

Case Report

Perfusion for the Jehovah's Witness Patient: An Example of Protocol Variability

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ABSTRACT

Several translated verses in the New and Old Testaments provide Jehovah's Witnesses with influential guidance when they are to undertake a surgical procedure. These patients refuse to accept homologous blood or its components for transfusion. They also refuse to accept autologous blood for re-transfusion if it has been isolated from the body. This case report communicates the perfusion protocol variations in equipment selection, hemostasis management, and religious respect that resulted in optimal cardiac surgery for a Jehovah's Witness.

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INTRODUCTION

The world's population includes over four million Jehovah's Witnesses. To outsiders this religious following is greatly misunderstood. However, there is a general conception within the medical community about the Jehovah's Witness and blood transfusions. A medical professional understands that a Witness will not accept the transfusion of blood or its components. This belief sometimes presents as a major medical conflict to those who lack any further knowledge. Sometimes blood transfusions are necessary to maintain the life of patients undergoing major operations. However, the religious tenets and requests of this patient must be respected and complied with even if it puts them at increased risk of morbidity and death (1, 2).

The first open heart surgery on a Jehovah's Witness was conducted in May of 1962 (3). Since then, there have been a few thousand successful cardiac operations in adults and children. Up to this present time there have been several medical strategies developed to guide those who provide treatment (4). Those ideas are:

- a) lowering the risks that are associated with bleeding
- b) use of meticulous surgical techniques
- c) use of hemostatic agents
- d) trying to begin medical treatment weeks in advance if possible for upcoming surgeries
- e) maintaining a high level of critical care and a continuous respect of a Witness' faith.

CASE INTRODUCTION

The University of South Alabama Medical Center received via transfer from a sister hospital, a 68 year old Caucasian female of Jehovah's Witness faith with severe triple vessel disease. On the day of her surgery her height was 165 cm, and she weighed 76 kg. Her calculated body surface area (BSA) (5) was 1.84 m², the circulating blood volume (CBV) (6) was 4.33 L, and her preoperative hemoglobin was 12.7 g/dl (Hct of 38.1%). She was a smoker, had long standing hypertension (>15 years), and was a non-insulin dependent diabetic (NIDDM). Her cardiac angiography revealed congestive heart failure with a left ventricular ejection fraction of less than 38%. The left coronary artery demonstrated a 90% proximal stenosis of the left

anterior descending artery, an 80% proximal stenosis of the circumflex artery with an additional 70% proximal stenosis of its first obtuse marginal branch. The right coronary artery demonstrated a long 50% occlusion up to the bifurcation of the posterior descending artery and its right ventricular branch.

The patient was quickly referred to the cardiothoracic service and subsequently was scheduled for a coronary artery bypass grafting (CABG) procedure the next morning.

METHODS AND MATERIALS

The perfusion team decided to revise the customized cardiopulmonary bypass (CPB) circuit normally used in order to minimize hemodilution via circuit priming volume and be able to satisfy an oxygen demand of 239 ml/min (7). The patient had a preoperative cardiac output of 4.21 l/min.

Standard Circuit

Capiiox SX^a 18R
Sarns 7850^b
Sorin BCD^c Adv-C
Bentley AF1025D^d

Modified Circuit

Capiiox SX
Sarns 7850
Sarns Conducer^b
Cobe Sentry^c
Medtronic MVR-1600^f
Medtronic Minimax 1316^f
Amicon D-30^e

The usual priming volume of the standard circuit was 1360 ml. It consisted of 700 ml of Plasmalyte-A^h, 500 ml of hetastarch, 100 ml (25g) of mannitol, 50 ml (50mEq) of sodium bicarbonate, and 10 ml (10,000 IU) of sodium heparin. The circuit revision allowed a reduction in crystalloid by 200 ml. An additional 100 ml of crystalloid was eliminated when the pre-bypass filter was removed, and the arterial and venous lines were clamped and cut to desired lengths for cannulation.

The circuit also had an additional oxygenator to patient connection. It involved using the oxygenator's recirculation line (1/4" I.D.) reduced to a pressure tubing connection via a perfusion adapterⁱ. A 72" length of pressure tubing was used to complete the circuit from this adapter to a central venous access port (CVAP) on a right heart catheter. The connection was fluid primed and then clamped until CPB was terminated. The CPB circuit had an arterial - venous loop of 3/8" I.D. and 1/2" I.D. respectively. The centrifugal pump was used to draw blood from a soft venous reservoir and force it through the selected oxygenator. Blood returning from the table, excluding that from the venous line, was filtered by the filtered hardshell reservoir/cardiomy. A Cobe Sentry arterial line filter and a Sarns Conducer cardioplegia system were selected because of dynamic volume considerations. A hemofilter was placed between the blood cardioplegia draw line and the filtered cardiomy for hemofiltration during CPB. This positioning provided an adequate pressure head to remove 720 ml of ultrafiltrate.

A median sternotomy was made immediately after the aprotinin loading dose. The left internal mammary artery and the

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b Sarns/3M Cardiovascular, Ann Arbor, MI 48103
c Sorin Biomedical, Irvine, CA 92713
d Baxter Health Care, Bentley Division, Irvine, CA 92714
e Cobe Cardiovascular, Inc., Arvada, CO 80004
f Medtronic Cardiopulmonary, Anaheim, CA 92807
g Amicon, Inc., Beverly, MA 01915
h Baxter Healthcare Corp., Deerfield, IL 60015
i DLP, Grand Rapids, MI 49501, p/n 10007
j Medtronic HemoTec, Inc., Englewood, CO 80112

greater saphenous vein were harvested. The leg was immediately closed and wrapped prior to heparinization.

The Hepcon/Hemostasis Management System (HMS)^j was used to manage the patient's anticoagulation and reversal. Using aprotinin^k, our Department's protocol is to maintain the HMS projected heparin concentration (HepCon) at greater than 3.0 mg/kg and the activated clotting time (ACT) greater than 480 seconds. A preoperative ACT/HepCon sample is drawn immediately after the radial arterial line is placed. The baseline ACT/HepCon sample is taken immediately after the aprotinin loading dose is finished. An initial dose of 25000 IU sodium heparin was administered for anticoagulation. The resultant ACT and HepCon were greater than 600 seconds and 3.5 mg/kg respectively. The patient's ACT remained greater than 480 seconds and the HepCon level varied from 3.0-4.0 mg/kg. No additional heparin was added during CPB. The HMS also calculated the required protamine sulfate dose of 350 mg for anticoagulation reversal. No additional protamine was required.

Aprotinin was administered in a low dose regimen as follows (8, 9) (a modified version B, as listed in product information supplement):

Test dose	1 ml	10,000 Kallikrein Inhibiting Units (KIU)
Loading dose	100 ml	1 million KIU
Pump prime	100 ml	1 million KIU
Maintenance dose	50 ml/hr	500,000 KIU/hr

A crystalloid prime volume of 100 ml was removed to allow the pump priming dose of 100 ml of aprotinin to be added.

During CPB, blood gases, electrolytes, and other blood chemistries were monitored and then normalized prior to CPB termination. These samples were taken every 15-20 minutes and as needed throughout the case for documentation and control. Hypotension during CPB was controlled by titrating phenylephrine (0.1 mg) aliquots to the CPB circuit. Perfusion induced hypothermia was begun immediately upon initiation of CPB to 32°C.

The patient received five distal anastomoses to surgically targeted vessels. Four proximal anastomoses were completed with a partially clamped aorta. Our experienced surgical team effectively kept the total CPB period to 86 minutes.

The patient was successfully weaned from CPB. Good contractions of the heart allowed the venous and arterial cannulae to be removed so that the lines could be drained. The CVAP line was opened immediately to allow the sequestered pump volume to be slowly transfused back to the patient. Most of the red cells were chased through the circuit with crystalloid. The anticoagulation was reversed with protamine sulfate and hemostasis was noted. The chest was closed and the patient was sent to the coronary care unit (CCU) with a final post-CPB Hgb measured at 13.3 g/dl (Hct of 31%). The patient had an unremarkable course and was successfully discharged from the hospital on the fifth postoperative day.

DISCUSSION

The Jehovah's Witness presents a unique situation for the cardiac team, and especially the perfusion discipline. The statement, "No human should sustain his life by taking in blood (10)," dictates a primary tenet. These patients uphold the Scriptural word of God, as written in verse found in the New and Old Testaments. The fundamental understanding is that the Witness will not accept the transfusion of blood or its components because it violates God's tenets. The medical community involved has to comply and uphold these patient requests. It should not prohibit the patients from receiving medical or surgical attention. Current technology has advanced enough to provide alternative treatment pathways.

The issue facing perfusion teams is the construction of a CPB circuit that will provide support yet will not compromise the Witnesses' beliefs. For the sake of simplicity every perfusion team should have a standard customized circuit setup. This allows for fast and effective setup in an emergency situation. For the Jehovah's Witness as discussed, there is a primary focus to eliminate the need for any homologous blood use. The perfusionist must begin by removing any dead space and minimizing the priming volume. This is achieved by selecting the proper tubing, pumps, oxygenator, and other devices. Each piece selected must be incorporated and arranged in its most efficient manner without sacrificing safety or simplicity (11). In this case, a key feature of each item selected is its low priming volume. The "closed" CPB circuit design supports the idea of "fluid continuity" with the patient's vascular system. Thus, even though Witnesses refuse homologous blood, their own blood should not become isolated from continuity within the circuit.

Much consideration was given to the individual components of the circuit. The Capiox SX oxygenator has a consistent and reliable oxygen and carbon dioxide transfer. It has a proven dependability for a wide range of patients and procedures. A 1600 ml venous bag reservoir was combined with the pediatric cardiotomy because of its dynamic capacity. The cardiotomy was case specific based on total circulating volume of the system. It allowed a low breakthrough volume, high filtration factor, and only needed a small volume to remain in contact with any hold-up volume within its filter.

The selected cardioplegia system utilizes a 4:1 blood to cardioplegia mix. The Conducer cardioplegia system was selected for this case because its overall prime volume is less than 150 ml. The blood draw line to the system was shortened to reduce overall priming volume. The procedure required 422 ml of crystalloid cardioplegia to be used. This volume was dependent on the number of grafts used for revascularization, myocardial mass, and myocardial temperature. It was easily removed via hemofiltration of the circuit during CPB. There was a diuresis

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of 19 ml/kg/hr throughout the procedure.

All of our circuits utilize an arterial line filter. The Cobe Sentry was used in this case because it has a priming volume less than 200 ml. There are reports that some centers will exclude this device altogether because of its priming volume. However, we feel this is an important safety device for patient care.

During CPB cases we utilize aggressive hemofiltration. This allows us to maintain meticulous control over fluid balances. It is very important in our procedure because we do not use a cell washing device for Witness cases. The residual blood in the circuit post CPB was hemofiltered as much as possible. Then it was "chased" back into the patient's vascular system using the CVAP connection.

Our perfusion team uses the Hepcon/HMS for individual patient anticoagulation and reversal profiles (12). When aprotinin is administered, there is only one additional step added to the hemostasis protocol (13, 8). Three to five minutes post infusion of the loading dose (1 million KIU), an additional sample is drawn and checked for ACT and heparinase time.

Aprotinin, to mention briefly, is a serine protease inhibitor. It provides inhibition of fibrinolytic activity, inhibition of the kallikrein-kinin system, and preserves platelet adhesiveness. Our heart team is adamant and very selective about using aprotinin in any cardiac procedures with a potential bleeding diathesis. Aprotinin's efficacy was seen by the surgical team during the chest closure and afterwards in the coronary care unit. In this case it provided excellent results in its ability to reduce bleeding intraoperatively and in the postoperative period. The postoperative chest tube drainage ended within two hours after arrival in the CCU (approximately 210 ml).

Due to the acute onset of the patient's condition, the use of recombinant erythropoietin could not be used in the pre-surgical period. However, even this drug can be rejected for use due to its manufacturing process (14). To be effective, synthetic erythropoietin therapy is begun at least two weeks prior to the scheduled elective surgery (15).

This report illustrates the relative safety of CPB on Jehovah's Witnesses through careful selection of equipment and techniques. In this case, revisions to the customized CPB circuit and small variations to normally followed protocols were implemented in order to comply with a Witness' tenets and requests. We feel that the techniques and equipment currently used for CPB permit us to manage lower perioperative hemoglobin levels (5 g/dl) (16), as seen on CPB with these patients. The risks involved with Jehovah's Witness CPB cases in earlier years have largely attenuated themselves to a point that is equivalent to those seen with patients having similar cardiac procedures (4). Updated and new technology used by the perfusion team permits hemodilution, blood loss, fluid continuity, and optimal hemostasis to be controlled in an acceptable manner that contributes to favorable cardiac patient outcomes.

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