TECHNIQUE

# Right Ventricular Assist with Conventional Cardiopulmonary Bypass Equipment

**Michael Corrigan, Paul J. DiGregorio, Jose Soto, Gary S. Freeman, and Alan Markowitz**
Division of Cardiothoracic Surgery
Mt. Sinai Medical Center
Cleveland, OH

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## Abstract

A technique of supporting a patient with perioperative right ventricular failure has been developed and used clinically. The method is simple, inexpensive, effective, and involves only conventional cardiopulmonary bypass equipment.

## Introduction

Right ventricular (RV) failure can account for significant patient morbidity during cardiac surgery, especially when the RV blood supply is compromised. Some of this may be reversed with prolonged support,[1,2] although implantable devices are quite cumbersome and require specialized monitoring and power sources. Using conventional equipment we have been able to rest the right ventricle for significant periods of time, with recovery of RV function.

## Materials and Methods

The assist circuit consists of a 500cc. collapsible reservoir,[a] a loop of 3/8″ I.D. polyvinyl chloride tubing, and a roller pump.[b] The 3/8″ cardiotomy and venous return ports of the reservoir are connected with a "Y" connector to prevent blood from stagnating. The pre-attached recirculation line supplied by the manufacturer is kept sterile by connecting it to a top port on the reservoir.

While still on cardiopulmonary bypass (CPB), the assist loop can be primed and recirculated. The loop is divided into assist outlet and inlet portions. The assist outlet is connected to a 24 Fr. aortic cannula[b] by a "luer-lok" connector with stopcock. The cannula is inserted into the main pulmonary and de-aired through the stopcock. CPB can still be maintained with one caval cannula while a new 34 Fr. venous cannula[c] is inserted into the right atrium. This cannula is then connected to the assist pump inlet tubing.

The patient is weaned from total CPB until heart failure becomes apparent. At this point RV assist is instituted and CPB terminated. When the patient is stable, chest tubes are placed and the chest is closed around the cannulas and tubing.

Maximum output of the assist circuit is determined by gravity return via the right atrium. Patient weaning is controlled by restricting gravity drainage while reducing assist output, thus forcing the right heart to do more work. This process requires the monitoring of left atrial pressure (LAP), central venous pressure (CVP), and systemic blood pressure (BP). An elevated CVP in the presence of a low LAP and BP indicates failing right heart function, corroborated by cardiac output measurements.

Anticoagulation is maintained with a heparin drip controlled by an infusion pump. Activated clotting times (ACT) should be monitored although the optimal target value for long-term support without an oxygenator is still in question. ACT should be checked every 60

Direct communications to: Michael Corrigan, C.C.P., Division of Cardiothoracic Surgery, 1800 E. 105th St., Cleveland, OH 44106

a SciMed Life Systems, Inc. Minneapolis, MN 55441
b Sarns 3M Inc., Ann Arbor, MI 48013
c USCI, Inc., Billerica, MA 01821



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minutes, and a value of 200 seconds is probably adequate.[3]

Chest tube drainage, urinary output, body temperature, white blood cell count, hematocrit, platelets, electrolytes, blood gases, and fluid balance all need to be monitored. A careful record of RV assist flows is obviously crucial.

## Discussion

The assist circuit employs a reservoir for additional safety. Our laboratory experience shows, in the absence of a reservoir, a positive CVP must be maintained constantly. Should the CVP approach zero, negative pressure will draw air into the assist inlet tubing through the cannula pursestring. The in-line reservoir prevents this from happening.

Fluid balance, bleeding, and infection are a constant concern. Maintenance of adequate cardiac output is vital, but fluid administration should be precise and diuresis aggressive in order to reduce myocardial edema and prevent dilution of clotting factors. Due to necessary anticoagulation, blood replacement may be extensive, making careful control of the ACT absolutely essential.

Since the assist tubings emerge through the skin, infection is always a risk. Sterile technique must be rigidly adhered to and prophylactic broad-spectrum antibiotics are strongly advised during the course of right heart assist.

This technique has been tested experimentally and employed twice clinically for right ventricular failure. The infrequent need for long-term support at our institution makes this approach much more attractive to us than specialized, implantable, assist devices. The particular utility of this approach with conventional perfusion techniques obviates the need for more sophisticated support in those very difficult patients.

*Addendum*

Presently we are using a centrifugal pump for ventricular assist. This non-occlusive pump eliminates the need for the reservoir and reduces the extent of required anticoagulation.

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