Special Attributes: Special Attributes apply only to cellular blood products, which are Red Blood Cells and Platelets. Special Attributes include products which are Leukoreduced, CMV seronegative, Irradiated, Volume-reduced, and Washed. Each Special Attribute has its own specific ordering criteria, which must be met before the Blood Bank is bound to comply with an order request. A Blood Bank Pathologist must be on-call at all times, and can be reached through the Blood Bank.

Special Attributes blood products:

- Leukoreduced RBCs and Platelets
- CMV seronegative RBCs and Platelets
- Irradiated RBCs and Platelets
- Volume-reduced RBCs and Platelets
- Washed RBCs and Platelets

LEUKOREDUCTION **definitions**: Leukoreduction uses filtration to remove almost all of the white blood cells from units of RBCs and Platelets. Leukoreduction significantly reduces the likelihood of HLA alloimmunization (HLA sensitization), significantly reduces transfusion-associated transmission of cytomegalic virus (CMV), and reduces the incidence of febrile nonhemolytic transfusion reactions. Leukoreduction reduces the degree of transfusion-related immunomodulation (TRIM), which is transient mild increased risk for infection following transfusion, lasting for about a month.

Leukoreduction is often performed at the time of collection, but may also be done during transfusion. Many hospital Blood Banks now only provide leukoreduced RBCs and Platelets; but if that is not the case in your hospital, it is preferable, but not necessary, for leukoreduction to be done in the Blood Bank, rather than at the bedside. Recent studies using highly sensitive RT-PCR methods have shown that 50% of massively transfused trauma patients have microchimerism at hospital discharge, and 50% of that 50% (25% of original) still have microchimerism at one year. The meaning of this finding is uncertain, but may add to the momentum for the leukoreduction of all RBCs and Platelets (universal leukoreduction) at the time of collection.

Leukoreduction of RBCs or Platelets requires that each unit of RBCs and each pack of single-donor (apheresis) Platelets must contain less than 5×10^6 leukocytes, and at least 95% of units shall meet this criterion. Random-donor Platelet units must each contain less than 8.3×10^5 leukocytes, and a pool of 5 random-donor Platelet units must contain less than 5×10^6 leukocytes. All leukoreduced units must retain at least 85% of the original RBC or platelet product.

LEUKOREDUCTION **indications**: Prevention of HLA alloimmunization is of great concern for patients with a likelihood of future organ transplantation, and also for patients with a likelihood of multiple Platelet transfusions in the future.

HLA alloimmunization is the most frequent cause of immune-mediated refractoriness to Platelet transfusion. Class I HLA antigens are expressed on white blood cells and weakly expressed on platelets, but are not expressed on RBCs. RBC units, Random Donor Platelet units, and Single Donor Platelet packs ('apheresis packs') all contain 'passenger' lymphocytes, so consideration of the patient's clinical status may warrant modification of an RBC or Platelet order to request leukoreduced products. Because the quantity of antigen exposure affects the likelihood of HLA sensitization, for the prevention of HLA alloimmunization, there is no difference between leukoreduced pooled Random Donor Platelets and leukoreduced Single Donor Platelets (N Engl J Med, 1997; 337: 1861-9).

Because cytomegalic virus (CMV) is carried in monocytes, leukoreduction is an effective method for prevention of transmission of CMV. While neither is perfect, leukoreduced products have been shown to be equivalent to products from CMV seronegative donors in preventing CMV seroconversion of recipients. [Blood, 1995 Nov 1; 86(9): 3598-603 and Blood, 2001 Jun 1; 97(11): 3469-7].

Leukoreduction significantly reduces the incidence of febrile nonhemolytic transfusion reactions, and is recommended for patients with a history of FNTR.

Leukoreduction may reduce nonspecific immunosuppressive effects of transfusion.

CMV SERONEGATIVE **definitions**: The same definition of seronegativity is applied to both donors and recipients of RBCs and Platelets. Both donors and recipients are considered to be Cytomegalovirus seronegative when testing shows that the CMV IgG is less than 10 AU/mL. Recipients of CMV seronegative products must have documented CMV seronegativity before the Blood Bank is bound to comply with an order request. In urgent instances, while the recipient's CMV serological testing is being performed by the clinical laboratory, the Blood Bank will release CMV seronegative RBCs and/or Platelets.

Because cytomegalic virus (CMV) is carried in monocytes, leukoreduction is also an effective method for prevention of transmission of CMV. While neither is perfect, leukoreduced products have been shown equivalent to products from CMV seronegative donors in preventing CMV seroconversion of recipients. [Blood, 1995 Nov 1, 86(9): 3598-603 and Blood, 2001 Jun 1, 97(11): 3469-7].

CMV SERONEGATIVE **indications**: Patient groups at risk for morbidity due to transfusion-transmitted CMV (TT-CMV) have been categorized [Tranfus Med Rev, 2000 Apr, 14(2): 112-36], with the highest risk for morbidity found in premature or low birth weight infants of CMV seronegative mothers, seronegative recipients of seronegative bone marrow transplants, seronegative recipients of seronegative solid organ transplants, and seronegative patients infected with human immunodeficiency virus (HIV). The majority of Blood Banks will honor requests for CMV seronegative RBCs and Platelets for all neonates under 4 months old regardless of maternal CMV serological status, also for all intrauterine transfusions.

IRRADIATION **definitions**: Irradiation will deactivate and prevent replication of mononuclear cells, including T lymphocytes, without causing significant damage to the function and lifespan of RBCs or Platelets. Most Blood Banks have a single unit irradiator that can irradiate a unit of RBCs or Platelets in about 3½ minutes, but only one unit can be irradiated at a time. The unit of RBCs or Platelets gets a maximal central dosage of 27 Gray (2700 rad) by exposure to gamma rays of Cesium^{137}, and is **NOT** radioactive after irradiation. After irradiation, the maximum storage time is shortened to 28 days for RBCs and is unchanged for Platelets.

IRRADIATION **indications**: Transfusion-Associated Graft Versus Host Disease (TA-GVHD) is a severe, and usually fatal, complication caused by engraftment of donor-derived T lymphocytes in a recipient whose immune system is unable to recognize and destroy them.

There are two groups of transfusion recipients at risk for TA-GVHD:

1) immunodeficient or immunocompromised recipients, and

2) recipients of HLA-matched products, eg. recipients of HLA-matched Platelets; and also recipients of familial blood donation who, by their familial relationship, are potentially HLA-matched.

The first group includes patients with congenital T cell immunodeficiencies such as Wiskott-Aldrich syndrome, DiGeorge's syndrome, subacute combined immunodefiency (SCID), etc.; and acquired immunodeficiencies, such as acute leukemias, Hodgkin's disease, lymphopenias with absolute lymphocyte count less than 500, bone marrow and peripheral blood stem cell transplants, or ablative chemotherapy with autologous stem cell rescue.

Because of the immaturity of their immune system, irradiated RBCs and/or Platelets must be given to all premature infants and neonates weighing less 1500 gm, neonates undergoing exchange transfusion for erythroblastosis, and for all intrauterine transfusions.

The second group includes patients whose immune system might not recognize 'passenger' lymphocytes as 'foreign', thus allowing engraftment. This group includes the recipients of HLA-matched products, such as HLA-matched Platelets, as well recipients of familial blood donation. With familial donation, there is the small possibility of a recipient sharing an HLA haplotype with an HLA homozygous donor, so only the donor lymphocytes will recognize the recipient as "non-self".

VOLUME-REDUCED **definitions**: RBCs and Platelets can be volume-reduced by centrifugation followed by removal overlying plasma/preservative. Units of RBCs with AS-1 or AS-3 preservative have an original hematocrit of 55 to 65%, and can be volume-reduced by about 20 to 30%, to a hematocrit of about 80%. Because units of RBCs with CPD preservative have an original hematocrit of 70 to 80%, they cannot be volume-reduced. Units of RBCs outdate

24 hours after being volume-reduced, except in those cases where the unit has been set up as a closed system with pre-attached multi-aliquot bags. Because they are stored in proportionately more plasma, both Random Donor and Single Donor Platelets can be volume-reduced by about 70 to 80%. Both RD and SD Platelets outdate 4 hours after being volume-reduced.

VOLUME-REDUCED **indications**: Volume reduction is rarely indicated except in pediatric patients with renal insufficiency and/or cardiovascular compromise. Because CPD RBCs already have a hematocrit of 70 to 80%, RBCs for preterm and term newborns are not often volume reduced; while Platelets are often volume reduced for these patients. Occasional adult patients with intractable congestive heart failure may also benefit from volume-reduction of RBCs or Platelets. As an alternative to volume reduced units, the Blood Bank can "split" units into aliquots, allowing for the unit(s) to be transfused in smaller quantities over a longer period of time.

WASHED **definitions**: 'Washing' of RBCs and Platelets involves dilution with saline, concentration by centrifugation, and removal of overlying diluted plasma. If repeated three times, it can replace over 99% of the plasma component with normal saline. The procedure is automated, most often being done at a blood collection center, rather than a hospital Blood Bank. Washed RBCs outdate 24 hours after washing. Washed Platelets outdate 4 hours after washing; however, because the 4 hour expiration time begins at the onset of the washing process, they may only have about 2 hours to outdate by when they are ready for release.

WASHED **indications**: Rare RBC phenotypes, i.e. lacking a high incidence antigen, are stored as frozen units in 40% glycerol cryopreservative. Patients who insist on receiving transfusion of their own blood can make autologous blood donations prior to a planned surgery; and autologous RBCs are also stored frozen in 40% glycerol. If a patient requires transfusion with RBCs that have been frozen, they must be washed in order to remove the glycerol solution. The washing is automated, and is done at the blood collection center where the frozen units are stored. After washing, the RBCs will outdate in 24 hours.

Washed RBCs are rarely indicated except for transfusion of IgA deficient patients who have developed an antibody directed against IgA. The transfusion of blood products containing IgA into these patients may cause serious, or even fatal, anaphylaxis. They can be given Washed RBCs, but the washing is more extensive than done for the 'de-glycerolization' of frozen RBCs. Alternatively, these patients may safely receive RBCs or Platelets from donors who are also IgA deficient. Washed RBCs may occasionally be indicated in cases of paroxysmal nocturnal hemoglobinuria in order to remove complement factors in the plasma component.

Washed CPD RBCs are occasionally given to premature neonates in order to remove the citrate anticoagulant and/or to remove the citrate and preservatives from AS-1 of AS-3 RBC units, and/or to remove free hemoglobin and extracellular potassium, which slowly accumulate in RBC units during storage.

Washed Platelets are rarely indicated except for transfusion of IgA deficient patients who have developed an antibody directed against IgA. Washed Platelets are occasionally indicated for premature neonates in order to remove citrate anticoagulant.

On occasion, washed Platelets are given for treatment of neonatal alloimmune thrombocytopenic purpura (N.A.T.P.). The administration of IVIG antepartum to the mother, and/or postnatally to the neonate, has largely supplanted this need for neonatal platelet transfusion in at risk newborns. However, if the newborn's thrombocytopenia is less than 25 to 50,000/μL, then platelet transfusion may be indicated; and on these occasions, the most expeditious treatment is often washed maternal platelets, administered as washed, volume reduced, irradiated maternal platelets. N.A.T.P. is almost always due to maternal antibody directed against the platelet antigen HPA-1a on the neonate's platelets. Washing an aliquot of maternal platelets will provide platelets which lack the offending paternal antigen, with removal of the plasma component containing the maternal antibody against the paternal antigen on the neonatal platelets.

Very rarely, some patients with multiple febrile non-hemolytic transfusion reactions while receiving Leukoreduced RBCs and/or Platelets may benefit by being given Washed RBCs or Platelets.