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Review Article

A New Era in Thalassemia Disorder: An Overview

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ABSTRACT

Alpha thalassemia is a blood disorder that reduces the production of hemoglobin. Haemoglobin is the protein in red blood cells that carries oxygen to cells throughout the body. A hemoglobin molecule has sub-units commonly referred to as alpha and beta. Both sub-units are necessary to bind oxygen in the lungs properly and deliver it to tissues in other parts of the body. The alpha chain is an important component of fetal hemoglobin (which is usually made before birth) and hemoglobin A and hemoglobin A2 (which are present after birth). Beta thalassemia is a fairly common blood disorder worldwide. Thousands of infants with beta thalassemia are born each year. Beta thalassemia occurs most frequently in people from Mediterranean countries, North Africa, the Middle East, India, Central Asia, and Southeast Asia. Thalassemia occurs when there is an abnormality or mutation in one of the genes involved in hemoglobin production. A physical exam may reveal a swollen (enlarged) spleen. Treatment for thalassemia major often involves regular blood transfusions and folate supplements. Untreated, thalassemia major leads to heart failure and liver problems, and makes a person more likely to develop infections.Avoid excess iron**.** Unless doctor recommends it, don't take vitamins or other supplements that contain iron. Eating a balanced diet that contains plenty of nutritious foods can help you feel better and boost your energy. Signs and symptoms are usually mild with thalassemia minor and little, if any, treatment is needed. Occasionally, you may need a blood transfusion, particularly after surgery, after having a baby or to help manage thalassemia complications.

Key-words: Thalassemia disorder, Genes, Life Style, Prevention

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INTRODUCTION:

Thalassemias (thal-a-SE-me-ahs) are a blood related genetic disorder which involves the absence of or errors in genes responsible for production of haemoglobin, a protein present in the red blood cells. Each red blood cell can contain between 240 and 300 million molecules of haemoglobin. The severity of the disease depends on the mutations involved in the genes, and their interplay.

A haemoglobin molecule has sub-units commonly referred to as alpha and beta. Both sub-units are necessary to bind oxygen in the lungs properly and deliver it to tissues in other parts of the body. Genes on chromosome 16 are responsible for alpha subunits, while genes on chromosome 11 control the production of beta subunits. A lack of a particular subunit determines the type of thalassemia (e.g. a lack of alpha subunits results in alpha-thalassemia). The lack of subunits thus corresponds to errors in the genes on the appropriate chromosomes [1].

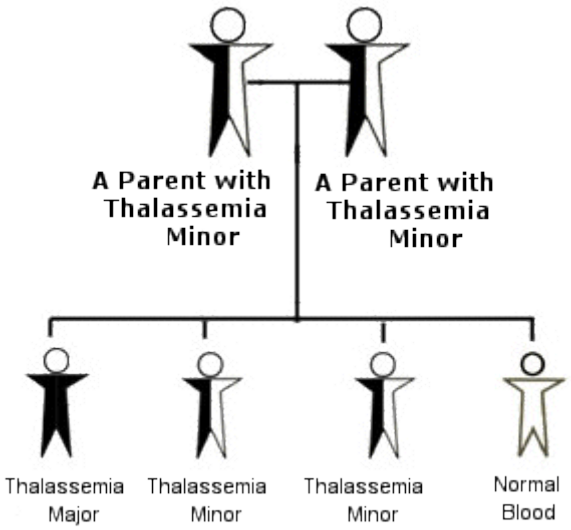

Figure 1

CLASSIFICATION:

1. Genetic
2. Clinical

1. Genetic Classification of the Thalassemias

Thalassemia[2] includes disorders affecting the alpha hemoglobin chain genes and the beta hemoglobin chain gene.

Alpha Thalassemia

Alpha thalassemia occurs when one or more of the four alpha chain genes fail to function. Alpha chain protein production, for practical purposes, is evenly divided among the four genes. With alpha thalassemia, the "failed" genes are almost invariably lost from the cell due to a genetic accident.

(i) The loss of one gene diminishes the production of the alpha protein only slightly. This condition is so close to normal that it can be detected only by specialized laboratory techniques that, until recently, were confined to research laboratories. A person with this condition is called a "silent carrier" because of the difficulty in detection.

(ii) The loss of two genes (two-gene deletion alpha thalassemia) produces a condition with small red blood cells, and at most a mild anemia. People with this condition look and feel normal. The condition can be detected by routine blood testing, however.

(iii) The loss of three alpha genes produces a serious hematological problem (three-gene deletion alpha thalassemia). Patients with this condition have a severe anemia, and often require blood transfusions to survive. The severe imbalance between the alpha chain production (now powered by one gene, instead of four) and beta chain production (which is normal) causes an accumulation of beta chains inside the red blood cells. Normally, beta chains pair only with alpha chains. With three-gene deletion alpha thalassemia, however, beta chains begin to associate in groups of four, producing abnormal hemoglobin, called "hemoglobin H". The condition is called "*hemoglobin H disease*". Hemoglobin H has two problems. First it does not carry oxygen properly, making it functionally useless to the cell. Second, hemoglobin H protein damages the membrane that surrounds the red cell, accelerating cell destruction. The combination of the very low production of alpha chains and destruction of red cells in hemoglobin H disease produces a severe, life-threatening anemia. Untreated, most patients die in childhood or early adolescence.

(iv) The loss of all four alpha genes produces a condition that is incompatible with life. The gamma chains produced during fetal life associate in groups of four to form abnormal hemoglobin called "*hemoglobin Barts*". Most people with four-gene deletion alpha thalassemia die *in utero* or shortly

after birth. Rarely, four gene deletion alpha thalassemia has been detected *in utero*, usually in a family where the disorder occurred in an earlier child. *In utero* blood transfusions have saved some of these children.

Beta Thalassemia

The fact that there are only two genes for the beta chain of hemoglobin makes beta thalassemia a bit simpler to understand than alpha thalassemia [3]. Unlike alpha thalassemia, beta thalassemia rarely arises from the complete loss of a beta globin gene. The beta globin gene is present, but produces little beta globin protein. The degree of suppression varies. Many causes of suppressed beta globin gene expression have been found. In some cases, the affected gene makes essentially no beta globin protein (beta-0-thalassemia). In other cases, the production of beta chain protein is lower than normal, but not zero (beta-(+)-thalassemia). The severity of beta thalassemia depends in part on the type of beta thalassemic genes that a person has inherited.

(i) **One-gene beta thalassemia** has one beta globin gene that is normal, and a second, affected gene with a variably reduced production of beta globin. The degree of imbalance with the alpha globin depends on the residual production capacity of the defective beta globin gene. Even when the affected gene produces no beta chain, the condition is mild since one beta gene functions normally. The red cells are small and a mild anemia may exist. People with the condition generally have no symptoms. The condition can be detected by a routine laboratory blood evaluation.

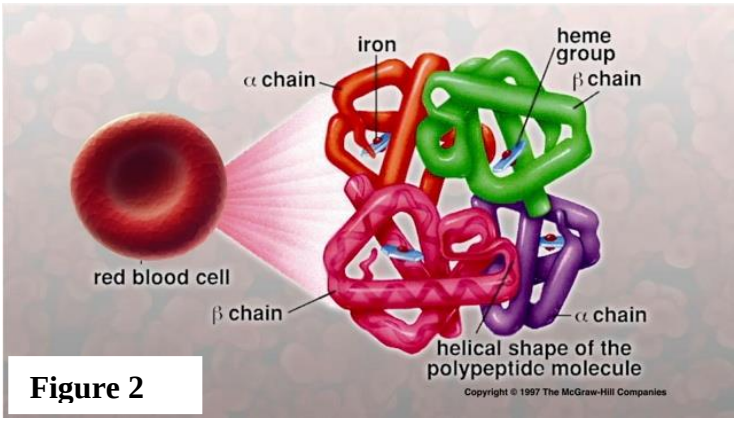

Figure 2

(ii) **Two-gene beta thalassemia** produces a severe anemia and a potentially life-threatening condition. The severity of the disorder depends in part on the combination of genes that have been inherited: beta-0-thal/ beta-0-thal; beta-0-thal/ beta-(+)-thal; beta-(+)-thal/ beta-(+)-thal. The beta-(+)-thalassemia genes vary greatly in their ability to produce normal hemoglobin. Consequently, the clinical picture is more complex than might otherwise be the case for three genetic possibilities outlined.

Clinical Classification of the Thalassemias

Alpha thalassemia

Alpha thalassemia has four manifestations that correlate with the number of defective genes. Since the gene defect is almost invariably a loss of the gene, there are no "shades of function" to obscure the matter as occurs in beta thalassemia.

(i) **Silent carrier state:** This is the one-gene deletion alpha thalassemia condition. People with this condition are hematologically normal. They are detected only by sophisticated laboratory methods.

(ii) **Mild alpha-thalassemia:** These patients have lost two alpha globin genes. They have small red cells and a mild anemia. These people are usually asymptomatic. Often, physicians mistakenly diagnose people with mild alpha-thalassemia as having iron deficiency anemia. Iron therapy, of course, does not correct the anemia.

(iii) **Hemoglobin H disease:** These patients have lost three alpha globin genes. The result is a severe anemia, with small, misshapen red cells and red cell fragments. These patients typically have enlarged spleens. Bony abnormalities particularly involving the cheeks and forehead are often striking. The bone marrow works at an extraordinary pace in an attempt

to compensate for the anemia. As a result, the marrow cavity within the bones is stuffed with red cell precursors. These cells gradually cause the bone to "mold" and flair out. Patients with hemoglobin H disease also develop large spleens. The spleen has blood forming cells, the same as the bone marrow. These cells become hyperactive and over expand, just as those of the bone marrow. The result is a spleen that is often ten-times larger than normal. Patients with hemoglobin H disease often are small and appear malnourished, despite good food intake. This feature results from the tremendous amount of energy that goes into the production of new red cells at an extremely accelerated pace. The constant burning of energy by these patients mimics intense aerobic exercise.

(iv) **Hydrops fetalis:** This condition results from the loss of all four alpha globin genes. The affected individual usually succumbs to the severe anemia and complications before birth.

Beta thalassemia

(i) **Thalassemia minor, or thalassemia trait:** These terms are used interchangeably for people who have small red cells and mild (or no) anemia due to thalassemia. These patients are clinically well, and are usually only detected through routine blood testing. Physicians often mistakenly diagnose iron deficiency in people with thalassemia trait. Iron replacement does not correct the condition. The primary caution for people with beta-thalassemia trait involves the possible problems that their children could inherit if their partner also has beta-thalassemia trait.

(ii) **Thalassemia intermedia:** Thalassemia intermedia is a confusing concept. The most important fact to remember is that thalassemia intermedia is a description, and not a pathological or genetic diagnosis. Patients with thalassemia intermedia have significant anemia, but are able to survive without blood transfusions. The factors that go into the diagnosis are:

- The degree to which the patient tolerates the anemia.
- The threshold of the physician to transfuse patients with thalassemia.

Most patients with thalassemia have substantial symptoms with aHb of much below 7 or 8 gm/dl. With hemoglobins of this level, excess energy consumption due to the profound hemolysis can produce small stature, poor weight gain, poor energy levels, and susceptibility to infection. Further, the extreme activity of the bone marrow produces bone deformities of the face and other areas, along with enlargement of the spleen. The long bones of the arms and legs are weak and fracture easily. Patients with this clinical condition usually do better with regular transfusions. On the other hand, some patients with marked thalassemia can maintain a hemoglobin of about 9 to 10 gm/dl. The exercise tolerance of these patients is significantly better. The question then becomes whether the accelerated bone marrow activity needed to maintain this level of hemoglobin causes unacceptable side-effects such as bone abnormalities or enlarged spleen. This is a judgment decision. A given patient at the critical borderline would be transfused by some physicians to prevent these problems, even if they are slight. The patient then would be *clinically* classified as having thalassemia major. Another physician might choose to avoid the complications of chronic transfusion. The same patient then would be *clinically* classified as thalassemia intermedia. The patient has thalassemia that is more severe than thalassemia trait, but not so severe as to require chronic transfusion as do the patients with thalassemia major. A patient can change status. The spleen is enlarged in these patients. The spleen plays a role in clearing damaged red cells from the blood stream. Since all of the red cells in patients with severe thalassemia have some degree of damage, clearance by the spleen accelerates the rate of cell loss. Therefore the bone marrow has to work harder to replace these cells. In some patients, removal of the spleen slows the rate of red cell destruction just enough, that they can manage without transfusion, and still not have the unacceptable side-effects. In this case, the patient converts *clinically* from thalassemia major to thalassemia intermedia.

(iii) **Thalassemia major:** This is the condition of severe thalassemia in which chronic blood transfusions are needed. In some patients the anemia is so severe, that death occurs

without transfusions. Other patients could survive without transfusions, for a while, but would have terrible deformities. While transfusions are life-saving in patients with thalassemia major, transfusions ultimately produce iron overload. Chelation therapy, usually with the iron-binding agent, desferrioxamine (Desferal), is needed to prevent death from iron-mediated organ injury [4].

Relationship of the Genetic and Clinical Classifications of Thalassemia:

The advent of modern molecular biology permits the genetic classification of thalassemias, outlined earlier in this document. A rough correlation exists between the clinical and genetic classifications. The relationship between genetics and clinical state is not absolute, however:

- Thalassemia trait (minor)- normal beta gene/ thalassemia gene (beta zero or +)
- Thalassemia intermedia- often two beta-(+)-genes
- Thalassemia major- two beta-(+)-genes (where the plus is not substantial); beta-(+)-gene/ beta-0-gene; beta-0-gene/ beta-0-gene

ETIOLOGY:

Alpha thalassemia [5]

Alpha thalassemia is caused by mutations in the alpha chain of the hemoglobin molecule. Normally, there are two alpha chain genes located on each #16 chromosome, for a total of 4. The alpha chain is an important component of fetal hemoglobin (which is usually made before birth) and hemoglobin A and hemoglobin A2 (which are present after birth). How these genes are altered determines the specific type of alpha thalassemia in a child:

- **Alpha thalassemia major(also called Hb Bart syndrome).** With this disorder, all four alpha chain genes are deleted. Alpha thalassemia major develops before birth and results in hydrops fetalis, a condition in which the body has excess fluid. The fetus can also have other problems including severe anemia, enlargement of the liver and spleen (hepatosplenomegaly), and defects in the heart, urinary system, or genitals. Most babies with hydrops fetalis due to alpha thalassemia major die during pregnancy or soon after birth. The mother can have pregnancy complications including preeclampsia (high blood pressure), bleeding problems, and preterm delivery.
- **Hemoglobin H disease.** Three alpha chain genes are deleted. Hemoglobin H disease occurs when a person has only one functioning alpha chain gene, resulting in a hemolytic anemia that can worsen with febrile illness or exposure to certain drugs, chemicals, or infectious agents. People with hemoglobin H disease are at increased risk to have a child with alpha thalassemia major, since they carry one #16 chromosome with an alpha chain two gene deletion (cis deletion).
- **Alpha thalassemia carrier.** Two alpha chain genes are deleted, either:
    - Both from the same #16 chromosome, called a cis deletion
    - One from each #16 chromosomes, called a trans deletion

When both parents are carriers of the cis deletion, there is a one in four, or 25 percent, chance with each pregnancy, to have a baby with alpha thalassemia major. A common hemoglobin test, hemoglobin electrophoresis, cannot diagnose alpha thalassemia. Carriers of the cis deletion versus the trans deletion can be distinguished by DNA analysis only. DNA testing is usually done from a blood sample to look at the alpha chain genes on each #16 chromosome to determine which genes are deleted.

- **Silent alpha thalassemia carrier.** One alpha chain gene is deleted (the other three are normal). Blood tests are usually normal, and the only way to confirm a silent carrier is by DNA studies.

Beta Thalassemia[5]

Beta thalassemia is caused by mutations in the beta chain of the hemoglobin molecule. There is one beta chain gene on each #11 chromosome, for a total of two. How these genes are altered determines the specific type of beta thalassemia in a child:

- **Beta thalassemia major (Cooley's anemia).** Both (two) beta chain genes have deletions, causing the most severe type of beta thalassemia. Thalassemia major patients need frequent blood transfusions and may not survive a normal lifespan. During the first 1 to 2 years of life, they can be pale, fussy, have a poor appetite, and have many infections. Without treatment, the spleen, liver, and heart become enlarged, and bones can become thin, brittle, and deformed. A major problem is the buildup of iron in the heart and other organs, resulting in heart failure for some patients in their teens or early twenties.
- **Thalassemia minor or thalassemia trait.** One beta gene has a deletion, resulting in anemia. Thalassemia minor is further divided into thalassemia minima (a person has little to no symptoms) and thalassemia intermedia (a person has moderate to severe anemia).

People with thalassemia minor have a 50/50 chance to pass the gene to their offspring, who would also have thalassemia minor. Many people are given iron replacement under the mistaken belief that their anemia is the iron-deficient type. Since too much iron can be harmful, it is important to demonstrate conclusively that a patient has iron deficiency before beginning treatment. If there is any question as to whether a patient has thalassemia, it is wise to consult a hematologist before beginning any treatment.

Thalassemia major is inherited by an autosomal recessive gene, which means that two copies of the gene are necessary to produce the condition, one inherited from each of two carrier parents who have thalassemia minor.

Genes related to alpha thalassemia[6]**:**

Alpha thalassemia typically results from deletions involving the *HBA1* and *HBA2* genes. Both of these genes provide instructions for making a protein called alpha-globin, which is a component (subunit) of hemoglobin.

People have two copies of the *HBA1* gene and two copies of the *HBA2* gene in each cell. Each copy is called an allele. For each gene, one allele is inherited from a person's father, and the other is inherited from a person's mother. As a result, there are four alleles that produce alpha-globin. The different types of alpha thalassemia result from the loss of some or all of these alleles.

Hb Bart syndrome, the most severe form of alpha thalassemia, results from the loss of all four alpha-globin alleles. HbH disease is caused by a loss of three of the four alpha-globin alleles. In these two conditions, a shortage of alpha-globin prevents cells from making normal hemoglobin. Instead, cells produce abnormal forms of hemoglobin called hemoglobin Bart (Hb Bart) or hemoglobin H (HbH). These abnormal hemoglobin molecules cannot effectively carry oxygen to the body's tissues. The substitution of Hb Bart or HbH for normal hemoglobin causes anemia and the other serious health problems associated with alpha thalassemia.

Two additional variants of alpha thalassemia are related to a reduced amount of alpha-globin. Because cells still produce some normal hemoglobin, these variants tend to cause few or no health problems. A loss of two of the four alpha-globin alleles results in alpha thalassemia trait. People with alpha thalassemia trait may have unusually small, pale red blood cells and mild anemia. A loss of one alpha-globin allele is found in alpha thalassemia silent carriers. These individuals typically have no thalassemia-related signs or symptoms.

Genes related to beta thalassemia [7]**:**

Mutations in the HBB gene cause beta thalassemia. The HBB gene provides instructions for making a protein called beta-globin. Beta-globin is a component (subunit) of hemoglobin. Hemoglobin consists of four protein subunits, typically two subunits of beta-globin and two subunits of another protein called alpha-globin.

Some mutations in the HBB gene prevent the production of any beta-globin. The absence of beta-globin is referred to as beta-zero (B^0) thalassemia. Other HBB gene mutations allow some beta-globin to be produced but in reduced amounts. A reduced amount of beta-globin is called beta-plus (B^+) thalassemia. Having either B^0 or B^+ thalassemia does not necessarily predict disease severity, however; people with both types have been diagnosed with thalassemia major and thalassemia intermedia.

A lack of beta-globin leads to a reduced amount of functional hemoglobin. Without sufficient hemoglobin, red blood cells do not develop normally, causing a shortage of mature red blood cells. The low number of mature red blood cells leads to anemia and other associated health problems in people with beta thalassemia.

SYMPTOMS [8]: Thalassemia symptoms include:

- Fatigue
- Weakness
- Pale appearance
- Yellow discoloration of skin (jaundice)
- Facial bone deformities
- Slow growth
- Abdominal swelling
- Dark urine

The signs and symptoms experience depends on the type and severity of thalassemia. Some babies show signs and symptoms of thalassemia at birth, while others may develop signs or symptoms during the first two years of life.

DIAGNOSIS/ PROGNOSIS:

Alpha Thalassemia	Beta Thalassemia
Alpha thalassemia is most commonly found in Africa, the Middle East, India, Southeast Asia, southern China, and the Mediterranean region. Carrier status can be determined by the following: • **Complete blood count (CBC).** A measurement of size, number, and maturity of different blood cells in a specific volume of blood. • **Hemoglobin electrophoresis with A2 and F quantitation.** A lab procedure that differentiates the types of hemoglobin present. This test can diagnose beta thalassemia and other hemoglobin changes, but not alpha thalassemia. • **Iron studies, FEP (free-erythrocyte protoporphyrin) and ferritin.** These studies are done to exclude iron deficiency anemia. All of these studies can be performed from a single blood sample. Prenatal diagnosis is determined from CVS (chorionic villus sampling) or amniocentesis [5].	Beta thalassemia is most often found in people who are of Mediterranean ancestry (Greek or Italian). Each child of two carrier parents is at 25 percent risk for the disease. The following tests help diagnose thalassemia: • **Complete blood count (CBC).** A measurement of size, number, and maturity of different blood cells in a specific volume of blood. • **Hemoglobin electrophoresis.** A lab procedure that differentiates the types of hemoglobin present. Only hemoglobin F and A2 are seen in beta thalassemia major. All of these studies can be performed from a single blood sample. Prenatal diagnosis is determined from CVS (chorionic villus sampling) or amniocentesis [5].

Diagnosis of thalassemia can be made as early as 10-11 weeks in pregnancy using procedures such as amniocentesis and chorionic villi sampling. Individuals can also be tested for thalassemia through routine blood counts. Thalassemic patients may have reduced fertility or even infertility. Early treatment of thalassemia has proved to be very effective in improving the quality of life of patients.

Currently, genetic testing and counseling, and prenatal diagnosis play an increasingly important role in informing individual as well as professional decisions around the prevention, management and treatment of this disease[1].

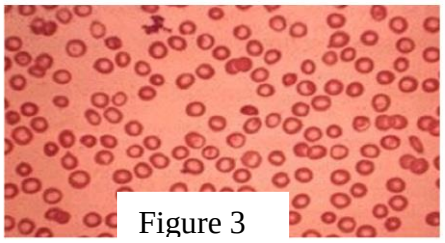

Figure 3

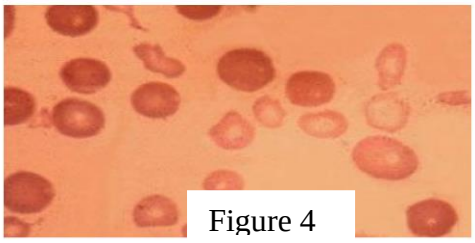

Figure 4

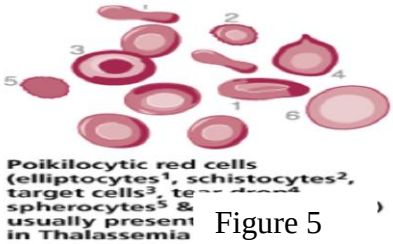

Figure 5

Minor thalassemia

Major thalassemia

TESTS FOR THALASSEMIA:

Blood tests and family genetic studies can show whether an individual has thalassemia or is a carrier. If both parents are carriers, they may want to consult with a genetic counselor for help in deciding whether to conceive or whether to have a fetus tested for thalassemia.

Prenatal testing can be done around the 11th week of pregnancy using chorionic villi sampling (CVS). This involves removing a tiny piece of the placenta. Or, the fetus can be tested with amniocentesis around the 16th week of pregnancy. In this procedure, a needle is used to take a sample of the fluid surrounding the baby for testing.

Assisted reproductive therapy is also an option for carriers who don't want to risk giving birth to a child with thalassemia. A new technique, pre-implantation genetic diagnosis (PGD), used in conjunction with in vitro fertilization, may enable parents who have thalassemia or carry the trait to give birth to healthy babies. Embryos created in-vitro are tested for the thalassemia gene before being implanted into the mother, allowing only healthy embryos to be selected [9].

TREATMENTS AND DRUGS: Treatment for thalassemia depends on type of severity.

Treatments for mild thalassemia

Signs and symptoms are usually mild with thalassemia minor and little, if any, treatment is needed. Occasionally, may need a blood transfusion, particularly after surgery, after having a baby or to help manage thalassemia complications.

Some people with beta-thalassemia intermedia may need treatment for iron overload. Although most people with this condition don't need the blood transfusions that often cause iron overload, people with beta-thalassemia intermedia may have increased digestive absorption of iron, leading to an excess of iron. An oral medication called deferasirox can help to remove the excess iron.

Treatments for moderate to severe thalassemia

Treatments for moderate to severe thalassemia may include:

- **Frequent blood transfusions.** More-severe forms of thalassemia often require frequent blood transfusions, possibly every few weeks. Over time, blood transfusions cause a buildup of iron in blood, which can damage heart, liver and other organs.
- **Stem cell transplant.** Also called a bone marrow transplant, a stem cell transplant may be used to treat severe thalassemia in select cases. Prior to a stem cell transplant, receive very high doses of drugs or radiation to destroy diseased bone marrow. However, because these procedures have serious risks, including death, they're generally reserved for people with the most severe disease who have a well-matched donor available — usually a sibling [9].

Treatment for thalassemia major often involves regular blood transfusions and folate supplements.

Persons who receive significant numbers of blood transfusions need a treatment called chelation therapy to remove excess iron from the body.(Chelation therapy[11] is a mainstream treatment used to treat heavy metal poisoning.

However, the term is also used to promote an alternative therapy that is supposed to treat heart disease, cancer, and other conditions. It most often involves the injection of ethylene diaminetetra acetic acid (EDTA), a chemical that binds, or chelates, heavy metals, including iron, lead, mercury, cadmium, and zinc. A bone marrow transplant may help treat the disease in some patients, especially children [10].

COMPLICATIONS:

Possible complications of thalassemia include:

- **Iron overload.** People with thalassemia can get too much iron in their bodies, either from the disease itself or from frequent blood transfusions. Too much iron can result in damage to heart, liver and endocrine system, which includes glands that produce hormones that regulate processes throughout body.
- **Infection.** People with thalassemia have an increased risk of infection.

In cases of severe thalassemia, the following complications can occur:

- **Bone deformities.** Thalassemia can make bone marrow expand, which causes bones to widen. This can result in abnormal bone structure, especially in face and skull. Bone marrow expansion also makes bones thin and brittle, increasing the chance of broken bones.
- **Enlarged spleen (splenomegaly).** The spleen helps body fight infection and filter unwanted material, such as old or damaged blood cells. Thalassemia is often accompanied by the destruction of a large number of red blood cells, making spleen work harder than normal, causing spleen to enlarge. Splenomegaly can make anemia worse, and it can reduce the life of transfused red blood cells.
- **Slowed growth rates.** Anemia can cause a child's growth to slow. Puberty also may be delayed in children with thalassemia.
- **Heart problems.** Heart problems, such as congestive heart failure and abnormal heart rhythms (arrhythmias), may be associated with severe thalassemia**[8]**

LIFESTYLE AND HOME REMEDIES:

Preventive measures of Thalassemia

- **Avoid excess iron.** Unless doctor recommends it, don't take vitamins or other supplements that contain iron.
- **Eat a healthy diet.** Eating a balanced diet that contains plenty of nutritious foods can help to feel better and boost energy. Doctor also may recommend to take a folic acid supplement to help body make new red blood cells. Also, to keep bones healthy, make sure diet contains adequate calcium and vitamin D.
- **Avoid infections.** Protect from infections with frequent hand-washing and by avoiding sick people.

  Thalassemia is one of the gravest human diseases. The fundamental abnormality in thalassemia is an impaired production of either the α and β haemoglobin chain.

  Thalassemia is a different subject to explain, since the condition is not a single disorder, but a group of defects with similar clinical effects.

  Thalassemia minor will never go away; people who think they have thalassemia minor or are at risk should have blood test so in future they can be aware for themselves in terms of not having a thalassemia major child. Also by having blood test will help the community so that, exact number of people who carry thalassemia minor can be assessed. Thalassemia major can be cured by bone marrow transplantation [8].

CONCLUSION

Awareness plays a major role in case of thalassemia. Owing to ignorance, patients often do not opt for such diagnosis and end up transferring faulty genes to their children.

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