

## Original Articles

# An Ultrafiltration Technique for Directly Reinfusing Residual Cardiopulmonary Bypass Blood

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**Abstract:** Given the shortages of banked blood, the risks of transfusion reactions, disease transmissions, and transfusion errors, we perfusionists must find ways to avoid blood transfusions. At the end of any given bypass run, there is residual blood left in the bypass circuit, the perfusionist must get this blood back to the patient. Most commonly either a cell saver or a hemoconcentrator (HC) has been used, in some fashion, to reinfuse residual circuit blood. The ideal method should: 1) be simple; 2) raise the hematocrit (HCT); 3) allow for changes in the patient's volume status; and 4) not compromise the integrity of the cardiopulmo-

nary bypass (CPB) circuit allowing for rapid re-institution of CPB. We describe a technique in which residual CPB circuit blood is pumped through an HC directly to the patient via a 3/16-inch diameter line into a 16-gauge intravenous needle positioned in a peripheral or central vein. This allows the perfusionist to give back concentrated blood that is protein-rich while maintaining the above criteria. **Keywords:** blood conservation, hemoconcentrator, hemofiltration, cardiopulmonary bypass, ultrafiltration. *JECT. 2004;36:231–234*

## INTRODUCTION

The percentage of patients undergoing coronary artery bypass surgery receiving packed red blood cells (PRBCs) ranges from 27–92%, depending on the institution (1). It is of the utmost importance to use blood conservation techniques to reduce exposure to banked blood products. Upon termination of cardiopulmonary bypass (CPB), the perfusionist is faced with the dilemma of how to process the blood volume left in the CPB circuit. Because of the priming volume required by CPB circuits and the hemodilution that follows, some measure should be taken to hemoconcentrate this residual blood. Most commonly, either a cell saver or an HC has been used in some fashion to reinfuse residual circuit blood. The ideal method should be simple, raise the hematocrit (HCT), allow for changes in the patient's volume status, and not compromise the integrity of the CPB circuit allowing for rapid re-institution of CPB. We describe a technique that allows

for returning residual circuit volume back in a concentrated, controlled fashion, while maintaining the integrity of the CPB circuit.

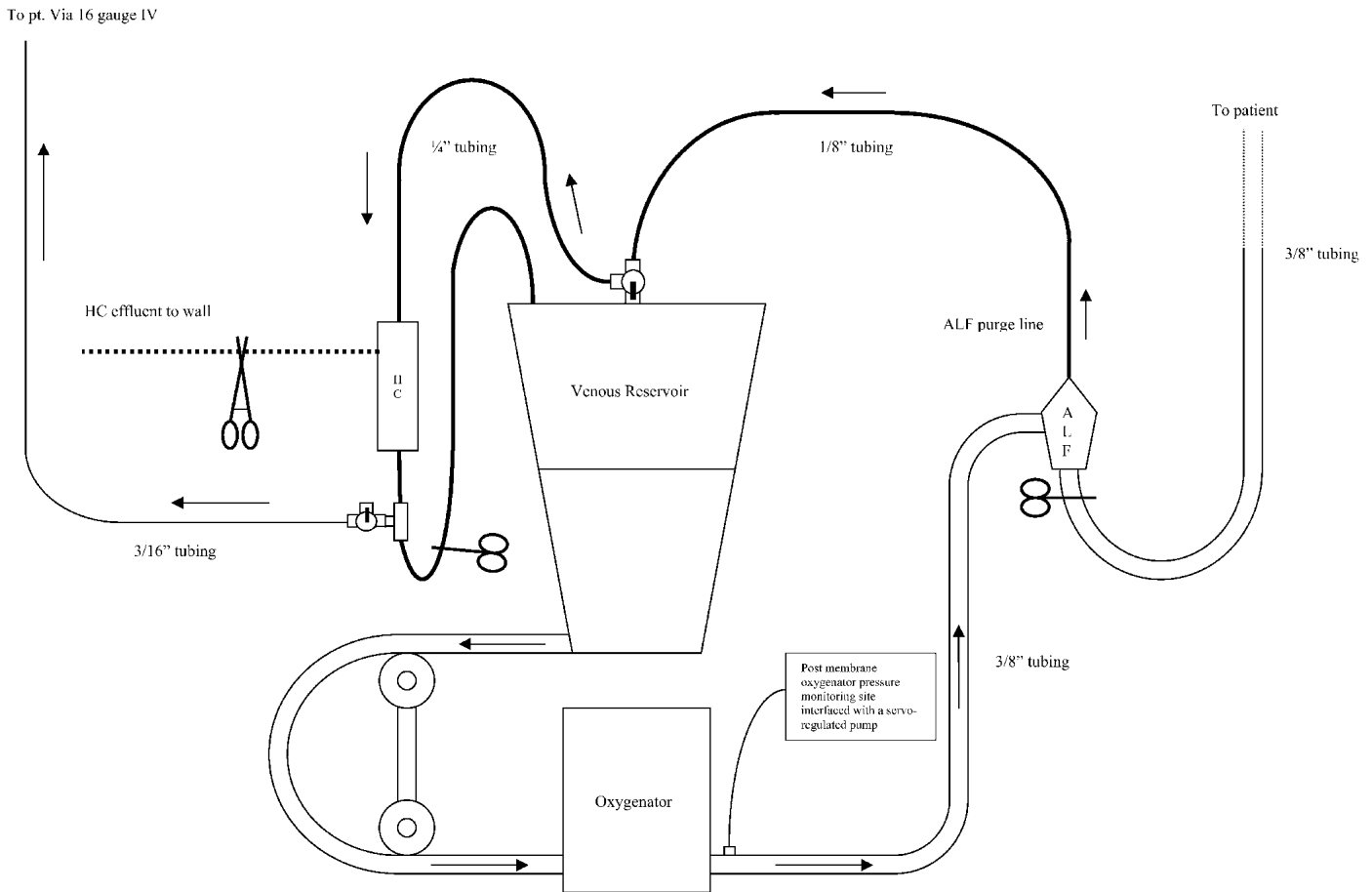
## DESCRIPTION

### Equipment

The circuit (Figure 1) consists of a ½-inch venous line, which returns to a COBE Duo oxygenator with an integral hard-shell venous reservoir (COBE Cardiovascular Inc., Arvada, CO). A Jostra HL 20 (Jostra Bentley Corp., Irvine, CA) heart–lung machine with an arterial roller pump is used for blood reinfusion via a 3/8-inch arterial line and through COBE Sentry arterial line filter (ALF). A COBE HC 1400 Maxi HC is connected to a stopcock on the ALF purge line and is returned to the venous reservoir. The heart–lung machine is servo-regulated for post-membrane oxygenator pressure, air bubble, and level sensor. A CDI 500 continuous blood gas monitor (Terumo Cardiovascular Systems, Ann Arbor, MI) is used to monitor arterial blood gases, and a COBE monitor is used to monitor venous saturation and HCT.

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**Figure 2.** Circuit configuration for post-CPB residual blood infusion. ALF, arterial line filter; HC, hemoconcentrator.

drained, 1000 mL of crystalloid is added to flush the blood through the circuit, after which the process is terminated. The circuit is left completely primed and ready for re-institution of bypass if needed. At this time, the remaining 15% of the protamine can be administered.

## DISCUSSION

Given the shortages of banked blood, the risks of transfusion reactions, disease transmissions, and transfusion errors, perfusionists must find ways to minimize hemodilution to avoid transfusions. We introduce this technique to process the residual circuit blood from the CPB circuit in a way that conserves coagulation proteins, concentrates formed elements, and leaves the CPB circuit ready to reinstitute bypass as necessary.

The three most commonly used methods to salvage circuit contents include: (1) direct infusion; (2) cell saver; or (3) ultrafiltration. Direct infusion involves giving the blood back through the aortic cannula or into an empty fluid bag, either draining the circuit or chasing the blood with clear prime. The advantages of this method are its simplicity and ability to infuse volume quickly. The disad-

vantages include the inability to raise the HCT, re-infusion of heparinized blood, and a compromised circuit if it has been drained.

Processing the blood through a cell-salvaging device can be done by either draining the circuit contents or by chasing the blood with clear prime into the cell saver reservoir. Advantages of using a cell saver are the ability to produce consistently a product with a high HCT containing little or no heparin (2,3). The disadvantages are the product contains no proteins or clotting factors and the perfusionist must wait for the blood to be processed before it is available for transfusion (4).

Single pass hemoconcentration has been shown to be an effective method of processing residual blood from the CPB circuit, increasing the whole blood concentration of albumin, WBC, RBC and Hgb (5).

Hemoconcentration can be used several ways. The circuit volume can be pumped through a HC into a bag, which is given to the anesthesiologist to be infused (5). Modified ultrafiltration (MUF), either arterial-venous or veno-venous is another option but has the disadvantage of having to remain fully heparinized for the duration of the MUF procedure. MUF also has a steep learning curve and

a high incidence of technical complications as documented in a 1996 survey by Darling et al. (6). A third option, which we use, is pumping the blood through an HC directly to a peripheral or central intravenous line. The advantages of this method are that it produces a concentrated whole blood product rich in proteins, it allows for good control of volume, it maintains the integrity of the CPB circuit, and it's simple. A disadvantage is that the blood being reinfused is heparinized; this can be corrected easily by giving more protamine once the residual blood has been reinfused.

In conclusion, this technique of reinfusing the residual CPB circuit volume through a HC directly to the patient is safe, simple, and allows immediate access to the processed blood, giving the perfusionist the ability to control filling pressures. The CPB circuit integrity is never compromised, allowing for rapid re-institution of support if needed.

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