Leukopoor Platelet Concentrates: A Direct Comparison of Three Blood Filters*

L. JEFFREY MEDEIROS, M.D.† and WALTER H. DZIK, M.D.

Blood Bank,
New England Deaconess Hospital,
Boston, MA 02215

ABSTRACT

Repeated exposure to foreign human leukocyte antigens (HLA) present on both platelets and leukocytes often results in refractoriness to transfusions of platelet concentrates. Evidence now exists which suggests that the leukocytes are more immunogenic and that their removal from blood products may delay or prevent the development of refractoriness.

In this study, the ability of three blood filters to remove leukocytes from platelet concentrates was directly compared. Pooled platelet concentrates were filtered through the Fenwal 4C 2131 depth microaggregate blood filter (MABF), the Pall Ultipor® SQ 40S screen MABF, and the Terumo Imugaard® IG-500 blood filter. The results were then compared to a previous study (done in the same laboratory) which used differential centrifugation to render platelet concentrates leukocyte-poor.

The Fenwal and Pall MABFs did not remove leukocytes or platelets from platelet concentrates. In contrast, the Terumo filter removed 90.2 percent of the leukocytes while sacrificing 7.5 percent of the platelets; results superior to differential centrifugation which removed 84.9 percent of the leukocytes but sacrificed many more platelets, 32.3 percent.

The Terumo Imugaard® IG-500 blood filter produces leukocyte-poor platelet concentrates as efficiently as differential centrifugation with much less platelet loss. Use of the Terumo filter may aid further studies required to evaluate the use of leukocyte-poor platelet concentrates for the prevention of platelet refractoriness.

Introduction

Refractoriness to transfusions of platelet concentrates is a common problem, occurring in as many as 70 percent of patients who receive multiple transfusions of platelet concentrates. Refractoriness is thought to occur following exposure to foreign HLA antigens, present on both the leukocytes and platelets of platelet concentrates. Recent studies have suggested that transfusion of leukocyte-poor platelet concentrates may...
reduce the incidence and/or delay the onset of platelet refractoriness.\textsuperscript{1,7}

Differential centrifugation has been the standard method of producing leukocyte-poor platelet concentrates. Though effective, differential centrifugation sacrifices a significant number of platelets.\textsuperscript{3,4}

Recently, Snyder et al\textsuperscript{6} showed that platelet concentrates could be transfused through microaggregate blood filters (MABFs) without significant loss of platelet number or function, as measured in vitro. Concurrently, the Terumo Medical Corporation has developed the Imugaard IG-500\textsuperscript{R} blood filter, designed to remove leukocytes from red cell transfusions.

In this study, the ability of two differently designed MABFs and the Imugaard IG-500\textsuperscript{R} blood filter to render platelet concentrates leukocyte-poor was compared.

**Materials and Methods**

Platelet concentrates were prepared from single unit, whole blood volunteer donations and were stored on a vertical rotator for 24 to 48 hours at 22°C. Ten pools, each consisting of 10 units of platelet concentrates, were prepared according to standard technique\textsuperscript{8} and were then divided into three aliquots. One aliquot was filtered by gravity through an unused Fenwal 4C 2131 depth 20μ MABF. A second aliquot was similarly filtered through an unused Pall Ultipor\textsuperscript{R} SQ 40S screen 40μ MABF. The third aliquot was filtered by gravity through an unused Terumo Imugaard IG-500\textsuperscript{R} blood filter. This filter was primed and unloaded with 250 ml of saline according to the directions specified by the manufacturer. Samples from each pool and each aliquot were diluted 1:500 (for platelet counts) and 1:224.7 (for leukocyte counts) with Isoton\textsuperscript{R} prior to duplicate platelet and leukocyte counting by a Coulter S plus instrument.

The results from this experiment were then compared to a previous experiment which measured the ability of differential centrifugation to render platelet concentrates leukocyte-poor.\textsuperscript{3}

**Results**

The results of filtration of platelet concentrates through the blood filters are summarized in table I. The Pall and Fenwal MABFs performed in a similar fashion and did not effectively remove leukocytes from platelet concentrates. In contrast, the Terumo blood filter removed 90.2 percent of the leukocytes while sacrificing 7.5 percent of the platelets. The 90.2 percent leukocyte removal

<table>
<thead>
<tr>
<th>TABLE I</th>
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<tbody>
<tr>
<td><strong>Comparison of the Pall, Fenwal, and Terumo Blood Filters on Platelet Concentrates</strong></td>
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<tr>
<td><strong>Before Filtration</strong></td>
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<tr>
<td><strong>Platelets</strong></td>
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<td>(number)</td>
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<tr>
<td>(% removed)</td>
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<tr>
<td><strong>Leukocytes</strong></td>
</tr>
<tr>
<td>(number)</td>
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<tr>
<td>(% removed)</td>
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*The mean total number/pool (±SD) and percent removal of platelets and leukocytes in 10 experiments is expressed.

†One way analysis of variance.
corresponds to a reduction of total leukocytes from $6.90 \times 10^8$ per pool (SD ± $4.21 \times 10^8$) to $0.68 \times 10^8$ per pool (SD ± $0.69 \times 10^8$). This reduction is similar to that obtained by Schiffer et al using differential centrifugation.

Differential centrifugation of platelet concentrates is compared to the Terumo blood filter in Table II. Differential centrifugation removed 84.9 percent of the leukocytes from platelet concentrates, not significantly different from the Terumo blood filter. However, differential centrifugation also removed 32.3 percent of platelets which is significantly greater ($p < 0.001$) than that obtained using the Terumo blood filter.

### Discussion

The results of this study show that platelet concentrates can be transfused through MABFs and the Terumo blood filter without significant loss of platelet number, confirming the findings of previous investigators. In addition, it was found that the Fenwal and Pall MABFs inefficiently removed leukocytes and thus would not be expected to aid in preventing platelet refractoriness. In contrast, the Terumo blood filter removed 90.2 percent of the leukocytes while preserving more than 90 percent of the platelets in platelet concentrates. Similar results have been achieved by Sirchia et al and Sniecinski et al. It is believed this blood filter produces leukocyte-poor platelet concentrates as efficiently as differential centrifugation while preserving platelet number and may prove to be useful in preventing platelet refractoriness.

At present, the Terumo blood filter is relatively inconvenient to use. First, the filter is not designed for bedside use. Second, the filter requires priming and unloading with saline. In this experiment, the filter was primed and unloaded with 250 ml of saline according to the directions provided by the manufacturer. Third, the Terumo filter is encased in opaque, tan plastic which makes it difficult to know when the platelet concentrate first passes through the filter, which can cause additional platelet loss. Lastly, between 20 and 30 minutes are needed to filter a pool of 10 units of platelet concentrates. Despite these difficulties, the Terumo blood filter has been found to be more efficient than differential centrifugation for the production of leukopoor, platelet-rich platelet concentrates. Further work evaluating this filter in patients at risk for alloimmunization seems warranted.
References


