

Pediatric Apheresis: Special Emphasis on Peripheral Blood Progenitor Cell Harvest in Children

Haewon C. Kim

*University of Pennsylvania School of Medicine, The Children's Hospital of Philadelphia,
Philadelphia, PA, USA*

Abstract

The effect of apheresis can be powerful when selectively applied, since it has the ability to directly remove or harvest target substance(s) or cells in circulating blood. In addition, direct removal may have potential immunomodulatory effects, which can further enhance therapeutic efficacy. Apheresis has been widely utilized in both donor and therapeutic procedures in adults. However, its use in pediatric patients remains limited primarily for two reasons. The first is a lack of generally accepted indications and treatment schedules. Even in illnesses in which the efficacy in adults has been proven, there has been reluctance to apply therapeutic apheresis guidelines formulated for adult patients to children without supporting data derived from controlled studies or clinical trials in children. The second reason is technical difficulty. Apheresis equipment is designed for adults and it is not possible for operators to perform safe procedures in infants and small children without modifying procedures. In addition, difficulty in securing adequate vascular access may discourage or even prohibit a trial of apheresis in children. Nevertheless, therapeutic apheresis has a definite role in the treatment of certain disorders in pediatric patients as a standard therapy or as a first-line adjunct to primary therapy. The objective of this talk is to provide practical guidelines for pediatric apheresis. During the first half, primarily three areas will be covered: 1) special considerations unique to pediatric apheresis, 2) guidelines for the modification of standard operating procedures, and 3) rather new applications of apheresis in children. The latter half will be dedicated to peripheral blood progenitor cell (PBPC) transplantation in children. PBPC transplantation has been used primarily as an adjunctive therapy to achieve hematopoietic reconstitution following myeloablative therapy in patients with malignant diseases. In this situation, nearly all transplantations have been performed using autologous PBPCs. However, the use of PBPCs from related allogeneic donors has gradually increased and other trials are exploring utilization of PBPCs for unrelated allogeneic transplantation. Currently, the minimum CD34⁺ cell dose needed for successful engraftment is $\sim 1 \times 10^6$ /kg body weight. In general, one procedure is sufficient, provided that PBPCs have been mobilized. For newer treatment protocols that require tandem PBPC transplantations or CD34⁺ cell and/or tumor cell-selection, at least $5\text{-}10 \times 10^6$ CD34⁺ cells /kg body weight are needed. The success of a PBPC harvest largely depends upon the number of circulating PBPCs. With various mobilization regimens, the number of circulating progenitor cells can be significantly increased. It is also important to determine the optimal timing for PBPC harvest, which coincides with the time of leukocyte recovery after chemotherapy compared with the pretherapy steady state. Studies indicate that preharvest assessment of CD34⁺ cells in the peripheral blood of the patient can predict the optimal timing of leukapheresis. To enhance the PBPC collection, several strategies have been employed: 1) increasing the number of leukapheresis procedures, 2) increasing the volume of blood processed per procedure, 3) increasing the efficiency of the MNC collection by technical improvements in cell separators, or 4) expanding the PBPC pool by the use of cytokines or other agents. Currently, combined strategies would allow collecting sufficient numbers of PBPCs for transplant with fewer leukapheresis procedures. To harvest such a large number of PBPCs successfully from a child, specific procedural issues unique to PBPC collection will be discussed: 1) intravascular fluid and red cell volume shifts, 2) citrate toxicity, and 3) removal of circulating platelets. In this presentation, PBPC harvest in children using the Spectra system will be discussed. The principles used for the Spectra can be applied to other equipment. In addition, various mobilization regimens, quality assurance, and clinical experience of PBPC transplantation in children will be presented.
