Modified Platelet Storage Device to Improve Quality During Storage

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THE CENTRE FOR BLOOD RESEARCH

Background

Storage conditions

- Platelets are stored on 22 °C shakers for 5-7 days
- Bags are made from polyvinyl chloride (PVC) plasticized with di(2-ethylhexyl) phthalate (DEHP) (Figure 1.).

Figure 1. Platelet storage bag. Approximately 350 mL of platelet-rich plasma is stored in PVC-DEHP bags.

Platelet Storage Lesion

- The hydrophobic surface of the bags activates platelets[1].
- Storage and activation comprise the quality of the platelet concentrates, known as the Platelet Storage Lesion (PSL)[2].

Bacterial Contamination

- One in 1500-2000 PCs is contaminated[3].
- The bacterial screening period is 24 h., putting great strain on platelet supply and shelf-life.

Pathogen Inactivation Techniques

- Pathogen Inactivation Technologies (PITs) destroy nucleic acids.
- PITs also damage platelets, leading to faster clearance and poorer transfusion outcome[4].

Figure 2. Diagram of the Intercept™ blood system mechanism. Amotosalen (red hexagons) is activated by UV light between 320-400 nm (hv). Amotosalen then cross-links pyrimidines (red line). Made using Biorender.com

Objectives

1. Develop a storage bag coating which extends the shelf life of platelets.
2. Optimize the coating for Pathogen Inactivation Technologies.

Hypothesis

I hypothesize that the novel platelet storage device will increase the viable storage period of platelets treated with PITs.

Anti-Adhesive Coating

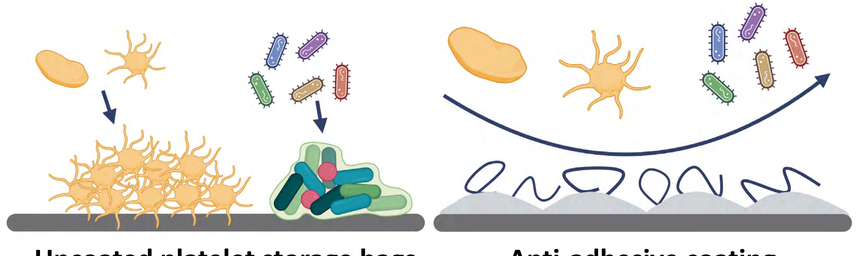


Figure 3. Graphic of the platelet storage bag coating. The figure on the left shows a schematic of uncoated bags. The hydrophobic surface allows platelet adhesion and activation, as well as biofilm formation, resulting in a decrease in the quality of the whole transfusion product. The figure to the right shows the effects of the proposed coating. By preventing these damaging interactions, this coating may resolve the problems that plague platelet storage.

Evaluating Storage Quality

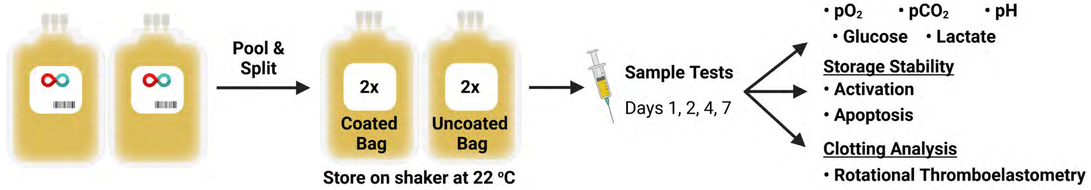
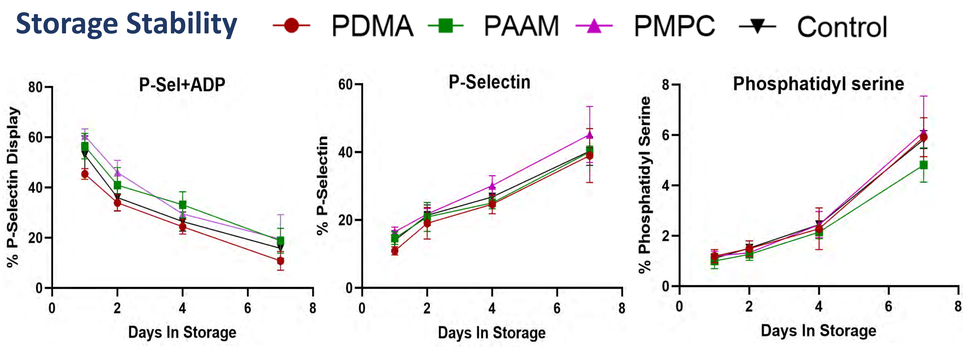


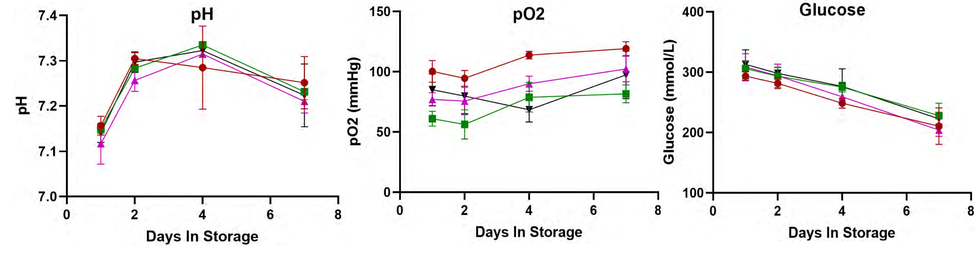
Figure 4. Workflow of the platelet characterization experiments. Two apheresis platelet concentrates are mixed and split into one coated and one uncoated bag. Platelets are then stored as per Canadian Blood Services standard procedure. The platelets are sampled on days 1, 2, 4, and 7. The cells are subject to a host of biochemical and cell physiology assays. Platelet activation and apoptosis are measured by immunofluorescent staining of P-selectin and phosphatidylserine, respectively. Platelet activity and metabolism is tracked through blood gas analysis of pH, pO_2, pCO_2, and glucose. Platelet function is assessed by rotational thromboelastometry and aggregometry. Figure produced using Biorender.com.

Platelet Assessment Results

Storage Stability



Metabolic Health



Clotting Analysis

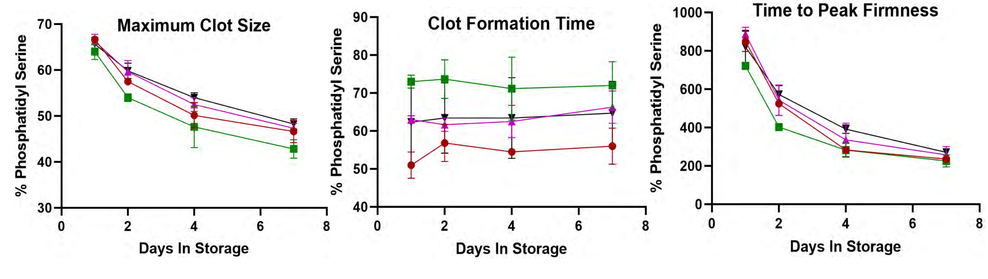


Figure 5. Results of platelet quality assays after storage in the novel coating and uncoated platelet storage bags. Platelets were pooled, split, and their quality during storage was evaluated as described in Fig. 4. For Storage Stability, platelets from coated bags showed better responsiveness (P-selectin + ADP) and displayed similar levels of P-selectin and phosphatidylserine as their uncoated counterparts. **No statistically significant differences were found.** For Metabolic Health (middle row), the plasma in the coated bags contained lower pO_2, greater CO_2, and had a lower pH than the uncoated bags. **No statistically significant differences were found.** To evaluate the Clotting Quality of the cells (bottom row), platelets were activated with tissue factor and the clotting was measured using rotational thromboelastometry. Results showed that the platelets from the coated bag had a lower peak firmness, but also displayed a shorter time to peak firmness and the same initial clotting rate. **No statistically significant differences were found.** The coated platelets are shown in red, and the uncoated platelets are in blue. N=3.

Conclusion & Future Directions

Conclusions

- Preliminary results show the coating does not significantly damage the quality of the platelet throughout storage, but uncoated platelets still perform better in some aspects

Future Directions

- Assess other polymers for the platelet-friendly coating to better preserve their quality throughout storage
- Investigate the anti-bacterial capabilities of the coating
- Assess the coating's effectiveness on PIT-treated platelets

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