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ASSESSMENT OF LEUKOCYTE FILTERS EFFECTIVENESS ON PACKED RED CELLS

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ABSTRACT

Introduction : Removing leukocytes from donated blood is crucial for eliminating the risk of pathogen transmission, febrile non-hemolytic transfusion reactions, and various other transfusion side effects. Filtration using commercial polyurethane or polyester filters is the most common method of leukocyte removal from blood. This study examines and compares the efficiency of two commercial filters in removing leukocytes from packed red cells (PRC).

Methods : This cross-sectional study utilized sixty bags of PRC collected from RSCM between 1-31 March 2014. Thirty bags each were filtered using Imugard® (Filter I) and BPF4® (Filter B). Samples were drawn from the PRC bags before and after filtration for hematology assessment. Complete blood count, including leukocyte counting, was done using an automatic cell counter (Sysmex XN-2000, Japan). Independent t-test was used to compare pre-filtration hematologic profiles of PRC bags in the two groups (I and B). Wilcoxon Signed-Rank test was used to test the difference in leukocyte content pre- and post-filtration for each filter, and percent leukocyte reduction between the two filters.

Results : Prefiltration leukocyte content were similar in both groups of PRC (p=0.051). Both Filters I and B successfully filtered >99.9% leukocyte from blood, with Filter B slightly better by 0.03% (p=0.003). Leukocytes remaining after filtration were polymolphonuclear cells.

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Conclusion : Commercial filters Imugard® and BPF4® effectively reduces leukocyte content from packed red cells. Both filters could be used for filtering donated blood prior to transfusion, especially for patients who need repeated transfusions.

INTRODUCTION

Blood transfusion is a medical therapeutic intervention that provides many benefits for its recipients, but can also cause side effects for some recipients. Side effects may arise due to the presence of leukocytes in erythrocyte and platelet components, for instance the transmission of viral infections, fever due to non-hemolytic transfusion reactions, transfusion of platelets refractory, graft-versus-host disease, acute lung injury due to transfusion, and immunosuppression.[1,2,3]

Some of the techniques that can be done in removing leukocytes from blood components are sedimentation, centrifugation, washing, freezing-thawing, and filtration. Mechanical filtration of blood is the most common technique for lowering blood leukocyte levels because the technique is simple, fast, effective does not require expensive equipment and does not require an open handling system so that the shelf life of blood can be extended.[4,5]

The first generation filter with a pore size of 170-240 μm are used to prevent the entry of aggregate and large blood clot in a blood product. The second generation filter with a pore size of 40μm were developed to get rid of microaggregate that often form during blood storage, therefore this generation of filter is called by the name microaggregate filter. The latest development of blood filter is a third-generation filter that is not only able to block microaggregate but also can block leukocytes. The next generation of leukocyte filter is an optimization of the reduction of the number of leukocytes so as to get rid of leukocytes up to 3log10 (99.9%) and leave residual leukocytes of only 10 cells / uL.[4]

This study aims to obtain information on the effectiveness of commercial leukocyte filters in reducing the number of leukocytes in a Packed Red Cell (PRC) blood bag and compare the effectiveness of different filters.

METHODS

This cross-sectional study was conducted in the Department of Clinical Pathology Cipto Mangunkusumo Hospital (RSCM) and has clearance from the Ethics Committee of Faculty of medicine-RSCM with research material in the form of 60 bags of PRC blood. Filtration process was done by using two types of filters, namely filter Imugard® (filter I, 30 PRC blood bags) and BPF4® filter (filter B, 30 PRC blood bags). Hematologic examinations before and after the filtration were performed at Saint Carolus Hospital - Jakarta by using Sysmex XN-2000. Inclusion criteria were PRC blood bags that qualified for blood donation and exclusion criteria were PRC blood bags that have been processed previously to reduce the number of leukocytes.

Statistical analysis

To determine whether there was a significant difference between the results of hematology before and after filtration, first normality test was done. If the test showed normal distribution, paired T test was done, if the data were not normally distributed, Wilcoxon test was performed. Statistical test using SPSS software version 11.5, $p < 0.05$ means statistically significant.

RESULTS

The pre-filtration leucocytes number was almost significantly higher in filter I ($p = 0.051$), however, both filters were capable to remove > 99.9% leukocyte. Filter B performed slightly better by 0.03% ($p = 0.003$). Leukocyte remaining after filtration was polymorphonuclear cells.

Table 1. PRC blood characteristics before and after the filtration process using filter I

	Before Filtration	After Filtration	p
Leukocyte /μL	14.750 ± 3.307	13 (3 – 36)	< 0,001
PMN(%)	58 ± 8	89 (0 – 100)	
MN(%)	42 ± 8	11 (0 – 100)	
Erythrocytes /μL	8,04 ± 0,6X10^6	8,44X10^6 (5,9 – 9,5X10^6)	< 0,001
MCV(fL)	86,45 (75 – 100)	85,95 (75 – 100)	0,045
Platelet/μL	189,5X10^3 (101-587X10^3)	7,67± 5,4X10^3	< 0,001

Table 2. PRC blood characteristics before and after the filtration process using filter B

	Before Filtration	After Filtration	p
Leukocyte /μL	12.711 ± 4.536	5 (2 – 29)	< 0,001
PMN(%)	55 ± 11	80 (0 – 100)	
MN(%)	45 ± 11	20 (0 – 100)	
Erythrocytes /μL	8,03 ± 0,7X10^6	8,24±0,7X10^6	< 0,001
MCV(fL)	88,2 (76 – 93)	88,4 (76 – 93)	0,001
Platelet/μL	152,6 ± 82,1X10^3	6X10^3 (1 - 52X10^3)	< 0,001

DISCUSSION

This study examined the effectiveness of the filtration of leukocytes from two commercial filters, namely filter I and filter B. It was found that filter B can reduce leukocytes more than filter I significantly, but both of these filters give good results because it can reduce more than 99.9 % leukocytes and meets the criteria established by WHO leucocyte-depleted PRC blood component ie <25 leukocytes / uL.[6]

This study found that leukocytes remaining after the filtration process were largely PMN. This can be caused by PMN has a greater deformability and lower adhesion ability than MN.[5]

The results of this study contradict the results by van der Meer, et al. that filter I can reduce leukocyte more than filter B. This may be due to differences in the type of sample used, where van der Meer used PRC blood bags that had been treated previously with an automatic blood component separator to reduce the number of leukocytes. In this process the number of platelets were lessened, thereby reducing the adhesion of leukocytes to the surface of the filter.[5,7]

In this study leukocyte filter B proved more effective than the filter I. This may be due to filter B operates via mechanical filtration and physicochemical mechanisms, whereas filter I uses mechanical filter with very small pore size.

As it was found that both filters can filter leukocytes with high effectiveness, it is recommended to perform filtering of blood before transfusion, especially for patients who require repeated transfusions. Low levels of leukocytes in the blood after being filtered can reduce the risk of side effects in blood transfusion. This study uses a sample size that is larger compared to the research conducted by van der Meer (n = 12) and Kijkornphan (n = 10) .[7,8] Therefore, this study should be considered reliable. However we recognize that the results of this study is limited because it only uses two types of filters for comparison. Other commercial filters can be examined further in subsequent studies.

CONCLUSION

This study has tested the ability of leukocyte filtration two commercial filters with different filtration mechanisms, and found that filter B proved to be slightly more effective than the filter I. Nevertheless, both these filters have to reduce the effectiveness of leukocytes above 99.9%, so that the use either filter may be advisable to filter the blood before transfusion, especially in patients who require repeated transfusions.

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