The Journal of Cardiovascular Diseases
J Cardiovasc Dis 2024;20(1):24 - 29

ORIGINAL ARTICLE
DOI: 10.55958/jcvd.v20i1.167

BLOOD LOSS AND ALLOGENEIC TRANSFUSION REQUIREMENTS IN NORMOTHERMIC CARDIO-PULMONARY BYPASS RELATIVE TO HYPOTHERMIC CARDIO-PULMONARY BYPASS (CPB)

Asma Tassawar[a], Rukhsar Fatima[b], Asif Mushtaq[b], Sheeraz Ahmed[b]

[a]Non Coummunicable Diseases, Primary and Secondary Healthcare Department, Punjab. Punjab Institute of Cardiology , Lahore.

Date of Submission: 06-06-2024; Date of Acceptance: 26-06-2024; Date of Publication: 05-07-2024

ABSTRACT:

BACKGROUND: *Transfusion of allogenic red blood cells (RBCs) is gradually recognized as a risk factor for opposing outcome after cardiac surgery. CPB is a procedure that temporarily replaces the function of heart and lungs during cardiac surgery. It continues blood circulation and oxygen in the body during operation.*

AIMS & OBJECTIVE: *To determine the blood loss and allogeneic transfusion requirements in normothermic CPB relative to hypothermic CPB.*

MATERIAL & METHODS: *Prospective, randomized study was carried out in cardiac surgery department. Out of 130 patients 57 were enrolled for CPB at normothermic (35°C) and 73 hypothermic temperature (25°C). Patients were under observation within first 24 hours in operating room or in intensive care unit for the blood loss and transfusion need. An independent t-test was used.*

RESULTS: *Hypothermic CPB had mean intraoperative blood loss 112.58±54.67 while normothermic CPB had mean blood loss 142.89±60.70 with 0.189 p-value. Intraoperative blood loss was highly significant with respect to CPB type. There was no difference between CPB groups excluding minimal temperature on CPB. Initial temperature and on arrival to ICU was not significant and p-value >0.05. While nominal temperature on CPB had p-value <0.05 was significant. Hypothermic CPB required mean post OP blood transfusion 968.63±629.96 ml, while normothermic CPB required mean post OP blood transfusion 789.72±702.43. As p- value was >0.05 so post OP transfusion was irrelevant with respect to CPB. Our study results show that there is no difference between blood transfusion in both groups. Hypothermic patients bleed intraoperatively more than that of normothermic CPB patients.*

CONCLUSION: *Normothermic and hypothermic CPB groups showed same blood transfusion requirements and without any difference in duration of CPB. Hypothermic patients bleed more during CPB as compared to normothermic patients. Post-operative bleeding after 24 hours of CPB was same in both groups.*

KEY WORDS: *Blood Loss, CPB, Allogeneic transfusion*

Correspondence : Asma Tassawar, Non Coummunicable Diseases, Primary and Secondary Healthcare Department, Punjab.. Email: asmatassawar77@gmail.com
Author's Contribution: AT: Principal Investigator, conducted the study and wrote the article. **RF:** Helped in conducted the study. **AM:** Supervised the study. **SA:** Helped in manuscript writing.

INTRODUCTION:

Transfusion of allogenic red blood cells (RBCs) is gradually recognized as a risk factor for opposing outcome after cardiac surgery. CPB is a procedure that temporarily replaces the function of heart and lungs during cardiac surgery. It continues blood circulation and oxygen in the body during operation.[1]

The CPB pump is commonly referred to as a heart-lung machine or "the pump". As a result, the development of cardiopulmonary bypass (CPB), which allows for open-heart surgery, is regarded as a 20th-century medical breakthrough. Since the introduction of CPB, hemo-dilutional anaemia has been widely utilized to lower blood viscosity and prevent arterial hypertension.[2] Therefore, this will lower the patient's hematocrits during CPB, increasing the risk of acute anaemia and accompanying complications. Despite significant developments in blood conservation measures that have reduced the need for red cell blood transfusions (BT), transfusions in cardiac surgery are still necessary in some patients to control life-threatening haemorrhage. As the frequency of CPB surgeries has increased, so has the rate of blood transfusions. Based on clinical judgement, we hypothesised that patients receiving normothermic CPB bled less than those receiving hypothermic CPB. [3-4]

MATERIAL AND METHODS:

This research was carried out in the Cardiac Surgery Department of PIC, Lahore from July 2017 to March 2018. Total 130 cases were enrolled by taking 95% confidence interval.

Formula used:

$n = Z2\ P\ (1-P)/d2$

Where:

P= Population proportion

$Z12\text{-}\alpha/2$ = for 95% confidence of interval=1.96(Standard value)

d2 = Margin of error = 5%

Total sample size = n = 130

It was hospital-based study, so the population to be dealt was the patients undergoing cardiac surgery. Non-probability Purposive sampling technique was use.

Preoperative platelet counts and hemoglobin concentration were noted. After the administration of heparin and after heparin counteraction with protamine, activated clotting time was recorded.

INCLUSION AND EXCLUSION CRITERIA:

Patient with primary sternotomy, single valve replacement and patients undergoing coronary artery bypass were included in the study. Patient having antifibrinolytic therapy, patient having weight <45kg, pre-op Hb level <10g / dl, pre-op platelets count < 100*10 ^ 3 /mm ^ 3, creatinine value > 2.0 mg/dl, pre-op administration of thrombolytic therapy and known history of bleeding disorder were excluded from the study.

STATISTICAL ANALYSIS:

The data was analyzed using SPSS (Statistical Package for Social Science) version 24.00. Mean ± S.D was given for quantitative (Age, height, weight, bypass time, cross clamp time, intraoperative blood loss, drain output and post-operative transfusion) variable. Frequencies, percentages and graphs were given for qualitative variables (Gender, diabetes mellitus, hypertension). Independent t-test was applied to perceive association between qualitative variable i.e., perioperative hemoglobin and postoperative blood transfusion while for quantitative variable independent t-test was applied. 5% level of significance will be used. All test applied for two tails. A p-value of ≤ 0.05 was considered as significant.

RESULTS:

Total 130 patients were enrolled in the study, out of 130 patients 49(37.69%) were females and 81 (62.31%) were

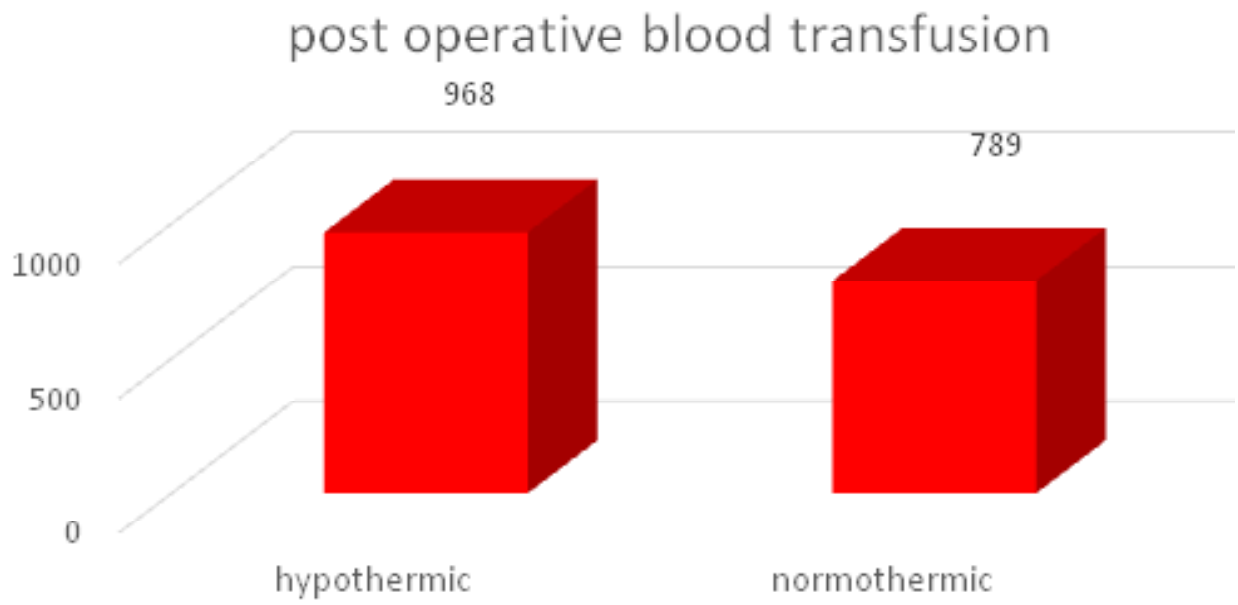

Figure: Graphical representation of post-operative blood transfusion.

Table-1: Intraoperative blood transfusion with respect to CPB			
CPB type	**Frequency**	**Mean ±S.d**	**p-value**
Hypothermic	73	904.11±468.87 ml	0.133
Normothermic	57	868.42±360.13 ml	
Total	130		

Table-2: Intraoperative blood loss with respect to CPB			
Type of CPB	**Frequency**	**Mean ±S.d**	**p-value**
Hypothermic	73	112.58±54.67 ml	0.189
Normothermic	57	102.89±60.702 ml	
Total	130		

males; the minimum age was 32 years and maximum was 71 years, who underwent cardiac surgery and the mean age was 53.77±8.11. There was no difference in demographic variables between the two groups. None of the patient had any organ dysfunction preoperatively. Out of 130 patients 122 (93.8%) were hypertensive, 83(63.8%) were diabetic, 68(52.3%) had positive family history, 51 (39.2%) were smoker. 57 (43.8%) patients undergoing normothermic CPB and 73 (56.2 %) patients undergoing hypothermic CPB Out of 130 patients ,115(88.5%) undergoing CABG and 15(11.5%) undergoing Valvular heart surgery.

Mean preoperative Haemo globin was 12.89 ±1.41, While postoperative mean haemoglobin was 11.33±1.71. Perioperative surgical characteristics have no difference in these variables. CPB duration was less than 100 minutes in 58 (44.6%) patients, while 72 (55.4%) patients have CPB time greater than 100 minutes. 93(71.5%) patients have cross clamp time less than 60 minutes, while 37(28.5%) patients have clamp time greater than 60 minutes. Intraoperative blood transfusion is highly significant with respect to CPB having p-value 0.133(Table-1). Hypothermic

CPB has mean intraoperative transfusion 904.11±468.87, while normothermic CPB has mean intra OP transfusion 868.42±360.13.

Hypothermic CPB has mean intraoperative blood loss 112.58±54.67 while normothermic CPB has mean blood loss 142.89±60.70. p-value is 0.189 (Table-2). Intraoperative blood loss is highly significant with respect to CPB type. There was no difference between CPB groups except minimal temperature on CPB. Initial temperature and temperature on arrival to ICU was not significant has p-values greater than 0.05. While minimal temperature on CPB has p value less than 0.05 is significant.

Hypothermic CPB required mean post OP blood transfusion 968.63±629.96, while normothermic CPB required mean post OP blood transfusion 789.72±702.43. p- value is greater than 0.05 so post OP transfusion is insignificant with respect to CPB.

Intraoperative blood transfusion is highly significant with respect to CPB having p-value 0.133. hypothermic CPB has mean intraoperative transfusion 904.11±468.87, while normothermic CPB has mean intra OP transfusion 868.42±360.13.

It shows that hypothermic CPB has mean intraoperative blood loss 112.58±54.67 while normothermic CPB has mean blood loss 102.89±60.70 with p-value is 0.189. Intraoperative blood loss is highly significant with respect to CPB type.

DISCUSSION

Our study verified that there are similar transfusion requirements between both groups of patients who were undergoing normothermic (35°C) CPB and hypothermic (25) CPB. Some researches assessed the influence of perfusion temperature on systemic effects of cardiopulmonary bypass (CPB) and blood loss. Our study shows, there is statically variance between blood loss intraoperatively. Hypothermic patients have mean blood loss 112.58±54.67 while normothermic CPB has mean blood loss 102.89±60.70 with a p-value is 0.189. Intraoperative blood loss is very significant with respect to CPB type. CPB or aortic cross-clamp duration was same in both groups. Standardized transfusion was performed in the operating room and the ICU.[5-6]

Some other studies, discuss that increased red blood cell transfusions were related to the heparin therapy, but other studies assessed that blood transfusion in patients undergoing cardiac surgery was not associated with preoperative heparin therapy.[7-8] Moreover, in the recent randomized research, there was no difference in preop heparin administration and no difference in blood loss or transfusion between normothermic and hypothermic groups. The CPB durations were short. We might have seen dissimilar results with longer CPB times. The study comprised only patients experiencing primary sternotomy and no more than single-valve replacement. Different results might have been noted with patients experiencing repeat sternotomy or more complex surgical procedures. Our study displays no difference in blood transfusion between these groups.[9,10,11]

Some more studies showed no difference in blood loss or transfusion necessities between normothermic and hypothermic CPB groups. In previous studies, length of CPB were almost same. Shorter CPB duration is the main advantage of normothermic CPB, as the time to cool and rewarm is removed. Duration of CPB results in platelet activation and following dysfunction increase. [12,13,14]

According to the comparative researches, hypothermic CPB increases duration. Therefore, duration of CPB or blood loss and transfusion supplies are more important than temperature during CPB. Despite documented evidence of hypothermia's inhibitory effects on platelet and coagulation factor function, the sole discernible distinction in coagulation test outcomes following CPB between normothermic and hypothermic groups in this investigation was a notable prolongation of aPTT in the hypothermic cohort. This prolonged aPTT post-CPB potentially signifies a subtle deterioration in hemostatic function within this group, a phenomenon not easily discernible through crude measures of blood loss and transfusion necessity. This study suggests that temperature during CPB

may play a less crucial role in determining perioperative blood loss and transfusion requirements than the duration of CPB itself. In summary, our findings, consistent with prior research, do not reveal any disparity in transfusion demands between normothermic and hypothermic CPB groups, despite conducting a prospective, randomized trial with comparable, relatively short CPB durations.[15-20]

CONCLUSION:

The result of the study shows that Normothermic CPB and Hypothermic CPB require the same amount of blood transfusion during CPB and postoperatively. Blood transfusion is non-significant with respect to temperature. But hypothermic patients bleed more during CPB than normothermic patients. Post-operative bleeding after 24 hours of CPB was same in both groups.

References:

1. Xiong, Y., Sun, Y., Ji, B., Liu, J., Wang, G. and Zheng, Z., 2015. Systematic Review and Meta-Analysis of benefits and risks between normothermia and hypothermia during cardiopulmonary bypass in pediatric cardiac surgery. Pediatric Anesthesia, 25(2), pp.135-142.
2. Lomivorotov, V.V., Shmirev, V.A., Efremov, S.M., Ponomarev, D.N., Moroz, G.B., Shahin, D.G., Kornilov, I.A., Shilova, A.N., Lomivorotov, V.N. and Karaskov, A.M., 2014. Hypothermic versus normothermic cardiopulmonary bypass in patients with valvular heart disease. Journal of cardiothoracic and vascular anesthesia, 28(2), pp.295-300.
3. Caputo, M., Bays, S., Rogers, C.A., Pawade, A., Parry, A.J., Suleiman, S. and Angelini, G.D., 2005. Randomized comparison between normothermic and hypothermic cardiopulmonary bypass in pediatric open-heart surgery. The Annals of thoracic surgery, 80(3), pp.982-988.
4. Ho, K.M. and Tan, J.A., 2011. Benefits and risks of maintaining normothermia during cardiopulmonary bypass in adult cardiac surgery: a systematic review. Cardiovascular therapeutics, 29(4), pp.260-279.
5. Corno, A.F., Bostock, C., Chiles, S.D., Wright, J., Tala, M.T.J., Mimic, B. and Cvetkovic, M., 2018. Comparison of early outcomes for normothermic and hypothermic cardiopulmonary bypass in children undergoing congenital heart surgery. Frontiers in Pediatrics, 6, p.219.
6. Amer, G.F., Elawady, M.S., ElDerie, A. and Sanad, M., 2020. Normothermia versus hypothermia during cardiopulmonary bypass in cases of repair of atrioventricular septal defect. Anesthesia Essays and Researches, 14(1), pp.112-118.
7. Mathew, P.J., Puri, G.D. and Dhaliwal, R.S., 2009. Propofol requirement titrated to bispectral index: a comparison between hypothermic and normothermic cardiopulmonary bypass. Perfusion, 24(1), pp.27-32.
8. "Cardiovascular diseases (CVDs)". World Health Organization. from the original on 10 March 2016. Retrieved 9 March 2016
9. "Portuguese Ordem dos Médicos- Medical specialties" (in Portuguese)
10. Caputo, M., Bays, S., Rogers, C.A., Pawade, A., Parry, A.J., Suleiman, S. and Angelini, G.D., 2005. Randomized comparison between normothermic and hypothermic cardiopulmonary bypass in pediatric open-heart surgery. The Annals of thoracic surgery, 80(3), pp.982-988.
11. Davidson's 2010, p. 525
12. Davidson's 2010, p. 554.
13. Mehta, R.H., Sheng, S., O'brien, S.M., Grover, F.L., Gammie, J.S., Ferguson, T.B. and Peterson, E.D., 2009. Reoperation for bleeding in patients undergoing coronary artery bypass surgery: incidence, risk factors, time trends, and outcomes. Circulation: Cardiovascular Quality and Outcomes, 2(6), pp.583-590.
14. Mohammadi, H. and Fradet, G., 2017. Prosthetic Aortic Heart Valves. Cardiovascular System, 5(1), p.2.
15. Moore, K.L., Dalley, A.F. and Agur, A.M., 2013. Clinically oriented anatomy. Lippincott Williams & Wilkins.
16. Starr, C., Evers, C. and Starr, L., 2015. Biology today and tomorrow with physi-

ology. Cengage Learning.
17. Pezawas, T., Rajek, A. and Plöchl, W., 2007. Core and skin surface temperature course after normothermic and hypothermic cardiopulmonary bypass and its impact on extubation time. European journal of anaesthesiology, 24(1), pp.20-25.
18. Oda, T., Yamaguchi, A., Yokoyama, M., Shimizu, K., Toyota, K., Nikai, T. and Matsumoto, K.I., 2014. Plasma proteomic changes during hypothermic and normothermic cardiopulmonary bypass in aortic surgeries. International Journal of Molecular Medicine, 34(4), pp.947-956.
19. Reyad, A.R. and Elgama, M.A.F., 2014. Neurological outcome of normothermic versus hypothermic cardiopulmonary bypass in simple congenital heart diseases. Ain Shams Journal of Anesthesiology, 7(4).Venes, D., 2009. Taber's Cyclopedic Medical Dictionary, Illustrated in full color. FA Davis Company.
20. World Health Organization, 2011. Cardiovascular diseases (CVDs): Fact sheet No. 317. 2011. Geneva: World Health Organization Google Scholar.