Efficacy of leukocyte depletion of residual pump blood

EM Heerdt¹, EJ Fransen², JG Maessen² and DS de Jong¹

¹Department of Extra-Corporeal Circulation, University Hospital Maastricht, The Netherlands; ²Department of Cardiothoracic Surgery, University Hospital Maastricht, The Netherlands

In this study, we examined whether leukocyte depletion from the residual heart-lung machine blood at the end of cardiopulmonary bypass (CPB) has an effect on the leukocyte counts in the systemic circulation.

Twenty-six patients undergoing coronary artery bypass grafting (CABG) were randomly allocated to a leukocyte-depletion group or a control group. In the leukocyte-depletion group (n = 13), all residual blood (400 mL to 1.4 L) was filtered by leukocyte-removal filters (Pall RS01) and reinfused to the patient after CPB, whereas, in the control group, an identical amount of residual blood after bypass was reinfused without filtration (n = 13). Leukocyte-depleted allogeneic blood was transfused if needed.

Preoperative risk profiles, pump support and duration of aortic crossclamping time were identical in both patient groups (ns). Leukocyte depletion removed more than 96% of leukocytes from the residual retransfused blood (p < 0.01) and significantly reduced circulating leukocytes (p < 0.05) compared with the control group. Remarkably, lower numbers of circulating leukocytes were found, not at 1 hour after reinfusion, but at 4 and 8 hours after reinfusion (p < 0.05). There were no statistical differences between the two groups with respect to postoperative blood loss, the number of transfused packed red cells and mechanical ventilation time.

These results show that leukocytes can be removed from the residual blood of the heart-lung machine after CPB very effectively. Furthermore, this leukocyte depletion results in a long-term effect, the clinical significance of which has to be elucidated in ongoing studies.


Patients
Twenty-six patients undergoing elective coronary artery bypass grafting (CABG) with CPB were randomly allocated to a leukocyte-depletion group (n = 13) or a control group (n = 13). In the leukocyte-depletion group, all residual blood was filtered using the Pall leukocyte RS filter (Pall Biomedical Ltd, Portsmouth, UK) and reinfused to the patient after CPB. In the control group, residual blood was reinfused after CPB without filtration.

The exclusion criteria were as follows: a) need for an intra-aortic balloon pump (IABP); b) reoperation; c) severe chronic obstructive pulmonary disease (COPD). Patient demographics are listed in Table 1, expressed as mean ± standard deviation and p value (p < 0.05).

Methods

Extracorporeal circulation
The extracorporeal circuit (ECC) consisted of the following components:

Address for correspondence: EM Heerdt, MSc, Department of Cardiothoracic Surgery, University Hospital Maastricht, PO Box 5800, 6202 AZ Maastricht, The Netherlands.
E-mail: e.heerdt@scpc.azm.nl

© Arnold 2004


10.1191/0267659104pf699cs
Table 1 Perioperative patient characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Control group, n = 13</th>
<th>Filter group, n = 13</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (M/F)</td>
<td>11/2</td>
<td>12/1</td>
<td>ns</td>
</tr>
<tr>
<td>Age (years)</td>
<td>65 ± 10</td>
<td>69 ± 9</td>
<td>ns</td>
</tr>
<tr>
<td>BSA (m²)</td>
<td>2.02 ± 0.16</td>
<td>1.98 ± 0.14</td>
<td>ns</td>
</tr>
<tr>
<td>CPB duration (min)</td>
<td>69 ± 25</td>
<td>72 ± 20</td>
<td>ns</td>
</tr>
<tr>
<td>ACC duration (min)</td>
<td>44 ± 17</td>
<td>50 ± 20</td>
<td>ns</td>
</tr>
<tr>
<td>Number of distal anastomoses</td>
<td>3 ± 1</td>
<td>4 ± 1</td>
<td>ns</td>
</tr>
</tbody>
</table>

ACC, aortic cross-clamp; BSA, body surface area; CPB, cardiopulmonary bypass. All values are expressed as mean±SD.

Results

No statistically significant differences were found for the perioperative patient characteristics (Table 1).

The effect of the leukocyte filtration of residual pump blood is shown in Figure 1. Up to 96% of leukocytes from the residual blood was filtered out. In the early postoperative period (up to 8 hours), patients in the filter group had significantly lower leukocyte counts (p < 0.05; Figure 2). However, this difference was no longer apparent at 18 hours after the operation. Also, we could not demonstrate a statistically significant difference in the main clinical characteristics included in the study (Table 2).

Discussion

Patients undergoing cardiac surgery with CPB develop a systemic inflammatory response syndrome (SIRS). Contact of the blood of the patient with the foreign surfaces of the CPB circuit triggers the generation of biological cascades, leading to the activation of leukocytes. Activation of leukocytes is considered a major cause of the development of SIRS.1,9

![Figure 1](image_url) Leukocyte counts in residual blood of the HLM pre- and postleukocyte filtration. Data are mean±SD. * p < 0.05.

- Roller pump heart-lung machine (Stockert Instruments GmbH, Munich, Germany)
- Roller pump tubing (Raumedic Silicone, Rehau AG, Rehau, Germany)
- Circuit tubing (Raumedic PVC, Silicone, Rehau AG, Rehau, Germany)
- Coating (Bioline Heparin Coating, Jostra AG, Hirrlingen, Germany)
- Pall LG-6, arterial line filter (Pall Biomedical Ltd, Portsmouth, UK)
- Capiox SX 18 oxygenator (Terumo, Tokyo, Japan)
- BMR-1900G venous reservoir (Bentley/Baxter, Irvine, CA, USA)
- Cardiotomy reservoir (BRC-3500 GOLD, Baxter, Bentley division, USA)
- Jostra 24 Fr. arterial cannula (Jostra Medizintechnik, Hirrlingen, Germany)
- Research Medical 51-36 Fr. Venous return cannula (Research Medical Inc., UT, USA)

The priming solution consisted of 1300 mL of haemaccel (Behringer), 200 mL of mannitol 20% (Baxter), 100 mL of albumin 20% (CLB), 50 mmol of NaHCO₃ 8.4% (Braun, Melsungen A.G., Germany), 20 mmol of KCL 7.45% (Braun, Melsungen A.G., Germany) and 6500 IU of heparin (Leo Pharmaceutical Products).

Measurements

Blood samples were taken upon induction of anaesthesia, at the start of CPB, at the end of CPB, out of the transfusion bags with the residual blood (in the filter group before filter and in the bags after the filter) and in the ICU after 1, 2, 4, 8 and 18 hours postoperatively. At all time points, leukocyte counts and leukocyte differentiations were measured in the laboratory. Before taking a sample from the transfusion bags, the bag was gently agitated to assure that a representative sample could be obtained.

The following clinical variables were also recorded: blood loss in operating room, blood loss in ICU (thorax drains), diuresis during the first 24 postoperative hours and time until weaning from ventilation.
In this study, we examined the efficacy of the Pall leukoguard RS filter. Approximately 96% of leukocytes were filtered out of the residual blood by the Pall leukoguard RS filter. The following reduction of systemic leukocyte count in the postoperative period in the filter group cannot be explained just by fewer reinfused leukocytes.

Decreasing numbers of activated leukocytes in reinfused blood results in significant reduction of leukocyte production in the early postoperative period, which confirms the data published by Hornick and George.\textsuperscript{10} It looks like our data show that simple filtration of leukocytes from the residual blood of the HLM, and its effects on postoperative leukocyte counts in the systemic circulation, could significantly diminish the postoperative inflammatory response in patients undergoing cardiac surgery. Whether this is true remains to be elucidated in ongoing studies.

### Conclusion

This study shows that leukocytes can be effectively removed from the residual blood after CPB. The effect of leukocyte depletion persists up to 8 hours postoperatively.

The clinical significance of leukocyte depletion has to be elucidated in larger, ongoing studies.

#### References
