A Simplified Blood-Cardioplegia Delivery System

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Abstract

A single-pump, one-pass, hemodilution system for administering cold blood cardioplegia during heart surgery is described. The system offers simple, quick, and effective myocardial protection.

Introduction

The use of blood cardioplegia is gaining greater acceptance,[1,3-10] and delivery systems and solution compositions are perhaps as numerous as the perfusion teams involved.[1,3-7,8,9] Our system has evolved its present form to meet our requirements for simplicity, reliability, effectiveness, and application to adult, as well as pediatric patients.

Dyson, et al.[4] described a hemodilution delivery system. We have put their concept to use, utilizing a standard, single, polyvinyl chloride tubing coil[a] as the heat exchange device. The cooling coil is made of tubing 0.187 inch inside diameter, 0.261 inch outside diameter, 0.037 inch wall thickness, and 252 inches in length with an internal volume of 124 cc. This system is diagrammed in Figure 1.

Blood from the coronary perfusion port of the oxygenator and a cold, crystalloid solution (1000 ml. Dextrose 5% in 0.25 normal saline with 30 mEq. potassium chloride and 5 mEq. sodium bicarbonate, kept on ice until used) are pumped through 1/4 inch (inside diameter) tubing by a single Sarns Low-Flow Pump[b] with double tube holder inserts. This double tubing system assures a 1:1 mixture of oxygenated blood and cold crystalloid as it passes through a Y connector to the cooling coil in an ice bath. Pressure is monitored through a luer-lock connector in the line to the patient. The resultant blood-cardioplegia solution is delivered with a hematocrit of 11 to 16 Gms.%, a potassium concentration of 17–18 mEq. per liter, pH 7.48 to 7.51, and osmolality 342 milliosmoles per liter. Infusions of 300 ml. to 800 ml. at flow rates of 400 to 500 ml./minute are given, maintaining line pressures of 200 to 250 mmHg. These delivery conditions produce aortic root pressure measured at 75 to 85 mmHg.

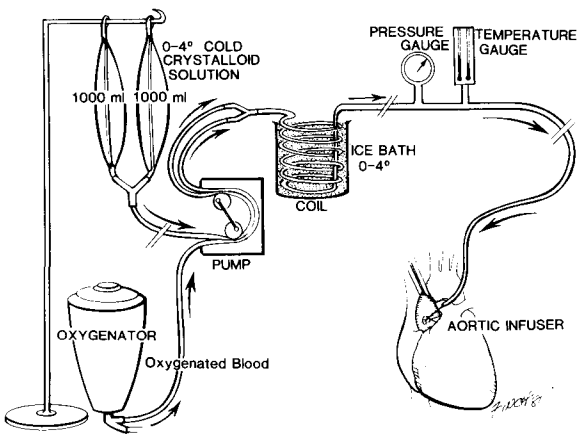

FIGURE 1.

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[a] CardioSystems, Inc., Hayward, CA 94545

[b] Sarns Low-Flow Pump, Model #6050, Sarns, Inc., Ann Arbor, MI 48103

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TABLE 1
Temp. (°C) of Blood Cardioplegic Solution Delivered

Amount of Blood Cardioplegic Solution Delivered	Temp. of Blood in Arterial Reservoir of the Oxygenator: 19°C. (During Systemic Cooling of the Patient)	28°C (During Hypothermic Perfusion of the Patient)	36°C (During Rewarming of the patient)
0 ml			
50 ml	7	6	6
100 ml	10	10	12
200 ml	13	13	15
300 ml	13	14	16
400 ml	13	14	17
500 ml	13	14	17
600 ml	14	16	18
700 ml	—	17	—
800 ml	—	16	—

The temperature of the blood cardioplegia solution delivered to the patient rises gradually towards the end of the infusion, due to the limited thermal transfer efficiency of the coil. These temperatures are recorded in Table 1. The temperatures were meaasured at various stages during infusion using a Sarns 1/4 inch In-Line Temperature Probe Connector,[c] i.e., at 0 ml., 50 ml., 100 ml., 200 ml., et cetera.

The temperature of the blood from the arterial reservoir of the oxygenator will influence the rate of rise in temperature of the blood cardioplegic solution delivered. This occurs because of the limited thermal transfer efficiency of the coil, but is not significant for our purposes of myocardial protection. Normally the infusions of blood cardioplegia solution are made during the period of hypothermic perfusion. To further simplify our system, we do not routinely monitor delivery temperature.

We have safely used this system on more than 600 clinical cases to date.

[c] Sarns, Inc., Ann Arbor, MI 48103

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