Nicholas B Mellas BS, CCP

Director of Cardiovascular Perfusion Montefiore Medical Center
Retrograde Autologous Priming

Are we RAP’ed out?
Disclosures

• No Financial Disclosures
Do you RAP at your institution?

• 1. All of the time
• 2. Some of the time
• 3. Never
• 4. Only when my Boss is working with me
• 5. When my Surgeon is in the mood
Is RAP included in your pre-op briefing?

• 1. Yes
• 2. No
Do you have a protocol for your RAP procedure?

• 1. Yes
• 2. No
• 3. Not sure
• 4. Yes but nobody follows it
Does your department share feedback with you about your performance?

- 1. Yes
- 2. No
- 3. Only in an annual review
- 4. Not on a regular basis
Does your department track when your RAP volume is re-infused?

- 1. Yes
- 2. No
- 3. I’m not sure
- 4. Yes and the information is provided back to me on a regular basis
Do you administer your medications into your prime before you RAP?

• 1. Yes
• 2. No
Does your Program collect data on your index flow?

- 1. Yes
- 2. No
- 3. Not sure
- 4. Yes and the information is provided to me on a regular basis
Open-Heart Surgery at the Texas Heart Institute:
The First 50,000 Operations

Denton A. Cooley, M.D.

THE FIRST open-heart operation with the use of temporary cardiopulmonary bypass was performed on April 5, 1956, on a 49-year-old man who had been admitted for emergency surgery because of an acute post-myocardial infarction causing perforation of the interventricular septum. He entered the operating room in frank, intractable pulmonary edema and cardiogenic shock, and was terminally ill. The operation was conducted with a DeWall-Lillehei oxygenator and Sigmamotor pump. The patient recovered from the operation, but expired 6 weeks later from extension of the myocardial infarction. Twenty-seven years later on February 16, 1983, a 46-year-old man with myocardial ischemia due to coronary artery occlusive disease underwent an elective and routine procedure. A double bypass with a reversed segment of saphenous vein was performed uneventfully, and he was discharged from the hospital 7 days later in good condition. His convalescence has been smooth. The contrast between the two patients is striking: The first operation was performed on a patient with a fatal complication of a severe myocardial infarction, while the second was done more as a preventive measure against myocardial infarction to provide relief of angina pectoris and restore a comfortable, symptom-free life.

increased each year until 1982, when a slight decrease occurred due to many factors, some economic and others medical. During the period of this experience, certain concepts have prevailed. Emphasis has been placed on simplicity, expeditiousness, and efficiency, both of performance and patient cost. From the outset, surgery was conducted with the briefest possible periods of cardiopulmonary bypass and perfusion. Bubble oxygenators have proved to be the most effective under these circumstances, although in some instances, predominantly of anticipated prolonged perfusion, membrane oxygenators have been employed. Development of disposable equipment, both in the extracorporeal circuit and in operating room supplies, has contributed to economy of time. Whenever possible, disposable drapes, surgical gowns, instrument trays, and some instruments have been developed to avoid delay and the time-consuming inefficiency of on-site hospital laundries, instrument clean-up personnel, etc. During the earliest period, only one operating room was assigned for cardiovascular procedures, while at present ten operating rooms routinely conduct open-heart procedures simultaneously.

Analysis of open-heart procedures has revealed a striking diversification between acquired and congenital cases (Table I).
History

Early Period (1956–1962)
“Blood Prime for the circuit was standard, requiring six to ten units of freshly drawn heparinized blood”
Open-Heart Surgery without the Need for Donor-Blood Priming in the Pump Oxygenator

Wilford B. Neptune, M.D.†, James A. Bougas, M.D.‡, and Frederick G. Panico, M.D.§


Open-heart operations with disposable oxygenators, 5 per cent dextrose prime, and normothermia.

COOLEY DA, BEALL AC Jr, GRONDIN P.
Middle Period (1963-1969)

More efficient and practical equipment was developed during this period. Plastic, disposable oxygenators replaced reusable oxygenators but equipped with a system to avoid hemolysis during the operation. Hemodilution provided a more effective means of tissue perfusion and oxygen transport. During this period, the Heart Institute became known for accepting patients of the Jehovah’s Witness church. Since then, more than 1200 patients of this faith have undergone operation with cardiopulmonary bypass.¹⁶,¹⁷

- **Plastic Disposable oxygenators**
- **Hemodilution techniques “non-blood prime”**

The Homologous Blood Reaction of Cardiopulmonary Bypass

An Experimental Study on Pathogenesis and Treatment

Robert L. Berger, M.D., Evangelos Iatrides, M.S., Thomas J. Ryan, M.D.

From the Departments of Surgery and Medicine, St. Elizabeth’s Hospital and Tufts University School of Medicine, Boston, Mass. Former Resident (1961–1962), Visiting Staff (1963–967), and Director (1967–), Thoracic Surgery Service, Boston City Hospital.
Open-Heart Surgery without the Need for Donor-Blood Priming in the Pump Oxygenator

Wilford B. Neptune, M.D. †, James A. Bougas, M.D. ‡, and Frederick G. Panico, M.D. §


The retrograde autologous priming, first introduced in 1959 by Panico and Neptune¹, was revised and reintroduced in clinical practice in 1990 by Rosengart and associates.¹³ Several authors have modified the basic technique of priming the CPB circuit with autologous blood. Balachandran and colleagues¹⁴ for an open circuit system, as well as Sobieski and associates¹⁵ for a closed ECC circuit, have reported a simple and practical modification.
Retrograde autologous priming for cardiopulmonary bypass: a safe and effective means of decreasing hemodilution and transfusion requirements.


Abstract

OBJECTIVES: The obligatory hemodilution resulting from crystalloid priming of the cardiopulmonary bypass circuit represents a major risk factor for blood transfusion in cardiac operations. We therefore examined whether retrograde autologous priming of the bypass circuit would result in decreased hemodilution and red cell transfusion.

METHODS: Sixty patients having first-time coronary bypass were prospectively randomized to cardiopulmonary bypass with or without retrograde autologous priming. Retrograde autologous priming was performed at the start of bypass by draining crystalloid prime from the arterial and venous lines into a recirculation bag (mean volume withdrawal: 880 +/- 150 ml). Perfusion and anesthetic techniques were otherwise identical for the two groups. The hematocrit value was maintained at a minimum of 16% and 23% during and after cardiopulmonary bypass, respectively, in all patients. Patients were well matched for all preoperative variables, including established transfusion risk factors. Subsequent hemodynamic parameters, pressor requirements, and fluid requirements were equivalent in the two groups.

RESULTS: The lowest hematocrit value during cardiopulmonary bypass was 22% +/- 3% versus 20% +/- 3% in patients subjected to retrograde autologous priming and in control patients, respectively (p = 0.002). One (3%) of 30 patients subjected to retrograde autologous priming had intraoperative transfusion, and seven (23%) of 30 control patients required transfusion during the operation (p = 0.03). The number of patients receiving any homologous red cell transfusions in the two groups during the entire hospitalization was eight of 30 (27%; retrograde autologous priming) versus 16 of 30 (53%; control) (p = 0.03).

CONCLUSIONS: These data suggest that retrograde autologous priming is a safe and effective means of significantly decreasing hemodilution and the number of patients requiring red cell transfusion during cardiac operations.
Retrograde and Antegrade Autologous Priming

- The passive displacement of crystalloid solution from the CPB circuit using the patient’s blood volume via the arterial and venous lines of the CPB circuit.

- Perceived benefits:
  - Less hemodilution during the initiation of CPB
    - ↑ Hemoglobin, COP, plasma and platelets
  - ↓ dilution of circulating pharmacologic agent
  - Reduced blood transfusions on CPB
  - Inexpensive

Retrograde autologous priming and allogeneic blood transfusions: a meta-analysis

Richard Saczkowski, Pierre-Luc Bernier, Christo I. Tchervenkov and Ramiro Arellano

*Corresponding author. Fax: +1–514–412–4330. E-mail address: richard.saczkowski@gmail.com (R. Saczkowski).

Received October 1, 2008. Revision received November 24, 2008. Accepted November 25, 2008.

Abstract

A literature review and meta-analysis were undertaken to assess the clinical effectiveness of retrograde autologous priming of the cardiopulmonary bypass circuit to reduce allogeneic packed red blood transfusions in adult cardiac surgery. Structured searches of Medline, Embase, Cochrane Collaboration Library, Scopus, Cumulative Index to Nursing and Allied Health Literature and Science Direct were performed to identify randomized trials comparing retrograde autologous priming to a prospective control group. A total of 21,643 studies were identified and after filtering a total of 21 randomized trials were included for analysis.
Retrograde autologous priming of the cardiopulmonary bypass circuit reduces blood transfusion after coronary artery surgery

Subramaniam Balachandran (FRCA), Michael H. Cross (FRCA), Sivagnanam Karthikeyan (FRCA), Anilkumar Mulpur (FRCS), Stephen D. Hansbro, Peter Hobsboun, RS

Is retrograde autologous prime a safe and effective means of reducing the use of banked blood during elective cardiac surgery?

Accepted:
V. J. Chilton and P. Fricker

DOI: http://  Article first published online: 10 JAN 2007
DOI: 10.1111/j.1365-2044.2006.04942_1.x

Low-prime perfusion circuit and autologous priming in CABG surgery on a Jehovah's Witness: a case report.

Brest van Kempen AR, Gasiorek JM, Bloemendaal K, Storm van Leeuwen RP, Bulder ER.

Abstract
Cardiac surgery on Jehovah's Witnesses is a great challenge for the cardiothoracic surgery team and especially for the perfusionist. To reduce the risk of surgery in these patients, a very small extracorporeal circuit was designed to decrease the amount of priming volume and thereby the degree of hemodilution. A small bypass system was built, consisting of a 3/8-in. arterial line and a 3/8-in. venous line, a venous collapsible reservoir, a centrifugal pump, a hollow fiber oxygenator and a cell saver reservoir. The circuit priming volume was 650 ml. By using antegrade and retrograde autologous priming, the total amount of priming was reduced to +/-50 ml. Bypass time was 63 min with an average blood flow of 5300+/-114 ml/min and postmembrane pressures of 180+/-45 mmHg. Venous line pressure was monitored and kept between -8 and -20 mmHg with a mean arterial pressure (MAP) of 55+/-12.3 mmHg. The hematocrit before extracorporeal circulation (ECC) was 36%, per-ECC 35% and post-ECC 35%. On the postoperative day, the hematocrit was 40%. The patient was discharged 7 days after surgery. A low-prime circuit, in combination with autologous priming, seems to be safe and effective in avoiding the use of banked blood.

PMID: 11822354 [PubMed - indexed for MEDLINE]
Strategies to Minimize Hemodilution

- Minicircuits (Class I Level of evidence A)
- Vacuum-assisted venous drainage (Class IIb Level of evidence C)
- Retrograde autologous priming (Class IIb Level B)
- Biocompatible CPB circuits (Class IIb Level of evidence A)
Matching the Circuit to the Size of the Patient

Mrs. Nussbaum

• Oxygenator with integrated arterial filter
  • 140mL prime
• 3/8 inch venous line
• All circuit tubing length minimized
• Biocompatible surface coating
• Retrograde and antegrade autologous priming
• Net prime 400mL
Oxygen Delivery During Cardiopulmonary Bypass and Acute Renal Failure After Coronary Operations

Marco Ranucci, MD, Federica Romitti, MD, Giuseppe Isgrò, MD, Mauro Cotza, CCP, Simonetta Brozzi, CCP, Alessandra Boncilli, CCP, and Antonio Ditta, CCP


\[ \text{DO}_2 = \text{pump flow} \times (\text{hemoglobin} \times 1.36 \times \text{hemoglobin saturation} + 0.003 \times \text{arterial oxygen tension}) \]
Oxygen Delivery vs. HCT At Different Flow Rates

\[ \text{DO}_2 = Q(\text{indexed}) \times 10 \times (\text{HGB} \times 1.36 \times \text{SaO}_2 + \text{pO}_2 \times 0.003) \]

272 ml/min/m²

Cardiac Index
- 2.0
- 2.4
- 2.8
### Hemodynamic Process Indicators (Pump Cases)

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Mean</th>
<th>Median</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump Time</td>
<td>94</td>
<td>93</td>
<td>97.9</td>
</tr>
<tr>
<td>Cardiac output on CPB in mL/kg of patient weight</td>
<td>6.5</td>
<td>4.7</td>
<td>5.3</td>
</tr>
<tr>
<td>Cardiac index on CPB</td>
<td>571.4</td>
<td>300</td>
<td>579.7</td>
</tr>
<tr>
<td>Number of patients with ultrafiltration used</td>
<td>58.5%</td>
<td></td>
<td>59.7%</td>
</tr>
<tr>
<td>Heparin/kg</td>
<td>437</td>
<td>453.9</td>
<td>1,109</td>
</tr>
<tr>
<td>Glucose</td>
<td>177</td>
<td>181</td>
<td>180.2</td>
</tr>
<tr>
<td>Lactate</td>
<td>154.3</td>
<td>146</td>
<td>160.2</td>
</tr>
<tr>
<td>Lactate level of highest lactate &gt; 3.0 mmol</td>
<td>2.4%</td>
<td></td>
<td>13.4%</td>
</tr>
<tr>
<td>Pump volume returned</td>
<td>333.5</td>
<td>315</td>
<td>367.5</td>
</tr>
<tr>
<td>Number of patients transfused intraoperatively with RBC</td>
<td>36.6%</td>
<td></td>
<td>33.5%</td>
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</table>

### Hemodynamic Type Breakdown (Pump Cases)

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<th>Type</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>61%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>29.3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.4%</td>
</tr>
</tbody>
</table>

### Other Indicators by BSA

<table>
<thead>
<tr>
<th>BSA</th>
<th>Personal Mean</th>
<th>Median</th>
<th>Group Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.8m2 (20)</td>
<td>36.9</td>
<td>39.5</td>
<td>34.1</td>
</tr>
<tr>
<td></td>
<td>657.9</td>
<td>600</td>
<td>971.9</td>
</tr>
<tr>
<td></td>
<td>371.6</td>
<td>500</td>
<td>456.3</td>
</tr>
<tr>
<td></td>
<td>25.6</td>
<td>27</td>
<td>24.4</td>
</tr>
<tr>
<td></td>
<td>23.9</td>
<td>23.5</td>
<td>23.5</td>
</tr>
<tr>
<td></td>
<td>27.4</td>
<td>27</td>
<td>25.8</td>
</tr>
<tr>
<td></td>
<td>27.8</td>
<td>27</td>
<td>25.5</td>
</tr>
</tbody>
</table>
Summary

• RAP is an appropriate adjunct
• Protocols should be set for the procedure
• Index flow should be carefully monitored for appropriate oxygen delivery
• Data collection for quality improvement
• Regular reporting mechanisms should be employed
Isolated CABG - Process Indicators

Utilizing STS Definitions, refer to Appendix B, "Definitions."

CABG - Any Intra-Op Transfusion (7/1/2013 - 6/30/2014)

- Montefiore
- STS Mean (35.8)

CABG - Any Post-Op Transfusion (7/1/2013 - 6/30/2014)

- Montefiore
- STS Mean (36.7)

CABG - Any Perioperative Transfusion (7/1/2013 - 6/30/2014)

- Montefiore
- STS Mean (52.3)

CABG - Extubated Within 6 Hours of Surgery (7/1/2013 - 6/30/2014)

- Montefiore
- STS Mean (44.3)

Data reported using date of surgery