

Technique

How to Do It: A Versatile Carmeda Coated Cardioplegia System

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Keywords: cardiopulmonary bypass; Carmeda; thrombo-resistant; cardioplegia; covalent bonding

ABSTRACT

A biocompatible Carmeda cardioplegia system was developed at Rhode Island Hospital for the administration of crystalloid and blood cardioplegia. The system uses a venous reservoir bag, a single pass heat exchanger with bubble trap, and a roller pump to circulate the cardioplegia solution. Because a Carmeda coated cardioplegia system does not exist, we designed a system that could be incorporated into a Carmeda coated cardiopulmonary bypass circuit.

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Figure 1. Cardioplegia recirculation mode.

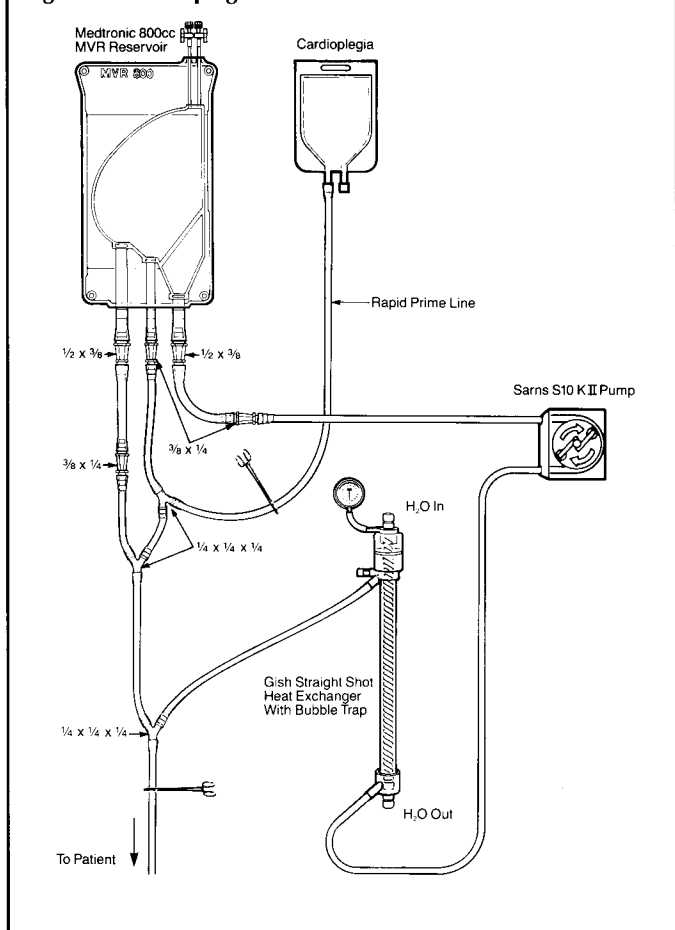
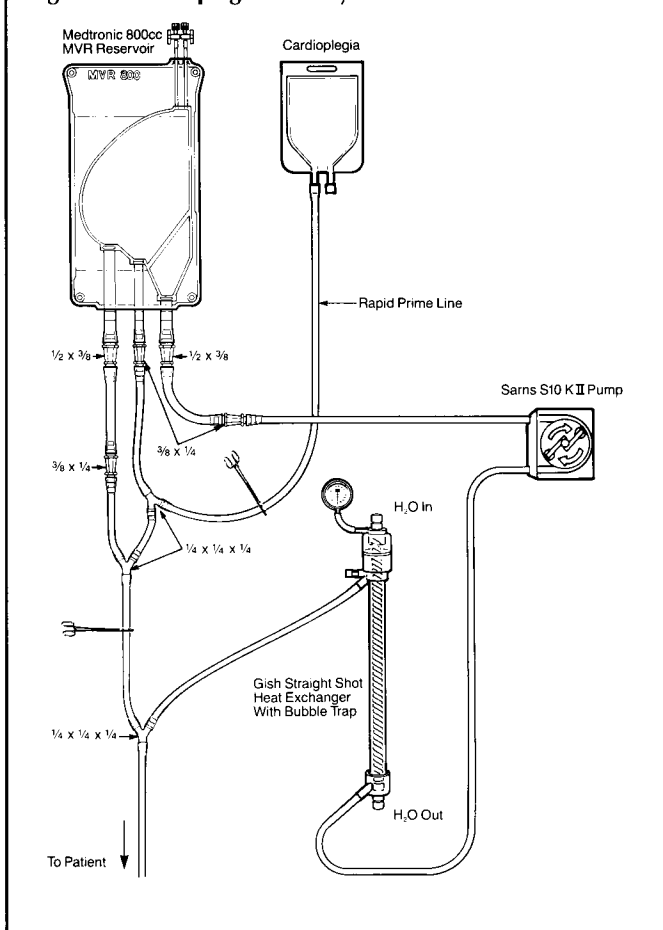


Figure 2. Cardioplegia delivery mode.



INTRODUCTION

An increase in cardiac surgical procedures utilizing Carmeda^a coated cardiopulmonary bypass (CPB) circuits at our institution produced a need to develop a Carmeda coated cardioplegia system that could be incorporated easily into the extracorporeal circuit, producing a completely biocompatible system.

Although a number of institutions use thrombo-resistant circuits for certain procedures, most surgery needing CPB requires large doses of heparin. However, studies indicate that heparin may exacerbate bleeding following cardiac surgical procedures (1,2).

Larm, et al, developed a thrombo-resistant coating in which heparin is end-point attached and covalently bonded to blood contact surfaces (3). This coating creates a biocompatible surface for the extracorporeal circuit and reduces or eliminates the need for heparin. The use of these circuits is becoming commonplace in cardiovascular surgery. Reported advantages of biocompatible circuits include desirable thrombo-resistant and blood-sparing properties such as reduction of blood trauma, preservation of platelet counts and function, and reduced heparin

requirements (2,4). Consequently, it is hoped that use of a Carmeda bioactive surface will result in reduced blood loss.

At Rhode Island Hospital, Carmeda circuits are used for most reoperations. However, a Carmeda coated cardioplegia system was unavailable. We desired a system that would be separate from our systemic circuit and could deliver either cold or warm crystalloid or blood cardioplegia. The circuit also needed to be designed using available Carmeda products.

MATERIALS AND METHODS

The cardioplegic system is completely Carmeda coated. The circuit consists of an 800 ml venous reservoir bag and holder^a, a straight shot heat exchanger with bubble trap^b, rapid prime line, delivery line, and recirculation line. A roller pump^c recirculates and delivers the solution, and a submersible pump^b circulates either hot or cold water through the heat exchanger.

The system is primed by adding the cardioplegia solution

a Medtronic Cardiopulmonary, Anaheim, CA 92807

b Gish Biomedical, Irvine, CA 92714

c Sarns, 3M Health Care, Ann Arbor, MI 48105

via the rapid prime line, displacing the air in the venous reservoir bag as the solution level increases. The pump is turned on and the system is circulated and debubbled. The solution circulates through both inlets on the bag to avoid any areas of stagnation within the circuit during blood delivery. To accomplish this, reducing connectors are incorporated as shown in Figure 1. The delivery line is flushed and debubbled and connected to two sterile Carmeda delivery lines on the surgical field (Figure 2). One line provides delivery via the aortic root while the other line is available for delivery of cardioplegia perfusate through a vein graft if necessary.

At Rhode Island Hospital from January 1, 1993 to June 30, 1994, 81 Carmeda coated circuits (46 with a Carmeda coated cardioplegia system) were used on reoperations. All patients were maintained at a systemic temperature of 37°C. A heparinizing dose of 75 U/kg to 150 U/kg was administered, which is 25 - 50% of our routine dose for non-Carmeda cases. Patients are placed on cardiopulmonary bypass regardless of the measured ACT.

After cross-clamping the aorta, a one liter dose of cold crystalloid cardioplegia solution is delivered via the aortic root by clamping the recirculation line and unclamping the delivery line. The solution is delivered at a root pressure of 80 mmHg. If more crystalloid cardioplegia is desired, the solution is added quickly through the rapid prime line into the reservoir bag. All subsequent cardioplegia infusions are of cold blood to which 50 ml of our standard cardioplegia solution is added. The blood is added to the cardioplegia solution via the arterial filter purge line, which is connected to the venous reservoir port of the cardioplegia system.

Our standard delivery routine is to give 300 ml of cold blood cardioplegia via the aortic root approximately every 15 minutes, and 100 ml of solution through the proximal ends of newly anastomosed vein grafts as needed. The hematocrit of the solution is approximately 20%.

Prior to cross-clamp removal, 300 ml of warm blood with 12.5 g of mannitol is delivered via the aortic root.

DISCUSSION

It is a constant challenge for the perfusionist to meet the needs of surgeons and to utilize new technology. We describe our adaptation of the extracorporeal circuit to provide a cardioplegia delivery system compatible with our surgeon's desire for a thrombo-resistant circuit and reduced heparin administration.

With any type of biocompatible circuit in which heparin levels are reduced or eliminated, it is important to avoid areas of stagnation to decrease the likelihood of clot formation (5). Within the cardioplegia circuit there is a possible area of stagnation from the recirculation line to the patient. This area is of some concern if heparin levels are going to be reduced. It is very difficult to design a cardioplegia circuit without some area of stagnation in the delivery line unless continuous cardioplegia delivery is employed.

Since the development of this Carmeda cardioplegic sys-

tem, it has been used on 46 patients without problems. This unit complements and completes the enhanced biocompatibility of a Carmeda cardiopulmonary bypass circuit.

ACKNOWLEDGMENT

We thank Ms. Abigail Crear for her help in preparing the manuscript.

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