

# AUTOLOGOUS BLOOD TRANSFUSION: A REVIEW OF LITERATURE

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## Abstract

**Background:** The purpose of this article is to review the literature regarding autologous blood transfusion.

**Materials and Methods:** An electronic search was performed for articles related to autologous blood transfusion, published from January 1950 to March 2016. Recommendations of British Committee for Standards in Haematology and American Association of Blood Banks were also included during preparation of the manuscript.

**Results-** 80 articles were obtained by electronic search. Publications were evaluated regarding appropriateness of content for preparing this review.

**Conclusion-** Autologous blood transfusion can be a safe and effective alternative to allogenic blood transfusion. The safety and efficacy of autologous blood transfusion is well established. Sufficient literature is present regarding this technique in journals related to blood transfusion. Still the use of this technique is under practiced in oral & maxillofacial surgery units. Lack of sufficient documentation in journals of surgery might be the reason for this. The technique of autologous blood transfusion should be considered in routine whenever possible. There is sufficient literature related to safety and efficacy of autologous blood transfusion. This method can be a safe alternative to allogenic blood in selected patients, and thus conserve the allogenic blood pool.

**Key Words:** - Autologous Blood Transfusion, Predeposit Autologous Blood Donation, Acute Perioperative Normovolaemic Haemodilution, Perioperative Cell Salvage.

## Introduction

The use of autologous blood donation prior to elective surgeries has been increased over the past decade.<sup>1</sup> There is significant reduction in adverse transfusion reactions attributed to allogenic blood.<sup>2</sup> These complications are immunosuppression, increased recurrence of malignancy, increased infections postoperatively, transmission of HIV infection, transient hypotension and decreased cell mass.<sup>3-6</sup> The purpose of this article is to present a review of literature regarding methods, indications, contraindications, advantages, and disadvantages of autologous blood transfusion.

## Materials and Methods

An electronic search was performed for articles, published from January 1950 to March 2016. Recommendations of British Committee for Standards in Haematology and American Association of Blood Banks were also included during preparation of the manuscript. The following key words and Boolean operators were used: "Autologous blood," "Autologous blood donation," "Autologous blood transfusion," "Predeposit blood donation," "Predeposit autologous blood donation," "Acute perioperative normovolaemichaemodilution," "Perioperative Normovolaemic haemodilution," "Normovolaemic haemodilution," "Perioperative cell salvage," "Preoperative cell salvage," "Postoperative cell salvage," and "Cell salvage."

## Results

Although there were enormous documentations regarding blood donations, 80 articles related to autologous blood donation were critically studied. Articles were evaluated regarding appropriateness of content for preparing this review.

## Discussion:

### Types of Autologous Blood Transfusion (ABT)

Three methods of autologous blood transfusion are (i) Predeposit Autologous Blood Donation (PABD), (ii) Acute Perioperative Normovolaemic Haemodilution (APNH), and (iii) Perioperative Cell Salvage (PCS).<sup>7</sup>

### Predeposit Autologous Blood Donation (PABD)

Predeposit Autologous Blood Donation (PABD) method involves preoperative deposition of autologous blood based on collection time schedule for a particular patient. Collection time schedule is based on the type of surgical procedure, number of blood units required, and haematological status of the patient. The design of collection time schedule is such that, it minimizes the collection time and maximizes the length of time between the surgical procedure and last blood donation.<sup>8</sup>

Patients should be informed regarding the procedure, its potential risk and benefits. Preoperative assessment of these patients is based on American Association guidelines for autologous blood donation. Patients should be assessed by physician prior to PABD.<sup>9</sup>

PABD method involves repeated preoperative phlebotomy to collect patient's blood. It can start 4-5 weeks before the scheduled surgery, during this time period 4-5 units of autologous blood can be collected and stored.<sup>10</sup>

The first blood donation occurred no more than 35 days prior to surgery. At least 4 days gap must be present between last donation and the surgery. Monitoring of haematocrit and haemoglobin is required before each autologous blood donation. Blood collection and storage was based on the American Association of Blood Banks requirements.<sup>11</sup>

The prerequisites for PABD method are medical fitness of the patient, confirmed date for surgical procedure, good intravenous access, and absence of anemia prior to first blood donation.<sup>12,13</sup>

To reduce the complications associated with PABD, British Committee for Standards in Haematology (BCSH) advocated few exclusion criteria. The contraindications for PABD method are cardiovascular, respiratory, and cerebrovascular diseases. Prior to PABD, patients should be assessed to rule out diseases of these systems and any other active infections. Intrauterine growth retardation, pregnancy with impaired placental flow, pregnancy related hypertension, renal diseases, preeclampsia, and insulin-dependent diabetes mellitus are other relative contraindications.<sup>12,13</sup>

PABD procedure leads to anemia in between the donation periods. Therefore, patients should be prescribed iron supplementation (300 mg ferrous sulfate 1-4 times daily by oral route). Multiple unit donors should receive 1000 µg of Vit. B-12 intramuscularly, and folic acid supplementation orally.<sup>14</sup>

PABD method reduces the exposure to allogenic blood. Therefore, it avoids risks associated with allogenic transfusions like transmission of infections and immunization to red cells, platelets & HLA antigens etc. Preoperative donation of blood leads to reduction in haematocrit and viscosity of the blood. This improves the microcirculation and tissue perfusion, and therefore, decreases the risk of thromboembolism. PABD is extremely safe, not requiring cross matching and avoid iso-immunization to foreign proteins. Allogenic blood units of general population pool are conserved.<sup>15</sup> The disadvantages of the PABD method are wastage of unused units, trauma to patient due to multiple venepunctures and increased risk of angina and severe vasovagal reaction during blood donations.<sup>16</sup>

The amount of blood collected and stored should be proportional to child's weight. Based on this principle a young patient is not predisposed to any greater risk of complications with PABD.<sup>17,18</sup> PABD in older patients for elective surgeries is common. Review of literature established the safety of PABD method in older individuals. These patients were not predisposed to greater risk as compared to other age groups.<sup>19-22</sup> Safety of PABD method can be judged from the fact that, few authors stated that for older individuals there is no definite requirement for specific medical examination and approval by the physician prior to PABD.<sup>14,23</sup>

#### **Acute Perioperative Normovolaemic Haemodilution (APNH)**

Acute Perioperative Normovolaemic Haemodilution (APNH) method involves removal of blood from the patient immediately prior to operation and simultaneous maintenance of circulating volume with an appropriate volume of colloid or crystalloid solution. The autologous blood collected was transfused to the patient toward the end of operation or postoperatively.<sup>13,24</sup>

APNH method can be considered in medically fit patients of any age group. APNH method is usually restricted for those surgical procedures in which substantial blood loss (> 1 liter or 20% of blood volume) is predicted. It should not

be considered in patients who are anaemic preoperatively [Haemoglobin (Hb) < 11.0 g/100 mL].<sup>13</sup> Patients with congestive cardiac failure and who were either unable or unwilling to give informed consent must also be excluded.<sup>25</sup> APNH method require establishment of central venous line and peripheral intravenous access. Usually two units of autologous blood are withdrawn from the central intravenous line. The collected blood units are mixed with anticoagulant and stored within the operation theatre.<sup>25</sup> The amount of blood to be withdrawn depends on target haematocrit. It can be calculated by formula

$$V = EBV \times [(H_o - H_f) / H_{av}]$$

[Where V= volume to be withdrawn, EBV = estimated blood volume (usually taken as 70 mL/kg body weight), H<sub>o</sub> = Initial Hb, H<sub>f</sub> = desired Hb and H<sub>av</sub> = average Hb (mean of H<sub>o</sub> and H<sub>f</sub>)].<sup>7</sup>

Simultaneous to blood collection procedure, appropriate volume of either crystalloid or colloidal fluids must be administered to maintain the circulatory blood volume. The volume of intravenous fluid used should be titrated to maintain constant heart rate, monitored by arterial pressure and electrocardiography (ECG) tracing. The blood can be stored within the operation theatre for up to 6 hours. APNH method can be employed simultaneously with other procedures like positioning of patient on operating table, patient preparation with betadine and draping etc.<sup>25</sup> Intraoperative blood loss should be simultaneously replaced with either crystalloid or colloidal solutions to maintain central venous pressure (CVP). Intraoperative blood loss can be measured by swab weighing method and adding the amount of blood collected in suction machine jar. Toward the end of operation, reinfusion of collected autologous blood started. Indication of allogenic blood if required is Hb < 8.0 gm/100 ml.<sup>25</sup>

APNH method has all the advantages of preoperative autologous blood donation (PABD) along with additional benefits.<sup>26</sup> The APNH method has no adverse effect and reduces the need for allogenic transfusions. It spares the patient from some known risks attributed to allogenic transfusion. These include variant Creutzfeldt- Jakob's Disease (vCJD), viral hepatitis and human immunodeficiency virus (HIV).<sup>25</sup>

Parkin et al. performed a comparative study to assess the need for allogenic blood transfusion in experimental group (undergoing APNH) and historical group (without APNH). They reported that, only 1 out of 21 patients who had APNH required allogenic blood. Whereas, 15 out of 24 patients in historical group require allogenic blood transfusion. The criterion to infuse allogenic blood was based on Hb estimation done during postoperative period. Any patient with Hb < 8.0 gm/100 ml was given allogenic blood to bring the Hb level > 10 gm/100 ml.<sup>25</sup>

Habler et al. evaluated APNH method for major maxillofacial surgical procedures. They showed that, APNH method reduces the need for allogenic blood transfusion in 89% of the patients.<sup>27</sup> In cardiovascular and

orthopaedic surgeries the need for allogenic blood transfusion has been reduced after extreme haemodilution.<sup>28</sup> In cancer patients, allogenic blood transfusions are better avoided because of its reported immunosuppressive effects. The immunosuppressive effect of allogenic blood was first described in 1970s after kidney transplant procedure. The increase in recurrence rate in lung, breast, colorectal and renal cancers has been co-related with the use of allogenic blood. Related to oral and maxillofacial surgery there are only small number of retrospective studies that compare the recurrence rate of head and neck cancers with the use of allogenic blood. The results were conflicting because a number of variables can affect the rate of recurrence.<sup>29,30</sup> Szakmany et al<sup>30</sup> and Taniguchi et al<sup>31</sup> have suggested that, transfusion of 3 or more units of allogenic blood might worsen the prognosis in patients operated for cancers of head and neck. They also reported that, a dose related immuno-suppression was the probable cause. Another advantage of APNH in patients with cancer of head and neck is greater survival of the free flaps. The greater survival rates have been attributed to iatrogenic anaemia and subsequently decreased viscosity of the blood.<sup>25</sup> Earle et al was the first to report that, survival rates of skin flaps improved secondary to reduced viscosity of the blood. They hypothesized that flow of blood in the flap is inversely proportional to blood viscosity. Haemoglobin (Hb) present in the RBCs is the main component which governs viscosity of blood; so haemodilution reduces Hb concentration and viscosity of blood, which improve flap survival.<sup>32</sup> Animal studies, were performed to evaluate the effect of haemodilution on microcirculation of blood and survival of flaps. These studies revealed that, anaemic state can be an effective method to improve survival of flaps.<sup>33-35</sup> Qiao et al performed free flap procedures after APNH and autologous blood reinfusion. They reported that, 93.3% flaps survived out of 30 free flaps.<sup>36</sup> There is a disadvantage of haemodilution following APNH method. Haemodilution can affect oxygen transport. Although, simultaneous drop in blood viscosity of blood and increased cardiac output compensate to restore oxygen delivery, it predisposes the patient to myocardial infarction in compromised high risk patients.<sup>16</sup> Degoute C. advocated additional measures to further reduce the blood loss during surgery. These measures are good communication with anesthetist and meticulous surgical technique. During general anaesthesia controlled hypotension is indicated to further reduce the blood loss intraoperatively. This is achieved by positioning of patient and use of combination of various anesthetic agents.<sup>37</sup> To reduce the blood loss in maxillofacial procedures, patients should be positioned in 30 degree head up position with legs at the level of heart.<sup>25</sup> Ultrasonic scalpel as an advancement tool further helped to reduce intraoperative blood loss.<sup>38</sup> Use of fibrin sealants has been found to be efficacious in reducing blood loss during postoperative period and reduce the need for blood transfusion.<sup>39</sup>

#### **Perioperative Cell Salvage (PCS)**

Perioperative Cell Salvage (PCS) includes: Intraoperative

Cell Salvage (ICS) and Postoperative Cell Salvage (PCS). In ICS the blood lost at the time of surgery is collected and concentrated RBCs are reinfused back to the patient after processing. The shed blood is collected in a specially designed centrifuge with the help of an aspirating machine. Heparin or citrate anticoagulant is added and mixed together. The contents are further filtered to remove debris and clots of blood. The centrifugation of this blood-coagulant mixture concentrates the salvaged RBCs. These concentrated RBCs are saline washed and reinfused. Postoperative cell salvage (PCS) utilizes the blood recovered from wound drains and salvaged RBCs reinfused back to the patient after appropriate processing.<sup>10</sup>

Infection of the operative field and presence of malignant cells are relative contraindications for PCS. However, data reported in literature revealed that, dissemination of malignant disease after PCS is minimal.<sup>16</sup> There are few disadvantages associated with PCS method. Dilution of extravasated blood by irrigation fluids used during surgery and mechanical haemolysis leads to decreased haematocrit of unprocessed salvaged blood.<sup>40</sup> Once extravasated blood come in contact with serosal tissue surfaces during operation, there is depletion of platelets and coagulation factors. Reinfusion of salvaged blood can lead to "Salvaged Blood Syndrome" characterized by multiple organ failure and stage of consumption coagulopathy.<sup>10</sup>

Qualitative abnormalities in the coagulation often present in patients receiving greater volume of salvaged blood are hypofibrinogenaemia, thrombocytopenia, elevated fibrin degradation products, prolonged prothrombin time and elevated partial thromboplastin time.<sup>41</sup>

During open cardiac surgeries, the mediastinal blood may have very high levels of cardiac muscle enzymes like creatine phosphokinase. Also, levels of lactate dehydrogenase are elevated because of haemolysis of RBCs.<sup>42</sup> The reinfusion of salvaged mediastinal blood can confound the diagnosis of myocardial infarction because of increased levels of cardiac enzymes in blood.<sup>43</sup>

PCS can be an efficacious and safe alternative to allogenic RBCs transfusion, if proper standards are followed. This method has the advantages of haemodilution similar to that of APNH. Also, large quantity of blood can be salvaged during operation and postoperatively far greater than any other autologous blood transfusion method. AS PCS is a relatively expensive method, it is usually restricted to those surgical procedures involving substantial blood loss (> 1-2 liters). This method was extensively used in cardiac surgeries, liver transplantation and trauma surgeries.<sup>10</sup>

#### **Conclusion**

Autologous blood transfusion can be a safe and effective alternative to allogenic blood transfusion. The safety and efficacy of autologous blood transfusion is well established. There is adequate literature regarding this technique in journals related blood transfusion. Still the use of this technique is under practiced in oral & maxillofacial surgery units. Lack of sufficient documentation in journals of surgery might be the reason for this. Oral & Maxillofacial Surgeons should consider autologous blood transfusion

technique in routine whenever possible. This method can be a safe alternative to allogenic blood in selected patients, and thus conserve the allogenic blood pool.

#### **Ethical Approval**

Not required.

#### **Conflict of Interests**

The authors declare no conflict of interest.

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