# Clinical Results with the Use of Blood Cardioplegia in the Community Hospital

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## Abstract

A retrospective data collection was carried out in order to determine the efficacy of blood cardioplegia in the community hospital setting. A total of 97 patient charts were reviewed and divided into two groups. Group A consisted of 72 patients undergoing coronary artery bypass grafting including three patients requiring concurrent left ventricular aneurysm resection. Group B consisted of all other procedures. Eleven (15%) patients in Group A required vasopressor support and eight (11%) patients required the use of an intra-aortic ballon. While six patients had elevations in enzyme levels, only one of them required the use of an intra-aortic balloon. Two of the patients had balloons inserted pre-operatively for pre-infarction angina. Five (20%) patients in Group B required vasopressor support and two (8%) patients required use of an intra-aortic balloon. There were two early deaths in this group. Four (16%) patients were identified as having a perioperative infarct. There was an overall mortality of 2% in the review. This may indicate that our use of blood cardioplegia was safe and effective.

## Introduction

Since the reintroduction of hypothermic potassium cardioplegia by Gay and Ebert,[1] there have been many reports of the advantages of several different delivery solutions and their composition. One important consideration is that the arrest of the myocardium must be rapid and that preservation of adenosine triphosphate (ATP) levels be maintained. It is also a prime consideration that profound hypothermia be used in order to reduce myocardial metabolism to a minimum. Utilizing these principals, Follette and co-workers describe the use of blood as their delivery solution.[2] Since that time there have been numerous reports in the literature of the experimental results with the use of blood cardioplegia.[3-5] There is also an increasing amount of literature on the clinical results.[6-8] However, most of those clinical results are reported from major institutions where much research work is being accomplished.

In order for the physician to evaluate what the ideal cardioplegic vehicle is and what the ideal potassium concentration should be, he must rely on the reports in the literature. This is especially true in the community hospital setting where it is very difficult to design and carry out experimental protocols without incurring a significant increase in the patient cost. Therefore the clinical methods of evaluating the cardioplegia solution must be relegated to gross indicators such as survival, the use of the intra-aortic balloon and the use of vasopressors for postoperative support. Myocardial enyzme levels can also be obtained and an indication of perioperative infarction can be assessed.

The purpose of this study was to assess the adequacy of our blood cardioplegia by using the gross indicators mentioned and to report the clinical results of our use of blood cardioplegia as a basis for comparison among community hospital settings.

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## Materials and Methods

A retrospective analysis of patients operated on by one surgeon from January 1982 to December 1982 was conducted for this study. The surgical preparation for cardiopulmonary bypass included cannulation of the ascending aorta and the use of two vena cavae cannulae with the cavae snared for total bypass, decompression of the left ventricle via the right superior pulmonary vein through the left atrium, systemic cooling to 26 degrees centigrade, and the same cardioplegic solution composition throughout the year.

Data collection consisted of the following parameters: age, weight, sex, aortic cross-clamp time, cardiopulmonary bypass time, and the amount of cardioplegia used while the aorta was cross-clamped. The use of vasopressors, vasodilators, and whether atrial or ventricular temporary pacing was required, was also recorded. The use of the intra-aortic balloon pump was recorded as well as the laboratory results from myocardial enzyme studies.

The cardioplegia delivery system consisted of a recirculating cooling coil[a], utilizing a low flow roller pump with delivery to the aortic root via a 10 french cannula. The system was primed with 400 ml. Plasmylyte 148[b] and connected to the coronary perfusion port of the oxygenator. Thirty mEq of potassium chloride were placed in the initial liter of blood and twenty mEq in each subsequent liter. Once the patient was on stable cardiopulmonary bypass, the system was filled with one liter of blood via the coronary perfusion port of the oxygenator. After several passes through the cooling coil, the aorta was cross-clamped and the initial bolus of cardioplegia was delivered to the aortic root at 5 to 10° Centigrade. Initial volume of cardioplegia was usually 300 to 500 ml. of blood delivered at an aortic root pressure of about 80 to 100 mmHg. The cardioplegic solution hematocrit ranged from 11% to 18%, depending on the patient's initial hematocrit level. Succeeding doses were given following each distal anastomosis for saphaneous vein grafting cases and every 30 minutes on all other procedures. The system was refilled via the coronary perfusion port of the oxygenator for those cases which required more than one liter of cardioplegia.

[a] CSD-103, Shiley Inc., Irvine, CA 92714
[b] Travenol-Baxter Labs, Inc., Deerfield, IL 60015

## Results

Of the 97 patients reviewed, two patients were eventually eliminated from the study. One patient underwent a resection of a descending thoracic aneurysm with lower body perfusion and received no cardioplegia. The other patient was an 11-year-old male undergoing a repair of an atrial septal defect. The remaining patients were divided into two groups. Group A consisted of all coronary bypass procedures and those patients having concurrent left ventricular aneurysmectomy. There were 72 patients in this group. Three patients had concurrent aneurysm resection. Group B included all other procedures requiring the use of cardiopulmonary bypass and receiving cardioplegia. This group included single and double valve replacement and other miscellaneous procedures. There were 25 patients in this group.

The mean age of Group A was 60 years. There were 57 males and 15 females who received a mean of 3.7 coronary bypasses. The mean aortic cross-clamp time was 59.6 minutes with a mean pump time of 98.8 minutes. These patients received an average of 608 ml. of blood cardioplegia.

Eleven patients (15%) required the use of a vasopressor following operation and 23 (32%) patients required the use of a vasodilator. Only 10 (14%) patients required the use of both for post-bypass support. Atrial pacing was used on 10 (14%) patients while atrial ventricular pacing was required on 13 (18%) patients. An intra-aortic balloon was needed on eight (11%) patients for post-operative support. However, two of these patients were having pre-infarction angina and the intra-aortic balloon was inserted pre-operatively. Only six (8%) patients required the use of both a vasopressor and the intra-aortic balloon. Six patients had elevations in serial enzyme levels to indicate a peri-operative infarct and 4 patients were at the pre-infarction stage prior to surgery. Of those patients having enzymatic indication of peri-operative infarct, only one patient required the use of the intra-aortic balloon. There were no deaths in this group.

The mean age of Group B was 55 years. There were 13 males and 12 females. Mean aortic cross-clamp time was 68 minutes and mean pump time

was 104 minutes. The average volume of cardioplegia was 543 ml. Five patients (20%) required the use of a vasopressor and 11 patients (44%) required the use of a vasodilator. Five patients (20%) required both. Atrial pacing was used in nine patients (36%) and five patients (20%) received atrial ventricular pacing. Four patients (16%) were identified as having a peri-operative infarct and two of those patients required the use of the intra-aortic balloon. Both patients were early deaths. There were three deaths (12%) in this group. The first death was a patient with sub-acute bacterial endocarditis and rupture of the Sinus of Valsalva. The second patient died one hour post-operatively from a rupture of the AV grove. The third patient presented to our hospital one year post mitral valve replacement with a thrombosed prosthetic valve and in cardiogenic shock. The intra-aortic balloon was inserted pre-bypass and the patient eventually expired one month post-op of septic shock and renal failure.

## Discussion

The advantages of blood cardioplegia have been debated ever since the reintroduction of hypothermic potassium cardioplegia by Gay and Ebert in 1973.[1] Some of the advantages of blood cardioplegia include the physiologic nature of the delivery solution, its buffering capacity, the natural presence of a colloid and the ability to deliver oxygen and remove carbon dioxide. Numerous reports have indicated the usefulness of blood cardioplegia. Follette and associates found that it reduced myocardial edema although there was some loss of left ventricular stroke work.[9] Their experience also indicates that blood cardioplegia hearts had recovery values similar to those of control hearts. Barner states that although recovery of ATP and ADP levels were lower, they were significantly higher than hearts perfused with crystalloid cardioplegia.[10] Engleman and associates also state that blood cardioplegia maintained higher levels of ATP.[11]

Clinical reports indicate better results with a reduction of myocardial injury, perioperative infarction, post-operative circulatory support and mortality. Cunningham and associates reported that ATP levels were maintained and cellular ultrastructure was not altered.[12] Roberts and coworkers stated that there were no differences between two groups of matched patients unless coronary ischemia time was greater than 90 minutes or with an impaired pre-operative left ventricular ejection fraction. Their work indicates that these patients did significantly better.[13] Singh and group reported that blood cardioplegia patients had near normal ultrastructure and increased glycogen stores. They also report lower filling pressures and lower CPK-MB levels.[7] Engleman and co-workers reported that crystalloid cardioplegia allowed a greater lactate production during arrest while blood cardioplegia allowed a greater potassium absorption.[6]

The reports in the literature allow the community based surgeon to make a decision on the type of cardioplegia to use in his practice. However, it is difficult for him to assess the impact of his cardioplegia without incurring significant expense. Therefore he must use gross indicators such as use of circulatory support, morbidity and mortality. The results reported here seem to indicate that our experience with blood cardioplegia is satisfactory. An operative coronary artery bypass mortality of 0% and a combined early mortality of 2% bears this out. An overall perioperative infarction rate of 10% seems excessive when compared to other reports. However when these results are compared to the clinical outcome of the patient, they seem to be contradictory. Only 3% of the patients with a presumptive diagnosis of perioperative infarction required the use of an intra-aortic balloon. Six percent required the use of some kind of vasopressor. This seems to indicate that reliance on clinical results may sometimes supersede the results of laboratory interpretations.

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