E-ISSN: 2987-209X
International Journal of Midwifery and Health Sciences
Vol. 2, Issue 3 (2024), November

The Effect of Blood Transfusion on Hemoglobin, Hematocrit, and Ferritin Levels in Children with Thalassemia at RSUDZA Banda Aceh

[1*]Arniat Christiani Telambanua, [2]Desi Maryasari

[1,2] Applied Bachelor Study Program, Medical Laboratory Technology Syedza Saintika University

**Corresponding Author: Arniat Christiani Telambanua, Syedza Saintika University, Indonesia, christianiarniat@gmail.com, 082185665713*

Submission date: 29-11-2024; Date of received: 30-11-2024

Abstract
In children with thalassemia, lower hemoglobin levels are associated with several symptoms of general weakness and decreased mental alertness that can cause disturbances in several quality-of-life domains. This study aimed to determine the effect of blood transfusion on hemoglobin levels, hematocrit, and ferritin levels in children with thalassemia at RSUDZA Banda Aceh. This type of research is a Quasy Experiment design one only group pretest and posttest. This research was conducted in July 2024. The population in this study was 59 pediatric patients with thalassemia while sampling used a simple random sampling technique of 30 respondents. Data were analyzed univariately and bivariately using the Paired sample t-test. The results of the study obtained an average hemoglobin level before blood transfusion of 6,350 gr / dL and after 11.44 gr / dL, an average hematocrit level before blood transfusion of 22.50% and after 40.23%, an average ferritin level before blood transfusion of 379.167 µg / L after 35.5475 µg / L. There is an effect of blood transfusion on hemoglobin levels (p = 0.000), hematocrit levels (p = 0.000), and ferritin levels (p = 0.000) in children with thalassemia at RSUDZA Banda Aceh. Based on the results, it can be concluded that blood transfusion affects hemoglobin levels, hematocrit, and ferritin levels in children with thalassemia. Suggestion: It is hoped that all health workers can provide information about the occurrence of thalassemia and it is hoped that they can provide information related to differences in hemoglobin, hematocrit, and ferritin levels in children with thalassemia.
Keywords: Children, Ferritin, Hemoglobin Level, Hematocrit, Thalassemia

Introduction

Thalassemia is a genetic disease caused by a disruption in the process of

forming red blood cell hemoglobin chains so that red blood cell breakdown is faster than normal (Alfian, 2021).

Based on research results, with calculations from the birth rate and population in the world, it is estimated that newborn thalassemia patients are quite high, reaching 2500 babies per year. The number of patients registered at the Thalassemia Center, Department of Pediatrics, FKUI-RSCM, until August 2021 reached 1,494 patients with the largest age range between 11-14 years. The number of new patients continues to increase every year, reaching 100 people/year (WHO, 2021).

Indonesia is one of the countries that has a population of thalassemia carriers, where the frequency of thalassemia carriers in Indonesia is around 3-8%. This means that 3-8 out of 100 people are carriers of the thalassemia gene, and if the average birth rate is 23% in a population of 240 million, it is estimated that 3,000 babies carrying the thalassemia gene will be born each year. Based on data from the Indonesian Thalassemia Foundation (YTI) / Association of Parents of Sufferers (POPTI), thalassemia sufferers in Indonesia have increased from 4,896 sufferers in 2020 to 9,028 sufferers in 2021 (Ministry of Health of the Republic of Indonesia, 2022).

Riskesdas (2018) noted that the highest number of thalassemia sufferers was in Nanggroe Aceh Darussalam Province (13.4%), then the second highest was DKI Jakarta (12.3%), while Central Java was ranked 16th (0.5%).

Beta-thalassemia is divided into three types which also distinguish the various symptoms that may arise. The three types are major, intermedia, and minor. The major type appears on its own in the first 2 years of life with symptoms of severe anemia, poor growth, and bone abnormalities, and as a treatment requires regular blood transfusions throughout life. In the intermediate type, the treatment only requires periodic blood transfusions and symptoms appear less frequently, while the minor type does not require special treatment and is usually asymptomatic (Alfian, 2021).

The main complaint most often found in children with thalassemia is paleness with an average Hb level of <7 g/dL which is classified as major thalassemia. The sooner the child is diagnosed and the older the child, the greater the frequency and number of blood transfusions received each month. Continuous and repeated blood transfusions in large amounts and over a long period cause iron accumulation which causes complications. This can interfere with the child's daily activities, resulting in a

decrease in the child's physical function (Maulana, 2020).

Thalassemia if the transfusion is inadequate will also result in physical changes such as facial bone deformities, bone marrow expansion, and short stature so that the child's physical appearance is different from their peers which makes the child withdraw from socializing and has an impact on the decline in the child's social function. Routine transfusions that must be carried out throughout life can have an impact on psychological reactions such as fear of death, negative thoughts about the future and changes in self-image that cause depression in sufferers. Blood transfusions that must be carried out routinely require thalassemia patients to be absent from school which has an impact on the poor academic performance of thalassemia patients. Children who have undergone transfusions and treatment for thalassemia major patients for >5 years, greatly affect the child's psychosocial reactions which interfere with the quality of the child's health (Muhyi, 2020).

Based on the results of a study conducted by Kristanty (2021) entitled the relationship between pre-transfusion hemoglobin and hematocrit levels with ferritin levels in children with thalassemia at the Faculty of Medicine Hospital, University of Indonesia. The results of the study showed that many were found, namely 56.8% low hemoglobin levels, many were found, namely 64.1% low hematocrit levels and many were found, namely 63.4% low serum ferritin levels. The results of the study also showed that there was a relationship between pre-transfusion hemoglobin and hematocrit levels with ferritin levels p-value 0.023 at the Faculty of Medicine Hospital, University of Indonesia. Based on the background above, the researcher has conducted a study entitled "The Effect of Blood Transfusion on Hemoglobin, Hematocrit and Ferritin Levels in Children with Thalassemia at RSUDZA Banda Aceh".

Method

This type of research is a Quasy Experiment design one only group pretest and posttest where a measurement or observation is carried out at one time or occasionally. This study is to see the effect of blood transfusion on hemoglobin levels, hematocrit, and ferritin levels in children with thalassemia at RSUDZA Banda Aceh.

Research design: Pre-Test (O1) → Treatment (O2) → Post-Test (O3)

O1: Hemoglobin, hematocrit, and ferritin levels before blood transfusion.

O2: Blood transfusion.

O3: Hemoglobin, hematocrit, and ferritin levels after blood transfusion.

The population in this study was all children with thalassemia in June 2024, totaling 59 patients. The sample size was calculated using the Federer formula with a sample size of 30 respondents, sampling using a simple random sampling technique by the researcher's criteria. Data collection by looking at the results of hemoglobin levels, pre-transfusion hematocrit, and ferritin levels. The collected data were processed with SPSS and analyzed univariately to see the average value of hemoglobin levels, hematocrit, and ferritin levels before and after blood transfusion in children with thalassemia at RSUDZA Banda Aceh.

Results

Respondent Characteristics

Table 1
Respondent Characteristics

Respondent Characteristics	f	%
Gender		
a. Laki-laki	27	90.0
b. Perempuan	3	10.0
Age		
a. 5-10 years old	6	20.0
b. 11-20 years old	24	80.0
Amount	**30**	**100**

Based on Table 1, it can be seen that of the 30 respondents, the majority were 27 respondents (90) male compared to 3 respondents (10%) female, and the majority were 24 respondents (80%) aged 11-20 years compared to 6 respondents (20%) aged 5-10 years in children with thalassemia at RSUDZA Banda Aceh.

Univariate analysis

Table 2
Average Hemoglobin Levels Before and After Blood Transfusion in Children with Thalassemia at RSUDZA Banda Aceh

Hemoglobin Levels	Average	SD	Min-Max	n
Hemoglobin Levels Before	6.350	0.721	4.8-7.6	30
Hemoglobin Levels After	11.44	0.671	10.3-12.8	

Based on Table 2, it can be seen that from 30 patients, the average hemoglobin level before blood transfusion was 6,350 with a standard deviation of 0.721 and the average hemoglobin level after blood transfusion was 11.44 with a standard deviation of 0.671. Before blood transfusion, the lowest hemoglobin level was 4.8 gr/dL and the

highest was 7.6 gr/dL, while after blood transfusion, the lowest hemoglobin level was 10.3 gr/dL and the highest hemoglobin level was 12.8 gr/dL in children with thalassemia at RSUDZA Banda Aceh.

Table 3
Average Hematocrit Levels Before and After Blood Transfusion in Children with Thalassemia at RSUDZA Banda Aceh

Hematocrit Levels	Average	SD	Min-Max	n
Hematocrit Levels Before	22.50	3.857	12-29	30
Hematocrit Levels After	40.23	5.104	32-49	

Based on Table 3, it can be seen that from 30 patients, the average hematocrit level before blood transfusion was 22.50 with a standard deviation of 3.857 and the average hematocrit level after blood transfusion was 40.23 with a standard deviation of 5.104. Before blood transfusion, the lowest hematocrit level was 12% and the highest was 29%, while after blood transfusion, the lowest hemoglobin level was 32% and the highest hemoglobin level was 49% in children with thalassemia at RSUDZA Banda Aceh.

Table 4
Average Ferritin Levels Before and After Blood Transfusion in Children with Thalassemia at RSUDZA Banda Aceh

Ferritin Levels	Average	SD	Min-Max	n
Ferritin Levels Before	379.167	248.7123	123.0-971.3	30
Ferritin Levels After	35.5475	2.085.099	1.251.0-8.521.0	

Based on Table 4, it can be seen that from 30 patients, the average ferritin level before blood transfusion was 379.167 µg/L with a standard deviation of 248.712 and the average ferritin level after blood transfusion was 35.547 µg/L with a standard deviation of 2.085.00. Before blood transfusion, the lowest ferritin level was 123.0 µg/L and the highest was 971.3 µg/L, while after blood transfusion, the lowest ferritin level was 1.251 µg/L and the highest ferritin level was 8.521 µg/L in children with thalassemia at RSUDZA Banda Aceh.

Bivariate analysis

Table 5
Effect of Blood Transfusion on Hemoglobin Levels in Children with Thalassemia at RSUDZA Banda Aceh

Hemoglobin Levels	Average	Difference	95% confidence interval of the difference		t	df	P value
			Lower	Upper			
Pretest Hemoglobin Levels	6.35	-5.09	-5.425	-4.760	-31.326	29	**0,000**
Posttest Hemoglobin Levels	11.44						

Based on Table 5, it can be seen that the average hemoglobin level before blood transfusion was 6.35 gr/dL, while the average hemoglobin level after blood transfusion was 11.44 gr/dL with a difference in average value of -5.09 gr/dL. Based on the results of the Paired sample t-test, a p-value of 0.000 ($p<0.05$) was obtained, so it can be concluded that there is an effect of blood transfusion on hemoglobin levels in children with thalassemia at RSUDZA Banda Aceh.

Table 6
Effect of Blood Transfusion on Hematocrit Levels in Children with Thalassemia at RSUDZA Banda Aceh

Hematocrit Levels	Average	Different	95% confidence interval of the difference		t	df	P value
			Lower	Upper			
Pretest Hematocrit Levels	22.50	-17.73	-20.04	-15.42	-15.686	29	**0,000**
Posttest Hematocrit Levels	40.23						

Based on Table 4.5, it can be seen that the average hematocrit level before blood transfusion was 22.50% while the average hematocrit level after blood transfusion was 40.23% with a difference in the average value of -17.73%. Based on the results of the Paired sample t-test, a p-value of 0.000 ($p <0.05$) was obtained, so it can be concluded that there is an effect of blood transfusion on hematocrit levels in children with thalassemia at RSUDZA Banda Aceh.

Table 7
The Effect of Blood Transfusion on Ferritin Levels in Children with Thalassemia at RSUDZA Banda Aceh

Ferritin Levels	Average	Different	95% confidence interval of the difference		t	df	P value
			Lower	Upper			
Pretest Ferritin Levels	379.167	343.620	-59.84	-50.49	-24,144	29	**0,000**
Posttest Ferritin Levels	35.5475						

Based on Table 7, it can be seen that the average hematocrit level before blood transfusion was 379,167 µg/L, while the average hematocrit level after blood transfusion was 35,547 µg/L with a difference in average values of 343,620 µg/L. Based on the results of the Paired sample t-test, a p-value of 0.000 ($p<0.05$) was obtained, so it can be concluded that there is an effect of blood transfusion on hematocrit levels in children with thalassemia at RSUDZA Banda Aceh.

Discussion

Univariate analysis

1. **Average Hemoglobin Levels Before and After Blood Transfusion in Children with Thalassemia at RSUDZA Banda Aceh**

Based on the results of the study, it can be seen that from 30 patients, the average hemoglobin level before blood transfusion was 6,350 with a standard deviation of 0.721 and the average hemoglobin level after blood transfusion was 11.44 with a standard deviation of 0.671. Before blood transfusion, the lowest hemoglobin level was 4.8 gr/dL and the highest was 7.6 gr/dL, while after blood transfusion, the lowest hemoglobin level was 10.3 gr/dL and the highest hemoglobin level was 12.8 gr/dL in children with thalassemia at RSUDZA Banda Aceh.

The results of this study are in line with the study conducted by Mustofa (2020) entitled The Effect of Blood Transfusion on Hemoglobin Levels in Children with Thalassemia at the Bandar Lampung Thalassemia Shelter. The results of the study stated that the hemoglobin level before blood transfusion was 7.62 gr/dL while the hemoglobin level after transfusion was 10.9 gr/dL in thalassemia patients in children at the Bandar Lampung Thalassemia Shelter.

The researcher's assumption is that the results of the study show that there is a change in hemoglobin levels before and after blood transfusion in children with thalassemia, this is because children with thalassemia experience a decrease in hemoglobin levels in red blood cells which causes children to experience thalassemia, so children need to be given continuous blood transfusions so that the hemoglobin levels in children are sufficient in red blood cells. In children with thalassemia, blood transfusions are essential so that proteins are broken down into amino acids. If the body's Hb decreases, then the condition in the body is very at risk for thalassemia.

2. Average Hematocrit Levels Before and After Blood Transfusion in Children with Thalassemia at RSUDZA Banda Aceh

Based on the results of the study, it can be seen that from 30 patients, the average hematocrit level before blood transfusion was 22.50 with a standard deviation of 3,857 and the average hematocrit level after blood transfusion was 40.23 with a standard deviation of 5,104. Before blood transfusion, the lowest hematocrit level was 12% and the highest was 29%, while after blood transfusion, the lowest hemoglobin level was 32% and the highest hemoglobin level was 49% in children with thalassemia at RSUDZA Banda Aceh.

The results of this study are in line with the study conducted by Aji (2020) entitled the effect of hematocrit levels on blood transfusion in children with thalassemia at RSCM. The results of the study stated that the average hematocrit level before blood transfusion was 18.27% and the average hematocrit level after blood transfusion was 39.48% in children with thalassemia at RSCM. The researcher's assumption is that the results of the study show that there is a change in hematocrit levels before and after blood transfusion in children with thalassemia, this is because in children with thalassemia, hematocrit levels are often problematic which is indicated by a decrease in the volume of red blood cells in the blood, the decrease in red blood cells in thalassemia patients is caused by B12 deficiency which causes children to experience thalassemia. Changes occur between hematocrit levels due to blood transfusion to children with thalassemia so that children get hematocrit levels from the blood transfusion so that they meet the needs in the blood.

3. Average Ferritin Levels Before and After Blood Transfusion in Children with Thalassemia at RSUDZA Banda Aceh

Based on the results of the study, it can be seen that from 30 patients, the average ferritin level before blood transfusion was 379.167 µg/L with a standard deviation of 248.712 and the average ferritin level after blood transfusion was 3,554.7 µg/L with a standard deviation of 2,085.00. Before blood transfusion, the lowest ferritin level was 123.0 µg/L and the highest was 971.3 µg/L, while after blood transfusion, the lowest ferritin level was 1,251 µg/L and the highest ferritin level was 8,521 µg/L in children with thalassemia at RSUDZA Banda Aceh.

The results of this study are in line with the study conducted by Widiyani (2021) entitled the effect of blood transfusion on ferritin levels in children with thalassemia at RSI Sultan Agung Semarang. The results of the study stated that the average ferritin level before blood transfusion was 20.15 µg/L while the average ferritin level after blood transfusion was 56.28 µg/L in children with thalassemia at RSI Sultan Agung Semarang. The researcher's assumption is that the results of the study show that there is a change in ferritin levels before and after blood transfusion in children with thalassemia, this is because in children with thalassemia ferritin levels increase after blood transfusion due to additional ferritin levels from the transfusion, in children with thalassemia who lack blood ferritin levels will not store protein and iron in red blood cells, so that children are prone to anemia which causes thalassemia.

Bivariate analysis

1. The Effect of Blood Transfusion on Hemoglobin Levels in Children with Thalassemia at RSUDZA Banda Aceh

Based on the results of the study, it can be seen that the average hemoglobin level before blood transfusion was 6.35 gr/dL, while the average hemoglobin level after blood transfusion was 11.44 gr/dL with a difference in average values of -5.09 gr/dL. Based on the results of the Paired sample t-test, a p-value of 0.000 ($p<0.05$) was obtained, so it can be concluded that there is an effect of blood transfusion on hemoglobin levels in children with thalassemia at RSUDZA Banda Aceh.

The results of this study are in line with the study conducted by Mustofa (2020) entitled the effect of blood transfusion on hemoglobin levels in thalassemia patients in

children at the Bandar Lampung Thalassemia Shelter. The results of the study stated that there was an effect of blood transfusion on hemoglobin levels (p = 0.000) in thalassemia patients in children at the Bandar Lampung Thalassemia Shelter.

In children with thalassemia, lower hemoglobin levels are associated with several symptoms of general weakness and decreased mental alertness which can cause disorders in several domains of quality of life. Disruption of school performance in children, due to the need to undergo transfusions to maintain hemoglobin levels and symptoms of anemia cause children to tire easily so that they experience disorders in activities and problems concentrating while studying. Chronic hypoxia that can occur is one of the risk factors for cognitive disorders that affect IQ performance in children with thalassemia (Riastiti, 2021).

The researcher's assumption, the results of the study show that there is an effect of blood transfusion on hemoglobin levels in children with thalassemia, the effect of blood transfusion is that children with thalassemia experience a lack of hemoglobin levels which is one of the hereditary diseases carried by genes in children. The effect of blood transfusion is also because, in children with thalassemia, the hemoglobin levels are irregular, so repeated blood transfusions are needed.

2. The Effect of Blood Transfusion on Hematocrit Levels in Children with Thalassemia at RSUDZA Banda Aceh

Based on the results of the study, it can be seen that the average hematocrit level before blood transfusion was 22.50%, while the average hematocrit level after blood transfusion was 40.23% with a difference in average values of -17.73%. Based on the results of the Paired sample t-test, a p-value of 0.000 (p <0.05) was obtained, so it can be concluded that there is an effect of blood transfusion on hematocrit levels in children with thalassemia at RSUDZA Banda Aceh.

The results of this study are in line with the study conducted by Aji (2020) entitled the effect of hematocrit levels on blood transfusions in children with thalassemia at RSCM. The results of the study stated that the effect of hematocrit levels on blood transfusions (p = 0.000) in children with thalassemia at RSCM.

In children with thalassemia, lower hemoglobin levels are associated with several symptoms of general weakness, and decreased mental alertness that can cause

disturbances in several domains of quality of life. Disruption of school performance in children, due to the need to undergo transfusions to maintain hemoglobin levels and symptoms of anemia cause children to tire easily so that they experience disturbances in activities and problems concentrating while studying. Chronic hypoxia that can occur is one of the risk factors for cognitive disorders that affect IQ performance in children with thalassemia (Riastiti, 2021). The researcher's assumption, the results of the study showed that there was an effect of blood transfusion on hematocrit levels in children with thalassemia, the effect of blood transfusion was because children with thalassemia experienced a decrease in the volume of red blood cells in the blood so that the red blood cells in children did not meet the needs of hemoglobin in carrying red blood cells throughout the body which resulted in children experiencing thalassemia. The effect of blood transfusion is also because children with thalassemia to increase hematocrit levels need to be given blood transfusions continuously or periodically.

3. The Effect of Blood Transfusion on Ferritin Levels in Children with Thalassemia at RSUDZA Banda Aceh

Based on the results of the study, it can be seen that the average ferritin level before blood transfusion was 379,167 while the average hematocrit level after blood transfusion was 3,554.7 µg/L. Based on the results of the Paired sample t-test, a p-value of 0.000 ($p<0.05$) was obtained, so it can be concluded that there is an effect of blood transfusion on hematocrit levels in children with thalassemia at RSUDZA Banda Aceh.

The results of this study are in line with the study conducted by Widiyani (2021) entitled the effect of blood transfusion on ferritin levels in children with thalassemia at RSI Sultan Agung Semarang. The results of the study stated that there was an effect of blood transfusion on ferritin levels ($p=0.000$) in children with thalassemia at RSI Sultan Agung Semarang.

Serum ferritin is a measure of iron stores in the reticuloendothelial. Serum ferritin is the same as iron staining in bone marrow, which provides the same clinical information. Every 1 µg/L of serum ferritin represents 8-10 mg of iron stores. Normal serum ferritin levels are around ≥30 µg/L. Serum ferritin levels are affected by age. The older you get, the higher the serum ferritin levels. Serum ferritin is not only used as a measure of iron

deficiency, it can also be used to see the effectiveness of anemia treatment with iron tablets (sulfa ferosus). Serum ferritin will increase if anemia has improved (Corwin, 2018). The researcher's assumption, the research results show that there is an effect of blood transfusion on ferritin levels in children with thalassemia, the effect of blood transfusion is because children with thalassemia experience a decrease in ferritin levels, the decrease in ferritin levels in children with thalassemia is caused by iron and protein deficiency in the blood in children with thalassemia, the effect is also caused by blood transfusion being able to provide additional ferritin levels into the blood content in children with thalassemia

Conclusion

1. The average hemoglobin level before blood transfusion was 6,350 gr/dL and the average hemoglobin level after blood transfusion was 11.44 gr/dL in children with thalassemia at RSUDZA Banda Aceh
2. The average hematocrit level before blood transfusion was 22.50% and the average hematocrit level after blood transfusion was 40.23% in children with thalassemia at RSUDZA Banda Aceh
3. The average ferritin level before blood transfusion was 3791.7 µg/L and the average ferritin level after blood transfusion was 3554.7 µg/L in children with thalassemia at RSUDZA Banda Aceh
4. There is an effect of blood transfusion on hemoglobin levels (p=0.000) in children with thalassemia at RSUDZA Banda Aceh
5. There is an effect of blood transfusion on hematocrit levels (p=0.000) in children with thalassemia at RSUDZA Banda Aceh
6. There is an effect of blood transfusion on ferritin levels (p=0.000) in children with thalassemia at RSUDZA Banda Aceh.

References

1. Asrin, Endang Triyanto, Arif Setyo Upoyo. 2006. Analisis Faktor-F Aktor Y Ang Berpengaruh Terhadap Kejadian Phlebitis Di Rsud Purbalingga.
2. Brunnert, Suddart. Keperawatan Medikal Bedah.8th ed. Jakarta: EGC; 2003.

3. Chandra Agustini, Wasisto Utomo, Agrina. 2013. Analisis Faktor Yang Berhubungan Dengan Kejadian Phlebitis Pada Pasien Yang Terpasang Infus Di Ruang Medikal Chrysant Rumah Sakit Awal Bros Pekanbaru
4. Christian, Komaling Lucky Kumaat, Franly Onibala. 2014. Hubungan Lamanya Pemasangan Infus (Intravena) Dengan Kejadian phlebitis Pada Pasiendi Irina F Blu Rsup Prof. Dr. R. D. Kandou Manado. ejournal keperawatan (e-Kp) Volume 2. Nomor 1
5. Ahmad (2016) Hubungan Kepatuhan Tranfusi dan Konsumsi Kelasi Besi Terhadap Pertumbuhan eJKI Vol. 6, No. 3, desember 2018.
6. Amalia, R 2017, Faktor yang Berhubungan dengan Kadar Hemoglobin pada Pedagang Kaki Lima di Terminal (Studi di Wilayah Terminal Mangkang dan Terminal Penggaron Semarang), Thesis, Universitas Muhammadiyah Semarang, diakses 10 April 2018
7. Amalia, W, Pustika dan Diah, Stephen. (2018). Pentingnya Mempertahankan Kadar Hemoglobin Pra-Transfusi Tinggi pada Pasien Thalasemia Mayor. eJKI Vol. 6, No. 3, desember 2018
8. Bandiara R., 2016, Penatalaksanaan anemia defisiensi besi pada pasien yang menjalani hemodialisis. Workshop: "Registrasi Unit Dialisis SeJabar" PPGII Jabar di Hotel Papandayan Bandung, 25 Februari 2003 [cited 19 Jan 2016].Available from: http://pustaka.undap.ac.id
9. Edi., (2019). Gambaran Kadar Hemoglobin Sebelum dan Sesudah Transfusi Darah Pada Pasien Anemia di RSUP Dr.M Djamil Padang, PadanG. Epidemiologi Thalassemia Jurnal Ilmiah Kedokteran Wijaya Kusuma. Vo.5, No.2: 33-44
10. Epran., (2018) Gambaran Kadar Hemoglobin Dengan Kebiasaan Mengkonsumsi Mie Instan Pada Mahasiswa Jurusan Analis Kesehatan Poltekkes Kemenkes
11. Kendari. Kementerian Kesehatan Republik indonesia Politeknik Kesehatan Kendari
12. Hanifah QR., (2020). Karakteristik Penderita Talasemia. Poltekkes ,56Tanjungkarang. Lampung
13. Kementerian Kesehatan Republik Indonesia., (2018). Peraturan Menteri Kesehatan Republik Indonesia Nomor 1109/MENKES/PER/VI/201 tentang Petunjuk Teknis Jaminan Pelayanan Pengobatan Thalassaemia. Jakarta Kurniati I., (2020) Anemia Defisiensi Zat Besi (Fe). Fakultas Kedokteran, Universitas Lampung

14. Larasati P.A., (2020). Karateristik Troponin I dan Feritin pada Pasien Talasemia β Mayor di Jember. Universitas Jember: Jember
15. Muktiarti D, dkk (2016). Thalassemia Alfa Mayor Dengan Mutasi Non Delesi. Universitas Indonesia: Jakarta
16. Petrina V., (2011). Hubungan Antara Kadar Feritin Serum Dengan Kadar Hepsidin Pada Carrier Talasemia β. Universitas Dipenogoro. Semarang
17. Purba REJ., Dkk., (2019). Faktor – Faktor Yang Memhubungani Pertumbuhan Anak Penderita Talasemia Mayor di Jawa Tengah Indonesia. Universitas Dipenogoro: Semarang
18. Puspitaningrum., (2016). Gambaran kadar feritin pada pasien penyakit ginjal kronik stadium 5 non dialysis. Fakultas Kedokteran Universitas Sam Ratulangi. Manada
19. Zahra N., dkk (2018). Hubungan antara Kadar Feritin dengan Kadar Glutation (GSH) pada Pasien Talasemia Beta Mayor di RSD dr. Soebandi Kabupaten Jember. Universitas Jember: Jember