

Blood Components Reference Manual Table of Contents

Puget Sound Blood Center Regional Edition

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Section F

Transfusion Safety

Part I: ABO/Rh Compatibility

ABO/Rh Compatibility

The presence or absence of A and/or B antigens and antibodies, as outlined in the table below, is the basis for determining ABO type compatibility between patient and donor. ABO antibodies develop naturally starting at approximately 3 months of age, whereas antibodies against Rh occur in Rh negative individuals only after exposure to Rh positive red cells via transfusion or pregnancy. When assessing the compatibility of blood and components, both patient and donor antigens and antibodies must be considered.

ABO Antigens/Antibodies Chart

Blood Type	Antigens on Red Cells	Antibodies in Plasma / Serum
O	Neither A nor B	Anti A and Anti B
A	A	Anti B
B	B	Anti A
AB	A and B	Neither Anti A nor Anti B

Compatibility Testing

When blood is ordered, the patient's ABO group and Rh blood type is determined. An antibody screen is performed, to test the patient's serum for antibodies against foreign red blood cell antigens. Based on the results of the antibody screen, a donor unit is selected for transfusion. The last step is a crossmatch, to confirm that the patient's plasma will not lyse the transfused donor red blood cells.

ABO typing consists of red blood cell typing and serum typing. If the expected antigens or antibodies are not reactive in the typing, an ABO discrepancy is present. This must be resolved prior to issue of ABO type-specific components.

Red blood cell typing - the patient's red blood cells are mixed with standard anti-A, anti-B, anti-D (Rh) test reagent and observed for agglutination

Serum typing - the patient's serum is mixed with known type A, and type B cells. The sample is centrifuged and observed for agglutination.

Antibody screen - the patient's serum is mixed with known red blood cells displaying minor red blood cell antigens (e.g. Kell, Duffy, Rhesus). The reaction is taken through 2 different test phases at 37°C. If the screening cells show agglutination or hemolysis in either phase, the screen is positive for the presence of one or more red blood cell antibodies.

Unit type and screen - each donated unit of whole blood has been tested for ABO/Rh and antibodies in the plasma, prior to processing into components. Prior to transfusion, the red cell unit must be re-typed for ABO. This is known as type confirmation of the unit.

There are two types of crossmatch tests that may be performed. If a patient has a negative antibody screen and no historical record of red blood cell antibodies, a **computer crossmatch** will be performed. If a patient has a positive antibody screen or a historical record of red blood cell antibodies, a more time consuming **antiglobulin crossmatch** will be performed.

Computer crossmatch - patient type is compared to historical type in computer or two separate typings are performed. After the antibody screen is completed, an ABO/Rh compatible red blood cell unit is issued to the patient without further testing.

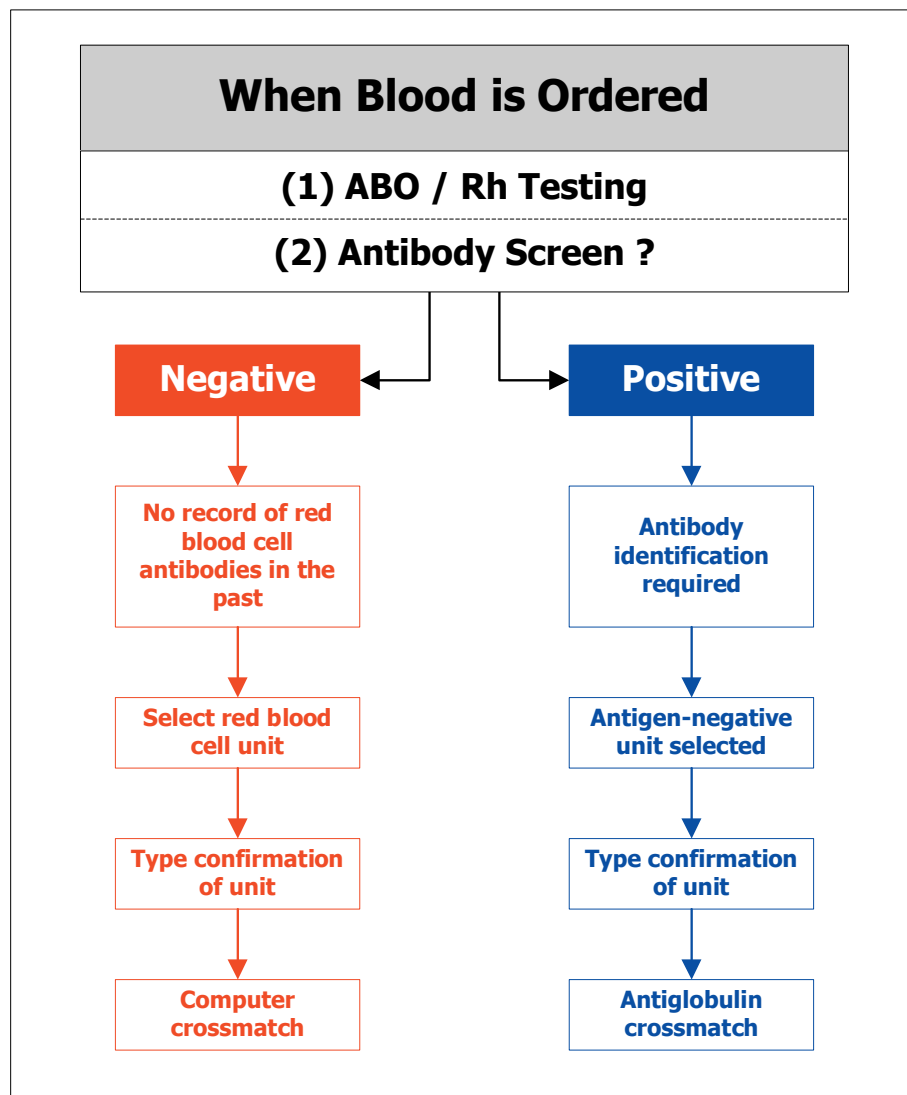
Antiglobulin crossmatch - red blood cells from the donor unit chosen for transfusion are mixed with the patient's serum and carried through a 37°C degree phase and an antiglobulin phase. Antiglobulin is human anti-IgG, which will cause red blood cell agglutination if IgG is bound to the red cells. If an appropriate unit was chosen, one would expect no agglutination or hemolysis. This is referred to as a compatible unit.

There are occasions, such as when a patient has developed auto antibodies against red cells, when no red cell unit will be compatible on testing. When this occurs, the patient's sample will be sent to the Red Cell Reference laboratory for further evaluation. The Blood Center will phone the patient care area to inform the nurse or physician of a delay in obtaining units for transfusion in these instances.

Compatibility Testing - continued

The compatibility test is valid for three days after the blood sample is drawn. The validity of compatibility testing is limited to three days because the patient's antibody status may change after transfusion. If the physician determines that more transfusions are necessary after three days, a fresh sample must be drawn and a new Request for Blood and Blood Components form must be completed. For platelet, plasma, or cryoprecipitate orders, a new sample is not required.

"When Blood is Ordered" Chart



See next page for ABO-Rh compatibility table

ABO-Rh Compatibility Table

(does not apply to patients undergoing Hematopoietic Stem Cell or ABO Incompatible Solid Organ Transplantation; for these patients refer to your institution's policy)

Patient Type	Component to be Transfused and Permissible Donor Type								
	Whole Blood (available only for cardiac bypass patients < 2 years old)	Red Blood Cells	Fresh Frozen or Thawed Plasma	Single Donor Apheresis Platelets ^{1,2}		Pooled Platelets ^{1,2}		Cryoprecipitate ⁶	
				Full Volume or Reduced Volume ³	Reduced Volume Required ⁴	Full Volume or Reduced Volume ³	Reduced Volume Required ⁵		
	All Ages	All Ages	All Ages	All Ages	All Ages	≥ 2 Years Old	< 2 Years Old	≥ 2 Years Old	< 2 Years Old
O	O	O	Any Type	Any Type	n/a	Any Type	n/a	Any Type	Any Type
A	A	A O	A AB	A B AB	O	Any Type	O	Any Type	A AB
B	B	B O	B AB	Any Type	n/a	Any Type	n/a	Any Type	B AB
AB	AB ⁸	Any Type	AB	A B AB	O	Any Type	O	Any Type	AB
Rh Considerations for Blood and Components									
Rh Positive	Positive or Negative	Positive or Negative	Positive or Negative	Positive or Negative	Positive or Negative	Positive or Negative	Positive or Negative	Positive or Negative	Positive or Negative
Rh Negative	Negative ⁷	Negative ⁷	Positive or Negative	Negative ⁷	Negative ⁷	Negative ⁷	Negative ⁷	Positive or Negative	Positive or Negative

1. ABO identical platelets are preferable, if available.
2. In a life-threatening emergency, platelets will not be volume reduced, as this process requires additional time and would delay the issuing of the units.
3. Single Donor Apheresis platelets and Pooled platelets in these two columns will only be volume reduced when volume reduction is specifically ordered by the medical provider.
4. All Type O Single Donor Apheresis platelets issued to Type A or Type AB recipients will be issued volume reduced by the Blood Center. The only exception to this is during a life-threatening emergency; see item number 2 above.
5. Due to the small circulating blood volume of children < 2 years old, Type O pooled platelets administered to a Type A or Type AB recipient should be volume-reduced due to the relative amount of anti-A in the accompanying plasma.
6. Each individual unit of Cryo is suspended in approximately 20 mL of plasma. Cryoprecipitate is essentially red cell free and given without regard to ABO-Rh except when the patient is a child < 2 years old. Children < 2 years old are issued ABO compatible cryoprecipitate (i.e. the donor plasma in the unit is compatible with the recipient's blood type) because of the relative volume of anti-A and/or anti-B in the accompanying plasma.
7. Rh-positive red cells and platelets may be administered to Rh-negative patients who do not have anti-D without fear of immediate transfusion reaction. However, there is a risk that such patients will subsequently develop Rh sensitization. Therefore, such transfusions should be avoided in Rh-negative females with childbearing potential (< 50 years old) because of the risk of hemolytic disease of the newborn. When possible, Rh-negative males < 18 years old should also be transfused with Rh-negative cellular components. If the transfusion of Rh-positive platelets is unavoidable in an Rh-negative patient, Rh immune globulin (RhoGAM, WinRho) may be indicated to help prevent anti-D formation. If the transfusion of Rh-positive red blood cells is unavoidable in an Rh-negative female with childbearing potential, relatively extreme measures may be required in the attempt to prevent formation of anti-D. In both of these cases, consultation with a Blood Center physician is recommended.
8. Type AB Whole Blood is not available from the Blood Center.

Granulocyte Compatibility Chart

(does not apply to patients undergoing Hematopoietic Stem Cell or ABO Incompatible Solid Organ Transplantation; for these patients refer to your institution's policy)

Granulocyte Compatibility Chart	
Patient ABO/Rh	Acceptable Granulocyte Donor ABO/Rh
O	O
A	A O Reduced Volume
B	B, O
AB	AB, A, B O Reduced Volume
Rh Type	
Rh Positive	Rh Positive or Rh Negative
Rh Negative	Rh Negative

Part II: Transfusion Trigger

"Transfusion Trigger" - When to Transfuse

Along with the recent heightened public and professional concern over the risk of transfusion, interest in the appropriateness of transfusion practice has also increased. In the past, a hemoglobin value of 10 g/dl (hematocrit of approximately 30%) was considered the "transfusion trigger" or the point at which red blood cell transfusion was indicated. New research and information on risks of transfusion coupled with evidence of patient tolerance to much lower hemoglobin/hematocrit levels has prompted a change in the approach to ordering transfusions. Essential to a decision about transfusing red blood cells (or any component) is weighing the relative benefits against the relative risks of transfusion for an individual patient.

Red blood cell transfusions are indicated for patients in need of increased oxygen-carrying capacity. Designation of a universal hematocrit value which indicates the need for transfusion is not possible. The following issues must be considered when determining the appropriateness of transfusion:

- patient's age
- underlying condition
- symptoms resulting from tissue hypoxia
- the rate of change of the hematocrit

Symptoms that would indicate a need for increased oxygen carrying capacity include extreme fatigue, headache, dyspnea, angina and palpitations. It would be rare for a patient to require a transfusion with a hematocrit of 30% or above. Patients who are otherwise healthy can often tolerate hematocrits of 15-20% without serious adverse effects. Patients with cardiorespiratory or other significant disease may develop symptoms of tissue hypoxia when the hematocrit falls below 30%, but most patients do not develop such symptoms until the hematocrit falls below 25%. The cause of the anemia must also be considered. Moderate symptoms of tissue hypoxia may be tolerated temporarily without transfusion if the anemia can be rapidly reversed by using other specific therapy.

Each unit of red blood cells can be expected to raise the hematocrit approximately 3% in an adult patient. Therefore, once a decision is made to transfuse, the frequency and number of transfusions should be aimed at maintaining, but not greatly exceeding, the patient's required hematocrit. The objective is to keep the patient symptom-free with the least amount of transfusions and thus exposure risk.

Transfusion Trigger - continued

In patients with acute bleeding, orthostatic changes in blood pressure and pulse usually do not occur until approximately 20% of the blood volume has been lost. Shock will occur after a 30-40% loss of blood volume. If shock occurs, the immediate concern is to maintain tissue perfusion by replacing intravascular volume. This can be achieved mostly, if not entirely, by administration of crystalloid or colloid preparations such as 5% albumin. The decision to administer blood depends on the underlying condition of the patient, the rate of bleeding and the hematocrit. Most patients can tolerate hemodilution to a hematocrit in the low 20's. Thus, if the baseline hematocrit is normal, it is probably reasonable to begin blood administration after a loss of 30-40% of the blood volume.

Part III: Use of Autologous Blood

Use of Autologous Blood

Autologous blood is a patient's own blood that is collected for subsequent reinfusion. Although not completely risk free, autologous blood is the safest form of transfusion. Exclusive use of a patient's own blood eliminates reactions due to donor recipient incompatibility and precludes exposure to transfusion transmitted infection.

Types of Autologous Blood

Four categories of autologous transfusions are generally recognized:

1. Preoperative autologous blood storage: units of blood are drawn from a patient usually starting 3-5 weeks before an elective surgical procedure and stored for transfusion at the time of the surgery.
2. Intraoperative hemodilution: blood is collected at the start of surgery (most often prior to cardiopulmonary bypass surgery), the fluid volume lost is replaced with appropriate IV solutions, and finally, stored blood is reinfused after surgery.
3. Intraoperative salvage: blood is salvaged from the surgical field for reinfusion during or after the surgical procedure.
4. Postoperative salvage: blood is collected postoperatively by drainage of the operative site and reinfused.

The appropriateness of these procedures varies with the clinical situation. They can be used alone or in combination to reduce or eliminate the need for allogeneic (volunteer donor) blood.

Risks

Although autologous transfusion is the safest possible option for some patients, it is not completely risk free. Clerical errors and the administration of the wrong unit of blood could occur with autologous blood as well as with allogeneic blood (volunteer donor blood). The label on autologous blood must be matched to the patient identification band at the time of transfusion as with any other transfusion. The risk of transfusion-related volume overload may also be increased if autologous blood is indiscriminately transfused. Generally, the indications for transfusion of autologous blood should not vary greatly from those for allogeneic blood. The risk of a bacterially contaminated autologous unit is no less than that of an allogeneic unit. Febrile non-hemolytic transfusion reactions may occur with infusion of autologous units.

Use of Autologous Blood - continued

Ordering Autologous Blood

Preoperative autologous blood donation is generated by a physician order. Starting 3-5 weeks before the planned surgery, patients can store 2-6 units of autologous blood for transfusion. For more information about ordering or qualifying criteria see Ordering Blood Components (Section A, Part IV), or call the Blood Center Autologous Program at (206) 292-6588.

Part IV: Use of Directed Donor Blood

Use of Directed Donor Blood

The Blood Center's Directed Donation Program permits patients to select blood donors for planned or potential transfusion needs. The program is provided as a medical service to patients in the community, many of whom feel strongly that their selection of donors is likely to result in safer blood. The available evidence suggests the contrary, that, if anything, blood from directed donors is less safe than that from volunteer community donors. The safest blood continues to be autologous blood, and patients who are able to store autologous blood for their transfusion needs should do so in preference to requesting directed donations.

Risks

Infectious Disease Risk

There is currently no medical evidence that blood from directed donors is safer than blood from community volunteer donors. Most studies indicate that the risk of positive hepatitis markers is significantly higher in directed donors than in community volunteer donors. Directed donors may feel pressure to donate and may be reluctant to reveal high risk behavior or other medical history that would disqualify them as blood donors. They may incorrectly think that the risk associated with their behavior is small compared to that of a stranger or think testing is 100 percent effective.

Potential Compromise of Future Organ or Marrow Transplant

Transfusion from family members may result in alloimmunization to family antigens. If the patient were to subsequently develop a disease requiring organ or bone marrow transplantation, the suitability of a family member, otherwise matched as a transplant donor, might thus be compromised because of the patient's previous transfusion exposure.

Immune Effects

Transfusions have been reported to cause impairment of the immune system as shown, for example, by increased rates of post operative infection. There is evidence that these immunosuppressive effects may be greater when patients are transfused with blood from close relatives.

Potential Antibody Reactions

Adverse reactions from unexpected antibodies may be more likely to occur with transfusion of blood from parents to their children, particularly if the child is a newborn.

Use of Directed Donor Blood Risks — continued

Hemolytic Disease of the Newborn

Women of childbearing potential should not receive blood transfusions from their spouse or their children since the risk of hemolytic disease of the newborn in future pregnancies would be substantially increased.

Transfusion Associated Graft Versus Host Disease

The risk of graft versus host disease, a fatal complication of transfusion, is much higher with transfusion from a relative. The Blood Center irradiates all cellular directed donation components to prevent this complication.

Ordering Directed Donations

Directed donations must be ordered by a physician on a "Directed Donation Physician's Order" form. The patient must also sign a "Directed Donation Patient Consent" form. For additional information about ordering a directed donation see Ordering Blood Components (Section A, Part IV) or call (206) 292-6588.

Part V: Universal Precautions

Universal Precautions

All blood and blood products should be treated as if they are infectious. All disposable supplies contaminated or potentially contaminated with blood or blood components should be discarded into plastic lined biohazard containers to be incinerated or autoclaved. Needle/sharps biohazard containers should be puncture resistant. Spills of blood or blood components should be cleaned with detergent followed by a disinfectant such as a 10% bleach solution. Gloves must be worn for any contact with blood or components and evaluation of the need for masks, gowns and/or protective eye wear should be made in situations where splashing or aerosolization is possible.

Part VI: Blood Collection and Testing

Blood Collection and Testing

Each day, more than 800 volunteers from 14 Western Washington counties donate blood at the Blood Center's donation centers or at mobile blood drives sponsored by regional businesses, churches, schools and civic organizations. Hundreds of other volunteers give their time and energy to register donors or perform other tasks to assist at blood drives. The work and commitment of these volunteers helps the Blood Center provide lifesaving blood for the approximately 100,000 patients who need transfusions in our region each year.

Blood Center donors come from all walks of life. All donors are volunteers who are not paid or offered any incentive to donate. All potential donors must answer questions about their health to identify and exclude those at risk of transmitting infectious disease. Each donor must also pass an abbreviated physical exam before donating. Sterile equipment is used throughout the donation process. Most donations are separated into as many as three components to be transfused.

Before blood components are sent from the Blood Center to a hospital, each unit is tested for blood group (A, B, AB, or O) and Rh type (positive or negative) and blood group antibodies. Each unit of donated blood is tested for hepatitis B, hepatitis C, HIV I and II (the viruses that cause AIDS), HTLV-I (a virus associated with a rare form of leukemia), syphilis and West Nile virus (WNV). If any of these tests is positive, the unit is not used for transfusion. After blood is tested and the processing complete, components from units which have tested negative for infectious diseases are made available for distribution. Platelets are screened for bacterial contamination as these units must be stored without refrigeration to preserve the viability of the platelets. Apheresis platelets are screened using a culture method (BacT Alert). At the Hospital Blood Bank, whole blood derived platelets are screened using reagent strips to test for pH and glucose values.

The Blood Center operates the largest centralized transfusion service in the United States and provides compatibility and specialized component preparation services to all King County hospitals. Blood Center physicians offer consultation 24-hours a day to assist in care for bleeding patients. Specialized laboratories include hemostasis, platelet immunology, immunogenetics, red cell reference and virology.