
A Versatile System for the Delivery of Sanguineous and Asanguineous Cardioplegia

J. Martin Jr., R. J. Massimino, J. D. Gough, and G. T. Stearns

Department of Clinical Perfusion
Rhode Island Hospital
Providence, Rhode Island

Abstract

A system has been designed for the delivery of cardioplegia which satisfies the requirements of a temperature range of 4°C to 37°C for both sanguineous and asanguineous solutions. The system is safe, simple and effective with the capability of monitoring flow, aortic root pressure, and temperature. This system has been used clinically by our institution for three years.

Introduction

The use of cardioplegia has gained wide acceptance in the field of cardiovascular surgery. As with all studies, numerous techniques have been developed that attempt to mimic the first accepted and successful approach.¹

These delivery methods have included syringe injection into the aortic root,² pressure bag delivery,³ and administration by means of a roller pump.⁴ The cooling process of the arresting solutions has been accomplished by refrigeration prior to administration, or as an in circuit cooling method via ice baths.²

We have incorporated simplicity as well as ver-

satility into a delivery system that encompasses warm and cold sanguineous cardioplegic solution as well as a cold asanguineous solution.

Methods and Materials

The system consists of a Sarns manually adjusted S10KII blood pump^a, a Travenol miniprime heat exchanger^b, a Bentley bubble trap^c, and ancillary tubing and connectors. Water to the heat exchanger is supplied by a Little Giant submersible pump^d recirculated in a five-gallon stainless steel pail. Temperature is recorded with a Sarns in-line disposable temperature connector^a distal to the heat exchanger. Pressure measurement is via the bubble trap utilizing a protected aneroid manometer. The cardioplegia infusion line bifurcates immediately distal to the outflow port of the bubble trap. The bifurcation is used for intermittent recirculation (Fig. 1). A second bifurcation is incorporated just proximal to the infusion site to allow selective perfusion of either the aortic root or to the homologous vein grafts (Fig. 2).

Two types of cardioplegia are employed: sanguineous and asanguineous. The sanguineous solution consists of one liter of oxygenated, hemo-

Please direct communications to: Ronald J. Massimino, 106 Moorefield St., Providence, RI 02909

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^a Sarns Inc., Ann Arbor, MI 48103

^b Travenol Labs Inc., Deerfield, IL 60015

^c Bentley Labs Inc., Irvine, CA 92714

^d Cole-Parmer Inst., Chicago, IL 60648

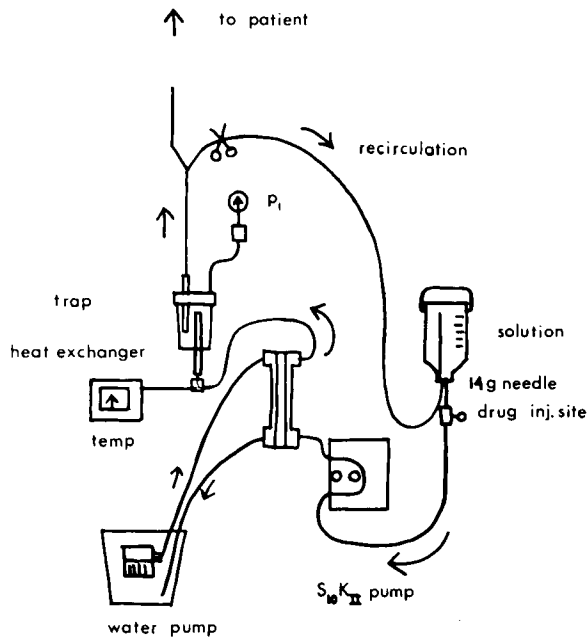


FIGURE 1. Circuit diagram for cardioplegia delivery system.

diluted blood (Hct approx. 20%) to which is added:

- 20 mEq Potassium Chloride
- 530 mg Citrate Phosphate Dextrose
- 360 mg Trihydroxymethylaminomethane

The osmolarity of this solution is approximately 365 mosm and the pH is 7.70.

The asanguineous solution consists of 1 liter of 5% Dextrose and Water in a self-venting bottle, to which is added:

- 30 mEq Potassium Chloride
- 3.1 mEq Magnesium Sulphate
- 27 mEq Sodium Chloride
- 1 mEq Sodium Bicarbonate

The osmolarity of this solution is 347 mosm and pH is 7.60.

The system is initially primed with 170cc of asanguineous solution. The solution is then recirculated at 400 ml/min., which reduces the solution temperature to 7°C in eight minutes. After the aorta is cross-clamped an initial infusion of 800cc of this solution is administered via a 14 gauge intracath. Flow rate is adjusted to maintain an aortic root pressure between 80–100 mmHg. Infusion

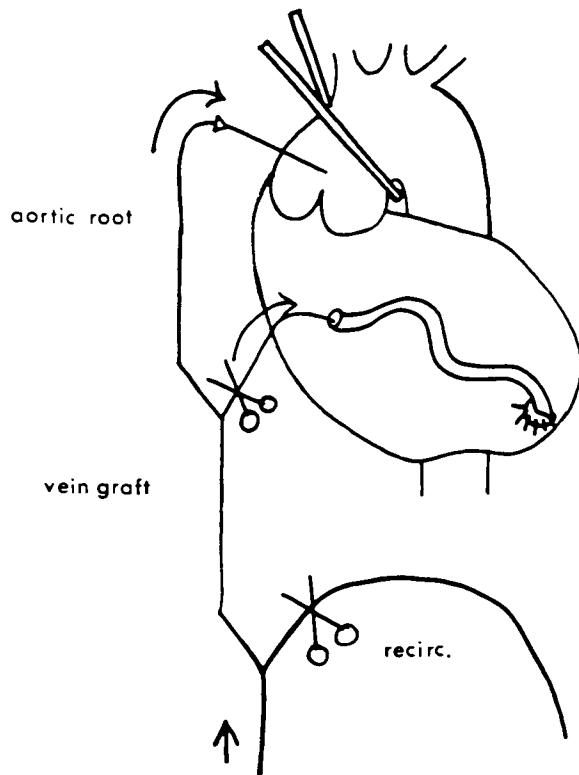


FIGURE 2. Selective infusion of cardioplegia for aortic root or vein graft.

flow rate ranged between 150–350 ml/min. All subsequent infusions are with sanguineous solution.

When needed, the self-venting bottle is refilled with hemodiluted blood which is diverted from the arterial filter via a purge line. The appropriate drugs are then added to the blood and recirculated (See Fig. 1 drug inj. site). The sanguineous solution is maintained at 12°C. Amount and time of cardioplegia delivery are tailored to individual requirements. This may require a second refilling with sanguineous solution. Prior to removal of the aortic cross clamp, the remaining sanguineous solution (approx. 600cc) is warmed to 37°C by substituting 42°C water in the five-gallon pail. The re-warming takes approximately seven minutes at a recirculation rate of 300cc/min. Then 12.5 gms. Mannitol are added and the entire volume of the solution is infused. The cross clamp is then removed.

Discussion

This system for cardioplegia delivery has been found to be simple, safe, and convenient to use.

Heat exchange with stainless steel has allowed excellent efficiency, as well as accurate control of temperature, ranging from 4°–37°C. The entire tubing circuit is pre-assembled by the manufacturer, thus facilitating set-up time. In the final analysis, the ultimate goal is the ability to deliver a cardioplegic solution at a specific temperature, flow rate and pressure. We feel that this has been accomplished to our satisfaction.

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