



EFFECT OF PREOPERATIVE HEMOGLOBIN LEVELS ON EARLY OUTCOME OF VALVE REPLACEMENT SURGERIES

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ABSTRACT

Background: Preoperative anemia is associated with increased morbidity and mortality after cardiac surgery, so we investigated the effect of preoperative hemoglobin levels on early outcome of valve replacement surgeries.

Aim of work: Studying the effect of preoperative hemoglobin levels on early outcome of valve replacement surgeries.

Patients & Methods: This retrospective cross-sectional study included (782 cases) all patients underwent open heart surgery for valve replacement surgeries, except those with the exclusion criteria (patients with preoperative heart failure, renal impairment, chronic liver disease or chronic obstructive pulmonary diseases), during a duration of 4 years from 1st of June 2013 till 31th of May 2017 in the department of cardiothoracic surgery at Zagazig University Hospitals. Anemia was defined as hemoglobin <12.0 g/dL in women and <13.0 g/dL in men as reported by the World Health Organization (WHO). The items we focused on during our study were ICU stay duration, post-operative bleeding, sternal wound infection, myocardial infarction, hospital stay duration and in-hospital mortality.

Results: In patients undergoing open heart surgery, 22% of males had preoperative anemia while 26% of females had preoperative anemia. The group with preoperative anemia was associated with increased incidence of adverse events more than the group with normal preoperative hemoglobin levels. The concluded results showed that: patients who suffered from prolonged ICU stay (59.8% vs. 29.8%), post-operative bleeding (88.0% vs. 54.9%), sternal wound infection (6.0% vs. 2.8%), myocardial infarction (3.9% vs. 2%), prolonged hospital stay (61.5% vs. 31.8%) and in-hospital mortality (7.7% vs. 4%) among the anemic and normal group respectively.

Conclusions: Our results indicate that preoperative anemia is associated with a significantly increased risk of post-operative morbidity and mortality.

Keywords: Anemia, valvular surgery, Cardiac surgery, Outcome

INTRODUCTION

Valve replacement surgeries are among the most commonly performed cardiac operations. Anemia is the most commonly encountered hematological problem during the preoperative evaluation of these patients. Anemia is the presence of a decrease in the oxygen transport capacity of the blood. As this is a function of the volume of total red blood cells present in the circulation, anemia

may also be defined as a decrease in the volume of red blood cells (Erythrocytes). While the measurement of chrome-labeled erythrocytes is the most accurate method to determine the volume of erythrocytes, due to its unpractical nature, hematocrit (Hct) and hemoglobin (Hb) values are used for clinical evaluation. However, it should be noted that

when evaluating anemia, Hct and Hb values could be influenced by plasma volume ^[1].

The World Health Organization (WHO) defines anemia as a hemoglobin (Hb) <13 g/dl for men and Hb <12 g/dL for women. Some observational studies have established the association between preoperative anemia and increased post-surgical complications in patients undergoing cardiac and non-cardiac surgeries. Such increased risk is attributed to the confounding effect of transfusions and the interactions between the co-morbidities and low Hb levels ^[2].

Abnormal preoperative hemoglobin (Hb) concentrations are associated with increased perioperative morbidity and mortality in patients undergoing cardiac and non-cardiac surgery. Anemia has a particularly high prevalence, and growing evidence suggests that red blood cell transfusions used to treat anemia contribute to increased perioperative morbidity and mortality. Additionally, acute treatment of anemia with red blood cell transfusion results in increased cost when compared with preoperative elevation of Hb concentration with iron or erythropoietin substitution. Several large-scale retrospective studies have reported that preoperative anemia is associated with an increased risk of 30 day postoperative mortality. These results indicate that preoperative anemia is a risk factor for poor perioperative outcome ^[3].

PATIENTS & METHODS

This retrospective cross-sectional study included (782 cases) all patients underwent open heart surgery for valve replacement surgeries, except those with the exclusion criteria (patients with preoperative heart failure, renal impairment, chronic liver disease or chronic obstructive pulmonary diseases), during a duration of 4 years from 1st of June 2013 till 31th of May 2017 in the department of cardiothoracic surgery at Zagazig University Hospitals

For these patients, the following procedures were done:

- Preoperative preparation:

The following was done for all patients:

- A. An informed consent was taken from the patients.
- B. Process:

1-Full history:

- a. Patient profile (age, sex, weight, height, body surface area, body mass index).
- b. History of other diseases or associated co morbidities (DM, HTN, cardiac, hepatic or renal diseases).
- c. Symptoms of present illness.

2-Full clinical examination:

-General examination:

Most commonly seen signs with preoperative anemia are pallor of skin and mucous membranes, jaundice, findings of bleeding, petechia, purpura, hepatosplenomegaly and lymphadenopathy.

-Local examination:

Murmurs are frequently observed during the cardiac examination of patients with anemia.

3-Plain chest x-ray and Echocardiography.

4-Routine hematologic investigations:

-Complete blood picture (CBC).

The Cut-off points of anemia are hemoglobin levels <12.0 g/dL in women and <13.0 g/dL in men as reported by World Health Organization (WHO) ^[4].

The minimum acceptable preoperative hemoglobin level for elective cardiac surgery in our department is 10 g/dl as reported by many international studies ^[5].

-Liver function tests.

-Kidney function tests.

-Prothrombin time & concentration and partial thromboplastin time.

- Operative data:

- Cardiopulmonary bypass time.
- Ischemic time.
- Numbers of chest tubes inserted.

- Post-operative hospital stay data:

• During ICU stay:

Ventilation time, use of inotropes, ECG, amount of drains, blood transfusion and duration of ICU stay.

The average post-operative ICU stay duration is 2 days and the ICU stay duration of more than 2 days is considered prolonged ICU Stay ^[6].

• After ICU discharge:

Routine hematologic investigations, chest X-ray, echocardiography, ECG, blood transfusion and duration of hospital stay.

The average post-operative hospital stay duration is (5-7) days and the hospital

stay duration of more than 7 days is considered prolonged hospital Stay ^[6].

- Outcome and complications:

The items we focused on during our study:

The medical records of the following post-operative clinical data of the patients who fulfilled the entry criteria for the study were collected, reviewed and statistically analyzed to be used for studying the effect of pre-operative hemoglobin levels on early outcome of open heart surgery with the cut-off points of Hb concentration to define anemia as mentioned before.

1- ICU stay duration:

The average post-operative ICU stay duration is 2 days and the ICU stay duration of more than 2 days is considered prolonged ICU Stay ^[6].

2- Post-operative bleeding and need for blood transfusion:

Post-operative bleeding that needed blood transfusion during hospital stay.

3- Sternal wound infection:

Either superficial or deep sternal wound infection (DSWI). According to Centers for Disease Control and Prevention (CDC) guidelines, the definition of a DSWI requires positive culture results of surgical sites or

drainage from the mediastinal area or evidence of infection during surgical re-exploration or fever, sternal instability, and positive blood culture results, while Superficial sternal wound infection involves the skin, subcutaneous tissue, and pectoralis fascia only ^[7].

4- Post-operative myocardial infarction:

Developing myocardial infarction during hospital stay after the surgery, according to the WHO criteria as revised in 2000, myocardial infarction can be diagnosed by a cardiac troponin rise accompanied by either typical symptoms or ECG changes (pathological Q waves, ST elevation or depression) ^[8].

5- Hospital stay duration:

The average post-operative hospital stay duration is (5-7) days and the hospital stay duration of more than 7 days is considered prolonged hospital Stay ^[6].

6- In-hospital mortality:

Mortality that occurred during hospital stay before being discharged.

RESULTS

- Baseline data of the studied group:

Table (1): Age of the studied group.

Age of the studied group	
N	782
Mean	48.49
Median	49
Std. Deviation	7.49
Range	32.0- 64.0

Table (2): Sex of the studied group.

		N	%
Sex	Female	189	24.1%
	Male	593	75.9%
	Total	782	100.0%

During the study period more males underwent open heart surgery than females (75.9% vs. 24.1%) respectively as shown in table (2).

Table (3): Hb concentration in the studied group.

				Hb concentration (g/dL)					
Gender	Anemia	N	%	Cut-off point	Mean	Median	Std.Deviation	Minimum	Maximum
Males	Anemic	131	22.0%	< 13	11.03	10.9	0.740	8.9	12.4
	Normal	462	78.0%	≥ 13	13.84	13.8	0.683	13	16.1
	Total	593	100.0%	-	13.22	13.5	1.357	8.9	16.1
Females	Anemic	53	28.0%	< 12	10.69	10.7	0.453	8.7	11.7
	Normal	136	72.0%	≥ 12	12.96	13	0.685	12	15.3
	Total	189	100.0%	-	12.32	12.7	1.198	8.7	15.3
Total cases	Anemic	184	23.5%	-	10.87	10.9	0.649	8.7	12.4
	Normal	598	76.5%	-	13.56	13.5	0.804	12	16.1
	Total	782	100.0	-	12.91	13	1.38	8.7	16.1

As mentioned before, The Cut-off points of anemia are hemoglobin levels <12.0 g/dL in women and <13.0 g/dL in men as reported by WHO.

The overall median of Hb concentration among the studied group is 13 and the mean of Hb concentration among the studied group is 12.91, while the mean of the normal group

is 13.56 and the mean of anemic group is 10.87.

As mentioned before, the minimum acceptable preoperative hemoglobin level for elective cardiac surgery in our department is 10 g/dl as reported by many international studies.

- Outcome and complications association with anemia:

Table (4): Prolonged ICU stay and hospital stay distribution.

			Anemia		Total
			Normal	Anemic	
Prolonged ICU Stay	No	N	420	74	494
		%	70.2%	40.2%	63.2%
	Yes	N	178	110	288
		%	29.8%	59.8%	36.8%
Prolonged Hospital Stay	No	N	408	71	479
		%	68.2%	38.5%	61.2%
	Yes	N	190	113	303
		%	31.8%	61.5%	38.8%
Total		N	598	184	782
		%	100.0%	100.0%	100.0%

Table (5): ICU and hospital stay in days association with anemia.

	Anemia	N	Mean	Std. Deviation
ICU Stay in Days	Anemic	184	3.1034	1.04677
	Normal	598	2.5958	1.01702
Hospital Stay in Days	Anemic	184	7.9972	1.92943
	Normal	598	7.0512	1.69364

There is a significant increased incidence of prolonged ICU stay and hospital stay among the anemic group. The mean of both ICU and hospital stay in days is significantly higher among the group with preoperative anemia. As mentioned before, the average post-operative ICU stay duration is 2 days and

the ICU stay duration of more than 2 days is considered prolonged ICU Stay, while the average post-operative hospital stay duration is (5-7) days and the hospital stay duration of more than 7 days is considered prolonged hospital Stay.

Table (6): Post-operative bleeding distribution.

			Anemia		Total
			Normal	Anemic	
Post-Operative Bleeding	No	N	270	22	292
		%	45.1%	12.0%	37.3%
	Yes	N	328	162	490
		%	54.9%	88.0%	62.7%
Total		N	598	184	782
		%	100.0%	100.0%	100.0%

Preoperative anemia is associated with an increased risk of post-operative bleeding that needed blood transfusion. Post-operative bleeding occurred in 88% of patients with

preoperative anemia, while it occurred in only 54.9% of patients with normal preoperative hemoglobin levels.

Table (7): Sternal wound infection distribution.

			Anemia		Total
			Normal	Anemic	
Sternal Wound Infection	No	N	581	173	754
		%	97.2%	94.0%	96.4%
	Yes	N	17	11	28
		%	2.8%	6.0%	3.6%
Total		N	598	184	782
		%	100.0%	100.0%	100.0%

Preoperative anemia is associated with an increased risk of sternal wound infection. It occurred in (6.0% vs. 2.8%) of patients with preoperative anemia and normal group respectively.

Table (8): Myocardial infarction distribution.

			Anemia		Total
			Normal	Anemic	
Myocardial Infarction	No	N	586	177	763
		%	98.0%	96.1%	97.5%
	Yes	N	12	7	19
		%	2.0%	3.9%	2.5%
Total		N	598	184	782
		%	100.0%	100.0%	100.0%

Preoperative anemia is associated with an increased risk of sternal wound infection. It occurred in (6.0% vs. 2.8%) of patients with preoperative anemia and normal group respectively

Table (9): In-hospital mortality distribution.

			Anemia		Total
			Normal	Anemic	
In-hospital Mortality	No	N	574	170	744
		%	96.0%	92.3%	95.1%
	Yes	N	24	14	38
		%	4.0%	7.7%	4.9%
Total		N	598	184	782
		%	100.0%	100.0%	100.0%

In-hospital mortality is significantly higher among the group with preoperative anemia. It occurred in (7.7% vs. 4.0%) of patients with

DISCUSSION

Our study demonstrates that males underwent open heart surgeries more than females (75.9% vs. 24.1%) respectively. In the study performed by Kinnunen ^[9] only 21% of cases during the study period were females.

According to our results, the mean Hb concentration among all cases involved in the study was 12.9. It was 10.87 among the preoperative anemic group, while it was 13.56

preoperative anemia and with normal preoperative hemoglobin levels respectively.

among the group with normal preoperative hemoglobin levels. In the study performed by Kinnunen ^[9], the mean of Hb concentrations of all cases involved in that study was 13.7. It was 11.5 among the anemic group, while it was 14.4 among the normal group. In the study conducted by Miceli et al. ^[6] the mean (\pm standard deviation, SD) hemoglobin concentration was 11.5 (SD, 1.1) g/dl versus 14.3 (SD, 1.1) g/dl, in the anemic and control patients group, respectively.

Our results revealed that there was a non-significant difference between incidence of preoperative anemia and age, but preoperative anemia occurred in females more than males. The study performed by Kinnunen ^[9] showed that preoperative anemia is significantly higher among females more than males.

Our study demonstrates that preoperative anemia as defined by the World Health Organization is a risk factor for mortality and morbidity in patients undergoing valve replacement surgeries. The studies performed by Miceli et al. ^[6] and Fowler et al. ^[10] found that preoperative anemia itself has been shown to be a risk factor for adverse events after cardiac surgeries.

Our study demonstrates that the duration of post-operative ICU stay duration in days is significantly higher among the group with preoperative anemia. The mean of ICU stay duration in days was 2.59 among the group with normal preoperative hemoglobin levels, while the mean among preoperative anemic group was 3.1. In the study performed by Kinnunen ^[9] the mean of ICU stay duration in days among the group with preoperative anemia was 2.9, while it was 1.9 among the group with normal preoperative hemoglobin levels.

According to our results, the incidence of post-operative bleeding that needed blood transfusion was significantly higher among the group with preoperative anemia. In the study conducted by Kinnunen ^[9], preoperative anemia was associated with a significantly increased risk of bleeding and exposure to blood products. In the study performed by Sanders et al. ^[11], preoperative anemic patients were more likely to receive a RBC transfusion than non-anemic patients (39.6% vs. 14.5%) respectively.

According to our results, the incidence of sternal wound infection was significantly higher among the anemic group. It was more than double the incidence among the normal group. In the studies performed by Tauriainen ^[12] and Kinnunen ^[9], the incidence of deep sternal wound infection was significantly higher among the group with preoperative anemia.

Our study demonstrates that preoperative anemia increases the risk for post-operative

myocardial infarction. The incidence of post-operative myocardial infarction was 2% among the normal group, while it was 3.9% among the group with preoperative anemia. In the study performed by Miceli et al. ^[6], There was no significant difference in post-operative myocardial infarction (1.9% vs. 2%, $p = 0.93$) between the two groups (normal & anemic) respectively.

Our study revealed that the duration of post-operative hospital stay duration in days was significantly higher among the group with preoperative anemia. The mean of hospital stay duration in days was 7 among the group with normal preoperative hemoglobin levels, while the mean among preoperative anemic group was 8. In the study performed by Miceli et al. ^[6], 54% of cases with preoperative anemia stayed more than 7 days in hospital after operation, while only 36% of the group with normal preoperative hemoglobin level stayed more than 7 days.

According to our study, preoperative anemia increases the risk of in-hospital mortality. The incidence of in-hospital mortality among the group with preoperative anemia was significantly higher than the incidence among the group with normal preoperative hemoglobin levels (7.8% vs. 4.0%) respectively. In the study performed by Kinnunen ^[9], The incidence of in-hospital mortality among the anemic group was significantly higher than the incidence among the normal group (4.2% vs. 1.2%) respectively. The study performed by Zindrou, Taylor & Bagger ^[13] observed that individuals with a preoperative hemoglobin concentration of 10 g/dl or less had a 3-fold increase in the odds of in-hospital mortality after open heart surgery than those with a higher hemoglobin concentration. In the study performed by Tauriainen ^[12], the incidence of in-hospital mortality among the anemic group was more than triple the incidence of in-hospital mortality among the normal group.

CONCLUSION

In the present study, the prognostic impact of preoperative anemia was investigated in patients undergoing valve replacement surgeries. Our results indicate that preoperative anemia is associated with a significantly increased risk of post-operative

adverse events. Preoperative anemia is associated with increased post-operative ICU stay and hospital stay durations and delayed discharge. It is also associated with an increased risk of post-operative bleeding that needed blood transfusion, sternal wound infection and myocardial infarction. In hospital mortality is significantly higher among the group with preoperative anemia.

According to the concluded results, strategies to reduce preoperative anemia are important to improve the outcome of valve replacement surgeries, as preoperative hemoglobin level is found to be an independent risk factor for post-operative morbidity and mortality.

REFERENCES

- Ganz ML, Wu N, Rawn J, Pashos CL, Strandberg-Larsen M. Clinical and economic outcomes associated with blood transfusions among elderly Americans following coronary artery bypass graft surgery requiring cardiopulmonary bypass. *Blood Transfus.* 2014;12 Suppl 1(Suppl 1):s90-9. doi:10.2450/2013.0170-12.
- Oliveros H, Linares ÉB. Preoperative Hemoglobin Levels and Outcomes in Cardiovascular Surgical Patients; systematic review and meta-analysis. *Colomb J Anesthesiol.* 2012;40(1):27-33. doi:10.1016/S2256-2087(12)40008-6.
- Wang JK, Klein HG. Red blood cell transfusion in the treatment and management of anaemia: The search for the elusive transfusion trigger. *Vox Sang.* 2010;98(1):2-11. doi:10.1111/j.1423-0410.2009.01223.x.
- WHO, Chan M. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. *Geneva, Switz World Heal Organ.* 2011:1-6. doi:2011.
- Messmer KFW. Acceptable hematocrit levels in surgical patients. *World J Surg.* 1987;11(1):41-46. doi:10.1007/BF01658458.
- Miceli A, Romeo F, Glauber M, de Siena PM, Caputo M, Angelini GD. Preoperative anemia increases mortality and postoperative morbidity after cardiac surgery. *J Cardiothorac Surg.* 2014;9:137. doi:10.1186/1749-8090-9-137.
- Singh K, Anderson E, Harper JG. Overview and management of sternal wound infection. *Semin Plast Surg.* 2011;25(1):25-33. doi:10.1055/s-0031-1275168.
- Alpert JS, Thygesen K, Antman E, Bassand JP. Myocardial infarction redefined--a consensus document of The Joint European Society of Cardiology/American College of Cardiology Committee for the redefinition of myocardial infarction. *J Am Coll Cardiol.* 2000;36(3):959-969. doi:10.1016/S0735-1097(00)00804-4.
- Kinnunen E. The Effect of Preoperative Anemia on the Outcome After Coronary Surgery. 2017;(June 2006):1910-1918. doi:10.1007/s00268-017-3911-0.
- Fowler AJ, Ahmad T, Phull MK, Allard S, Gillies MA, Pearse RM. Meta-analysis of the association between preoperative anaemia and mortality after surgery. *Br J Surg.* 2015;102(11):1314-1324. doi:10.1002/bjs.9861.
- Sanders J, Cooper JA, Farrar D, et al. Preoperative anaemia is associated with total morbidity burden on days 3 and 5 after cardiac surgery: a cohort study. *Perioper Med.* 2017;6(1):1. doi:10.1186/s13741-017-0057-4.
- Tauriainen T. *Complications Associated with Preoperative Anemia, Perioperative Bleeding and Blood Transfusions after Isolated Coronary Artery Bypass Grafting.*; 2017.
- Zindrou D, Taylor KM, Bagger JP. Preoperative haemoglobin concentration and mortality rate after coronary artery bypass surgery. *Lancet.* 2002;359(9319):1747-1748. doi:10.1016/S0140-6736(02)08614-2.