Blood Component Therapy

- Blood Components
- Special Processing/Attributes
  - Irradiation
  - Leukoreduction
  - CMV Negative/CMV Safe
  - Washing
  - Volume Reduction
- Patient Safety
  - Type and Crossmatch Verification
  - Unit Verification

Composition of Blood

- ~ 55-60% Plasma
- ~ 40-45% Formed Elements:
  - Red Blood Cells (RBC)
  - Leukocytes (WBC)
  - Platelets

Whole Blood Collection
Blood Processing Laboratory

Whole Blood Components

- RBC
- Platelet
- Plasma
- WBCs
- Cryoprecipitate

Pooled Platelets
(a.k.a. 4, 5, or 6 pack)

Pooling Platelets into One Bag
Apheresis Collection

- Platelets
- Granulocytes
- Plasma
- RBCs

Apheresis Platelets

- One unit equivalent to pool of 4-6 units of whole blood platelet concentrates

- Type
  - Apheresis Platelets
  - HLA Matched Apheresis Platelets (MAPs)

Red Blood Cells

Indications

- Symptomatic anemia
- Severe bleeding
- General Guidelines:
  \[ \text{Hgb} / \text{Hct} \]
  - <7 / 21%: Likely required
  - 7-10 / 21-30%: Varies with clinical condition
  - >10 / 30%: Unlikely required

Red Blood Cells

Therapeutic Effect

- Average size Adult (per unit)
  \[ \uparrow \text{Hgb} \sim 1 \text{ gm/dL} = \uparrow \text{Hct} \sim 3\% \]
- Dose: number of units given depends on clinical situation
**Platelets – Indications**

- Prevention or treatment of bleeding due to thrombocytopenia and/or platelet dysfunction
- Prevent bleeding in patients with bone marrow failure:
  - <10,000/µl: clinically stable pts
  - <20,000/µl: pts with ↑ risk factors
- Active bleeding or surgery:
  - <50,000/µl: general med/surg patients
  - <100,000/µl: eye surgery, neurosurgery, massive hemorrhage, severe vascular injury

**Platelets Therapeutic Effect**

- Apheresis Platelets
  - ↑ ~ 30,000/µl per unit
- Pooled Platelets
  - ↑ ~ 7,000/µl per each unit in pool
  - Example – 5 unit pool expect increment of 35,000/µl
- Adult dose - usually:
  - One apheresis platelet or 4-6 pooled platelets

**Fresh Frozen Plasma Indications**

INR > 1.6:
- To treat active bleeding
- Or prevent bleeding during surgical or invasive procedures

**Fresh Frozen Plasma Therapeutic Effect**

- Adult: One unit ↑ most coagulation factors ~ 2.5%
- Dose based on clinical condition and underlying disease process
  - Adult dose: 10-15mL/kg (3-6 units)
Cryoprecipitate

**Indications**

- Hypofibrinogenemia
  (< 100 mg/dL)

**Therapeutic Effect**

- 1 pool (6 units/pool):
  - ↑ fibrinogen ~ 50 mg/dL
- Adult Dose:
  - 1-2 units per 10kg (1 or 2 pools)

**Cryoprecipitate = Fibrinogen**

**Granulocytes - Indications**

- **Preparation**
  - Collected by apheresis machine
  - Always Irradiated
- **Indications - Severe neutropenia with:**
  - Life-threatening bacterial or fungal infection not responsive to antimicrobial therapy
  - Neonates with sepsis
Granulocytes
Therapeutic Effect

- Dose
  - Pediatrics: max 20mL/kg/day
  - Adults: 1 unit/day
- May or may not see increase in WBC count

Irradiation Process

- HOW
  - Gamma Irradiator
- EFFECT - Inactivates Lymphocytes
  - Alters the genetic material
  - Prevents replication and ability to attack the recipient’s tissue

Whole Blood Components

- RBC
- Platelet
- Plasma
- WBC
- Cryoprecipitate

Note: Granulocytes ALWAYS IRRADIATED WBCs

Irradiation - Purpose

- Prevent Transfusion-Associated Graft versus Host Disease
Transfusion-Associated Graft Versus Host Disease

- Similar to GVHD seen in BM/Stem Cell transplant recipients
- Immunocompromised patients do not destroy the infused lymphocytes in the blood component
  - Lymphocytes engraft and proliferate
  - Attack host tissue

Transfusion-Associated Graft Versus Host Disease

- Lymphocytes launch attack against
  - Skin, Liver, Gut
  - Bone Marrow

- Clinical symptoms present 8-12 days post-transfusion
  - Fever
  - Skin - skin rash
  - Liver - elevated LFTs, hepatitis
  - Gut - diarrhea, anorexia, nausea/vomiting
  - Bone marrow - bone marrow failure (pancytopenia)

Transfusion-Associated Graft Versus Host Disease - Outcome

- Outcome: ~ 90% mortality
  - Infectious complications
  - Bleeding complications
  - Death typically occurs 3-4 weeks post-transfusion
- No effective treatment
- Prevention is a must!

TA-GVHD – Skin Rash
Transfusion-Associated Graft Versus Host Disease

- Patients with competent immune systems at risk for TA-GVHD
  - * Components from blood relatives
  - * HLA matched components
    * ALWAYS irradiate above component types for ALL recipients

Irradiation – Indications (see handout)
- Hematopoietic stem cell (HSC) transplant recipients (allogeneic, autologous/candidates
- HSC donors if allogeneic transfusion must be given prior to completing the harvest
- Aggressive chemotherapy/radiotherapy/T-cell immunosuppression
- T-Cell Immune Deficiency
- Hodgkin's disease
- Patients who have had Fludarabine therapy
- Leukemia
- Lymphoproliferative Disorders
- Neonates
- Intrauterine / neonatal exchange transfusion
- Transfusions from family members or HLA-selected donors

Leukoreduction Process

- HOW
  - Pass blood component through a Leukoreduction filter
  - Apheresis machine during collection

- Effect
  - Majority of the leukocytes are removed

Whole Blood Components

- RBC
- Platelet
- Plasma
- WBCs
  - 4 - 6 pooled

Note: Granulocytes NEVER Leukocyte Reduced WBCs

6 pooled
Leukoreduction – Purpose

- Reduce unwanted effects caused by WBCs and their by-products released during storage
  - Prevent Febrile Non-Hemolytic Transfusion Reactions
  - Prevent Alloimmunization
  - Use as substitute for CMV negative components to prevent CMV transmission

Leukoreduction

- Prevent recurrent Febrile Nonhemolytic Transfusion Reactions (FNHTR)

  - Cause – not completely understood
    - Antibody mediated
      - Patient antibodies react with infused WBCs
    - WBCs breakdown during storage
      - Cytokines released into the component

Leukoreduction

- Help prevent Alloimmunization/Platelet Refractoriness

  - Alloimmunization
    - Development of patient antibodies against donor HLA antigens
  - WBCs contain human leukocyte antigens (HLA)
  - Recipients exposed to donor’s WBCs through transfusion
    - Can develop antibodies to the foreign HLA antigens

Leukoreduction

- Use of Leukoreduced components

  - Significantly decrease the development of HLA antibodies
  - Significantly decrease the incidence of platelet refractoriness
Alloimmune Platelet Refractoriness

- Patients with HLA antibodies can become refractory to platelet transfusions
  - Platelets express HLA class I antigens on their surface
  - The infused platelets will be destroyed by the HLA antibodies

- Difficult to maintain an adequate platelet count

Multiple Non-Leukoreduced Transfusions

- HLA Class I
- HLA Class II
- Donor White Blood Cell

HLA Antibody Development – 2 to 4 weeks later

- HLA Class I
- HLA Class II
- Donor White Blood Cell
- Recipient anti-HLA antibody
- Donor Platelet
- Transfused Platelet

Alloimmune Platelet Refractoriness

- Multiple antibodies to different HLA antigens via multiple transfusions with non-LR products
- Premature removal by the spleen
- No increase in platelet count

Platelet refractoriness due to alloimmunization against HLA antigens
Alloimmune Platelet Refractoriness

- Poor platelet count increment at 1 hour post transfusion
  - Poor increment ~ < 5,000
  - Normal increment ~ 30,000 +

- Poor increments on at least two occasions in the absence of the following:
  - DIC, Sepsis, High Fever, ITP, Splenomegaly, Bleeding

HLA Matched Platelets

- Donor’s HLA typing is matched to patient’s HLA typing (HLA A, B)
- Apheresis platelets are collected from matched donor
- Initial order often requires 48 hours notice
- Resource limited by donor pool

Leukocyte Reduction

- Reduce rate of HLA alloimmunization in organ transplant patients/candidates
  - Renal
  - Heart
  - Lung

- Risk of transplant rejection due to HLA antibodies

Leukoreduction

- Create a CMV “Safe” Component to help prevent CMV transmission
CMV (Cytomegalovirus)

- Herpes virus
- CMV lies dormant in tissues and circulating leukocytes of infected individuals
- ~ 50% of population in WA is CMV positive
- Poses little problems to those with competent immune systems - most have no history of illness

CMV Neg/Safe Components

- Purpose – Prevent primary CMV infection in immunocompromised CMV-negative patients
- Serious complications from primary CMV infection
  - CMV-associated pneumonia, myocarditis, retinitis, hepatitis, gastroenteritis

CMV Safe Components

- CMV transmission via transfusion – reduced by use of either:
  - CMV Negative Components
  - Leukoreduced Components
- AABB:
  - Laboratory and clinical data support conclusion that LR reduces Transfusion Transmitted-CMV to a level at least equivalent to that of CMV-negative components

CMV Safe Indications (see handout)

- CMV negative patients:
  - Hematopoietic stem cell (HSC) transplant recipients
  - Solid Organ Transplant recipients from CMV neg donor
  - Potential HSCT or Organ Transplant candidates
  - AIDS/HIV infected recipients
  - Congenital Immune Deficiency
CMV Safe Indications (cont.)

- Regardless of CMV status of the mother or patient:
  - Premature/Low birth weight infants (< 1200-1500 g), Infants under 4 months old
  - Intrauterine transfusions
  - Exchange transfusions in newborns

Washing Blood Components

- How
  - Plasma is removed and cells are resuspended in NS

- Effect
  - Removes the donor plasma, volume is reduced
  - Adverse Effect of washing - Cell loss
    - Platelets / RBCs - loss of ~ 20% of the cells

- Components
  - RBCs and Platelets

Washed Red Blood Cell Unit

Washing - Indications

- History of anaphylactic reaction to blood components

- * Recurrent moderate allergic reactions not made tolerable by pre-medications
  - * Volume reduction without washing may be effective
Volume Reduction

• How
  – Component is centrifuged
  – Majority of plasma removed

• Effect
  – Plasma proteins/cytokines removed
  – Volume reduced to ~ 100 ml (or other volume)

• Components
  – Platelets
  – Granulocytes

• Purpose - Prevent various adverse reactions

Volume Reduction - Indications

• Extremely volume sensitive patients at risk for volume overload

• ABO incompatible single donor platelets or granulocytes

• Recurrent allergic reactions not made tolerable by pre-medications
  – If not successful, consider washing

• Recurrent febrile reactions not prevented by leukoreduction
  – If not successful, consider washing

Patient Safety

• Verification of Type and Crossmatch Sample

• Verification of unit prior to transfusion

Verification of PSBC Blood Samples (Type and Crossmatch, Type and Screen, Hold)

Verified by TWO Staff at BEDSIDE:
Patient Name, MRN and Birth date

ARMBAND
Must Match

LABEL on TUBE

PSBC REQUISITION
Must Match

(label at bedside immediately after draw, sign, add date/time)
**2 Person BEDSIDE CHECK**

- Informed Consent
- Check component against MD's order
- Involve patient, ask patient to state name and birth date, verify against armband
- Compare items shown below, must be identical
- Compare patient's blood type on trans report with unit type to ensure they are compatible
- Check compatibility testing date/time, if performed
- Visual Inspection
- Check boxes - sign tag

**Reference Information**

- Special Attributes Indications Sheet
- ABO/Rh Compatibility Chart
- Component Therapy Guidelines Table
- Transfusion Reaction Table

**Conclusion**

- Nurse plays a key role in administration of a safe and effective transfusion
- Understanding appropriate indications for components and special attributes will help ensure that the recipient receives the right blood component
Resources

- Institution’s Policies and Procedures
- Transfusion Safety Officer, Mary Grabowski
  Pager 206-969-5222 or marygr@psbc.org
- Puget Sound Blood Center Lab (206) 292-6525, #3