

A RETROSPECTIVE OBSERVATIONAL STUDY OF THE IMPACT OF MID PUMP HEMATOCRIT ON THE NEED OF TRANSFUSIONS AND THE LENGTH OF HOSPITAL STAY IN PATIENTS FOLLOWING CARDIOPULMONARY BYPASS IN A TERTIARY CARE CENTRE IN CHENNAI

Cardiovascular

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ABSTRACT

Objective: The primary aim of the study is to observe if the lowest hematocrit during cardiopulmonary bypass affects the need for transfusions post-cardiopulmonary bypass and the length of hospital stay. **Methodology:** This is a retrospective analysis of patients who underwent cardiopulmonary bypass to analyse if the mid-pump hematocrit influenced the post-operative blood transfusions and the length of stay in the postoperative period. The data was collected from the case records, conducted in the Department of Cardiothoracic Surgery-Government Stanley Medical College, Chennai from January 2021 to June 2022. All the surgeries were performed by the same team of surgeons and perfusionist. **Results:** A total of 50 patients were included in the study of which 58% male and 42% female patients. The minimum preoperative hematocrit in the study population was 24%. All cases were subjected to elective cardiopulmonary bypass under standard protocols. All the cases were divided into two groups based on the mid-pump hematocrit. Group A with mid-pump hematocrit <21% included 29 patients and Group B with mid-pump hematocrit >21% included 21 patients. Group A, only 31% received blood transfusions, whereas in Group B 38% needed transfusions. On statistical analysis, the p value in the two groups is 0.603 which shows there is no statistical significance between the two groups with the number of transfusions. In group A, the length of postoperative stay of the patients for more than 7 days was 31% whereas in group B it was 28.6%. The p value of number of days of postoperative stay is 0.851, which shows there is no statistical significance between the two groups. **Conclusion:** In this study of 50 patients, we found that hemodilutional anemia during surgery was not significantly related to number of RBC transfusions required and was not associated with the length of the post-operative stay. These findings support the benefits of restrictive transfusion strategies in patients with hemodilutional anemia in the presence of stable hemodynamics to prevent transfusion related complications and indirectly prolong the days of stay.

KEYWORDS

INTRODUCTION

Cardiopulmonary bypass (CPB) provides a bloodless field for cardiac surgery by incorporating an extracorporeal circuit to provide physiological support in which venous blood is drained to a reservoir, oxygenated, and sent back to the body using a pump. The use of Cardiopulmonary Bypass, the bleeding during and after surgery, the use of anticoagulant and antiplatelet drugs during and after the surgery, hemodilution, frequent blood analysis, significant shift of intravascular volume, mechanical trauma of blood cells, therapeutic hypothermia, co-morbidities, transfusion of blood products, cause significant changes in the three major cellular components of the hematopoietic system^[1]. During cardiac surgery with cardiopulmonary bypass, hemodilution of different degrees is bound to happen, and a low hematocrit (HCT) on CPB is accompanied by worse outcomes. Moderate hemodilution is thought to be generally well tolerated during CPB, and it offers the advantage of reducing the need for blood transfusion and the consequences associated with it. A lower Hct changes the rheological characteristics of blood by decreasing its viscosity, with resultant increases in microcirculatory blood flow. Low levels of HCT on CPB result in poor oxygen delivery and dysoxia of end organs leading to the building up of lactates in the body increasing the morbidity and mortality in the patients.

Aim And Objective Of The Study

The primary aim of the study is to observe if the lowest hematocrit during cardiopulmonary bypass affects the need for transfusions post-cardiopulmonary bypass and the length of hospital stay.

MATERIALS AND METHODS

This is a retrospective observational study, conducted in the Department of Cardiothoracic Surgery-Government Stanley Medical College, Chennai from January 2021 to June 2022. The study population included patients who have undergone cardiac surgery with the support of a cardiopulmonary bypass. The Institutional Ethics Committee (Government Stanley Medical College & Hospital) gave the approval on 20.08.2022 to the study design and waived the need for informed consent from the patients.

All the surgeries were performed by the same team of surgeons and perfusionist.

Inclusion Criteria

All the patients with preoperative hematocrit >24gm% of age >18 years undergoing elective cardiac surgery were included in the study.

Exclusion Criteria

- All the patients with preoperative hematocrit <24gm% were excluded.
- All perioperative deaths were excluded.

Data Collection and Definitions

Data was collected from the case records retrospectively.

Transfusion Protocol

All the patients were transfused blood products in the immediate post-operative period if hematocrit <24%.

Intraoperatively blood products were not transfused based on mid-pump hematocrit with stable hemodynamics.

Parameters Which Were Taken For Consideration

Preoperatively: Preoperative hematocrit

Intraoperatively: Intraoperative Hematocrit while weaning off bypass, CPB duration.

Postoperatively: Post-op Hematocrit, number of transfusions, length of stay.

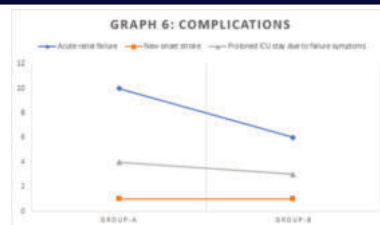
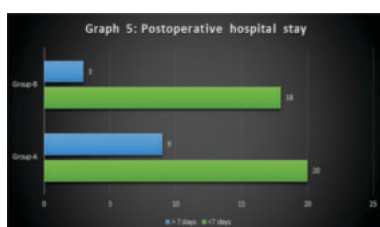
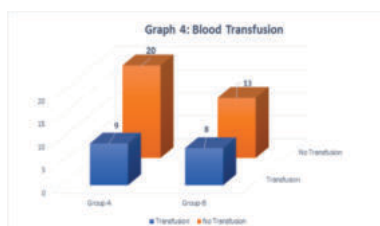
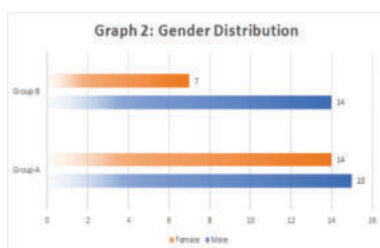
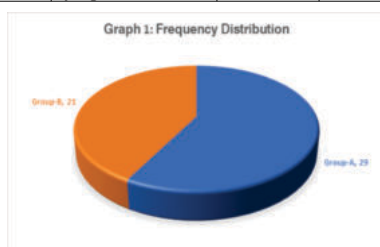
RESULTS

In our study, we had 58% male and 42% female patients. The most commonly performed surgery in our study group was Mitral valve replacement 64%, while Aortic Valve Replacement was 20%, Double Valve Replacement was 10%, and Atrial septal defect was 6% of the cases. The minimum preoperative hematocrit in the study population was 24%. All cases were subjected to elective cardiopulmonary bypass under standard protocols. All the cases were divided into two groups based on the mid-pump hematocrit. Group A with mid-pump hematocrit <21% and Group B with mid-pump hematocrit >21%. Group A included 29 patients, and Group B included 21 patients.

Of the 29 patients in Group A, only 31% received blood transfusions in the post-operative period whereas 69% did not need transfusions, whereas in Group B 38% needed transfusions.

Table 1: Summary Of The Results

		GROUP-A (mid-pump Hct <21%)	GROUP-B (mid-pump Hct >21%)	P- value
Frequency (n)		29	21	-
Age (years)		39.10 ± 10.67	43.71 ± 8.07	0.102
Gender	Male	15 (51.72%)	14 (66.7%)	0.29
	Female	14 (48.28%)	7 (33.3%)	
CPB Time (min)		130.35 ± 47.31	158.38 ± 57.41	0.06
Transfusion	Yes	9 (31%)	8 (38%)	0.603
	No	20 (69%)	13 (62%)	
Post-operative hospital stay	<7 days	20 (68.9%)	15 (71.4%)	0.851
	>7 days	9 (31%)	6 (28.6%)	
Complications	Acute renal failure	10 (34%)	6 (28%)	0.93
	New onset stroke	1 (3.4%)	1 (4%)	
	Prolonged ICU stay due to failure symptoms	4 (13.79%)	3 (14.2%)	



In group A, the length of postoperative stay of the patients for more than 7 days was 31 % whereas in group B it was 28.6%.

On statistical analysis, the value of the of transfusion in the two groups is 0.603 which shows there is no statistical significance between the two groups with the number of transfusions.

The p value of number of days of postoperative stay is 0.851, which shows there is no statistical significance between the two groups.

In our patients, the post operative stay was prolonged due to most common complications like acute renal failure, new onset of cerebrovascular accidents and due to heart failure symptoms.

DISCUSSION

Cardiopulmonary bypass is incomparably needed for cardiac surgeries as well as causes inflammatory reactions which can be harmful in the postoperative period. The principle of hemodilution is to reduce inflammatory reactions, which can be detrimental, as the lowest level of hematocrit on cardiopulmonary bypass (CPB) is considered a risk factor for postoperative acute kidney injury^[2], stroke^[3,4], and mortality^[3]. The commonly accepted interpretation for this association is that running CPB at a very low HCT value may determine poor oxygen delivery, leading to end organ dysoxia and consequent organ failure^[5]. The prolonged condition of poor oxygen delivery triggers anaerobic energy production, leading to increased levels of blood lactates^[6]. Hyperlactatemia (HL) during CPB is associated with low oxygen delivery and with bad outcomes in adult^[7] and pediatric patients which is a vicious cycle that follows. About 75-90% of intra-operative and early post-operative bleeding is associated with technical factors and CPB which is associated with hemodilution^[8].

In our study, the lowest hematocrit while weaning off the pump was 16% and 58% of the patients had hematocrit below 21%. In favour of this observation, a study by Fang et al^[9] shows a safe Hct level somewhere between 14% and 19% during CPB. In the study by Viele. M.K et al^[10], Jehovah witness, patients who underwent cardiac surgery suggested that hemodilution to a Hb of 5.0 g/dl (hct-15%) could be tolerated with minimal morbidity.

In our study, there was no significant correlation between the mid-pump hematocrit and the no. of transfusions. In a study by El Hilali et al^[11], the logistic regression analysis of the results, it was identified that the nadir hematocrit value on CPB was inversely related to blood transfusions, which meant low hematocrit was associated with more no. of transfusions, which was supported by the study by Habib RH et al^[13], the frequency of intraoperative and postoperative transfusion and the direct variable costs of surgery were strongly related to the severity of hemodilution. In favour of our study, Bracey et al^[14] prospectively divided the patients into two transfusion trigger groups after coronary artery bypass grafting surgery to receive RBC transfusion if HB<8g/dl (restrictive transfusion) or <9g/dl (liberal transfusion) and reported that reducing the Hb trigger to 8 g/dl did not adversely affect the patient outcome and resulted in lower costs.

In our study, the postoperative stay and the mid-pump hematocrit were not statistically significant. In favor of this observation, the study by Von Hemann et al^[13], univariate analysis of all risk factors that may have influenced the length of ICU stay was performed but did not find the lowest Hct during CPB to be predictive for the ICU stay. In contrary to the above observation, the study by El-hilali F et al^[11], there was an insignificant effect for prolonged ICU stay in transfused and non-transfused patients and in the study by Loor et al^[12] there was a significantly higher postoperative hospital length of stay with low hematocrit.

CONCLUSION

In this retrospective regional observational study of 50 patients, we found that hemodilutional anemia during surgery was not significantly

related to number of RBC transfusions required and was not associated with the length of the post-operative stay. These findings support the benefits of restrictive transfusion strategies in patients with hemodilutional anemia in the presence of stable hemodynamics to prevent transfusion related complications and indirectly prolong the days of stay. Intraoperative anemia is considered often the result of hemodilution which is partially reversible using ultrafiltration techniques and /or using forced diuresis with 20-40 mg bolus of IV furosemide based on the urine output.

REFERENCES

1. Wang A, Bashore TM. Hematologic Disorders after Cardiac Surgery. Valvular Heart Disease Book. 2009:432–35.
2. Ranucci M, Pavesi M, Mazza E, Bertucci C, Frigiola A, Menicanti L, et al. Risk factors for renal dysfunction after coronary surgery: the role of cardiopulmonary bypass technique. *Perfusion*. 1994;9: 319–326.
3. Habib RH, Zacharias A, Schwann TA, Riordan CJ, Durham SJ, Shah A. Adverse effects of low hematocrit during cardiopulmonary bypass in the adult: should current practice be changed? *J Thorac Cardiovasc Surg*. 2003; 125:1438–1450.
4. Karkouti K, Djaiani G, Borger MA, Beattie WS, Fedorko L, Wijeyesundera D, et al. Low hematocrit during cardiopulmonary bypass is associated with increased risk of perioperative stroke in cardiac surgery. *Ann Thorac Surg*. 2005; 80: 1381–1387.
5. Bennett MJ, Rajakaruna C, Bazerbashi S, Webb G, Gomez-Cano M, Lloyd C. Oxygen delivery during cardiopulmonary bypass (and renal outcome) using two systems of extracorporeal circulation: a retrospective review. *Interact Cardiovasc Thorac Surg*. 2013; 16:760–764. 10.1093/icvts/ivt057.
6. Berend K, de Vries AP, Gans RO. Physiological approach to assessment of acid-base disturbances. *N Engl J Med*. 2014; 371:1434–1445. 10.1056/NEJMra1003327.
7. Demers P, Elkouri S, Martineau R, Couturier A, Cartier R. Outcome with high blood lactate levels during cardiopulmonary bypass in adult cardiac surgery. *Ann Thorac Surg*. 2000; 70: 2082–2086.
8. Kim P, Dixon S, Eisenbrey AB, O'Malley B, Boura J, O'Neill W. Impact of acute blood loss anemia and red blood cell transfusion on mortality after percutaneous coronary intervention. *Clinical Cardiology*. 2007;30 11:35–43.
9. Fang WC, Helm RE, Krieger KH, Rosengart TK, DuBois WJ, Sason C, Lesser ML, Isom OW, Gold JP. Impact of minimum hematocrit during cardiopulmonary bypass on mortality in patients undergoing coronary artery surgery. *Circulation*. 1997 Nov 4;96(9 Suppl):II-194-9. PMID: 9386097.
10. Viele MK, Weiskopf RB: What can we learn about the need for transfusion from patients who refuse blood? The experience with Jehovah's Witnesses. *Transfusion* 1994, 34: 396-401. 10.1046/j.1537-2995.1994.34594249050.x.
11. El-Hilali F, El-Hilali H, Dheeb BI, Traore BM, Messouak M, et al. (2016) Blood Transfusion Utility During Cardiopulmonary Bypass and Correlation with Key-Biochemical Laboratory Findings: A New Approach to Identify Preventive and Risk Factors (1-Year Practice at University Hospital Hassan-II of Fez). *Biochem Anal Biochem* 5: 290.
12. Looor, G., Li, L., Sabik, J. F., Rajeswaran, J., Blackstone, E. H., & Koch, C. G. (2012). Nadir hematocrit during cardiopulmonary bypass: End-organ dysfunction and mortality. *The Journal of Thoracic and Cardiovascular Surgery*, 144(3), 654-662.e4.
13. Von Heymann, C., Sander, M., Foer, A. et al. The impact of an hematocrit of 20% during normothermic cardiopulmonary bypass for elective low risk coronary artery bypass graft surgery on oxygen delivery and clinical outcome – a randomized controlled study [ISRCTN35655335]. *Crit Care* 10, R58 (2006).
14. Bracey AW, Radovancevic R, Riggs SA, Houston S, Cozart H, Vaughn WK, et al. Lowering the hemoglobin threshold for transfusion in coronary artery bypass procedures: Effect on patient outcome. *Transfusion*. 1999;39:1070–7.