

Pre-operative blood donation versus acute normovolemic hemodilution in cardiac surgery

Mohammad Rezvan Nobahar,
Azita Chegini, Faranak Behnaz

Department of Cardiac Anesthesia
(Anesthesiology in Cardiac Surgery),
Shahid Modares Hospital, Saadat
Abad, Tehran, Iran

Address for correspondence:

Dr. Azita Chegini,
Anesthesiologist, Assistant Professor,
Cardiac Anesthesiology Department
Shahid Modares Hospital,
Saadat Abad, Shahid Beheshti
University, Tehran, Iran.
E-mail: azita_chegini@yahoo.com

ABSTRACT

Introduction: Acute normovolemic hemodilution (ANH) and preoperative autologous blood donation (PABD) have questionable efficacy, viral and bacterial infection risks, intermittent blood shortages as homeostasis problem, electrolyte and hemodynamic disturbances. **Materials and Methods:** In this cross sectional survey, we studied 70 patients undergoing open heart coronary artery bypass grafts [CABG] and different valvular replacement 1 ml surgery (35 in ANH, 35 in PABD) in Shaheed Modares - Hospital. We measured electrolytes and homeostatic factors to evaluate the influence of two transfusion methods on homeostatic function and hemodynamic balance. **Results:** We compared 70 patients (38 male [54.3%] and 32 female [45.7%]) with mean age 54.8 years undergoing open heart surgery (CABG and valvular). In ANH group, significant decrease was detected in Na (28.5%) K (2.5%), prothrombin time (PT) (88.57%), partial thromboplastin time (PTT) (94.28%), creatine phosphokinase (CPK) (11.4%), lactic dehydrogenase (LDH) (11.43%), albumin (Alb) (17.14%), globulin (91.43%) and total protein (80%). Mean initial and post-operative hemoglobin was 14.12 ± 1.06 versus 11.97 ± 0.98 , hematocrit 42.22 ± 3.45 versus 35.40 ± 2.88 , systolic blood pressure 124.1 ± 14.4 versus 110.88 ± 15.6 (reduction 22.86%) diastolic blood pressure 76.02 ± 10 versus 69.26 ± 11 (reduction 3%) and pulse rate was 75.45 ± 10 versus 84.45 ± 12 (12%) in this case difference between two groups was strongly significant ($P = 0.001$). In PABD group, significant decrease was detected in Na (20%), K (2.5%), PT (91.43%) PTT (80%), CPK (8.57%), LDH (5.72%), Alb (57.15%), globulin (71.43%) and total-protein (62.85%), the value of hemodynamic changes were in normal range. **Conclusion:** Though autologous blood transfusion (ANH and PABD) was preferable to allogeneic transfusion in cardiac surgical patients; but PABD offers more advantages in homeostasis, hemodynamic stability and electrolyte balance.

Key words: Acute normovolemic hemodilution, autologous transfusion, pre-operative autologous blood donation, cardiac surgery

INTRODUCTION

Major cardiovascular operations are with considerable blood loss and the allogeneic blood transfusion is a common well-recognized technique to compensate. Allogeneic blood transfusions are related with questionable efficacy, viral and bacterial infection risks, intermittent blood shortages and considerable

cost.^[1-3] Hence, various alternatives as acute normovolemic hemodilution (ANH) and pre-operative autologous blood donation (PABD) have been employed to decrease allogeneic transfusion.^[4-6] In PABD method, patients gave two to four units of autologous blood several weeks before surgery, whereas in ANH method, anesthesiologists phlebotomize one to two units from patients in the operating room. In this technique ANH each 1 ml of whole blood is replaced with 3-4 ml of crystalloid or 1 ml colloid solutions at the same time.^[1,7-9] Some studies have compared PABD and ANH techniques and showed these techniques protect against allogeneic transfusion, however, these studies have not proven which method is preferred.^[1] Hence, in this survey, we compared the limits and possible clinical uses of PABD and ANH focusing on open heart cardiac surgery patients.

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MATERIALS AND METHODS

In this cross-sectional survey, we studied 70 patients undergoing open heart surgery coronary artery bypass grafts [CABG] single and multiple and different valvular replacement in two groups (A and B) in cardiac surgery department of Shaheed Modares University Hospital.

- Group A: In ANH group, hemoglobin (Hb) and hematocrit (Hct) were measured in all patients before surgery. In patients with Hb between 12 and 16 g/dl we took one unit of blood and in patients with Hb >16 two units of blood were taken before operation. When patients were hemodynamically stable, 1 ml of whole blood removed being replaced with 3 ml.
- Group B: Patients undergoing PABD, 17 days before the operation patients donated one unit blood and 14 days later take a ferrous sulfate tablet and 72 hours before operation they donated second unit blood. The entitled patients for ANH and PABD were required to have pre-operative Hb about 12 g/dl or higher. Those who had the history of severe myocardial ischemia, unstable angina, oncological disorder and severe anemia were excluded from the study. One autologous unit was assumed to contain 450 ml of whole blood. The results obtained from application of the model for PABD, ANH were subjected to regression analysis and tested for parallelism of slopes. $P < 0.05$ were accepted to indicate a significant difference between slopes.

RESULTS

Totally, we compared 70 patients (38 male [54.3%] and 32 female [45.7%] mean age 54.8) undergoing open heart surgery (CABG and valvular). In ANH group, significant decrease was detected in Na (28.5%) maximum and minimum decreasing in Na level was 9 and 1 mEq/l (milli equivalent/l) respectively, in addition K (2.5%), prothrombin (PT) (88.57%), partial thromboplastin time (PTT) (94.28%), creatine phosphokinase (CPK) (11.4%), lactic dehydrogenase (LDH) (11.43%), albumin (Alb) (17.14%), globulin (91.43%) and total protein (80%) of patients had remarkable decreasing. In ANH group, mean initial and post-operative Hb level was 14.12 ± 1.06 versus 11.97 ± 0.98 and mean Hct level was 42.22 ± 3.45 versus 35.40 ± 2.88 . Moreover, pre- and post-operative systolic blood pressure was 124.1 ± 14.4 versus 110.88 ± 15.6 (reduction 22.86%) also, pre- and post-operative diastolic blood pressure was 76.02 ± 10 versus 69.26 ± 11 (reduction 3%). As well post-operative pulse rate decreased 12% (75.45 ± 10 vs. 84.45 ± 12). Regarding pre- and post-operative Hb, Hct, blood pressure and pulse rate differences were strongly significant ($P = 0.001$).

In PABD group, mean pre- and post-operative level of Hb was 14.37 ± 0.93 versus 13.05 ± 0.83 , Hct 44.07 ± 3.20 versus 39.57 ± 3.08 , systolic blood pressure 124.7 ± 12.7 versus 115.9 ± 10.6 , diastolic blood pressure 75.4 ± 7 versus 71.9 ± 6 and pulse rate was 71.05 ± 6.7 vs. 78.2 ± 5.5 . The value of changes regarding pre and post-operative of Hb, Hct, blood pressure and pulse rate were in normal range. In PABD group, post-operative level of Na decreased 20% ranged 135-145 maximum decreasing 9 mEq/l, K decreased (2.5%) (maximum decreasing = 0.7), PT (91.43%) PTT (80%), CPK (8.57%), LDH (5.72%), Alb (57.15%), globulin (71.43%) and total protein decreased 62.85% [Tables 1 and 2].

DISCUSSION

Blood loss during cardiac surgery procedures can be extensive and the need for allogeneic blood is an ordinary necessity. However, blood transfusion obscures a number of well-known risks and complications and blood products have become more costly because of their specific preparation procedures.^[1,2,11] In this case, anesthesiologists developed other alternatives like AHN and PABD methods.^[11] In the current survey, we compared patients undergoing AHN and PABD to discuss their similarities and to predict their efficacy in current clinical practice, also suggest guidelines based on anticipated operative blood loss. Based on our results, ANH and PABD because of protection against bacterial and viral infection as well absences of allogeneic and hemolytic reactions are preferred to homologous transfusion. In addition we showed PABD was preferable to ANH regarding pre and post-operative CPK and LDH levels,

Table 1: Percent distribution of patients in each group (according to decrease of results lab tests)

Number of patients	Na	K	PT	PTT	CPK	LDH	Alb	Glo	Total protein
ANH 35 (no) %	28.5	2.5	88.57	94.28	11.4	11.43	17.14	91.43	80
PABD 35 (no) %	20	2.5	91.43	80	8.57	5.72	57.15	71.43	62.8

ANH: Acute normovolemic hemodilution; PABD: Pre-operative autologous blood donation; LDH: Lactate dehydrogenase; PT: Prothrombin time; PTT: Partial thromboplastin time; CPK: Creatine phosphokinase; Alb: Albumin; Glo: Globulin

Table 2: Distribution of change hemodynamic's patients

number of patients	Systolic blood pressure	Diastolic blood pressure	Heart rate increases
ANH (N=35)	22.86% decrease	3% decrease	12% increase
PABD (N=35)	Normal range	Normal range	Normal range (no change)

ANH: Acute normovolemic hemodilution; PABD: Pre-operative autologous blood donation

Furthermore, considering pulse rate and blood pressure. On the other hand, ANH was preferable to PABD regarding the changes of Alb, PT, Hct, Hb parameters. However, regarding PTT, total protein and globulin values we did not detect any differences between PABD and ANH. Billotte in a study showed PABD exemplifies a “chronic” form of ANH in current clinical practice and offers little advantage over ANH as a blood conservation technique for high-blood-loss operations. Furthermore, he showed When surgical blood loss is predictably mild to moderate (range 250-1,000 ml), neither blood conservation technique is necessary.^[11] In other study, Goodnough *et al.* showed ANH is safe and can be considered equivalent to PABD in effectively reducing exposure to allogeneic RBCs and is less costly than PABD.^[12] Oga *et al.* in a study showed that allogeneic blood products (units, platelets, fresh frozen plasma, cryoprecipitate) and PABD have inherent risks associated with blood bank collection, processing and storage.^[13] Other study by Epstein in 2008 showed ANH reduced allogeneic transfusion requirements from 79% to 37%.^[14] Segal *et al.* in a study in review of 42 trials compared hemodilution to usual care or to another blood conservation method and showed: The risk of allogeneic transfusion was similar among patients receiving ANH and those receiving usual care or another blood conservation method. However, hemodiluted patients were transfused from 1 to 2 fewer units of allogeneic blood and they had less total bleeding than patients receiving usual care although more intraoperative bleeding, also only one-third of studies reported adverse events.^[15] Consequently, Though autologous blood transfusion (ANH and PABD) was preferable to allogeneic transfusion in cardiac surgical patients; but PABD offers more advantages in homeostasis, hemodynamic stability and electrolyte balance compared with ANH group.

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