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Review

Platelet concentrates, from whole blood or collected by apheresis?

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ABSTRACT

Platelet concentrates can be isolated from donated whole blood with the platelet-rich plasma-method or the buffy coat-method. Alternatively, platelets can be obtained by apheresis, harvesting the platelets but returning all other cells to the donor. The quality and characteristics of platelets during storage are affected by a number of factors, such as anticoagulant, centrifugation and processing after collection, and pre- or post storage pooling, but when comparing literature on the various methods, most differences balance out. To have sufficient platelets to treat an adult patient, whole-blood-derived platelet concentrates need pooling of multiple donations, thereby increasing the risk of infectious agent transmission at least two-fold as compared with apheresis units. Allo immunization rates, acute reaction rates, and transfusion related acute lung injury rates are not different. Apheresis donation procedures have fewer adverse events. All these factors need to be considered and weighed when selecting a method of platelet collection for a blood center.

Contents

1. Introduction

There are three principal methods to collect platelets from donors intended for transfusion to patients. Two use whole blood as source material, the platelet-rich plasma (PRP) method and the buffy coat (BC) method. In the PRP- procedure, whole blood is centrifuged softly to collect PRP, which in turn is spun hard to sediment and isolate the platelets. Shortly before transfusion, multiple (generally 5–10) units are pooled to make an adult dose. This method has long been the main method for preparation of platelet concentrates (PCs). However, it is increasingly being replaced by either the BC method, or by collection of platelets using apheresis devices.

For the BC method, whole blood is centrifuged hard, forming a BC layer on top of the packed red cells, consisting of leukocytes and platelets. The BC-layer is isolated, and pools of 4 or 5 BCs are made. Following soft-spin centrifugation, the platelet-rich supernatant is harvested, so that the unit is ready for transfusion at the onset of storage.

The essence of plateletapheresis is to solely collect platelets for transfusion, while the remainder of the blood cells is returned to the donor. For this purpose, devices have been developed that draw, centrifuge and return blood to the donor, integrated in one process. In this apheresis procedure, an entire platelet dose for an adult patient can be collected from one donor.

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2. Method of platelet collection: does it really matter?

Is there difference between the methods of collection of platelet concentrates, and if so, which should be preferred? There are a number of ways to look at that.

The first issue to consider is the platelet quality. The difference between whole blood-derived platelets and those collected by apheresis starts early on: whole blood is generally collected in citrate-phosphate-dextrose (CPD) anticoagulant, while plateletapheresis procedures generally use acid–citrate–dextrose. Phosphate is known to stimulate glycolysis in platelets [1] which may affect storage characteristics.

A comparison of PRP-derived PCs and apheresis PCs from the same donor, showed a poorer hypotonic shock response of 32 ± 13% for PRP and 57 ± 14% for apheresis platelets on day 5 [2]. On the contrary, ADP response was better for PRP, while other measures showed minor differences. For PCs with comparable platelet content, pH on day 5 was 7.30 ± 0.12 for BC-derived PCs and 7.04 ± 0.21 for apheresis PCs [3]. Other *in vitro* measures, including activation markers CD62P and CD63, and the apoptosis marker phophatidyl serine exposure, showed minor differences between the preparations. Others confirmed that BC-derived and apheresis platelets have similar *in vitro* quality during storage [4].

A comparison of more functional laboratory parameters revealed a better maintenance of ADP- and collagen-induced aggregometry response for apheresis platelets, in addition to a more rapid closure time of the PFA-100 as compared with BC-derived platelets [5].

When considering clinical data, PRP-derived platelets had a recovery of 35.2 ± 6.7% versus 36.8 ± 5.3% for apheresis, when collected from and reinfused to the same volunteer (not significant) [2]. Survival at 72 hours was 44.1 ± 18.6% for PRP and 53.8 ± 10.5% for apheresis. Platelets obtained by the BC method or by apheresis and stored for 5 days, showed an average recovery of 34.8% and 28.1%, respectively [6]. Survival was 6.9 days for BC-derived platelets and 5.4 days for apheresis platelets. Although the performance of apheresis platelets might seem poorer in this study, it might be confounded by the higher platelet concentration that induces a platelet storage lesion. A more recent comparison, evaluating leukoreduced PRP-platelets versus apheresis using a paired cross-over study design in 22 volunteers, found a recovery of 51.1 ± 17.4% for apheresis platelets and 43.0 ± 17.8% for PRP-platelets ($p = 0.032$) on day 5 of storage. Survival was also shorter for BC-platelets, 5.6 ± 2.0 days versus 4.2 ± 1.9 days, respectively ($p < 0.001$).

A comparison of PRP, BC and apheresis platelet concentrates showed no difference in the 1-h corrected count increment (CCI), which was 9.2 ± 1.5 for PRP, 11.1 ± 1.3 for BC, and 12.0 ± 1.2 for apheresis (p = 0.763); the 24-h CCI showed the same pattern, 6.2 ± 2.2, 6.5 ± 1.8 and 8.6 ± 1.7, respectively (p = 0.761) [7]. A similar study comparing only BC versus apheresis platelets found no significant differences for the 1-h and 24-h CCIs; for the 1-h CCI, 68% of the BC platelets and 69% of the apheresis platelets gave a value >7.5 [8]. The 24-h CCIs were acceptable for 50% of the BC-PCs and 46% of the apheresis PCs. Finally, a meta-analysis of whole blood-derived versus apheresis platelets did show better 1-h and 24-h CCIs for apheresis platelets [9] with a higher weighed mean difference of 2.49 and 1.64, respectively. However, the authors cautioned that the trials used for this meta-analysis were small and that the results should be interpreted with caution.

Overall, looking at the laboratory and clinical evidence, there appear to be minor differences in quality between whole blood-derived and apheresis platelets, certainly in the light of factors, other than the method of collection, contributing to changes during storage of platelets.

Another important aspect of platelet transfusions is the safety of the product. Apheresis concentrates are from one donor, while whole blood-derived concentrates need pooling of multiple donations. The higher donor exposure is evident, and modelled data indeed showed an increased incidence of viral transmission [10]. For PRP-derived PCs there was also an increased risk for bacterial contamination, though for BC-derived PCs no increased risk could be found as compared with apheresis PCs; the meta-analysis could not be used to explain why the latter yielded no difference.

Safety for donors is another consideration, analysis of over 1 million donation data revealed that 0.38% of whole blood donations was associated with moderate reactions, versus 0.12% for plateletapheresis procedures; these values were 0.09% and 0.03% for the severe reactions [11].

When comparing the percentage of acute adverse events in patients after transfusion, no significant difference in a meta-analysis could be found provided leukoreduction was applied, with an odds ratio of 1.78 (95% confidence interval, 0.87–3.62) [9].

In summary, platelets from whole blood or apheresis are comparable in quality, but additional factors such as infectious risks, number of adverse reactions, availability of donors, cost aspects as well as ethical considerations, may lead to the final choice of the desired method of collection of platelets for transfusion.

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