Variables	Compliance		Statistical Test	p Value
	Yes (n=7)	No (n=17)		
MRI T2* Heart, n (%)				
Normal	2 (28.6)	10 (58.8)		0.245
Moderate	0 (0)	0 (0)		
Severe	2 (28.6)	2 (11.8)		
MRI T2* Liver, n (%)				
Normal	2 (28.6)	1 (5.9)	0.782[b]	1.00
Moderate	2 (28.6)	6 (35.3)		
Severe	4 (57.1)	4 (23.5)		
Serum ferritin range, n (%)				
<1000 µg/L	3 (42.9)	4 (23.5)	2.03[b]	0.425
1000 – 2500 µg/L	2 (28.6)	3 (17.6)		
>2500 µg/L	2 (28.6)	10 (58.8)		
Median serum ferritin, mcg/L (IQR)	1358 (239.9 to 3361.4)	5244.3 (1929.55 to 8318.45)	-2.537[a]	0.011*
Number of iron chelators used, n (%)				
1	2 (28.6)	3 (17.6)	0.728[b]	0.816
2	4 (57.1)	11 (64.7)		
3	1 (14.3)	2 (11.8)		

frequencies and percentages, whereas continuous data were presented as median and interquartile range. Univariate analyses were performed using Mann-Whitney, Chi-square test and Fisher's exact test, as appropriate. Univariate linear regression was used to identify factors associated with high serum ferritin levels, and multivariate linear regression (MLR) was performed for significant variables. P values <0.05 were considered as statistically significant

RESULTS

Demographic Data

A total of 38 patients were identified. Out of 38 patients, only 24 were able to complete the study. Fourteen patients were excluded, 2 refused to join the study, and 12 were unreachable. Summary of demographic data is shown in Table I. Majority of patients were female (16, 66.7%), median age of 24.5 years old (interquartile range (IQR) 21 to 43). Most of the patients had tertiary education level (13, 54.2%), had median income of RM 600 per month (IQR 0 to 1625), and more than half were not working (14, 58.3%). The most common diagnosis was Hb E β-Thalassaemia (17, 80%), with half of the patients underwent splenectomy. Majority of the patients were transfusion dependent thalassaemia (TDT) (22, 91.7%). Sixteen percent had severe cardiac MRI T2*, and 8 (25%) had severe LIC. Half of the patients had serum ferritin of >2500 µg/L, with median serum ferritin of 3361.4 µg/L (IQR 1385.9 to 6214.55). Majority of the patients received at least 2 iron chelators (15, 72.75%). A significant difference was found in the median serum ferritin between compliant and non-compliant patients (U=15, z=-2.537, p=0.011). Summary of iron overload status and total iron chelators used are shown in Table II.

Deferoxamine Injection Practice

Median of mean daily dose (MDD) of DFO received by the patient per day was 18.63 mg/kg (IQR 11.7 to 47.5). In terms of DFO practice, most of the patients administered the drug independently (19, 79.2%) with more than half applied eutectic mixture of local anaesthetics (EMLA®) cream before injection (15, 62.5%). The most common injection site was abdomen (19, 79.2%), followed by arm (3, 12.5%) and outer thigh (2, 8.3%). Majority of the patients administered DFO at night (23, 95.8%). Most of them missed dose more than four times per month (10, 41.6%). Summary of DFO injection practice is as shown in Table III.

Common Administration Errors

Most of the patients made errors during administration of DFO (22, 91.7%). Common DFO practice errors found were divided into three parts which are dilution error, administration error and disposal error. Among these 3 errors, the most common error was dilution error (83.3%), followed by administration error and disposal error. Overall, 18 (75%) of the patients had good DFO score, however majority of the patients treated with DFO were non-compliant (17, 70.8%). These are the examples of dilution errors identified:

- Dilution of DFO with smaller amount of diluent which resulted in concentrated DFO solution and may cause irritation during infusion.
- Did not fully syringe out DFO solution from the vials, which cause inadequate dose administered.
- Administration of DFO without waiting for the drug powder to fully dissolve, which may cause precipitation.
- Wrong method of dilution: using one of the reconstituted DFO to dilute another vial, instead of using pure water for injection (WFI) to reconstitute all vials. This may lead to
- inaccurate measurements and incomplete dissolution of drug powder.

Table III. DFO injection practice and common administration errors. DFO, deferoxamine; EMLA, eutectic mixture of local anesthetics; IQR, interquartile range. [a]Mann-Whitney U test, [b]Fisher's Exact test.

Variables	Compliance		Statistical Test	p Value
	Yes (n=7)	No (n=17)		
Median MDD DFO, mg/kg/day (IQR)	18.63 (11.7 to 47.5)	19.9 (17.68 to 27)	0.000[a]	1.00
EMLA® cream application, n (%)				
Yes	4 (57.1)	11 (64.7)	0.974[b]	0.393
No	3 (42.9)	6 (35.3)		
Injection Site, n (%)				
Arm	0 (0)	3 (17.6)	1.774[b]	0.406
Abdomen	7 (100)	12 (70.6)		
Thigh	0 (0)	2 (11.8)		
Time setup, n (%)				
Morning	0 (0)	1 (5.9)	0.43[b]	1.00
Night	7 (100)	16 (94.1)		
Errors made, n (%)				
Yes	1 (14.3)	16 (94.1)	0.458[b]	0.507
No	6 (85.7)	1 (5.9)		
DFO score, n (%)				
Good	5 (71.4)	13 (76.5)	1.50[b]	0.587
Satisfactory	2 (28.6)	2 (11.8)		
Fail	0 (0)	2 (11.8)		

Factors Associated with Serum Ferritin Level

Univariate linear regression was performed on each variable to identify factors associated with serum ferritin level. Variables included were age, gender, working status, income, education level, MRI T2* liver, MRI T2* cardiac, number of iron chelators, injection site, and frequency of missed dose. Variables that showed a trend towards significance were selected for MLR which are working status, MRI T2* liver, injection site, and frequency of missed dose in a month. Compliance was not included for MLR due to its relationship with frequency of missed dose in a month. Summary of linear regression is shown in Table IV. MLR was done using stepwise method, and the results showed that MRI T2* liver and injection site were not statistically significant (p >0.05).

However, the results revealed that there was a statistically significant interaction between working status and frequency of missed dose. Result shows that 57.4% of the variance in serum ferritin can be accounted for by two predictors, F (2,11) = 9.773, p=.004. In this model, interaction was found between working and frequency of missed dose. The predicted serum ferritin is equal to 3475.48 + (1152.39 × frequency of missed dose) + (-5557.06 × working status) - 1637.28 (working status × frequency of missed dose), per one unit increase in each factor. No multicollinearity was found, and the final model met all the assumptions.

Table IV. Factors affecting serum ferritin level among adult thalassaemia patients. DFO, deferoxamine; CI, confidence interval; MDD, mean daily dose; MRI T2*, magnetic resonance imaging T2*; TDT, transfusion-dependent thalassaemia. [a]Method: Multivariate logistic regression, stepwise method, *variables that were included for multivariate linear regression.

Variables	Univariate Linear Regression			Multivariate Linear Regression		
	B	95% CI	p Value	B[a]	95% CI	p Value
Age	-28.37	-363.44 to 306.7	0.861	-	-	-
Gender	-1692.8	-6288.87 to 2903.27	0.450	-	-	-
Working Status						
Yes	5044.88	1365.2 to 8724.55	0.010*	4664.13	1609.41 to 7718.86	0.005
No						
Income	0.32	-1.078 to 1.722	0.629	-	-	-
Education				-	-	-
Primary	-6399.59	-14928.89 to 2129.71	0.131			
Secondary	-5700.93	-13487.08 to 2085.22	0.140			
Tertiary						
MRI T2* Cardiac				-	-	-
Normal	3083.85	-2992.97 to 9160.67	0.293			
Severe						
MRI T2* Liver				-	-	-
Normal	-15640.31	-21938.63 to -9341.99	<0.001*			
Moderate	-16986.56	-23491.44 to -10481.68	<0.001*			
Severe						
Number of Iron Chelators	538.226	-3060.5 to 4136.95	0.758	-	-	-
Injection Site				-	-	-
Arm	-8799.68	-15118.97 to -2480.39	0.009*			
Abdomen	-10332.05	-18785.44 to -1878.66	0.019*			
Thigh						
Frequency of missed dose in a month	1107.57	284.18 – 1930.95	0.011*	1021.51	341.84 to 1701.17	0.005

DISCUSSIONS

Median serum ferritin was 3361.4, which is more than usual target in most facilities that requires serum ferritin level to be less than 2500 µg/L. Half of the patient had serum ferritin level of more than 2500 µg/L. A study reported mean serum ferritin of 2767.52 µg/L, which is lower than our current findings [31]. Another study reported mean serum ferritin level of 4236.5 µg/L among thalassaemia major patients, which are expected to have higher levels than HbE β-thalassaemia [32].

The high median serum ferritin could be explained by its association with compliance status, as majority of the patients were non-compliant to iron chelation. As a result, 16.7% of the patients had severe cardiac iron overload, and 25% had severe liver iron overload, based on MRI T2* findings. These findings were correlated with high prevalence of non-compliance among the patients studied. A systematic review revealed that serum ferritin levels were achieved with increased adherence to iron chelators [33].

There were several benefits gained by achieving low level of serum ferritin. A report by Liu et al. mentioned that, those patients who had serum ferritin level of less than 2500 µg/L would have cardiac disease free survival outcome of 91% after 15 years of chelation with DFO, compared to patients who had serum ferritin of 2500 µg/L and above [34]. Another report showed lower serum ferritin of less than 1000 µg/L were significantly associated with reduction in heart failure event and prolonged survival [11].

Our findings showed a significant association between median serum ferritin and compliance status, whereby patients who had higher serum ferritin level were associated with non-compliance. This association can be explained by a direct effect of iron chelators in reducing iron burden, which is showed as reduction serum ferritin levels. Similar findings were demonstrated by other study which showed significantly higher serum ferritin level, cardiac and severe liver iron overload among non-adherent patients [24]. Although serum ferritin is not accurate to determine patient iron overload status and MRI T2* is preferred, it can be used as a surrogate marker to represent iron overload. A study showed that cardiac and hepatic MRI T2* had significant correlation with serum ferritin level [35]. This was supported by another study that demonstrated higher serum ferritin can predict the severity of cardiac and liver iron overload [36]. Another study also found that serum ferritin was highly predictive for hepatic iron overload and fairly predictive for myocardial iron overload [13].

In this study, we were unable to identify number of iron chelators as a predictive factor that may contribute to serum ferritin level, which is related to patient compliance. This finding is similar to results from Cochrane systematic review that was also unable to ascertain whether medication interventions such as DFX will have impact on adherence. It was also uncertain whether patients who received combination therapy would affect their compliance differently compared to monotherapy. There was only one trial in the review that reported combination of DFX plus DFO may improve adherence compared to combination of DFP plus DFO [25]. The review advocates for more real-world studies to investigate adherence issues, as the adherence in clinical trials may be contributed to increased attention and involvement of clinicians. Overall adherence reported in the systematic review was high, ranged from 70% to 100% [25]. In contrast, our study reported medication adherence rate of only 29.2%, which is very low.

In MLR analysis, working status and frequency of missed dose were identified as factors that were associated with serum ferritin level. Interaction was found between these two variables; this interaction can be explained by patients who are working tend to miss dose more frequently due to busy schedule, compared to those who did not work. A qualitative study had explored lack of integration of routine as one of the barriers towards medication adherence, whereby participants claimed that they were unable to inject DFO due to busy schedule [37]. This could also explain why patients still low compliance have despite having good knowledge on DFO administration.

We would like to highlight common administration errors among patients recruited. While performing the interview, a few of injection practices that were unexplored before was revealed, such as cleaning the needle with hot water to be used again for next administration, injecting DFO less than 45°, did not fully syringe out DFO solution from the vials, dilution for DFO which was too concentrated, and administered DFO without waiting for the drug to dissolve properly. The same qualitative study explored the barriers of medication adherence towards iron chelation therapy. Five barriers had been classified in the study: patient-related, medication-related, sociocultural-related, patient-provider relationship, and environmental context. For patient-related barriers, lack of knowledge was reported to be one of patient-related barriers, apart from negative attitude, negative emotion, and lack of integration into routine [37].

Having a good insight on the disease is very important to ensure that patient is aware on the complications of iron overload, hence will appreciate the value of medicine and adhere to them. In our results, although most of the patients made errors, they still had good insight on DFO injection. However, the compliance rate was low. Another study similarly found no correlation between disease knowledge and adherence to iron chelation therapy [24]. In contrast, another study found positive association between knowledge and treatment adherence [38]. There are a lot of other factors other than knowledge that were reported in previous studies, such as socioeconomic status, number of siblings who had thalassaemia, age, and thalassaemia complications [33]. Hence, we cannot deduce that patients who had good insight of the disease and medication will have greater compliance.

The limitations of this study mainly were small sample size, as we did not proceed with multicentre study. Furthermore, we were having limited face-to-face sessions due to postponement of clinic visits due to COVID-19 pandemic. Although we shifted the strategy to phone calls, it is more difficult to obtain data compared to face-to-face sessions. There were limited number of patients ongoing DFO therapy; some of them stopped taking a long time ago, and a few of the patients newly started on DFO. Most patients who refused to participate in the study were those who were contacted through phone calls. Furthermore, the self-reported compliance may be potential for recall bias among patients.

CONCLUSIONS

As a conclusion, DFO administration errors persist among thalassaemia patients. Dilution error was the most common error among thalassaemia patients. Although most of the patients had good DFO administration practice, the overall compliance rate was low. Patients who are working and non-compliance were identified to be associated with high serum ferritin level. Effective interventions such as support groups, educational interventions, are needed to improve DFO administration and patients' compliance. Further studies are needed to identify in depth about working status and non-compliance to medications.

CONFLICT OF INTEREST

None

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Not available.

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