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Review article

Practice of iron chelation therapy for transfusion-dependent thalassemia in Southeast Asia

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Background: Thalassemia is a common monogenic disease in Southeast Asia. Patients with transfusion-dependent thalassemia require frequent blood transfusions, which can lead to iron overload and subsequent organ dysfunction and damage. Iron overload is avoided by chelation therapy. There are 3 types of chelators available for iron chelation therapy, namely, desferrioxamine, deferiprone, and deferasirox. Although practical guidelines are available for the management of transfusion-dependent thalassemia, not all countries are able to provide "ideal" treatment for their patients.

Objectives: To discuss the scope of iron chelation practices including the types of chelators that are available in Southeast Asia, and explore issues relevant to the treatment of transfusion-dependent thalassemic patients in this region.

Methods: A literature search for information pertaining to thalassemia and its management from 2000 to 2015 was conducted using the following websites: PubMed/MEDLINE, Google Scholar, Scopus, and SpringerLink.

Results: Not all Southeast Asian countries have yet published detailed information about their iron chelation practice and not all countries in Southeast Asia have uniform practices for thalassemia management based on published recommendations.

Conclusions: Advances in treatment have improved the management of thalassemic patients. However, because of various issues, not all countries are able to provide an ideal treatment for their patients. Southeast Asian countries should work together to prevent this inherited disease.

Keywords: Iron chelation therapy, practice, Southeast Asia, thalassemia

Thalassemia is a monogenic disease [1, 2] which is common in Southeast Asia [3], Bangladesh, India, and the Mediterranean region [4]. Thalassemia can be treated by regular blood transfusion and iron chelation therapies [5]. About 55 million carriers of thalassemia live in Southeast Asia [6]. Southeast Asia includes 11 countries: Malaysia, Indonesia, Brunei, The Philippines, Myanmar, Thailand, East Timor, Laos, Singapore, Cambodia, and Vietnam with a total population of about 400 million [7]. These countries have a diversity of populations, heterogeneous economic status, political, and geographical boundaries [8].

In transfusion-dependent thalassemia, frequent blood transfusions will progressively [9] lead to iron overload, which is responsible for multiple organ dysfunction and damage [10] in, for example, the liver, spleen, myocardium, and endocrine organs [11]. About 200 to 250 mg iron is infused into a thalassemia major patient's body during each blood transfusion [12, 13].

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After 10 to 20 repeated blood transfusions, the serum ferritin level is expected to exceed 1000 µg/L [12, 14]. This level is a signal for iron chelation therapy to be initiated [15].

There are 3 iron chelators marketed for clinical use; desferrioxamine (DFO), which is administrated parenterally, and another 2, deferiprone (DFP) and deferasirox (DFX), which are given orally [16-18]. Important points for ideal iron chelation therapy include: slow rate of metabolism, able to penetrate tissues and cells, nontoxic, affordable, no redistribution of iron, oral availability, and high chelating efficiency [19-21].

All 3 chelators (desferrioxamine, deferiprone, and deferasirox) have the same goal of reducing the serum ferritin level [22] and organ iron content [23]. The iron chelator of choice depends on several factors including patient compliance, patient preference, cost, and iron chelator efficiency. These iron chelators do not cure the disease, but rather are to avoid complications of iron overload, and to maintain iron balance in transfusion-dependent patients. It is important for clinicians to ensure a patient's understanding of the side-effects of each iron chelator before starting the therapy [23]. That DFO should be offered as a first line therapy because its efficiency and safety in treating iron overload has been established. A patient's compliance to this drug needs to be monitored as some patients do not comply with this treatment because of the inconvenience of the parenteral method of administration, which is time consuming [15, 24]. The clinician will ultimately consider whether there is a need to change to another chelator or a combination therapy. In the absence of iron chelation therapy, iron will continue to accumulate in the patient's organs leading to clinical manifestations of iron toxicity.

There are variations in managing thalassemic patients especially in the management of iron chelation. Although many practical guidelines are available for the management of transfusion dependent thalassemia, not all countries are able to provide ideal treatment to their patients, mainly because of financial constraints. In some countries in Southeast Asia, there is a scarcity of information about iron chelation practices, such as choice of agents, and the cost of medical services available. The lack of accurate data about iron chelation practices and the cost of managing the patients results in miscalculations of the impact of the disease burden [25].

This review is aimed at determining the scope of iron chelation practices, including types of chelators that are available in Southeast Asia, and to explore important issues relevant to this treatment in transfusion-dependent thalassemic patients.

A literature search for information pertaining to thalassemia and its management from 2000 to 2015 was conducted using the following websites: PUBMED/ MEDLINE, Google Scholar, Scopus, and SpringerLink. The following information were retrieved from the websites.

(1) Types of iron chelators available in Southeast Asian countries.

(2) The cost of iron chelation treatments in Southeast Asian countries.

Types of iron chelators

Three types of licensed iron chelators are available; DFO, DFP, DFX, and a combination of DFO and DFP, as will be discussed separately below.

Desferrioxamine (DFO)

Iron chelator therapy began in the 1960s and the first was the subcutaneously-administered iron chelator, DFO [19, 26]. It is a hexadentate iron chelator (1 molecule DFO binds with 1 molecule of iron) and has a short half-life compared with DFP and DFX [27]. DFO has traditionally been started only after 2 to 3 years of transfusion or when ferritin exceeds 1,000 ng/mL [28]. The Thalassaemia International Federation (TIF), United Kingdom, Italian and Australian guidelines endorse DFO as a first-line choice of treatment, and all guidelines recommend DFO as the first line therapy for children <6 years old [29]. It is capable of removing iron from cardiac tissue resulting in improved function. To determine the effectiveness of DFO chelation therapy, serum ferritin level must be monitored every 3 months, and assessment of liver and cardiac iron contents made annually [30].

Iron is excreted though the stool and urine [31]. The higher the dosage of DFO, the higher the amount of iron excreted through the feces compared to the urine. Through the urine, iron from macrophages would be excreted, while that from the liver would be eliminated through the feces.

The DFO dosage used is dependent on the therapeutic index. It is not suitable to treat children <3 years old with DFO because of its potential toxicity, which can affect bone and growth development. Therefore, it has been recommended by some studies to start on a low dose, such as 20 mg/kg/day, until

growth is completed before any dosage increase [32]. Although DFO has a high affinity for ferric iron and is efficient in inactivating iron, approximately 59%–78% of patients show poor compliance because of administration problems [19, 33]. One third of the transfusion-dependent thalassemia patients still develop iron overload complications, such as growth retardation, delay or absent puberty, hypogonadism, hypothyroidism, cirrhosis, heart disease, and bone deformities mostly because of compliance and DFO toxicity issues [30].

Deferiprone (DFP)

This is a second generation iron chelator marketed after DFO in 1999. It is the first oral bidendate chelator (3 molecules DFP bind with one iron) [34, 35], and has a short half-life (3 to 4 hours). Therefore, DFP must be given 3 times daily [26]. It is mainly used for thalassemia major patients who are not compliant or have toxicity reactions to DFO. It is suitable for children ≥6 years old [15].

An advantage of DFP is that it does not carry a net charge, thus membrane penetration and iron removal from the tissues are achieved effectively. DFP also has the ability to remove cardiac iron. The serum ferritin level must be measured quarterly, while cardiac and liver iron levels need to be monitored annually. However, alanine aminotransferase (ALT) is required to be measured monthly for the first 3 to 6 months, and then every 6 months [31].

DFP has several side effects namely arthropathy, agranulocytosis, neutropenia, and transient gastrointestinal symptoms, such as nausea, vomiting, and abdominal pain [35-37]. Agranulocytosis occurs when the absolute neutrophil count drops to 0.5×10^9/L. This usually occurs in the first year of therapy. However, the side effects of DFP can be controlled and managed by using a lower dose of DFP, or by combining it with DFO [38].

Deferasirox (DFX)

DFX is the latest oral tridentate chelator for treating chronic iron overload. It is a tridentate iron chelator, that is, 2 molecules of DFX bind to one molecule of iron [39, 40]. It has a longer half-life compared with the other chelators, being about 8 to 16 hours. Therefore, it can be taken once daily [41]. It was introduced in the USA in 2005 and has been registered as a first line therapy in over 100 countries worldwide [39]. DFX is suitable for children >2 years old [15, 28, 42]. However, compared with the other iron chelators, DFX is more expensive [19].

DFX is available as a dispersible tablet added to water, apple, or orange juice. Iron will be excreted mainly in the feces. It has been approved for use in Europe [27] and Asian countries when DFO is inadequate or when a patient is not compliant with DFO treatment [43]. DFX has the same effect as DFO in maintaining iron balance in the body.

Serum ferritin, alanine transaminase, and serum creatinine levels must be monitored every month, while liver and cardiac iron levels need to be monitored annually [31]. The most common side effects of DFX are skin rashes and gastrointestinal events. Gastrointestinal events include abdominal pain, nausea, vomiting, and constipation. These do not usually require having to stop iron chelation therapy [28, 40].

The initial dosage is 20 mg/kg/day, which is prescribed to patients with thalassemia. The dosage is increased up to 40 mg/kg/day depending on the serum ferritin and biochemical data [44]. DFX is the first-line therapy for patients with thalassemia major in the US who are <2 years old [29], while in Europe, DFX is approved as a first-line therapy for patients <6 years old, and as a second-line therapy in children from 2 to 6 years of age who are resistant to DFO [43].

Combination of DFO and DFP

Combination therapy was introduced in 1990 when monotherapy alone was unable to remove iron in different organs like the heart (DFP) and liver (DFO). Combination iron chelation therapy can gradually improve the cardiac dysfunction in patients with severe iron overload in asymptomatic or symptomatic heart disease by increasing total iron excretion compared with monotherapy [30].

These drugs can be administered on the same day, either simultaneously or sequentially [45, 46]. However, combination treatment with DFO and DFP administered sequentially is recommended. For example, DFO is administered at night, while DFP is given during day. Thus, these chelators can provide a constant exposure to chelation activity [28].

While there is no specific guideline for the combination drug administration [32], a 5-year follow-up study recommended the following: DFP 75 mg/kg for 4 days/week and DFO 50 mg/kg/day for 3 days/week, compared with DFP alone 75 mg/kg for 7 days/week [28].

A new tool is used to determine cardiac iron content

The cardiac iron can be monitored using T2-weighted magnetic resonance imaging (MRI). This tool is fast, robust, and sensitive. If the cardiac MRI T2* value falls between 10 to 20 ms, this indicates that iron is deposited in the heart, and if the value is <10 ms, this indicates severe iron deposition.

This assessment needs to be made only once every 2 years if the patient's cardiac iron status is normal. If the T2* value is between 10 to 20 ms the assessment is made annually, and every 6 months if the value is <10 ms [47, 48].

The present iron chelation agents allow personalized treatment of thalassemia according to the patients' requirements. Introduction of iron chelation therapy has contributed to the increased survival of thalassemic patients with a good quality of life wherever these iron chelation therapies are available and accessible to patients.

Iron chelation in Southeast Asian countries

Availability of an effective regimen depends on availability of expertise, social, financial, and health care policies, and government priorities regarding management of transfusion-dependent thalassemic patients. The World Health Organization (WHO) considers that thalassemia is a major economic burden [49]. Variations in iron chelation practices among Southeast Asian countries reflects the variations in regional treatment practices, accessibility, cost, affordability, and reimbursement facilities [50]. This review attempts to describe the use of iron chelating agents in each of the Southeast Asian countries based on the information available in common search engines. Conditions and practices are constantly changing, but we are attempting to provide general information on the most current practices in these countries. Issues and problems maybe similar between countries, and sharing experiences and solutions could improve patient care across this region.

Malaysia

Malaysia consists of 2 parts: Peninsular Malaysia and Sabah and Sarawak states on the Island of Borneo. Peninsular Malaysia is located south of Thailand, north of Singapore, and east of the Indonesian island of Sumatra, while the 2 Borneo states share borders with Brunei and Indonesia. Malaysia has a multiethnic population with over 30 million in 2014 consisting of Malays (50.4%), Chinese (23.7%), Indians (7.1%), indigenous people (11%), and others (7.8%). The average Malaysian income based on the gross domestic product (GDP) per capita was about USD 12,127 in 2015 (International Monetary Fund nominal). The total expenses on health as a percentage of GDP was 4.75% in 2010 and the government allocated 8.02% from the national budget to the Ministry of Health [15, 25].

From the Malaysia Thalassemia Registry in June 2014, approximately 6056 patients with thalassemia were registered, of which about 3000 patients were transfusion dependent [51]. The Ministry of Health provides free blood transfusion treatment in all government hospitals. Most patients were expected to suffer from iron overload complications [52]. In the past, from 40% to 50% of the transfusion-dependent thalassemic patients received subcutaneous DFO at optimum dose, and the rest suffered from iron overload complications [53]. Fortunately, the practice of iron chelation is improving in Malaysia.

Currently in Malaysia, free supply of chelating agents is recommended when the serum ferritin exceeds 1,000 μg/L (Malaysian Clinical Practice Guidelines 2009) [24]. The dosage for the iron chelators are as listed below.

- DFO: the minimum dosage for children is 20 to 40 mg/kg/day, while for adults, 50 to 60 mg/kg/day.
- DFP: the optimal dosage is 75 to 100 mg/kg/day. It is suitable for older children >6 years old.
- DFX: the ideal dosage is 20 to 40 mg/kg/day in patients >2 years old.
- Combination DFO and DFP: the dosage for DFP is 100 mg/kg/day and for DFO is 40 mg/kg/day [24].

In 2012, about 65.7% of patients were treated with DFO, 9.9% with DFP, a combination of DFO and DFP in 14.8%, and 9.6% were treated with DFX [25]. A report in 2009 showed a combination of iron chelation therapy was better than monotherapy alone, and combination therapy was suitable when monotherapy alone was unable to give a good response [24].

Before 2003, less than 20% of patients received sufficient iron chelation, and another 80% died from complications of multiple organ failure [15]. From 2005, chelation agents in the form of subcutaneous DFO and oral DFP were freely accessible to patients leading to increase in their survival rates and quality of life. Following that, the perception of parents changed and

they no longer considered thalassemia a "serious almost hopeless condition" [29, 52]. In 2012, the newer oral chelator, DFX became more accessible, especially for younger patients. Thus, the majority of Malaysian patients with thalassemia now undergo regular blood transfusion and receive subcutaneous DFO iron chelation therapy [29, 52].

The Malaysian government, especially the Ministry of Health, has moved forwards and initiated a combined effort with the National Thalassaemia Prevention and Control Program and other relevant parties to further alleviate this problem. The implementation of a national policy to enhance and mobilize resources for case screening, registration, and optimizing the least effective dosage of iron chelators, which may contribute to further success in improving quality of life and reduction of the cost of managing patients with thalassemia.

Thailand

Thailand is located to the north of Peninsular Malaysia. Its population is over 67 million in 2014. The largest ethnic group are Thai (95.9%), followed by people from Myanmar (2%), others (1.3%), and unspecified (0.9%). About 35,000 of the population inherited the β-thalassemia syndrome with 17% being hemoglobin (Hb) E trait and 7% being β-thalassemia trait. A study conducted in Thailand in 2001 showed an estimated lifetime cost of USD 149,899 per patient over a period of 30 years covering blood transfusion and iron chelation therapy. Three hospitals were selected: Saraburi Hospital, Phramongkutkloa Hospital, and King Chulalongkorn Memorial Hospital. The latter 2 hospitals are located in Bangkok where patients received optimum treatment. Severe cases received optimum treatment of blood transfusions and iron chelation therapy. The cost for 100 units DFO (500 mg) was USD 452, while the cost for 100 units DFX (250 mg) was USD 1243 in 2010. However, not all patients in Thailand received optimum iron chelation therapy because the government only supported half of the iron chelation cost [54].

The average cost per year for a patient was approximately USD 950 in 2010. Patients with severe complications (homozygous β-thalassemia) had higher cost compared with patients without severe complications. The cost of the thalassemia burden is comprised of 60% direct medical fee (39% iron chelation drugs and 21% blood transfusion), 17% direct nonmedical fee, and 24% indirect fee. Optimum iron chelation reduces the complications of iron overload, but definitely requires more financial support [54]. It was estimated that about 1.3 to 6.6 million baht (USD 32,500 to 185,166) is spent for one patient from the age of 10 to 30 years [4].

Although this study did not cover all hospitals in Thailand. It shows a near complete cost evaluation for the treatment of iron overload and the types of iron chelation therapy practices in this country [54].

Myanmar

Myanmar borders Laos, China, and Thailand in the east, while in the west it borders India and Bangladesh. The incidence of α-thalassemia is about 10% to 56.9%, Hb E 1% to 28.3%, β-thalassemia 0.54% to 4.07% with 1 to 4.9 births per 100 infants [54]. Every year, it has been estimated that about 1300 to 6500 babies are born with transfusion-dependent thalassemia [25]. From the hospital registry, about 4.6% to 58% patient inherited Hb E, and 6% to 37% Hb H disease [54]. The Myanmar government spent about 65 billion kyat for health in 2009–2010. Thalassemia is commonly inherited in middle- and low-income families. In Myanmar, all 3 iron chelators are available; DFO, DFP, and DFX. These iron chelators are definitely available at the central hospitals. However, although they are available, patients have to purchase the iron chelators [25].

Diagnostic facilities for hemoglobinopathies are only accessible at the central and national hospitals, while molecular diagnostic facilities are only present at the National Health Laboratory. Patients who can afford to be treated in tertiary care hospitals and their day care centers, receive iron chelation therapy and are attended by clinical specialists [25]. The Myanmar health authorities can provide all types of iron chelators, but they unable to support the costs, which must be borne by the patients.

Singapore

Singapore is to the south of Peninsular Malaysia. Its total population is about 5 million. The ethnic groups of Singapore are Chinese (74%), Malays (13.4%), Indians (9.1%), and others (3.3%) [55]. The prevalence of β-thalassemia trait is approximately 0.9% and hemoglobin E (Hb E) trait is 0.55% [56].

There is an established National Thalassaemia Registry (NTR). The objectives of this NTR include case detection, individual registration, counseling, and funded screening for marriage of partners and first

degree relatives. Now, the number of severe transfusion-dependent cases of thalassemia in Singapore is close to zero [25, 57].

There are subsidies for the 3 types of iron chelation therapy; DFO, DFP, DFX, and combination DFO and DFP. The iron chelation therapy is free for thalassemia patients and approximately 90% of thalassemia patients received DFO, another 10% received DFP, DFX, and combination DFO and DFP [25].

Prevention by active prenatal diagnostic screening brought Singapore's incidence of thalassemia disease close to zero [25]. The significant reduction in the number of new cases of thalassemia was a result of providing optimum treatment and subsidies to all patients, which includes the cost of iron chelators.

Indonesia

Indonesia is similar to Malaysia in terms of culture and ethnicity. Indonesia is the largest archipelago in the world. It is bordered by 3 countries: Malaysia to the northwest, Timor-Leste (East Timor) and Papua New Guinea to the east. The population of Indonesia is estimated to be about 252 million in 2014. The ethnic groups are Javanese (40.1%), Sundanese (15.5%), Malays (3.7%), Bataks (3.6%), Madurese (3%), Betawi (2.9%), Minangkabau (2.7%), Buginese (2.7%), Bantenese (2%), Banjarese (1.7%), Balinese (1.7%), Acehnese (1.4%), Dayaks (1.4%), Sasaks (1.3%), Chinese (1.2%), and others (15%). About 80–100 new cases are recognized annually, and 7670 patients with thalassemia are registered in Indonesia. The incidence of β-thalassemia is approximately 3% to 10%, α-thalassemia 2.6% to 11%, and Hb E 1.5% to 36% [58]. Most patients acquired insurance from the Indonesian government through agencies like Gakin, Jamkesmas, and Jamkesda. In the same month, the Jampelthas took initiatives to cover all patients who were not covered by other insurance agencies. However, this policy only covered blood transfusion and iron chelation therapy with a cost limit of USD 750/patient/month, excluding monitoring [59]. All iron chelation therapies are available: DFO, DFP, and DFX [58]. The Indonesian government spends about USD 23,000/year/patient to support blood transfusion and iron chelation [58].

Like Malaysia, Thailand, and Singapore, the Indonesian government provides free iron chelation therapy for thalassemia patients. However, not all patients receive optimum treatment. About 9,000 cases of thalassemia are reported, but only half of patients received iron chelation treatment [25]. In view of the diverse demographic and ethnic backgrounds, the Indonesian government was not able to deliver optimum therapy to all patients across the large country consisting of about 18,000 islands.

The Philippines

The Philippines are located between Borneo and Taiwan. The total population was about 108 million in 2014. The ethnic groups of the Philippines are Tagalog (28.1%), Cebuano (13.1%), Ilocano (9%), Bisaya/Binisaya (7.6%), Hiligaynon Ilonggo (7.5%), Bikol (6%), and Waray (3.4%) [60]. The Philippines Health Insurance System covers the therapeutic expenses for patients with thalassemia, but not diagnostic tests. There are also patients who pay for their own treatment. The Philippines government spends more money on infectious diseases and cancer than on thalassemia. Insurance companies may deny claims if the patient is diagnosed to have thalassemia, because it is considered a hereditary disease. Awareness and knowledge of thalassemia among the public are limited. In the Philippines, all the 3 iron chelators are available. The combination DFO and DFP treatment is also practiced [25]. Iron chelation therapy is available in the Philippines, but because of financial constraints, many patients cannot afford it.

Vietnam

Vietnam borders China in the north and its western border is with Laos and China. The Vietnamese population was about 93 million in 2014 with 54 ethnic groups. Vietnam is a multiethnic country with over 50 distinct groups (54 are recognized by the Vietnamese government), each with its own language, lifestyle, and cultural heritage. Many of the local ethnic groups are known collectively in the West as Montagnard. The largest ethnic groups are: Kinh (Viet) 86.2%, Tay 1.9%, Tai Ethnic 1.7%, Mường 1.5%, Khmer Krom (Kho' Me Cro'm) 1.4%, Hoa 1.1%, Nùng 1.1%, Hmong 1%, others 4.1% in 2000. In Vietnam, the government approved USD 30,055 billion for the health sector. It has been estimated that approximately 70,000 thalassemia patients live in Vietnam. In August 2011, the National Institute of Hematology and Blood Transfusion was established [25]. Three types of iron chelation therapies are available; DFO, DFP, and DFX, which are offered in all Central Hospitals, but they are limited in supply [61]. Besides that, the patients are covered with health insurance. The health

insurance covers both the cost of blood transfusion and iron chelation therapy. The Vietnamese government is trying to improve the quality of thalassemia treatment by providing sufficient blood transfusion services and iron chelators in all provincial hospitals, and to acknowledge chelators as important drugs [25]. Vietnam endeavors to improve iron chelation therapy and to ensure that patients receive chelation therapy free of charge.

Cambodia

Cambodia borders Thailand and Laos in the north and Vietnam in the east and south, and the Gulf of Thailand along the western coast. Cambodia's population was about 15 million in 2014. The main ethnic groups are Khmer (90%), Vietnamese (5%), Chinese (1%), and others (4%). Compared with other countries, iron chelation therapy is not available here. Besides that, the blood available for transfusion is also limited because the government is unable to provide a free blood transfusion service [25]. Overall, Cambodia is unable to provide good thalassemia management. This is because of various factors like economic constraints, poor health infrastructure, and others.

Discussion and conclusion

Advances in medical practice have led to improvements in the management of transfusion-dependent thalassemic patients. Thalassemia treatment is currently well established in most of the Southeast Asian region, but in some areas, it needs on-going surveillance, including sufficient and safe blood transfusion services, availability of optimum iron chelation therapy, and other related management requirements. Oral chelators such as DFP and DFX can increase patient compliance, but there is no uniformity in their use, probably because of major differences in geographical and socioeconomic factors.

This article is an overview of iron chelation practices in 2000–2015 as covered by this review. It is expected that management in this region will continue to improve. Until more recent data become available, this overview aims to give an overview and understanding of the challenges faced in practicing iron chelation therapy in each of the countries mentioned. Some Southeast Asian countries have not yet published detailed information about their iron chelation practices. Statistical data from the registry of the transfusion-dependent cases, and the total cost of managing the patients would allow an estimate of the impact of the disease burden on each country.

It is important for thalassemia experts to make the best recommendations for iron chelation therapy that would be effective, and yet acceptable and economical for use as treatment guidelines. In general, almost all patients with thalassemia were able to receive sufficient blood transfusions. However, the proportion of those who receive lifelong chelation therapy was smaller than the proportion receiving transfusion therapy in some areas [4]. It is difficult to assess the treatment practices and how these influence the quality of life of thalassemic patients in Southeast Asian countries because of the limited data currently available in the published literature.

The governments and healthcare authorities in Southeast Asia are expected to explore and monitor strategies to improve healthcare management, including professional training [62, 63], on-going prevention, and national screening program [64]. Singapore has successfully adopted an effective prevention program that could be used as a model to be studied for feasibility of implementation by other countries in this region. Besides that, healthcare authorities should make efforts to ensure that thalassemia treatment is accessible to all patients in their countries and by removing geographical barriers [8, 50].

Awareness of the importance of iron chelation therapy should be stressed to patients and their family members [65]. Patients should be made to understand the rationale of using iron chelation therapy. Health authorities, especially physicians, should provide adequate information and explanation of the importance of and how to increase compliance of iron chelation therapy [50]. Thalassemia awareness programs to reach the public should be made through the media like radio, television, newspaper, the internet, and others with the aid of health authorities and nongovernmental organizations [4, 8]. Genetic counselling and premarital and prenatal diagnosis are important components of thalassemia prevention programs. The goal of genetic counselling is to provide information about thalassemia to families of thalassemia carriers. Prenatal diagnosis is offered for expectant mothers and usually given at 15–18 weeks gestation [11]. Hematopoietic stem cell transplantation is a potential treatment to cure thalassemia disease [66]. Donor selection is crucial to ensure a successful procedure. Only matching donors, usually, normal siblings, are eligible to be matching donors [11, 41]. All Southeast Asian countries are now able to provide hematopoietic stem cell transplantation except Myanmar and Cambodia. **Table 1** shows a summary of the current thalassemia management in

Table 1. Summary of thalassemia management in Southeast Asian countries.

Policy/Service	Country							
	Malaysia	**Thailand**	**Myanmar**	**Singapore**	**Indonesia**	**The Philippines**	**Vietnam**	**Cambodia**
Iron chelation fees	Free [24, 66]	Partial free [54]	Not free [66]	Free [66]	Free [56, 66]	Not free [66]	Free [25]	Not free [25, 66]
National policy	Yes [24, 66]	Yes [66]	None [66]	Yes [66]	Yes [66]	None [66]	Yes [25]	None [66]
Patient registry	Yes [24, 66]	Yes (hospital based) [66]	Yes [56]	Yes [66]	Yes [56, 66]	Hematology association [66]	None [66]	Initiated [66]
Availability of counselling and prenatal diagnosis	Available [24, 66]	Available [66]	NA [56]	Available [66]	Available [56]	Limited [66]	Available [62]	No [66]
Stem cell transplantation	Yes [24]	Yes [66]	No [66]	Yes [69]	No [66]	No [66]	Yes [70]	No [66]
Magnetic resonance imaging	Available [24, 66]	Available [8]	NA [66]	Available [66]	Available [56, 66]	No [66]	None [66]	No [66]

Adapted from Thalalassaemia International Federation report 2013 [68]
*Not available

Southeast Asian countries adapted from Thalassaemia International Federation (TIF) report in 2013 [8]. Any upcoming recommendations for improvement in patient care approaches should take these regional differences into account. With the limited resources available in most Southeast Asian countries, it is important that an effective and economical prevention and control program for thalassemia syndromes be formulated and be considered seriously for implementation. Southeast Asian countries should initiate collaborative efforts and implement common strategies to break the chain of this inherited disease.

In conclusion, not all countries in Southeast Asia have uniform practices in thalassemia management based on published guidelines, such as the Children's Hospital and Research Center, Oakland, California, Standard of care guidelines for thalassemia [67], and Thalassaemia International Federation Guidelines for the management of transfusion dependent thalassemia [39] and Guidelines for the management of non-transfusion dependent thalassemia [68]. In some Southeast Asian countries, progress of thalassemia management is on-going, but still with some limitations. Accessibility of iron chelation drugs differs across geographical regions and this has played substantial roles in differences in therapeutic practices between the various countries.

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Conflicts of interest statement

The authors have no conflicts of interest to declare.

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