**Risks and Benefits of Blood Transfusions**

Patient and Family Conference
Aplastic Anemia & MDS International Foundation
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Childrens Hospital Los Angeles

**Objectives**

- Understand the following:
  - Benefits and indications for blood transfusions
  - Safety - incidence of infections
  - Cross matching and alloimmunization
  - Transfusion reactions
  - Iron overload - cause and screening
  - Importance of irradiation

**Red Cells (Erythrocytes)**

- Carry Oxygen to tissues
- Remove Carbon Dioxide from tissues

- Whole Blood
- Packed RBC
  - ~14 million units/year in U.S.
  - Usually stored for 3-6 weeks
  - at 4-10°C
**Blood: The Life Source**

- Blood transfusions a vital treatment for many illnesses
- AA/MDS/PNH/Cancer/BMT: correct anemia caused by disease and therapy
- Thalassemia: replace what body can’t make
- Sickle Cell: prevent life-threatening complications
- Replace blood loss due to trauma or surgery

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**Transfusions: The Benefit**

- Safe: advanced donor screening and unit testing
- Available
- Simple
- Improve the quality of life for the patient

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**Transfusions: The Cost**

- Infection
- Alloimmunization
- Transfusion Reactions
- Iron Overload
- TR- GVHD
Infection

- New advances in donor screening and testing
- Incidence of infected units
  - Hepatitis B 1:205,000
  - Hepatitis C 1:2 million
  - HIV 1:2 million

Vigorous donor screening and interviewing

“The next infection”

Every Donation is Tested

- ABO, Rh (blood type), Ab screen
- Hepatitis B HBsAg, Anti-HBc
- Hepatitis C Antibodies, Nucleic Acid Test
- HIV 1/2 Antibodies, Nucleic Acid Test
- HTLV I and HTLV-II Antibodies
- Syphilis Antibodies
- West Nile Virus Nucleic Acid Test
- T. cruzi (Chagas) Antibodies
- Bacteria Platelets only
- Optional CMV (Cytomegalovirus) Antibodies
- Sickle cell Hgb. S

ABO blood groups

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Red cell antigens</th>
<th>Frequency in caucasians</th>
<th>Serum antibody</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA, AO</td>
<td>A</td>
<td>40%</td>
<td>anti-B</td>
</tr>
<tr>
<td>BB, BO</td>
<td>B</td>
<td>11%</td>
<td>anti-A</td>
</tr>
<tr>
<td>AB</td>
<td>AB</td>
<td>4%</td>
<td>none</td>
</tr>
<tr>
<td>OO</td>
<td>O</td>
<td>45%</td>
<td>anti-A, anti-B</td>
</tr>
</tbody>
</table>
**Compatibility Testing**

<table>
<thead>
<tr>
<th>RECIPIENT</th>
<th>DONOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ABO and Rh (D) type</td>
<td>X</td>
</tr>
<tr>
<td>2. Antibody screen</td>
<td>X</td>
</tr>
</tbody>
</table>

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<table>
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<tbody>
<tr>
<td>3. Crossmatch (serum)</td>
<td>PLUS</td>
</tr>
</tbody>
</table>

**Alloimmunization**

- All patients transfused based on A,B,O and Rh factor
- 30-40 lesser antigens on the RBC
- Ethnic trends in antigen expression
- Donor pool: mostly Caucasian
- RBC phenotyping and antigen matched blood for patients receiving multiple transfusions
  - Especially critical for non-Caucasian patients
The Pathophysiology of Alloimmunization

• Presentation of foreign antigens on donor cells
• Stimulate immune system: Ab response
  – Repeated exposure and immunization: sustained clonal response and clinically significant Ab response
  – Some antibodies are not clinically significant
• Can lead to AIHA syndrome

Treatment and Prevention

• Antigen-matched blood
  – E, Kell, D, c, Jk(a), Fy(a), e
• Observation, hydration
• Immunomodulating therapy
  – IVIG, CSA, rituximab, prednisone, vincristine

Leukoreduction

• White cells removed, usually by filtration
• Benefit
  – reduce recipient febrile reactions
  – Reduce CMV transmission
  – Reduce alloimmunization
**Non Hemolytic Transfusion Reactions**

- Exposure to donors WBC in trace
- Fever, hives
- Rx: premedication, leukoreduction, washed cells

**Leukoreduction**

**Pre-BMT Considerations**

- Irradiated Units
- CMV negative units
- Directed donor
- Unit exposure
Irradiation

- Irradiation kills certain white cells (lymphocytes) that can attack the recipient’s system
  - Donations from first degree blood relatives
  - Recipients who are severely immunocompromised
    - neonates
    - transplant patients

Iron Overload from Transfusions

- Each unit of blood deposits 200 mg of iron in the body.
- Iron deposits in the liver, pancreas, thyroid, parathyroid, pituitary gland, and heart.
- Oxidative damage from iron causes tissue damage.
- THERE IS NO PHYSIOLOGICAL MECHANISM TO EXCRETE THE IRON!!
- Signs of iron overload appear after 10-20 transfusions.
Complications of Iron Overload

- Arrhythmia
- Heart Failure
- Liver failure
- Pan-endocrine failure
  - Diabetes
  - Hypothyroidism
  - Growth hormone deficiency
  - Hypogonadism

Iron Input

Total Iron (LIC) = Tissue iron x Tissue Sensitivity x Time

Tissue Iron

Organ Damage

Organ Dysfunction

Measurement of Tissue Iron

- Ferritin
- Liver biopsy
- SQUID
- MRI
  - Heart T2* / SIR
  - Liver R2
  - (other organs?)
- NTBI / LPI

SQUID = Superconducting Quantum Interference Device
NTBI = Non-transferrin Bound Iron
LPI = Labile Plasma Iron

Iron Overload

- We have no method now to predict when a patient will suffer catastrophic side effects of iron overload.
- MRI, liver biopsy, SQUID and other tests can tell us where the iron is but not when the organ will fail.
- Each patient is different: genetic factors influence effect of iron on organs.
Chelators

- desferrioxamine (Desferal®)
- deferasirox (Exjade®)
- Future: L1 (deferiprone), HES-DFO, combination therapies

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