Author(s): Robertson Davenport, M.D., 2009

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Blood Components

- Red blood cells
- Plasma
- Cryoprecipitated Antihemophilic Factor
- Platelets
- Granulocytes
- Mononuclear cells
- Hematopoietic progenitor cells
Blood Donation

• Types of donations
  – Allogeneic
  – Autologous
  – Directed

• Methods of blood collection
  – Whole blood
  – Apheresis
Blood Donor Qualification

- Determined by FDA
- Health history
  - Infectious disease risks
  - Cancer, heart or lung disease, bleeding
  - Medications
  - Pregnancy and transfusions
  - Donation reactions
- Vital signs
- Confidential self exclusion
- Donor deferral registry
- Infectious disease testing
Current Infectious Disease Testing

- *Treponema pallidum* antibody
- Hepatitis B surface antigen (HBsAg)
- Hepatitis B core antibody (anti-HBc)
- Hepatitis C virus antibody (anti-HCV)
- HIV-1 and HIV-2 antibody (anti-HIV-1 and anti-HIV-2)
- HTLV-I and HTLV-II antibody (anti-HTLV-I and anti-HTLV-II)
- HIV, HCV, West Nile Virus RNA (NAT)
- *Typanosoma cruzi* antibody
- HBV NAT under IND
Adverse Effects of Donation

- Iron deficiency
- Hematoma
- Pain at phlebotomy site
- Syncope
- Hyperventilation
- Arterial puncture
- Nerve injury
Autologous Donation Criteria

- Lower minimum hematocrit
- Shorter donation interval
- Risk factors for infectious diseases acceptable
Whole Blood Derived Components

- Red Blood Cells
- Platelet Concentrate
- Fresh Frozen Plasma
- Cryoprecipitate
Apheresis Components

- Red Blood Cells
- Plasma
- Platelet concentrate
- Granulocytes
- Mononuclear cells
- Hematopoietic progenitor cells
Storage Changes in Red Blood Cells

- Hemolysis
- $K^+$ leakage
- ↓2,3-DPG
- Senescence
- Loss of SNO-Hb?

![Graph showing percent survival over days post-transfusion](image)

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Storage Changes in Liquid Plasma

Days of storage

Percent activity

100

FVIII
FII
FV
FVII
FX
Fibrinogen

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Storage Changes in Platelets

- **Activation**
  - P-selectin
  - CD40L
- **Granule release**
  - Beta-thromboglobulin
  - CCL5, CXCL4, CXCL7
- **GP Ib clustering**
Blood Group Serology

• Red cell antibodies
  – Naturally occurring
  – Secondary to exposure
  – Autoantibodies

• Leukocyte antibodies
  – HLA
  – HNA
  – Autoantibodies

• Platelet antibodies
  – HPA
  – Autoantibodies
Detection of Red Cell Antibodies

• Direct agglutination
  – IgM antibodies

• Indirect antiglobulin test
  – IgG antibodies

• Direct antiglobulin test
  – IgG or C3 coated red cells
Red Cell Antibody Screen

- Indirect antiglobulin test
  - Patient serum
  - Known phenotype red cells
  - Antiglobulin (anti-IgG) serum
Direct Antiglobulin Test

- Patient red cells
- Antiglobulin (anti-IgG or anti-C3) serum
Applications of Direct Antiglobulin Test

• Autoimmune hemolytic anemia
• Transfusion reactions
• Drug induced hemolysis
• Cold agglutinin disease
• Autoimmune diseases
Routine Pretransfusion Testing

• ABO typing
  – A and B antigen test
  – Anti-A and Anti-B antibody test

• Rh typing
  – Rh(D) antigen test

• Red Cell antibody screen
# Common Blood Types

<table>
<thead>
<tr>
<th>Blood type</th>
<th>A antigen</th>
<th>B antigen</th>
<th>Anti-A</th>
<th>Anti-B</th>
<th>Rh(D) antigen</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Positive</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>O Negative</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

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Selection of Compatible Blood

• ABO type
• Rh type
• Unexpected antibodies
  – Antibody identification
  – Phenotype negative donors
• Crossmatch
Emergency Transfusion

- Group O red cells
- Group AB plasma
- Rh negative preferable
  - Women of child bearing potential
- Obtain pretransfusion sample ASAP
- Good communication is essential
Blood Component Therapy

• Clinical considerations
  – Cause of bleeding or red cell loss
  – Rate of blood loss
  – Underlying diseases
  – Risks of future bleeding
  – Physiologic compensations
Indications for Red Blood Cell Transfusion

- Symptomatic anemia
- Bleeding > 15% total blood volume
- Chronic hypoproliferative anemia
- Hemolytic anemia
  - Sickle cell anemia
    - Hemolytic crisis
    - Acute chest syndrome
    - Stroke prophylaxis
- Uremic bleeding
TRICC Trial

• 838 ICU patients with Hb <9.0
• Restrictive transfusion
  – Hb <7.0 target 7.0 - 9.0
• Liberal transfusion
  – Hb <10.0 target 10.0 - 12.0

TRICC - Overall Outcome

All Patients

Survival (%)

Days

Restrictive-transfusion strategy
Liberal-transfusion strategy

P = 0.10
TRICC Subgroup Outcomes

1. Patients Younger than 55 Years
   - Restrictive-transfusion strategy
   - Liberal-transfusion strategy
   - Survival (%)
   - Days
   - P = 0.02

2. Patients with APACHE II Score ≤ 20
   - Restrictive-transfusion strategy
   - Liberal-transfusion strategy
   - Survival (%)
   - Days
   - P = 0.02

Red Cell Transfusion Examples

- Usually indicated
  - Acute blood loss of 1000 ml in an adult
  - Chronic anemia, hematocrit 24%, in a patient with dyspnea and angina

- Usually not indicated
  - Hematocrit 30% in a patient scheduled for tonsillectomy
  - Hematocrit 25% in a patient with autoimmune hemolytic anemia
Indications for Platelet Transfusion

- Hemorrhage due to thrombocytopenia
- Hemorrhage due to platelet dysfunction
- Hypoproliferative thrombocytopenia with risk of hemorrhage (e.g. <10,000/µl)
- Thrombocytopenia (e.g. <50,000/µl) with bleeding or invasive procedure
Prophylactic Platelet Transfusion in AML

- Threshold, 20,000 platelets/mm³
- Threshold, 10,000 platelets/mm³

Proportion without Major Bleeding

Day

P = 0.54
Platelet Transfusion Examples

• Usually indicated
  – Platelet count 5,000/µl in a patient on chemotherapy
  – Platelet count 40,000/µl in a patient on aspirin with hemorrhage

• Usually not indicated
  – Platelet count 20,000/µl in a patient with ITP
Factors Affecting Platelet Transfusion Effectiveness

- Antibodies
  - HLA
  - Platelet specific
  - ABO
- Splenomegally
- Consumption/DIC
- Sepsis
- Drugs
- Body size
- Rate of transfusion
Contraindications to Platelet Transfusion

- Immune thrombocytopenic purpura
- Thrombotic thrombocytopenic purpura
- Heparin-associated thrombocytopenia
Indications for Plasma Transfusion

- Coagulation factor deficiency (consider factor concentrates)
- Disseminated intravascular coagulation
- Reversal of warfarin anticoagulation
- Dilutional coagulopathy (massive transfusion)
- Hemorrhage in liver disease
- Thrombotic thrombocytopenic purpura
Transfusion in Trauma

Transfusion in Trauma

Logrank p < 0.001

FFP<sub>H</sub>
Plasma:RBC >1:2

FFP<sub>L</sub>
Plasma:RBC <1:2

Plt<sub>H</sub>
Platelet:RBC >1:2

Plt<sub>L</sub>
Platelet:RBC <1:2

Source Undetermined
Indications for Cryoprecipitate Transfusion

- Factor VIII deficiency
- von Willebrand’s disease
- Hypofibrinogenemia
- Factor XIII deficiency
- Uremic bleeding
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