Transfusion Medicine
Kristine Krafts, M.D.
Transfusion Medicine Outline

• Blood groups
  • Introduction
  • ABO system
  • Rh system
  • Other systems

• Blood transfusion
  • Blood products
  • Testing
  • Dangers
Transfusion Medicine Outline

- Blood groups
  - Introduction
Q. What determines a blood group?
Q. What determines a blood group?
A. The antigens on the red cell surface.
Red Cell Antigens

- Antigens are inherited (Mendelian pattern)
- Real function unknown
- Damn important during transfusion
- Lots of antigens exist (grouped into systems)
- Most important systems: ABO and Rh
Transfusion Medicine Outline

- Blood groups
  - Introduction
  - ABO system
What are the antigens?

- A and B
- Some people have A antigen ("type A")
- Some people have B antigen ("type B")
- Some people have both A and B ("type AB")
- Some people have neither A nor B ("type O")
How do you make the antigens?

- Start with a protein precursor
- Add fucose to make H antigen
- Add N-acetylgalactosamine to H Ag to make A Ag
- Add galactose to H Ag to make B Ag
What are the genes?

H gene
- Everyone* has this one
- Codes for an enzyme that makes H antigen

A, B, and O genes
- Everyone has two genes
- Six possible genotypes: AA, BB, AB, AO, BO, OO
- A and B code for enzymes that make A and B antigens
- O has no gene product.*

* Almost
<table>
<thead>
<tr>
<th>Genotype</th>
<th>Antigens</th>
<th>Blood type</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>AO</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>BB</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>BO</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>AB</td>
<td>A and B</td>
<td>AB</td>
</tr>
<tr>
<td>OO</td>
<td>None</td>
<td>O</td>
</tr>
</tbody>
</table>
• We have antibodies to the antigens we don’t have!
• Anti-A antibodies lyse type A red cells.
• Anti-B antibodies lyse type B red cells.
• This is very important during blood transfusion.
Type A

Type B

Type AB

Type O
<table>
<thead>
<tr>
<th>Genotype</th>
<th>Antigens</th>
<th>Blood type</th>
<th>Antibodies</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>A</td>
<td>A</td>
<td>anti-B</td>
</tr>
<tr>
<td>AO</td>
<td>A</td>
<td>A</td>
<td>anti-B</td>
</tr>
<tr>
<td>BB</td>
<td>B</td>
<td>B</td>
<td>anti-A</td>
</tr>
<tr>
<td>BO</td>
<td>B</td>
<td>B</td>
<td>anti-A</td>
</tr>
<tr>
<td>AB</td>
<td>A and B</td>
<td>AB</td>
<td>none</td>
</tr>
<tr>
<td>OO</td>
<td>None</td>
<td>O</td>
<td>anti-A anti-B</td>
</tr>
</tbody>
</table>
## Compatible blood types

<table>
<thead>
<tr>
<th>Recipient blood type</th>
<th>Donor blood type</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A or O*</td>
</tr>
<tr>
<td>B</td>
<td>B or O</td>
</tr>
<tr>
<td>AB</td>
<td>AB, A, B, or O</td>
</tr>
<tr>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

* type O = universal donor!
Transfusion Medicine Outline

- Blood groups
  - Introduction
  - ABO system
  - Rh system
What are the antigens?

- Most important antigen: D!
- “Rh” because discovered using Rhesus monkeys.
- “Rh factor” refers to the D antigen.
- Two alleles: D and d.
- People with the D allele make D antigen and are Rh+. 
<table>
<thead>
<tr>
<th>Genotype</th>
<th>Antigens</th>
<th>Blood type</th>
</tr>
</thead>
<tbody>
<tr>
<td>DD</td>
<td>D</td>
<td>Rh +</td>
</tr>
<tr>
<td>Dd</td>
<td>D</td>
<td>Rh +</td>
</tr>
<tr>
<td>dd</td>
<td>none</td>
<td>Rh -</td>
</tr>
</tbody>
</table>
What are the antibodies?

- Antibodies in this system are **acquired**!
- To make anti-D you must:
  1. lack the D antigen on your red cells
  2. get exposed to D + blood
- Donor and recipient are tested for the D antigen.
Transfusion Medicine Outline

- Blood groups
  - Introduction
  - ABO system
  - Rh system
  - Other systems
Don’t tell me there are more systems.

- There are a almost a sh*tload of other systems.*
- These are not included in routine testing.
- Antibodies to antigens in these systems are usually acquired (like anti-D), so unless a patient has been transfused or pregnant, you don’t need to worry too much.

* Not quite: a sh*tload is defined as more than 42.
Transfusion Medicine Outline

• Blood groups
  • Introduction
  • ABO system
  • Rh system
  • Other systems

• Blood transfusion
  • Blood products
What do you mean, products?

- In olden times, there was only whole blood.
- Now, we separate blood into its components.
- Better for the patient.
- Conserves blood supply.
What are the products?

- Whole blood
- Red cells
- Platelets
- Granulocytes
- Cryoprecipitate
- Fresh frozen plasma
Transfusion Medicine Outline

• Blood groups
  • Introduction
  • ABO system
  • Rh system
  • Other systems

• Blood transfusion
  • Blood products
  • Testing
Forward typing is done using both anti-A and anti-B antibodies!
Reverse typing is done using both type A and type B reagent cells!
CROSSMATCH

patient serum

RBC

donor

AHG

Positive test result
Transfusion Medicine Outline

- Blood groups
  - Introduction
  - ABO system
  - Rh system
  - Other systems

- Blood transfusion
  - Blood products
  - Testing
  - Dangers
What can go wrong?

- Hemolytic transfusion reactions
- Non-hemolytic transfusion reactions
- Infections
Acute Hemolytic Transfusion Reactions

- Happen when patient has ABO antibodies against the donor red cells.
- Most common reason: clerical error!
- Symptoms: fever, chest pain, hypotension.
- Hemoglobin in serum, urine.
- Labs: ↓ haptoglobin, ↑ bilirubin, DAT positive.
donor type A
anti-B

recipient type B
anti-A

clumping of donor cells

donor cells burst

kidney damage

small vessels blocked

reduced blood supply
Delayed Hemolytic Transfusion Reactions

- Hemolysis occurs days after transfusion.
- Caused by antibodies to non-ABO antigens.
- Hemolysis usually extravascular.
- Presentation: falling Hgb after transfusion.
- Usually not severe.
Non-Hemolytic Transfusion Reactions

- Febrile (caused by recipient antibodies against donor WBC).
- Allergic (probably a reaction to donor plasma proteins).
Infections

- Donor tests: HIV, HTLV, Hepatitis B and C, syphilis.
- Despite testing, these diseases are still transmitted.
- Other transmissible infections:
  - bacteria (dangerous!)
  - viruses (EBV, CMV)
  - parasitic diseases (malaria, Lyme disease)
What’s the risk of getting an infection?

<table>
<thead>
<tr>
<th>Bug</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacterial infection</td>
<td>One in 50,000 - 500,000 *</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>One in 300,000</td>
</tr>
<tr>
<td>Hepatitis C</td>
<td>One in 2 million</td>
</tr>
<tr>
<td>HIV</td>
<td>One in 2 million</td>
</tr>
</tbody>
</table>

* 1 in 50,000 platelet transfusions; 1 in 500,000 RBC transfusions
What’s the risk of other complications?

<table>
<thead>
<tr>
<th>Complication</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allergic reaction</td>
<td>One in 100 (severe: one in 20,000)</td>
</tr>
<tr>
<td>Febrile reaction</td>
<td>One in 200</td>
</tr>
<tr>
<td>Delayed hemolysis</td>
<td>One in 4,000 (fatal: one in 4 million)</td>
</tr>
<tr>
<td>Acute hemolysis</td>
<td>One in 20,000 (fatal: one in 600,000)</td>
</tr>
</tbody>
</table>