Plateletapheresis: An invaluable blood resource

Platelet transfusion has increased dramatically in recent years since the preparation of platelet concentrates from units of whole blood has become routine. In many areas of the United States, 50% to 70% of the whole blood collected is converted to blood components to supply platelets for transfusion.[1] Since platelets must be separated from fresh units of whole blood, those whole blood units collected at sites distant from a regional blood center's component preparation laboratory are unavailable for platelet production. As platelet requirements increase, a source other than whole blood collections, such as plateletapheresis, is essential.

See also the paper by Bator and Hoeltge (pp 411–416).

The efficacy of platelet transfusion in the treatment of hemorrhage is well established.[2–4] The ready availability of platelet concentrates has contributed significantly to the successful management of bone marrow transplant recipients and of patients with acute leukemia, aplastic anemia, and disorders of platelet function. There is a well-described inverse relationship between the peripheral blood platelet count and the frequency and severity of hemorrhage in these patients with hypoproliferative thrombocytopenia.[5] The incidence of hemorrhage increases as the platelet count decreases below 100,000/mm^3; the frequency of serious bleeding increases at platelet counts below 50,000/mm^3. Sepsis, coexistent plasma coagulation disorders, uremia, various medications, and other clinical features increase the risk of hemorrhage at any given platelet count, and therefore alter the platelet count at which transfusion is judged to be appropriate. In patients with platelet dysfunction, bleeding in the presence of a template bleeding time greater than twice normal requires platelet transfusion.

Prophylactic platelet transfusions are more controversial than therapeutic transfusions.[3–8] Published studies include various patient populations and analyze results according to different end points, making direct comparison difficult. Several studies, however, have demonstrated that prophylactic platelet transfusions significantly reduce the incidence of hemorrhage among leukemia patients receiving myelosuppressive therapy. Although there is no threshold platelet count above which such patients are free of hemorrhagic risk, prophylactic platelet transfusion regimens are most often designed to maintain the patient's platelet count above 20,000/mm^3. Prophylactic platelet transfusions are perhaps most beneficial in patients intensively treated with chemotherapy, such as those with acute nonlymphocytic leukemia and in those undergoing bone marrow transplantation, in whom prolonged thrombocytopenia can be predicted, and concomitant profound neutropenia and immunosuppression exist. Thrombocytopenic patients also require prophylactic transfusion in preparation for invasive procedures. A preprocedure platelet count of 75,000–100,000/mm^3 is the usual goal.

Patients with idiopathic thrombocytopenic purpura demonstrate a shorter bleeding time than expected for the observed platelet count, experience significantly less bleeding, do not have a platelet count increment following transfusion, and rarely if ever require prophylactic platelet transfusion. Prophylactic platelet transfusion also has no demonstrable benefit in thrombocytopenic postoperative cardiopulmonary by-

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pass patients or in massively transfused patients unless unusual bleeding occurs.[3,9]

To meet these varied and growing needs, two platelet products are commonly available: (1) platelets obtained by centrifugation from units of fresh whole blood, the platelets from several donors pooled to constitute a single transfusion dose, and (2) platelets harvested from a single donor using apheresis technology as described by Bator and Hoeltge in this issue of the CLEVELAND CLINIC JOURNAL OF MEDICINE.[10] There are several important advantages to the single-donor apheresis product. Since each apheresis platelet concentrate provides platelets equivalent to the number derived from five to eight whole blood donations, a single apheresis product constitutes the usual adult transfusion dose. The number of donor exposures is therefore decreased, minimizing the risk of exposure to infectious agents, and possibly reducing and/or delaying alloimmunization in some patients.[11,12] Single-donor apheresis platelets make it possible to match donor and recipient for antigens of the HLA system, or for platelet-specific antigens, improving the probability of a successful transfusion outcome in an alloimmunized patient. Emerging techniques such as platelet crossmatching are also feasible using a single-donor platelet product. Since a significant percentage of patients who receive multiple transfusions become alloimmunized and random donor platelet transfusions are therefore ineffective, improved compatibility between platelet donor and recipient achieved by HLA-matching and/or in vitro crossmatching is the most important current indication for single-donor apheresis platelets. Apheresis platelets may also be conveniently used when blood components that lack antibody to cytomegalovirus are needed, such as in profoundly immunosuppressed bone marrow allograft recipients.

Various automated centrifugal blood cell separators are currently available for plateletapheresis.[13,14] Each instrument has particular advantages and disadvantages; however, all are generally reliable, equipped with safety devices and alarms to reduce immediate donor risk, and, when operated optimally, generate a satisfactory plateletapheresis concentrate. As plateletapheresis procedures are performed more frequently and unrelated volunteer donors make up the majority of the donor pool, it is imperative to assess both the acute and the long-term effects of these donations on normal donors. In the study by Bator and Hoeltge,[10] changes in donors' hematologic parameters (red blood cell count, leukocyte count and differential, and platelet count) were evaluated during and immediately following plateletapheresis, and a comparison was made between two different types of blood cell separators based on these observed hematologic changes. At least two important conclusions are demonstrated in this study. First, the early and overall changes in donor red cell count, leukocyte count, platelet count, and granulocyte and lymphocyte percentages throughout the procedure are small and consistent with changes observed by other investigators.[15] No donor experienced cell counts below established normal ranges. These data confirm that the acute hematologic alterations that occur during a single plateletapheresis donation pose no known increased risk of hemorrhage or of immune impairment to the donor. Whether long-term alterations in lymphocyte counts, lymphocyte subset percentages, and immune function in normal donors may result from repeated plateletaphereses is unknown and deserves continued investigation. Second, changes in the donors' hematologic parameters were independent of the particular blood cell separator used, the Haemonetics V 50 or the Fenwal CS 3000. Thus, it is reasonable to assume that, at least for these two instruments, acute changes in donors' hematologic parameters need not be considered as important variables when choosing a machine to purchase or to utilize for a particular collection. Attention can be concentrated on other factors such as staff and donor time required for a procedure, the versatility of the equipment, the need to store the plateletapheresis product up to 5 days prior to transfusion (available only with the CS 3000), or limited vascular access, necessitating a discontinuous-flow system like the Haemonetics V 50.

It is likely that the need for apheresis platelets will continue to grow as more patients undergo new intensive therapies and as regional blood centers approach the maximum capacity for platelet production from whole blood collection.[1] Traditionally, the demand for red blood cells and whole blood has been the driving force behind blood collection efforts in the voluntary sector of the Blood Services Complex. Red cell usage has increased only modestly in recent years compared with the rapid escalation in platelet usage. Clearly, donations beyond those required to meet red cell demand are or will soon be needed to

provide platelets for increasingly complex patients. The technology is available, and cost-effective apheresis programs are a feasible way to supplement platelet inventories and thereby meet these patients' blood component needs. Such apheresis programs should be encouraged, with continued emphasis on the importance of the safety and well-being of the blood-component donor both during the donations and in the long term.

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