



## Technique

# *Improved Fluid Management By A Simple Extracorporeal Circuit Design Change*

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### **ABSTRACT**

Extracorporeal circulation (ECC) circuits vary in design in order to fulfill the needs and perfusion plans of the surgical team. There are as many variations in these configurations as there are perfusion techniques. This article describes a simple circuit modification that has diverse advantages in its application. The implementation of this modification may improve sterile technique, lower prime volume, sequester blood, and add versatility in fluid management.

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## INTRODUCTION

An interest in employing minimal prime volumes, sequestering whole blood on initiation of cardiopulmonary bypass (CPB), and dealing with system volume overloads led to the implementation of a very simple ECC circuit modification. By connecting the recirculation line with the priming tube, greater versatility in fluid management is available.

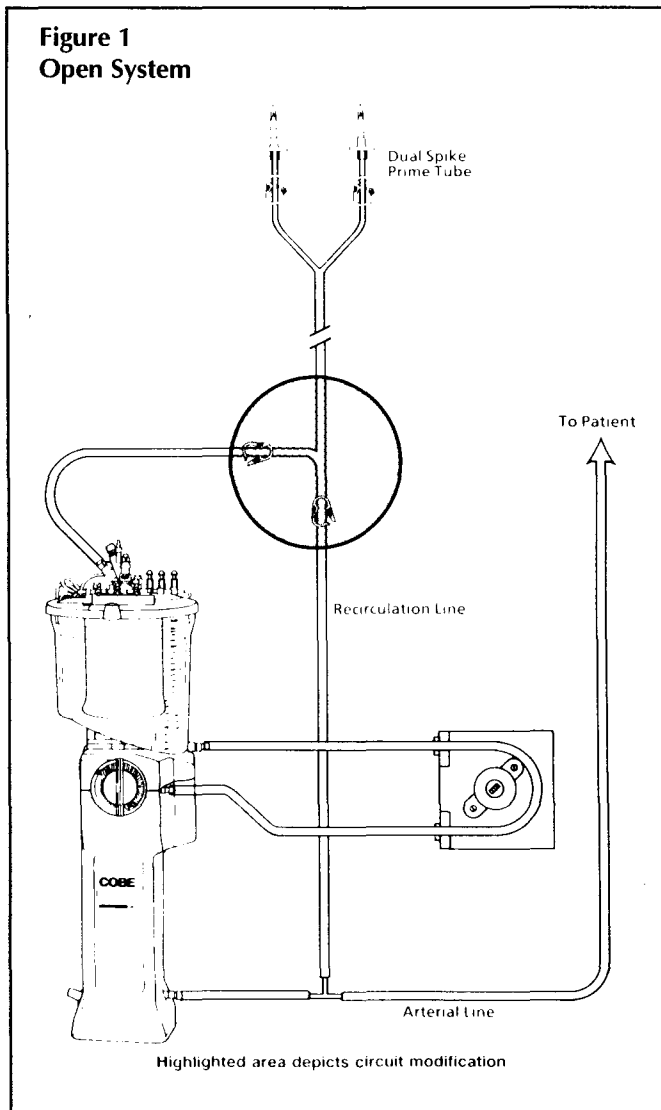
## MATERIALS AND METHODS

A communication was established between the recirculation line and the priming tube (Figure 1) in our open system<sup>a</sup>. This alteration is also possible when using a closed-system<sup>b</sup> (Figures 2 & 3). This change will allow crystalloid solutions or blood to be selectively directed into the attached intravenous (IV) fluid bags, which were used for priming the ECC circuit. This adaptation provides for some useful applications.

Our system is primed with two liters of PlasmaLyte-A<sup>c</sup> to facilitate debubbling, recirculation, and patient infusion. This priming volume may be easily reduced at any point with the following technique during the initiation of CPB. Prime may be eliminated from the arterial line by lowering the IV bags to the level of the heart, collecting crystalloid until the arterial line has passively filled with the patient's blood. Be aware that a pressure drop occurs at the site of aortic cannulation with this technique. A venturi effect could pull air into the cannula. Therefore, avoid lowering the fluid bags below the level of the heart. Also, air can be pulled across the membrane if an IV bag is inadvertently lowered below the oxygenator. This approach may best be reserved for use with those surgeons who routinely use a stretch-dilation aortic cannulation method with double purse-string tourniquets. Incoming venous blood may be used to displace the prime from the venous line, venous reservoir, and oxygenator into the IV bags. This simple modification encourages a more aggressive approach to decreasing priming volume, as this volume can be reinfused immediately if necessary.

Whole blood can be sequestered simply by first observing the displacement of crystalloid in the system by the incoming venous blood. The blood passing through the system several seconds after the crystalloid has been displaced has had little hemodilution. This "whole blood" can be diverted into one of the IV bags by lowering them and/or occluding the arterial line. It remains to be investigated what functional effect a single pass through the oxygenator might have on blood formed elements. By late rewarming, the red blood cells have usually settled out, and can be returned to the patient, leaving plasma for post-bypass infusion.

A dual spike prime line provides the option of combining these techniques of priming volume management and whole



blood sequestration to the extent deemed best for a particular patient's size, hematocrit, degree of hypothermia, etc. One IV bag is employed to collect crystalloid, the other blood.

Any excess hemodiluted blood may be sequestered in an IV bag to save it from the trauma of CPB. Excessive system volume may be present in congestive heart failure or acute severe hypertension, especially if a down-sized oxygenator and circuit is employed.

After termination of CPB and decannulation, blood can be easily displaced from the reservoir and oxygenator into an IV bag for infusion by the anesthesiologist. Also, the spikes on the prime lines plug inside the 1/4" blood inlet ports on the cardiotomy reservoir of autotransfusion machines for washing of residual blood rinsed from the system by the sequestered prime.

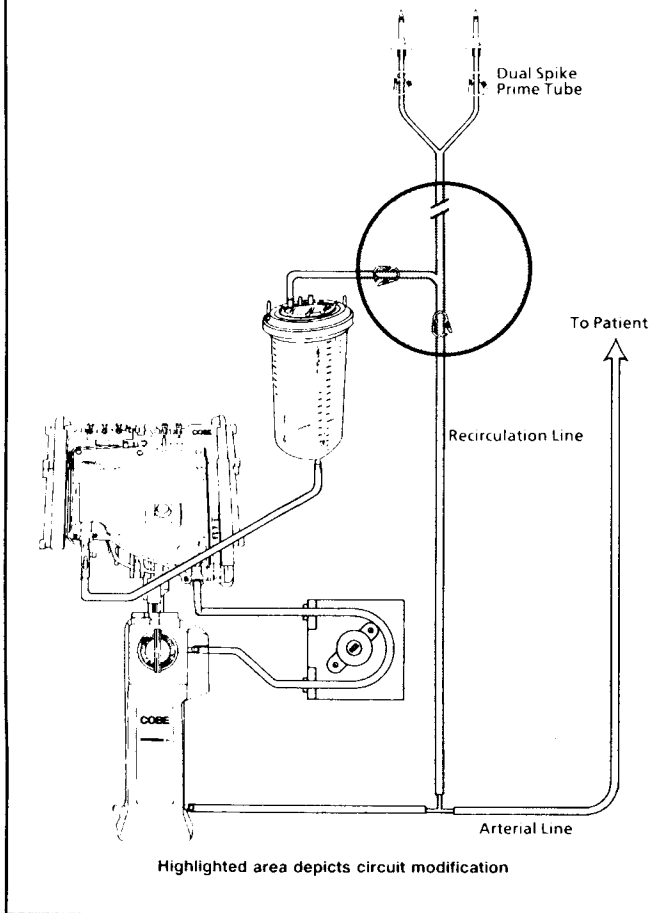
Ultrafiltration, another method of fluid management utilized during ECC, may be easily incorporated during ECC using this circuit modification. Simply add the ultrafiltration set-up in as an extension of the recirculation line. One of the prime line

a Excel, Cobe Cardiovascular Inc., Lakewood, CO 80215

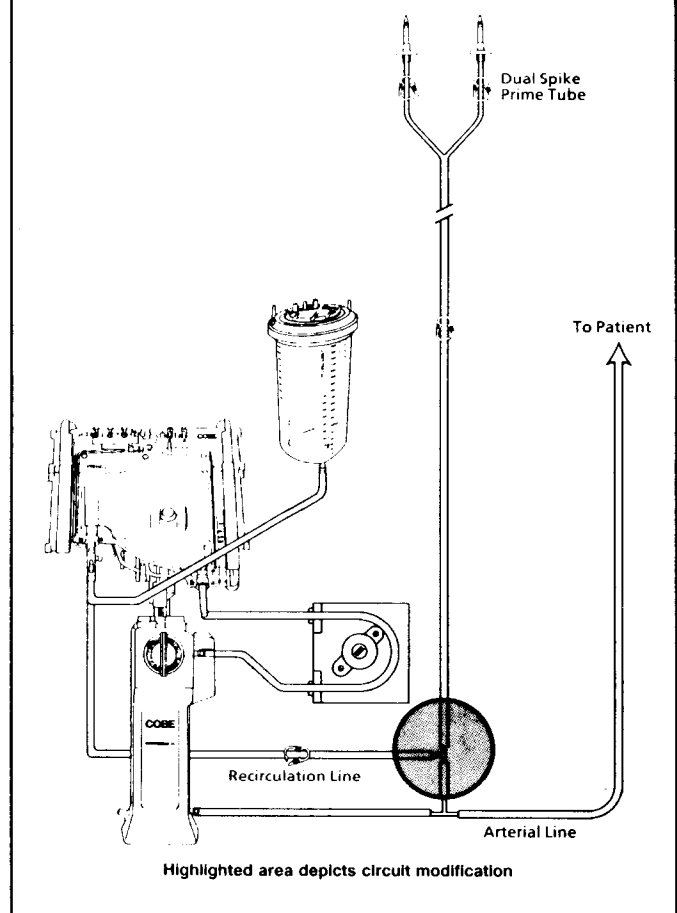
b CMS, Cobe Cardiovascular Inc., Lakewood, CO 80215

c Baxter IV Systems Division, Deerfield, IL 60015

**Figure 2**  
Closed System



**Figure 3**  
Closed System



spikes can then be inserted into the 1/4" blood inlet ports on the cardiotomy reservoir or oxygenator, thus preserving the recirculation capabilities of the circuit.

This circuit modification can also be effectively used when employing a centrifugal pump. The rotation speed of the vortex head must be set at an adequate speed to advance fluid out the arterial line while the connection to the arterial cannula is performed. To predetermine this rotational speed, place tubing clamps to direct the vortex head output into the IV bags. Position the IV bags to the height of the right atrium. Finally, augment the pump speed until the displacement of the pump head is adequate to begin filling the elevated IV bags, taking note of the rotational speed required.

Retrograde priming of the oxygenator and vortex head may easily be accomplished. Clamp the arterial line and the recirculation line where it enters the reservoir. Upon priming, the prime is directed retrograde via the arterial line.

Sterile technique should also be improved. There is no need to reduce priming volume by breaking the circuit (e.g.: disconnecting the recirculation line from the cardiotomy reservoir) in order to pump prime volume out of the circuit. Fluid

volume may be managed within an intact system.

## DISCUSSION

Designs for perfusion circuits are predicated on philosophies ranging from a "keep it simple" principle to a "cover all contingencies" approach. The system feature described is both simple and versatile. Proponents of priming volume reduction or of blood sequestration will find this circuit design offers an alternative method to accomplish either technique. Although this feature will not revolutionize cardiovascular surgery, many perfusionists may find it functional and versatile.