Adverse Effects of Blood Transfusion

[Harmening Ch. 18]
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Adverse Effects of Blood Transfusion

• ANY unfavorable consequence is considered an adverse effect of blood transfusion. It is also referred to as a Transfusion Reaction.

• The risks of transfusion must be weighed against the expected therapeutic benefits.
Adverse Effects of Blood Transfusion

1. **Acute (<24 hours) Transfusion Reactions - Immunologic**
   - Hemolytic; Febrile-non hemolytic; Allergic; Anaphylactic; Non Cardiogenic Pulmonary Edema (NCPE)

2. **Acute Transfusion Reactions - Nonimmunologic**
   - Circulatory overload; Hemolytic (Physical or Chemical destruction of RBC); Air embolus; Hypocalcemia; Hypothermia

3. **Delayed (>24 Hours) Transfusion Reaction - Immunologic**
   - Hemolytic (Anamnestic response); Graft vs. Host Disease; Posttransfusion Purpura

4. **Delayed Transfusion Reactions - Nonimmunologic**
   - Iron Overload

5. **Infectious Complications of Blood Transfusion**
Transfusion Reactions

Most common causes of transfusion related DEATHS:

1. Improper specimen identification
2. Improper patient identification
3. Antibody identification error
4. Crossmatch procedure error
   • Most transfusion reactions (not all) are the result of human error. As you work through this lecture, consider what could be done to prevent each outcome.
Acute Transfusion Reactions

Immunologic

Immediate or Acute Hemolytic Transfusion Reaction

- Onset within minutes to hours (<24 hours)
- Associated with Intravascular Hemolysis
- **Etiology:** Antibodies that activate complement to completion in the vasculature: ABO antibodies are predominant but not the only ones implicated.
- **Prevention:** Give ABO compatible blood.
Intravascular Hemolysis

**Characteristics**
- Reaction begins within minutes of infusion
- IgM &/or IgG antibody
- RBC Lysis within vasculature
- Complement activation to completion
- Release of histamine and serotonin

**Signs may include:**
- Pain along vein of infusion site
- Shock
- Abnormal bleeding
- Release of cytokines: fever, hypotension
- Patient apprehension
- Renal failure due to Hgb and RBC stroma
Intravascular Hemolysis
Signs & Symptoms continued...

1. Fever or fever & chills
2. Oliguria, may progress to...anuria
3. Sustained hypotension
4. Coagulopathy: May progress to Disseminated Intravascular Coagulopathy (DIC)
5. Free hemoglobin in serum & urine
Acute Transfusion Reactions

Immunologic

Febrile Transfusion Reactions

- Etiology: An INCREASE in temperature of 1°C during infusion of blood component
  - Associated with transfusion
  - Usually “mild & benign” = not life threatening
  - Can have more severe symptoms, not usually

- Non-hemolytic

- Cause: Recipient antibodies to donor leukocyte antigens
Febrile Transfusion Reactions

Seen in...

- Multiply transfused patients
- Multiple pregnancies
- Previously transplanted

Must rule out...

- Hemolytic transfusion reaction
- Bacterial contamination of unit

Prevention

- Leukocyte reduction or depletion of component.
Acute Transfusion Reactions
Immunologic

**Allergic (Urticarial-Hives) Transfusion Reactions**

- **Etiology:** Form of *cutaneous hypersensitivity* triggered by recipient antibodies directed against:
  - Donor plasma proteins or
  - Other allergens (food, medicines) in donor plasma
- Begins within minutes of infusion
- Characterized by *rash and/or hives* and itching
- Usually involves *release of histamine.*
Allergic (Urticarial) Reactions

- **MUST be sure** that the only reaction is the development of urticaria
- **Must rule out more severe symptoms that could lead to anaphylaxis:**
  - angioneurotic edema
  - laryngeal edema
  - bronchial asthma
- **Prevention:** Can pre-treat recipient with anti-histamines before transfusion.
Acute Transfusion Reactions
Immunologic

**Anaphylaxis**

- Life threatening!!

- **Etiology:**
  - Recipient is *IgA deficient* & has anti-IgA in serum
  - Recipient anti-IgA can react to even small amounts of donor IgA in the plasma in any blood component

- Reaction may occur within minutes of beginning transfusion: **Onset of symptoms is SUDDEN**

- **Prevention:** Wash blood components to remove plasma.
Anaphylaxis

Symptoms

- Burning sensation at infusion site
- Coughing, difficulty in breathing, and bronchospasms can lead to cyanosis
- Nausea, vomiting, severe abdominal cramps, diarrhea
- Hypotension which can lead to shock, loss of consciousness, & death

• MUST STOP TX'N IMMEDIATELY
Acute Transfusion Reactions

Immunologic

Non-Cardiogenic Pulmonary Edema

Etiology:

- When transfusion recipient experiences acute respiratory insufficiency and/or evidence of pulmonary edema without evidence of cardiac failure.

Mechanism's

- **Primary Suspect:** Donor antibodies to recipient WBCs
- Another cause: WBC emboli aggregate in the lungs causing edema
- Also called **TRALI:** Transfusion Related Acute Lung Injury
Non-Cardiogenic Pulmonary Edema (NCPE)

• Symptoms
  - Chills, fever, cough, cyanosis, hypotension, increased difficulty breathing
  - Frequently associated with multiple transfusions over a short period of time

• Prevention: For recipient antibody, give leukoreduced blood products. For donor antibody, may limit future donations of that donor.
Acute Transfusion Reactions
NONimmunologic

Circulatory Overload

• **Etiology:** Rapid increases in blood volume to patient with compromised cardiac or pulmonary status. (Most at risk are elderly and pediatric patients) Infusion of 25% albumin is also a cause.

**Signs and Symptoms**

• Dyspnea, cyanosis, severe headaches, hypertension or CHF (congestive heart failure).

• **Prevention:** Stop infusion and place patient in sitting position. Slow down future infusions.
Acute Transfusion Reactions
NONimmunologic

Physically or Chemically Induced Red Cell Destruction

Etiology:

• Destruction of red blood cells in the collection bag and infusion of free hemoglobin, etc.

  Improper temperatures: High or Low

• Microwave blood bag, malfunctioning blood warmer or water bath, inadvertent freezing of blood.
Physically or Chemically Induced Red Cell Destruction

**Osmotic Hemolysis**

- Addition of drugs or hypotonic solutions (5% dextrose, deionized water, etc.) to transfusion.

**Mechanical Hemolysis**

- Caused by rollers in blood pump
- Pressure infusion pumps
- Small bore needles
- **Prevention**: Adherence to procedures for all aspects of procuring, processing, issuing and administering red blood cell transfusions.
Acute Transfusion Reactions
NONimmunologic
Hypocalcemia

- **Excess citrate**: When plasma (or platelets) are infused at rate >100 mL/minute or individuals with impaired liver function:
  - Citrate is broken down by liver.
- Seen more in pediatric and elderly patients
- **Signs and Symptoms**: Facial tingling, nausea, vomiting.
- **Prevention**: Slowing or discontinuing infusion. Administration of Calcium is not usually necessary.
Acute Transfusion Reactions
NONimmunologic

Hypothermia

- **Etiology:** Drop in core body temperature due to rapid infusion of large volumes of cold blood. Especially if using central cardiac catheter.

- **Symptoms:** Decreased body temperature and ventricular arrhythmias.

- **Seen** in small infants or massive transfusion

- **Prevention:** Reduce rate of infusion or use blood warmers. Pull catheter away from heart.
Air Embolism

- **Etiology:** If blood in an open system is infused under pressure or if air enters the system while container or blood administration sets are being changed. Infusion of air.

- **Treatment:** Place patient on left side with head down to displace air bubble from pulmonic valve.
Delayed Transfusion Reactions

Immunologic

Delayed Hemolytic Transfusion Reaction

- Onset within days (Anamnestic response, >24 hours)
- Associated with Extravascular Hemolysis
- **Etiology:** Antibodies that usually do **NOT** activate Complement to completion: Rh, Kell, etc.
- **Prevention:** Give antigen negative blood.
Extravascular Hemolysis

Characteristics

• Reaction within hours to days
• Antibody attaches to RBC: RBC destroyed in spleen or liver, etc.
• Commonly IgG
• May or may not activate Complement

Signs may include:

• No release of free Hgb, RBC stroma, or enzymes into circulation
• May be immediate (hours) or delayed (days)
• May have bilirubinemia or bilirubinuria
Extravascular Hemolysis

Signs & Symptoms continued...

1. Fever or fever & chills
2. Jaundice
3. Unexpected anemia
   • Some may present as an **ABSENCE** of an anticipated increase in Hemoglobin and hematocrit.
Graft vs Host Disease (GVHD)

- **Etiology**: Donor T-Lymphocytes attack recipient (host) tissues.
- **Groups at risk**: Immunocompromised patients (Cancer, fetus, neonatal, bone marrow transplant and HIV).
- **Signs**: Fever, dermatitis, or erythroderma, hepatitis, diarrhea, pancytopenia, etc.
- **Prevention**: Irradiation of blood products.
Delayed Transfusion Reaction

Immunologic

Post-transfusion Purpura

• **Etiology**: Antibodies to platelet antigens causes abrupt onset of severe thrombocytopenia (platelet count <10,000/µl) 5-10 days following transfusion.

• **Signs**: Purpura, bleeding, fall in platelet count

• **Prevention**: High dose intravenous immunoglobulin (IVIG)
Iron Overload

- **Etiology:** Excess iron resulting from chronically transfused patients such as hemoglobinopathies, chronic renal failure, etc.
- **Signs:** Muscle weakness, fatigue, weight loss, mild jaundice, anemia, etc.
- **Treatment:** Removal of iron without reducing patients circulating hemoglobin. Infusion of deferoxamine - an iron chelating agent has been useful.
Infectious Complication of Blood Transfusion

Bacterial Contamination

• **Etiology:** At what point is the bacteria introduced into the donor unit?
  – At time of collection: either from the donor or the venipuncture site.
  – During component preparation, etc.

• Usually involves **endotoxins**
  – *Pseudomonas, Escherichia coli, Yersinia enterocolitica*
Bacterial Contamination

- **Components**: Most often from platelet components (room temp). Red cell units will look dark.
- **Symptoms**: Rapid onset
  - Fever, hypotension, shaking chills, muscle pain
  - Vomiting, abdominal cramps, bloody diarrhea, hemoglobinuria, shock, renal failure, & DIC.
Bacterial Contamination

Transfusion must be stopped immediately

- **Gram stain & blood cultures** should be done on the unit, patient and all infusion sets associated with the patient at the time of transfusion.
- **Broad-spectrum antibiotics** should be given immediately intravenously
- **Prevention**: Maintain standards of donor selection, blood collection and proper maintenance of collected blood components.
Transfusion Reaction
Follow-up

Clinical Information Needed:

• Recipient diagnosis
• Medical history of pregnancy &/or transfusion
• Current medications
• Signs & symptoms during transfusion reaction
• How many mL’s of RBC’s or plasma were transfused?
Clinical Information Needed

• Were rbc’s cold or warm when transfused?
  – Was a blood warmer used?
  – Was component manipulated in any way? Water bath, refrigerator, freezer, etc.
• Were red cells infused under pressure?
• What was the size of the needle used?
• Were other solutions given through the IV line at the same time? If so what?
• Were any other drugs given at the time of transfusion? If so, what?
• What were pre- & post- transfusion vital signs?
Transfusion Reaction Follow-up

Post Transfusion Reaction blood samples to be collected from the recipient:

- Clotted specimen
- EDTA specimen
- Clotted specimen
- 1st voided urine specimen post-tx’n
- Repeat ABO, Rh, IAT and Crossmatch. Visual check for hemolysis and compare with pre transfusion sample.
- DAT (Direct Antiglobulin Test)
- Collect 5-7 hours post transfusion to check for bilirubin
- Free hemoglobin determination
Transfusion Reaction Workup

**CLERICAL CHECKS**
1. Correct identification of patient, specimen, and transfused unit.
2. Agreement of records and history with current results and interpretation of results.
3. Correct labeling of transfused unit

**SPECIMEN CHECKS**
- Visual inspection of post-transfusion specimen
- Check of records for hemolysis in pre-transfusion specimen:
  - detectable at 20mg/dL
- Post transfusion bilirubin monitoring
- Visual inspection of Blood bag and lines
Post Transfusion Lab Testing

Direct Antiglobulin Test (DAT)

- Recipient post-tx’n spec. (DO THIS FIRST)
- Positive? Perform eluate and identify antibody

ABO Grouping and Rh Typing

- Recipient pretransfusion and posttransfusion specimen
- Donor segment and bag.
Post Transfusion Lab Testing

Crossmatch

• Recipient pre-transfusion sample with unit and pre-transfusion sample with segment
• Recipient post-transfusion sample with unit and post-transfusion sample with segment

Indirect Antiglobulin Test (IAT)

• Recipient Pre- & post-transfusion reaction specimens
• Positive? Identify antibody and compare results of serum panel with eluate panel.