

MODERATE ACUTE NORMOVOLAEMIC HAEMODILUTION – A LIMITED EXPERIENCE WITH AUTOLOGOUS BLOOD TRANSFUSION

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ABSTRACT

Introduction: Blood is transfused to increase the oxygen carrying capacity and the intravascular volume. The requirement of blood transfusion is not simply dependent upon the haemoglobin or haematocrit values but the emphasis is also placed upon the age and health of the patient. The potential risks of blood transfusion have necessitated finding alternatives to allogeneic blood transfusion. This study was conducted to determine the efficacy and safety of moderate acute normovolemic hemodilution to reduce allogeneic red blood cells transfusion in operations in which blood transfusion was otherwise required. It is an interventional clinical trial. The study was carried out in the department of anaesthesia, operation theatre and intensive therapy care unit, Combined Military Hospital, Okara Cantt, during the period from January 2003 to October 2003. **Materials and Methods:** Twenty five patients of ASA-I and II status, who were undergoing elective surgical procedures, were subjected to the technique of moderate acute normovolaemic haemodilution. The intravascular volume of the patients was maintained with lactated Ringer's solution and 6% hexaethyl starch solution. Autologous blood was reinfused after the operation. **Results:** All patients in this study remained haemodynamically stable. No patient required any homologous blood transfusion. Moderate ANH was found a useful, safe and economical technique. It can be used as an alternative technique in operations in which homologous blood is otherwise required.

INTRODUCTION

Blood is transfused to increase the oxygen carrying capacity and the intravascular volume. The requirement of blood transfusion is not simply dependent upon the haemoglobin or haematocrit values but the emphasis is also placed upon the age and health of the patient.^{1,2} There is an agreement upon that otherwise healthy patients with a haematocrit value greater than 30% rarely require preoperative blood transfusion, whereas patients with acute anaemia having haematocrit of less than 21% frequently require blood transfusion.³

Blood to be transfused may be homologous or autologous. The inherent risks of blood transfusion have led to concerted efforts to find alternatives to allogeneic blood transfusion. Autologous blood is assumed to be much safer than homologous blood because of the decreased risk of potential complications of blood transfusion. There are 3 types of autologous blood transfusions, preoperative blood donation, acute normovolaemic haemodilution (ANH) and intra and postoperative blood salvage. The term

acute normovolaemic haemodilution refers to the removal of blood from the surgical patients immediately before or after the induction of anaesthesia, replacement with exanguinous fluid and later on retransfusion of the withdrawn blood. Moderate ANH is suggested to be considered for any patient who is otherwise healthy, has adequate preoperative haemoglobin and is expected to lose more than 25% of estimated blood volume.

This study was conducted at Combined Military Hospital, Okara Cantt to determine the efficacy and safety of moderate acute normovolaemic haemodilution in operations in which blood transfusion was otherwise required.

PATIENTS AND METHODS

This interventional clinical trial was performed at CMH, Okara Cantt from Jan 2003 to Oct 2003. Twenty five patients of ASA-I and II status who were undergoing elective general surgical, gynecological and orthopaedic surgical procedures (Table 1) were included in the study. Seventeen patients were

male and eight were female having ages ranging from 18 to 60 years (mean age 43.52 ± 12.2 years). Patients having emergency operations, haemoglobin less than 10 g/dl (Hct 30%), renal and respiratory diseases, history of taking anti-coagulants and age less than 18 years were excluded from the study.

Table 1: Types of operations ($n = 25$), performed.

Abdominal Hysterectomy	05 (20%)
Cystic Hygroma	01 (04%)
Fracture Femur / Tibia (open reduction)	05 (20%)
Laparotomy	03 (12%)
Pheochromocytoma	01 (04%)
Prostatectomy	03 (12%)
Thyroidectomy	04 (16%)
Varicose Veins	03 (12%)

Informed consent was taken from every patient and general anaesthesia was induced before withdrawing the blood. Size 16G catheter was placed in right internal jugular vein which was used for withdrawal of blood, monitoring CVP and administration of fluids. In patients undergoing neck surgery, size 18G cannula was placed in femoral vein. Patient's estimated blood volume (EBV), preoperative Hct and lowest desired Hct were considered when blood was withdrawn. In this study lower limit of Hct was kept near 30. Allowable blood loss (ABL) was calculated for each patient and same quantity of blood but not more than 1500 ml was withdrawn with the help of 50 ml syringe and collected into the blood bags. Blood bags were labelled with patient's name; time of blood collected and kept in the same operation room at room temperature. Hct level and Hb concentration were checked thrice, preoperatively, after haemodilution and at the end of re-transfusion of patient's own blood. For each pint of withdrawn blood 1 liter crystalloid solution and 0.5 liter colloid solution (HAES) were given intravenously. In addition fluid deficit, maintenance fluid and intra-operative fluid losses were replaced with crystalloid solutions. Intra-operative monitoring included pulse oximetry, ECG, BP, SpO₂, ETCO₂, CVP, body temperature and urine output. Blood was re-transfused in the reverse order of collection at the end of operation. After the operation patients were kept in the recovery room until full recovery and re-transfusion, and then shifted to surgical ITC.

RESULTS

The data was fed in MS Excel 2002. Mean values, standard deviation and P-values were accordingly drawn. Paired t-test was used to calculate p-values. P-values less than 0.05 were considered as signifi-

cant. Mean Hb concentration and mean Hct after haemodilution were 11.4 ± 1.05 gram/dl and 33.16 ± 3.11 respectively. Mean haemoglobin concentration and Hct recorded before operation, after haemodilution and after re-transfusion are shown (Table 2). All the patients remained haemodynamically stable peroperatively and none of them required allogeneic blood transfusion. Even a case of pheochromocytoma successfully underwent ANH. Considering uncertainty about anticipated blood loss, homologous blood was arranged for that patient, although not demanded for transfusion. In this study moderate ANH was found to be a very useful, safe and economical technique.

Table 2: Demographic data of the patients undergoing ANH ($n = 25$).

	Hemoglobin, gm/dl (mean values)	Hematocrit (mean values)
Pre-operative	13.82 ± 1.24	41.52 ± 3.56
After Haemodilution	11.4 ± 1.05	33.16 ± 3.11
After Re-transfusion	12.58 ± 0.99	37.20 ± 3.61

DISCUSSION

The technique of autologous transfusion was used only as a life saving measure especially in patients of haemothorax, where blood was salvaged and re-transfused.⁴ Later on the technique was refined and in 1974 the cell saver system was introduced.⁵ The role of anaesthetist is evolving in acute normovolaemic haemodilution but very few papers appeared in medical literature on this technique, particularly in Pakistan.^{6,7} ANH as compared to other autologous transfusion techniques is simple, more convenient and economical as is proved in this study. It not only reduces the cost of laboratory tests but also safeguards the patients against the possible complications of blood transfusion. In one study it was observed that by using ANH technique, there was a decreased requirement (up to 20 to 90%) of allogeneic blood transfusion.⁸ In our study of 25 patients, none of them required any allogeneic blood transfusion, because Hct of the patients after retransfusion remained only 5 – 10% lower than that of pre-operative Hct values. In another larger non randomized study of 250 patients; Monk et al found the two techniques, preoperative autologous blood donation (PABD) and ANH, comparable in decreasing the requirement of allogeneic transfusion and also demonstrated that ANH was more cost effective than PABD. Autologous predonation is an extra expense for the patient. In addition the clerical error,

which is the major cause of incompatible blood transfusion, is not eliminated.⁹ Other studies reported decreased number of allogeneic blood units transfused in ANH patients.¹⁰ Although withdrawal of blood and its replacement with acellular fluid may cause reduction in Hb concentration and oxygen content but oxygen delivery is usually unaffected as tissue perfusion is increased due to decreased viscosity. Oxygen delivery to the tissues is most pronounced at Hct value of 30 – 33%, that is why the Hct after haemodilution was kept around 30% in this study. Crystalloids and/or colloids may be used as replacement fluids. Colloids have the primary advantage of longer intravascular retention and can be infused equal to the amount of blood removed. Hemodynamic studies comparing dextran, albumin and hydroxyethyl starch solution have demonstrated no significant differences among diluents.¹¹

ANH has successfully been used in patients of all age groups where overall health of the patients was good.¹² In Pakistan moderate ANH at present is being practiced in patients undergoing cardiac operations such as CABG, valvular surgery and paediatric cardiac surgery.¹³ Moderate ANH in addition to cardiac surgery can be used in all operative procedures in which blood transfusion is anticipated. There are studies in which ANH technique was used in patients undergoing operations in spinal or epidural anaesthesia along with induced hypotension.^{14,15} Acute normovolaemic haemodilution is a safe alternative that eliminates the risks of mistransfusion, minimizes the shed red cell mass when bleeding occurs and reduces the risk of perioperative transfusion. At present efficacy of ANH seems uncertain because of a lack of controlled trials, nevertheless in future the technique may be a necessary companion of oxygen carrying solutions.¹⁶

It is **Concludes** that the technique of moderate ANH was found practicable, useful and very economical in this study. All the patients remained haemodynamically stable and no patient required homologous blood. Patient safety is increased by ANH and there is less requirement of allogeneic blood transfusion. At present all anaesthesiologists know about the technique but very few are practicing it. As the incidence of viral hepatitis is on the increase and the number of healthy blood donors is becoming limited, it is suggested that the technique of moderate ANH may be practiced more frequently.

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